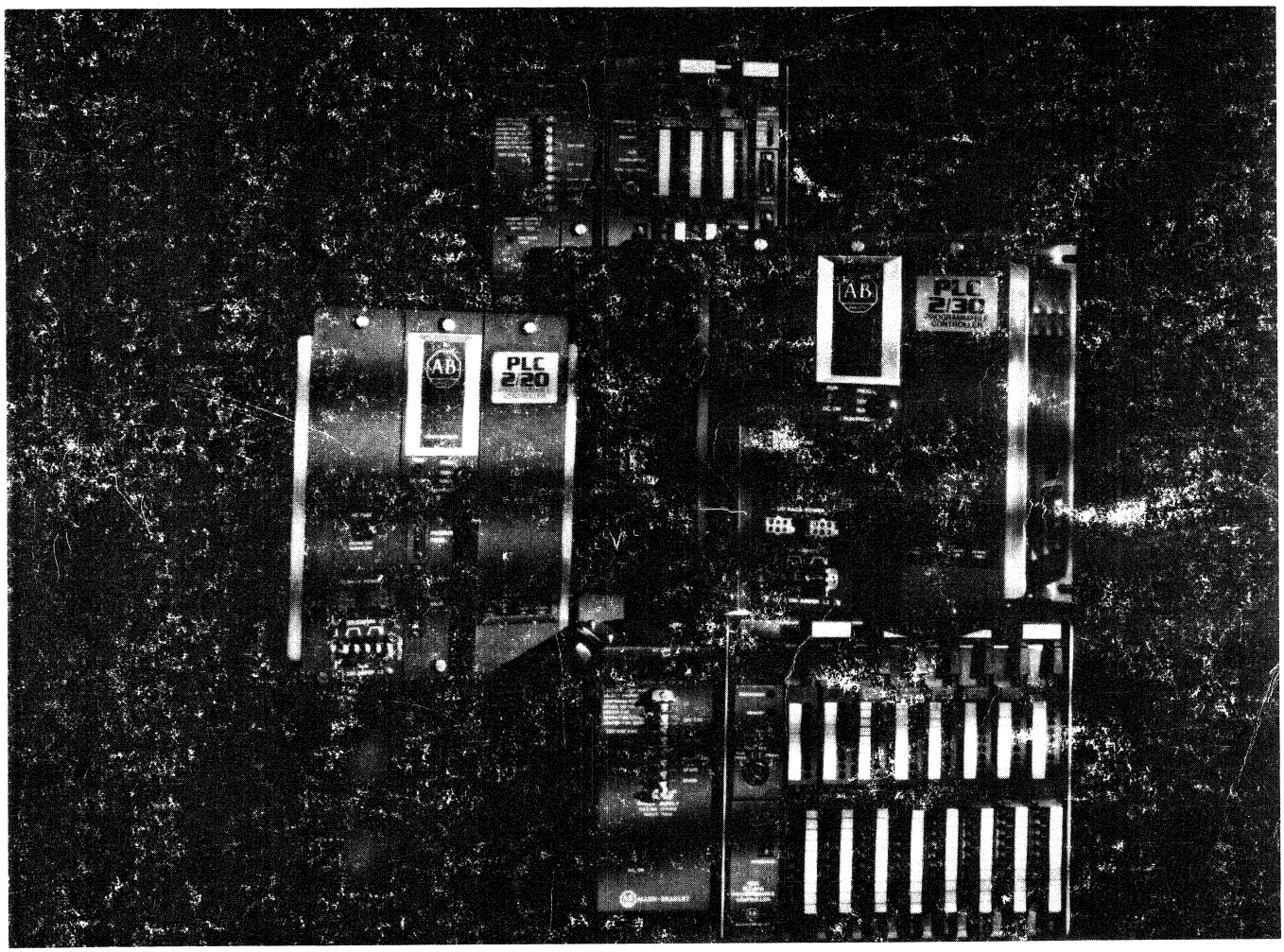
# 1772-801-1

## Bulletin 1772
# PLC-2 FAMILY PROGRAMMABLE CONTROLLER

## Support Documentation




ALLEN-BRADLEY

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# PLC-2 AND MINI-PLC-2 PROGRAMMABLE CONTROLLER

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# THE ORGANIZATION AND STRUCTURE OF THE MINI-PLC-2 MEMORY

**1.0 General** – This Publication is written for use with Mini-PLC-2 Processors having Cat. No. 1772-LN1, -LN2. It has two purposes:

- To serve as an introduction to the basic concepts and terminology necessary for a general understanding of the programmable controller memory.
- To detail the memory organization principles of the Allen-Bradley Bulletin 1772 Mini-PLC-2 programmable controller.

No attempt is made here to explain the solid state memory beyond what is necessary for an understanding of the Mini-PLC-2. (Fundamentals and detailed explanations have been published scores of times in literature easily available in a technical section of any library.)

**2.0 Bulletin 1772, Mini-PLC-2** – The memory of the Bulletin 1772 Mini-PLC-2 programmable controller is a read/write, low-power Complementary Metal Oxide Semiconductor (CMOS) type. These solid-state memory components, the support circuitry needed to store and retrieve information, and all Processor control circuitry are mounted on a pair of printed circuit boards. Two "D size" alkaline batteries provide battery back-up for the user program during power loss on the AC line or Power Supply shutdown.

**2.1 Basic Structural Units** – The memory of the Bulletin 1772 Mini-PLC-2 controller can be thought of as a large array of storage points, each of which is called a "bit." (Bit is an acronym for BInary digiT.) A bit is the smallest unit of information a memory is capable of retaining.

A group of bits form a single "byte." A byte is defined as the smallest complete **unit** of information that can be transmitted to or from the Processor at a given time.

In general, bytes are made up of varying numbers of bits, depending on the specific hardware requirements of the individual system. The Mini-PLC-2 byte is composed of 8 data bits and 1 parity bit.

A group of 18 bits make up a "word," or Mini-PLC-2 Instruction, which is to say 16 data bits and 2 parity bits. This word can also be thought of as being made up of two 9-bit bytes. (Mini-PLC-2 documentation generally does not discuss parity bits, since they are transparent to most users.)

In this and most other Mini-PLC-2 documents, the 16 data bits of the Mini-PLC-2 word are the subject of detailed discussion.

Because of its function in the memory, one word may also be thought of as a memory location: when a word is being used, an actual physical address in the memory is being accessed.

Note that in Mini-PLC-2 controller documentation it is a convention to show bits with the most significant digit (MSD) at the left and the least (LSD) at the right. Mini-PLC-2 bits are numbered 00 thru 07 and 10 thru 17. (Refer to Figure 1.)

**2.2 Memory Capacity** – The maximum memory configuration in the Mini-PLC-2 system is 1024 words, or 1K. However, two sizes are available. A 512-word memory on the Mini-Processor Module (Cat. No. 1772-LN1) is provided as standard with each Mini-PLC-2 controller. A 1024-word memory on another version of the Mini-Processor Module (Cat. No. 1772-LN2) is also available.

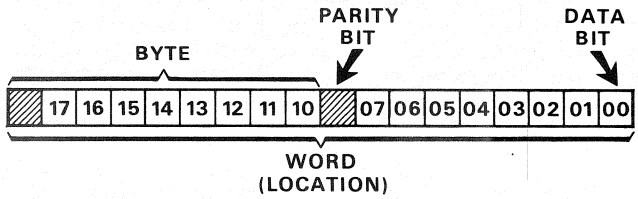



**Figure 1 – Mini-PLC-2 Word Structure**

Should a user desire to expand the smaller memory, this can also be done.

The entire memory is **not** available for user program. The first 128 words of the memory are set aside by the Processor for Data Table use. (An assumption is made here that the maximum number of words in the Timer and Counter areas has not been changed. Refer to Paragraph 2.3.1.6.)

This leaves 384 words for user program Instructions in the 512-word memory Mini-Processor Module. When a 1024-word memory Mini-Processor Module is used, a total of 896 words remain for user program Instructions.

**2.2.1 Data Entry** – The nature of the information stored in the memory is very simple: a bit is either energized or de-energized, ON or OFF. These states can be represented as "1" or "0". (Mini-PLC-2 literature does not use the equally common phrases "high-level voltage" and "low-level voltage.")

In order to store anything more complex than ON or OFF, groups of bits, in the form of a Mini-PLC-2 word, must be grouped together.

How are individual bits energized or de-energized, placed into the ON or OFF state, set to "1" or cleared to "0"? The state of the inputs from Mini-PLC-2 controlled devices determines the condition of some bits. User program logic changes the energized or de-energized state of other bits. Still others can be changed by the PLC-2 Program Panel (Cat. No. 1772-T1) or the Bulletin 1774 Program Panel (Cat. No. 1774-TA). (This second unit requires the use of the PLC/PLC-2 Program Panel Adapter, Cat. No. 1772-T4.)

There are other means of energizing and de-energizing bits, or entering data, but these require the use of one of the Program Panels as an intermediate device. A user-supplied RS-232-C compatible punched paper tape-reading device, such as the type provided on Teletype-writers, can be used to enter a program. (When the Bulletin 1774 Program Panel is used in this way, the Program Panel Adapter is also required.)

Another means of entering data is the Digital Cassette Recorder (Cat. No. 1770-SA) or the Digital Cassette Recorder System (Cat. No. 1774-T2) both of which can be used to load a program into memory. (It is also used to verify or copy a program previously entered.)

All of these devices are means with which data can be entered into the Mini-PLC-2 controller's memory.

**2.2.2 Ending A Program** – The Mini-PLC-2 controller does not require that an END (of program) Instruction be entered by the user after the last program Instruction. An END Instruction is generated by the Processor. It is present before any program steps are entered and is auto-

matically positioned after the last programmed Instruction, once program entry is begun. (An additional END Instruction can be entered, although its use is not mandatory.)

Starting with the first program Instruction, the Processor scans the program and executes all Instructions in the sequence called for by the program. The END Instruction stops the Processor from scanning unused memory, and, in effect, shortens the scan time by returning to the first Instruction of the user program.

In normal operation, an END Instruction is displayed on the Program Panel when the cursor is moved past the last user program Instruction. The END Instruction also appears before program steps are entered. When a user-supplied Teletypewriter or keyboard/printer is used, the END Instruction is also printed on the hardcopy printout. At the right of the END Instruction, a 3- or 4-digit number also appears. This number indicates the number of words in decimal actually entered into memory before the END Instruction. (Note that the size of the Data Table, usually 128 words, must be subtracted from the number displayed in order to determine the exact number of user program words.)

Should a user attempt to enter more Instructions than the maximum capacity of the available memory, the message ERR 1 is displayed on the Program Panel screen. Additional program Instructions cannot be entered.

Mini-PLC-2 Instructions take an average of 10 to 30 $\mu$sec for the Processor to scan and execute each word. The execution time for different Instructions varies considerably and is dependent on the exact Instruction and, in some cases, its TRUE/FALSE state.

A typical program using 1024 words of memory (including the Data Table) would have a scan time of approximately 25 msec, or nearly 40 scan cycles per second, assuming a distribution with approximately 75% of common Mini-PLC-2 Instructions such as Examine Input Open, Closed, Examine Output Open, etc.

**2.3 Memory Organization** – The Mini-PLC-2 memory can be divided into two major parts:

- Data Table
- User Program

All input/output status and user program Instructions are stored in one of these parts. Each of these is discussed in subsequent paragraphs. (Refer to Figure 2.)

**2.3.1 Data Table** – As was stated earlier, the Data Table area of the Mini-PLC-2 memory is not available to store user program Instructions. Data Table words, and/or 16 bits in each word, are controlled and utilized directly by the Processor.

The Processor **does not** directly control Instructions in the user program. User program Instructions are repeatedly and sequentially scanned and executed by the Processor according to the control logic established in the user program. The input devices wired to Input Module Field Wiring Arms and the user-written application program directly control output instructions.

The Processor automatically reserves the first $128_{10}$ words in the first Memory Segment for use as the Data Table. A user has the option of reducing the size of the Data Table to a minimum of $48_{10}$ words. (Refer to Paragraph 2.3.1.6.)

The Data Table in the Mini-PLC-2 system can be divided into eight distinct areas:

- Processor Work Area No. 1
- Output Image Table
- Bit/Word Storage Area
- Timer and Counter Accumulated Values, or bit and word storage
- Processor Work Area No. 2
- Input Image Table
- Timer and Counter Preset Values, or bit and word storage
- Bit/Word Storage Area

These Data Table areas are discussed in following paragraphs: Output Image Table in Paragraph 2.3.1.1; Input Image Table in Paragraph 2.3.1.2; Timer and Counter Accumulated Values in Paragraph 2.3.1.3; Timer and Counter Preset Values in Paragraph 2.3.1.4; Bit/Word Storage areas are covered in Paragraph 2.3.1.5; both Processor Work Areas in Paragraph 2.3.1.6.

The function of the Data Table may be explained in relation to inputs and outputs. The Mini-PLC-2 input and output modules cannot store information; they contain interface circuits only. Information in the form of input/output status (ON/OFF) is stored in the memory in areas called Image Tables. (An image is defined as an exact duplicate array of information – that is, the states – stored in a different medium.) The following paragraphs discuss the Mini-PLC-2 Image Tables.

**2.3.1.1 Output Image Table** – The function of the Output Image Table in the Mini-PLC-2 controller is to primarily control the status of outputs wired from the output modules. If a bit in the Output Image Table is set ON, its corresponding output is ON. If a bit is cleared to OFF, its corresponding output is OFF. These bits are controlled by Instructions in the user's program.

The Processor controls the status bits in the Output Image Table as it generates output commands by interpreting Instructions from the user program. (The user program is stored in another portion of the memory.) Actual hardware outputs change state only if corresponding bits in the Output Image Table change state.

The Output Image Table begins with word $010_8$ and ends with word $017_8$ [1] (Refer to Figure 2.) The Output Image Table therefore contains $8_{10}$ word addresses, or $128_{10}$ bit addresses. These $128_{10}$ bits represent the maximum number of outputs the Mini-PLC-2 controller can control, although no actual system would ever be configured for outputs exclusively.

Each bit in the Output Image Table may be associated with a terminal address, although this is not always the case. (See next paragraph.) If it is however, the terminal address is the **same** as the bit address.

A secondary function of the Output Image Table is to contain storage bits. Words, or individual bits in them, not actually used to store the ON/OFF status of devices can be used for data storage.

**2.3.1.2 Input Image Table** – The single function of the Input Image Table is to duplicate the status of the inputs wired to input modules. If an input is ON, its corresponding Input Image Table bit is set ON. If an input is OFF, its corresponding bit in memory is cleared to OFF. These bits are monitored by Instructions in the user program.

The Input Image Table is constantly changing to correspond to the information supplied through the input modules.

The Input Image Table is bound by word addresses $110_8$ to $117_8$. (Refer to Figure 2.) This area contains $8_{10}$ word addresses, or $128_{10}$ bit addresses. These $128_{10}$ bit ad-

[1] The subscript 8 indicates that an octal numbering system is being used. Thus no numbers larger than 7 are used. Counting begins at 0. The subscript 10 indicates that a decimal numbering system is being used. The decimal numbering system, being most common, is implied if no subscript is used.

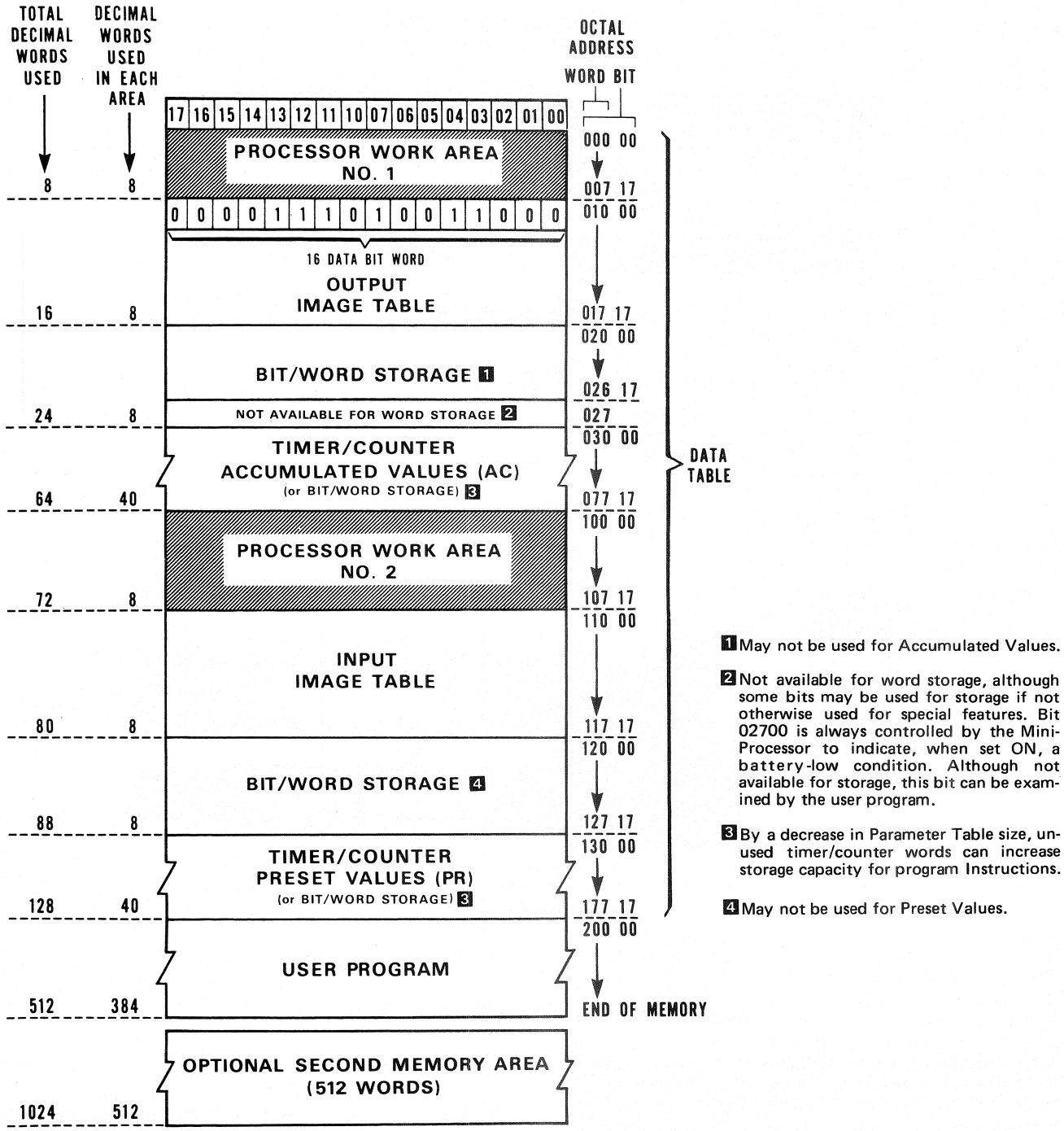



**Figure 2 – Mini-PLC-2 Memory Organization**

dresses represent the maximum number of inputs the Mini-PLC-2 controller can monitor, although no actual system would ever be configured for inputs exclusively.

Note however, in a single PLC-2 controller, the **total bits used**, which represent actual hardware inputs and outputs, **together cannot** exceed $128_{10}$. This figure represents the maximum I/O capability of the Mini-PLC-2 controller, and is equivalent to 16 I/O modules.

Each bit in the Input Image Table may have a corresponding real terminal on the I/O Rack associated with it, although this may not always be the case, since a corresponding Input Module may not be assigned. If it does, the terminal address is the same as the bit address. The correspondence between the two is illustrated in Figure 3.

Note that the Input Image Table **cannot** be used for bit stores.

**2.3.1.3 AC, Stores** – This area of the memory is used to store Accumulated Values of Timers and Counters internal to the controller and, if needed, internal storage words and bits.

Word addresses $030_8$ to $077_8$ bound this area. (Refer to Figure 2.) There are enough memory locations here for 40 internal Timers and/or Counters. Note that each Timer or Counter used actually requires that two words of memory be reserved: one from the ACcumulated Value area and the other from the PReset Value area ($130_8$ to $177_8$).

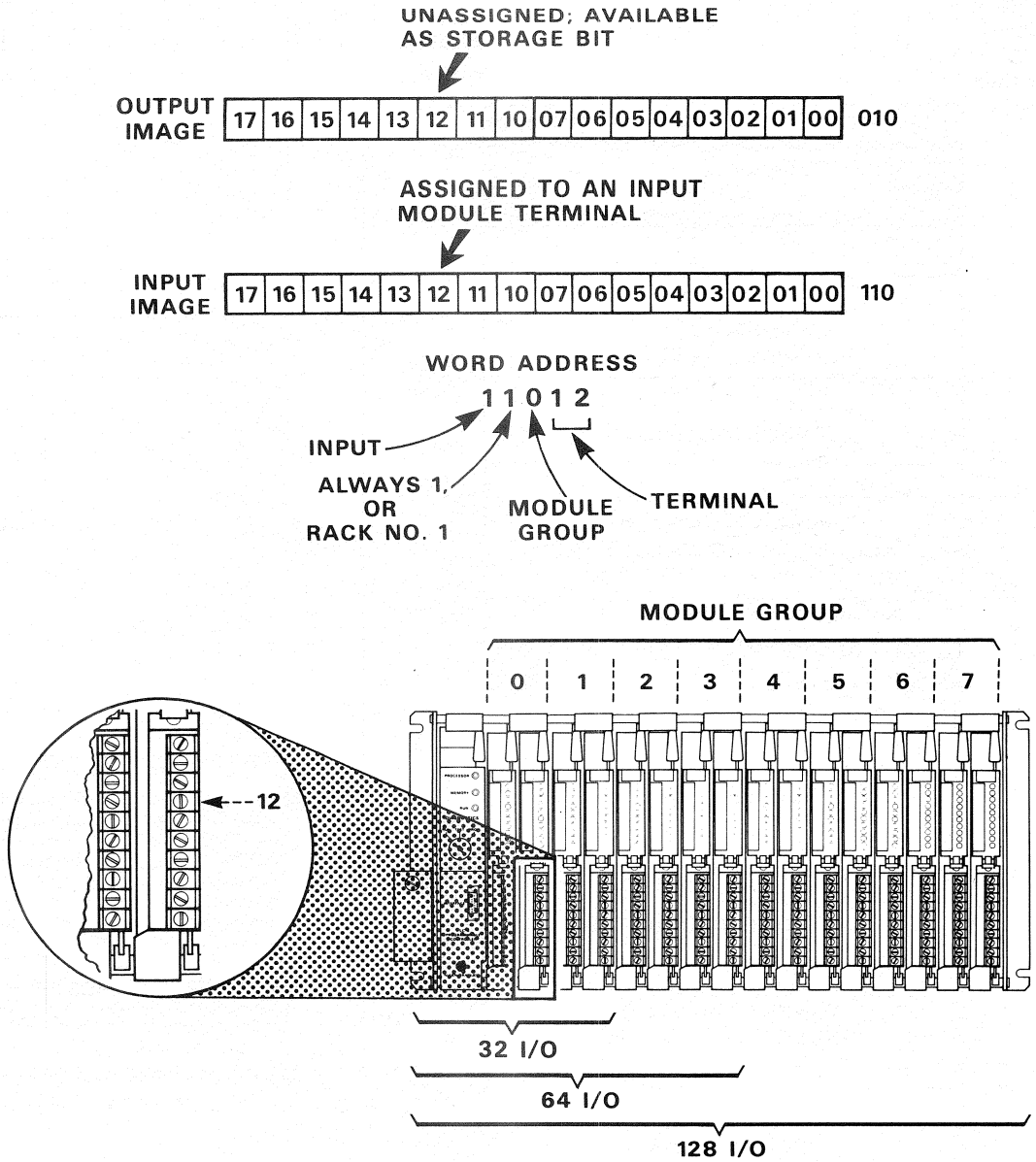



**Figure 3 – Relation of Word Address to Hardware**

**2.3.1.4 PR, Stores** – The last area of the Data Table is used for PReset Values of Timers and Counters and/or internal storage. It occupies word address $130_8$ to $177_8$.

**2.3.1.5 Bit/Word Storage** – There are two additional Bit/Word Storage areas. The first is located at addresses $020_8$ to $027_8$, and the second at $120_8$ to $127_8$. (Refer to Figure 2.) These memory locations are available for single bit and also for word (all 16 bits of an octal address) storage. Timer and Counter Instructions **cannot** be given addresses from the Bit/Word Storage areas.

**2.3.1.6 Processor Work Areas** – There are two Processor Work Areas: Processor Work Area No. 1 (addresses $000_8$ to $007_8$) and Processor Work Area No. 2 (addresses $100_8$ to $107_8$). (Refer to Figure 2.) These memory locations **cannot** be accessed by the user. Their word addresses are **not** available for addressing of any kind. The Processor uses both Areas to establish the number of words in the Timer/Counter, Stores Areas of the Data Table, in addition to other internal control functions.

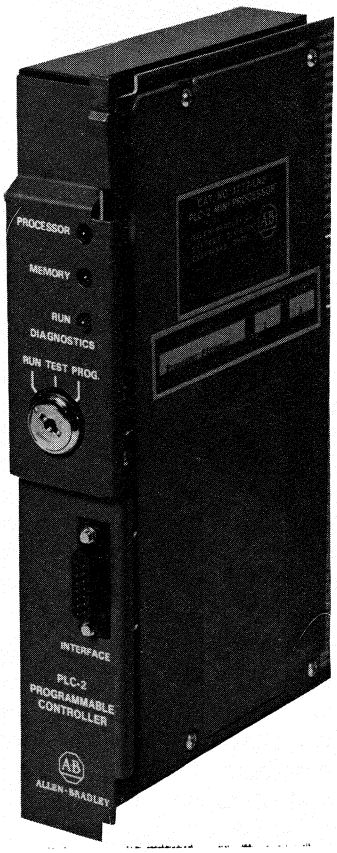
Through programming techniques the user may optionally reduce the size of the Timer/Counter, Stores Areas from 80 words to a minimum of 0 words to make additional space available for user program Instructions. Changing the number of words in this Area to a minimum condition of 0 words reduces the Data Table to 48 words. (The memory locations in both Areas being reduced must not be occupied with PReset and ACcumulated Values or bit stores. If the memory locations are occupied with either PReset, ACcumulated Values or bit stores, the attempt to reduce the size of the Timer/Counter Stores will abort.)

Once reduced, these memory locations cannot be addressed by the user program.

**2.3.2 User Program** – Following word address $177_8$ the user program begins. (Refer to Figure 2.) All user program Instructions are stored in this area as groups of energized and de-energized bits. Each word in the user program area of the memory is capable of storing only one user program Instruction.

# MINI-PROCESSOR MODULE

## Cat. No. 1772-LN2, -LN3




### SPECIFICATIONS

**Location**
Bulletin 1771 I/O Chassis
Left-Most Slot

**Input Voltage**
(Supplied by System Power Supply)
+5.1V DC (logic)
+5V DC (memory)

**Memory Size**
1024 words

**Data Table Size**
128 words (max.)

**Memory Word Length**
16 data bits plus 2 parity bits
1 parity bit and 8 data bits per byte

### DESCRIPTION

The control processing unit and memory of the Bulletin 1772 Mini-PLC-2 Programmable Controller is the Mini-Processor Module (Cat. No. 1772-LN2 or -LN3). The Mini-Processor examines data from input devices wired into the input/output (I/O) structure. It compares this data to the user-entered control program and, subsequently, generates logic commands which, through output modules, control a wide variety of user-supplied output devices. In addition to energizing or de-energizing outputs, the Mini-Processor can perform timing and counting functions, data comparison and transfers, and arithmetic operations.

The Mini-Processor Module monitors the status of its own operation, of data in memory, and of power from the System Power Supply. Orderly shutdown is provided to protect the user's application if a malfunction from any of these points is detected. Visual indicators illuminate to show that the Controller is operating normally or that a malfunction has been detected.

### FEATURES

The Mini-Processor Module gives the Mini-PLC-2 Programmable Controller the capability to monitor and control a maximum of 128 I/O devices. Its small size allows installation of an entire Programmable Controller—Mini-Processor, I/O interfacing, and power supply circuitry—within an enclosure of 8-inch working depth.

The Mini-Processor Module has these additional features:

- Programmed in ladder-diagram format
- Up to 40 internal timers and counters
- Timers programmable for 1.0-, 0.1- and 0.01-second time-bases
- Unused timer/counter memory areas can be used to increase storage capacity for instructions
- 16 full words of memory exclusively for bit or word storage
- Diagnostic indicators for ease of troubleshooting
- Ability to compare values in the user's application
- Battery backup for memory contents
- Programmable response to low-battery condition.

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Supersedes Publication 1772-701 Dated May, 1979

The Mini-Processor Module is compatible with the Industrial Terminal System and Program Panels used with Bulletin 1774 PLC and Bulletin 1772 PLC-2 Programmable Controllers. This makes these troubleshooting features available:

- Ability to examine ON/OFF status of input or output devices from a central monitoring room or at the Controller
- FORCED I/O function, which allows the user to change the ON/OFF status of individual bits in memory during operation
- On-line data change which allows the user to alter values in the Mini-Processor memory during operation

These programming terminals also allow interfacing with several different types of RS-232-C compatible data terminals. This allows these additional capabilities:

- Printout of the user's program in ladder-diagram format
- Programmable Report Generation
- Contact Histogram, which displays the time, in seconds, that an input or output device is ON or OFF
- Loading/recording of the user program onto magnetic or punched tape

## MEMORY

The memory size of the Mini-Processor Module (both Cat. No. 1772-LN2 and -LN3) is 1K (1024) words. The user memory is composed of two parts: Data Table and user program area. The Data Table contains all input/output device status information and values for timers, counters, arithmetic results, analog-to-digital conversions, and constants for comparison. The user program area contains all user-entered program instructions to the Mini-Processor Module.

The Data Table is normally 128 words in length; the remainder of the memory area, 896 words, is available for program storage. However, the Data Table can be shortened to allow more area for user instructions. Up to 80 additional instructions can be entered by shortening Data Table length.

Knowledge of the memory structure of the Mini-Processor is essential to an understanding of programming. Refer to Publication 1772-700, The Organization and Structure of the Mini-PLC-2 Memory, for information on this subject.

## MODES OF OPERATION

On the front face of the Mini-Processor Module is a 3-position keylock switch. (Refer to Figure 1.) This switch permits selection of 3 operating modes:

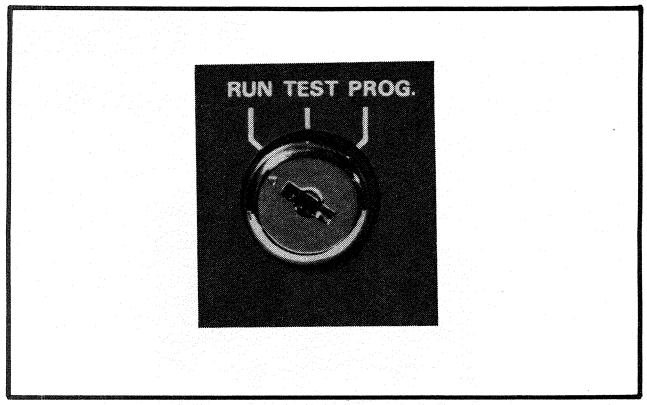



**FIGURE 1 — Mode Select Switch**

- PROG - In the PROGRAM mode, the user enters his instructions into the Mini-Processor Module. Instructions are entered either directly from the Industrial Terminal or Program Panel keyboard, from a punched tape reader, or from the Digital Cassette Recorder (Cat. No. 1770-SA), connected through a programming terminal. Outputs are disabled in this switch position.
- TEST - In the TEST mode, the user's program can be tested and Controller behavior may be observed under simulated operating conditions. This allows preliminary de-bugging of a program without risking damage to controlled equipment or to personnel. Outputs are disabled in this switch position.
- RUN - In the RUN mode, the Mini-Processor scans and executes the user's program. Outputs are energized according to the user's program.

  This is the only position that allows removal of the Mode Select Switch key.

## DIAGNOSTICS

The Mini-Processor Module has diagnostic circuitry which continuously monitors its operation. Indicators on the front of the Mini-Processor show the status of its operation and of these self-checking diagnostic routines. (Refer to Figure 2.) These indicators are:

- PROCESSOR - This red indicator illuminates if the Processor is unable to scan the user's program and Data Table in memory. It is normally OFF.
- MEMORY - This red indicator illuminates if the Mini-Processor detects no user memory, a discrepancy in memory data or a parity error. It is normally OFF.

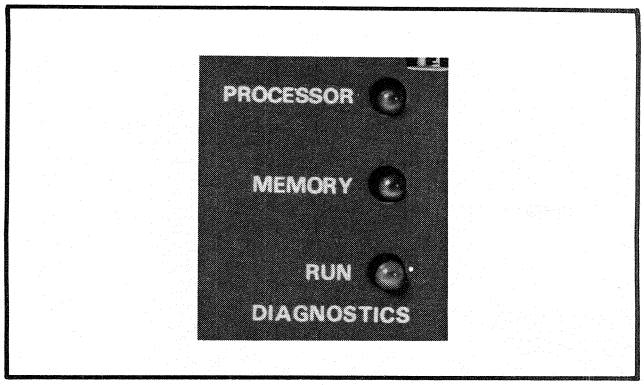



**FIGURE 2 — Diagnostic Indicators**

- RUN - This green indicator illuminates when the Mini-Processor is operating with the Mode Select Switch in the RUN mode and outputs enabled.

## PROGRAMMING

To perform its control function, the Mini-Processor Module requires a user-written program. A program is simply a listing of things to be done, in the order they are to be done, under the conditions they are to be done.

Programming the Mini-Processor Module is relatively simple and straightforward. The user enters his program by pressing keys on the Industrial Terminal or Program Panel in the proper sequence. The programming terminal automatically sets up the user's instructions in ladder-diagram format.

Ladder-diagram format is easily readable and, because it is patterned after relay logic, is designed to be readily learned by maintenance and controls personnel.

### PROGRAMMING TERMINALS

Programming terminals compatible with the Mini-Processor Module are:

- Industrial Terminal System (Cat. No. 1770-T1, -T2)
- Bulletin 1772 PLC-2 Program Panel System (Cat. No. 1772-T1)
- Bulletin 1774 PLC Program Panel (Cat. No. 1774-TA, -TH) which must be used with the PLC/PLC-2 Program Panel Adapter (Cat. No. 1772-T4)

Figure 3 shows the Industrial Terminal System. Figure 4 shows the PLC-2 Program Panel System.

Programming terminal connection is made to the INTERFACE socket on the front of the Mini-Processor. Figures 5 and 6 show these connections for

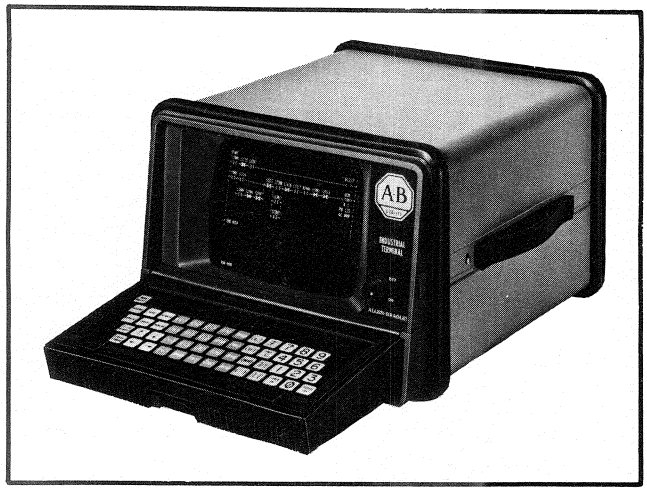


**FIGURE 3 — Industrial Terminal System**

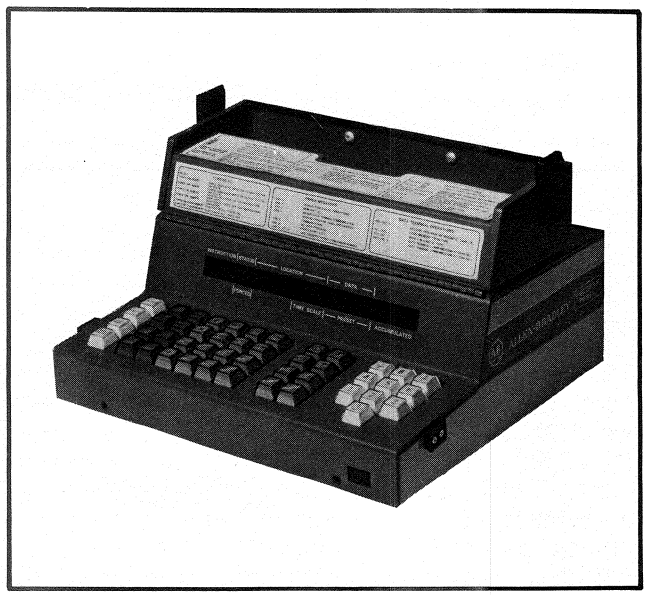


**FIGURE 4 — PLC-2 Program Panel System**

the Industrial Terminal and PLC-2 Program Panel. To make this connection, use the Program Panel Interconnect Cable (Cat. No. 1772-TC).

At the Industrial Terminal, this Cable connects to the socket labeled Channel A PLC-2. At the PLC-2 Program Panel, this Cable then connects to the socket labeled PROCESSOR.

Should the Bulletin 1774 Program Panel be used, connect it to the PLC/PLC-2 Program Panel Adapter, using the PLC/PLC-2 Program Panel Adapter Cable (Cat. No. 1772-TR). This Cable runs from the PROCESSOR socket on the back of the PLC Program Panel to the socket labeled PLC PROGRAM PANEL on the Program Panel Adapter. The Pro-

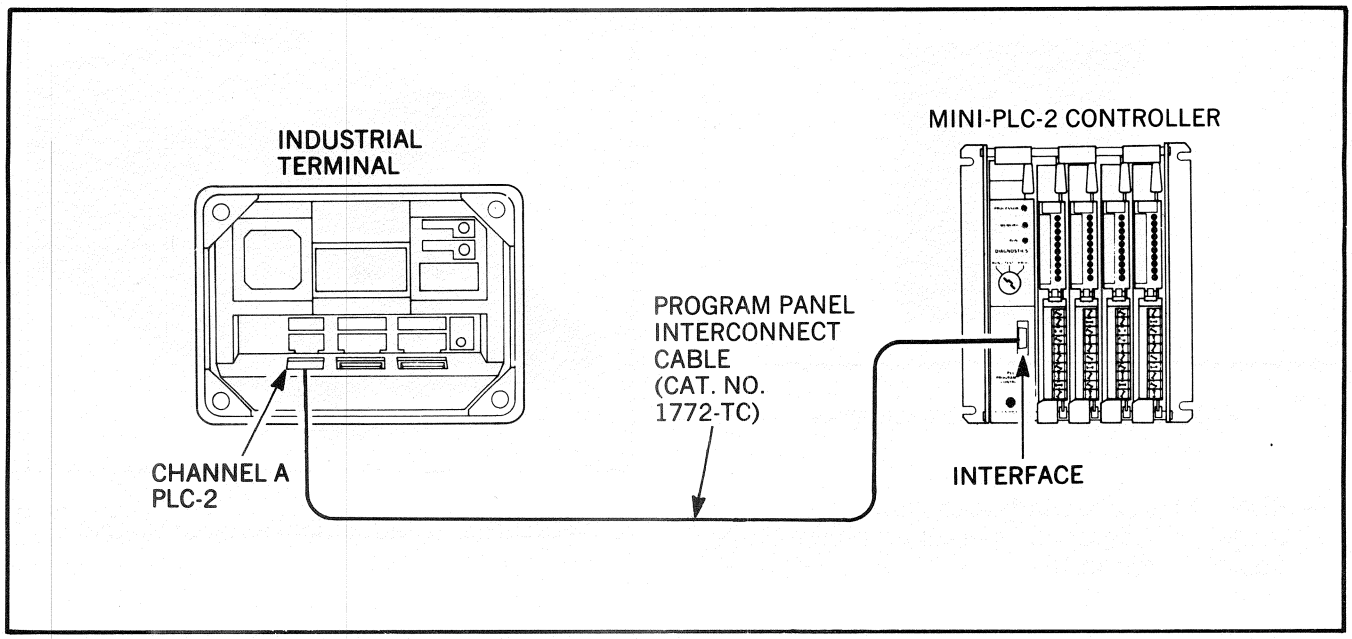



**FIGURE 5 — Connection to Industrial Terminal**

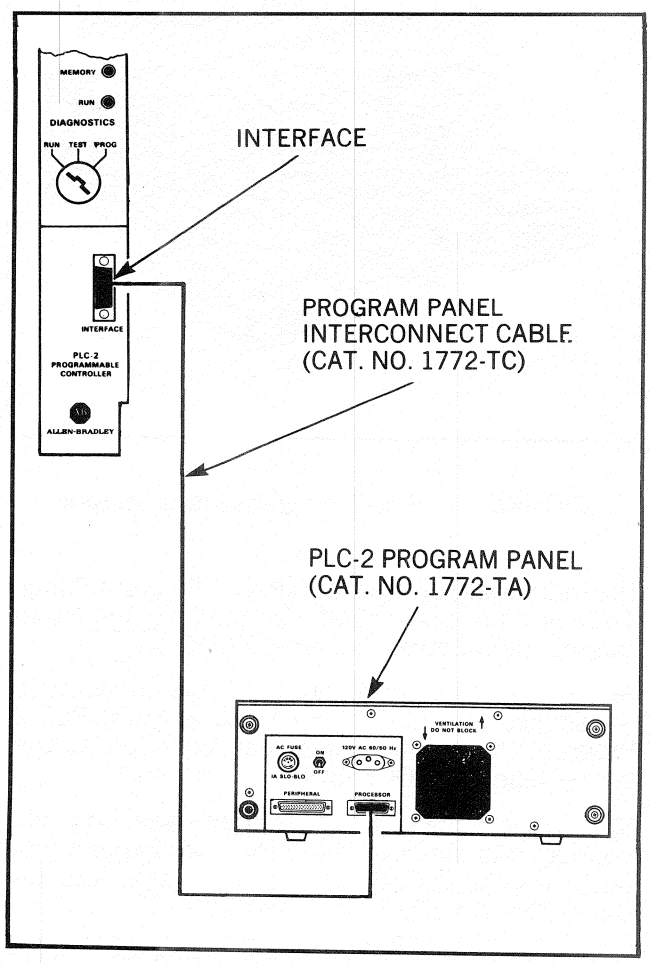



**FIGURE 6 — PLC-2 Program Panel Connection**

gram Panel Interconnect Cable (Cat. No. 1772-TC) then connects from the socket labeled PROCESSOR on the PLC/PLC-2 Program Panel Adapter to the socket labeled INTERFACE on the Mini-Processor.

## KEYBOARD LAYOUT

Programming terminal keys are grouped for ease of identification and use. (The Industrial Terminal keyboard layout is shown in Figure 7.) The keys labeled "Instructions" are used with the "Numerics" to enter the user's program to the Mini-Processor Module. Other keys control editing and other operating functions of the programming terminal.

NOTE: The PLC-2 Program Panel or PLC/PLC-2 Adapter must be Series B, or later, to provide the following functions:

- Contact Histogram
- Report Generation
- 0.01-second timer time base
- GET BYTE/LIMIT TEST Instructions

Program Panels prior to Series B provide the other programming functions listed in this Publication.

Series B, or later, Program Panels and Adapters display Series and Revision level upon power-up. With the PLC-2 Program Panel, a numerical equivalent message, such as STA 2.1, appears upon power-up. (In this message, 1 means A, 2 means B, etc.) With the PLC Program Panel, the CRT will display Series and Revision levels in this form:

READY (SER.B/REV.A)

Earlier Program Panels do not display Series/Revision levels.

## INSTRUCTION SET

The control capability of the Mini-Processor Module is best illustrated by its instruction set. Instructions which can be used to program the Mini-Processor Module can be divided into these basic groups:

- Relay-type
- Timers and Counters
- Data Manipulation

### RELAY-TYPE INSTRUCTIONS

Programmable controllers are used in many applications for replacement of relays. The Relay-type instructions give the Mini-Processor Module the capability to perform most of the functions available with hard-wired relays.

The Relay-type instructions are listed in Table A.

### TIMER AND COUNTER INSTRUCTIONS

The Mini-Processor Module makes available up to 40 internal timers and/or counters. These versatile operations are accessed by simple programming techniques.

Timers can be used in many applications where measurement of specific time intervals is important. Timers can be individually set for 1.0-, 0.1-, and 0.01-second time-bases.

Counters allow the Mini-Processor Module to keep track of a repetitive cycle or process. Each counter is capable of 999 counts. A higher count can be reached by "cascading" counters. Counting may be either up or down.

Timer and Counter instructions are shown in Table B.

### DATA MANIPULATION INSTRUCTIONS

Data from the user's application, such as the ON/OFF status of I/O devices or timer/counter values, is stored in the Mini-Processor memory. Data Manipulation instructions access a complete group (8 or 16 bits) of memory data, perform an operation with this data, and provide a usable result for program use. Such data may include timer or counter accumulated values, tolerance values selected in the user's program, or values inputted through a thumbwheel switch or similar device.

The Data Manipulation instructions give the user many advantages over the use of relays or discrete

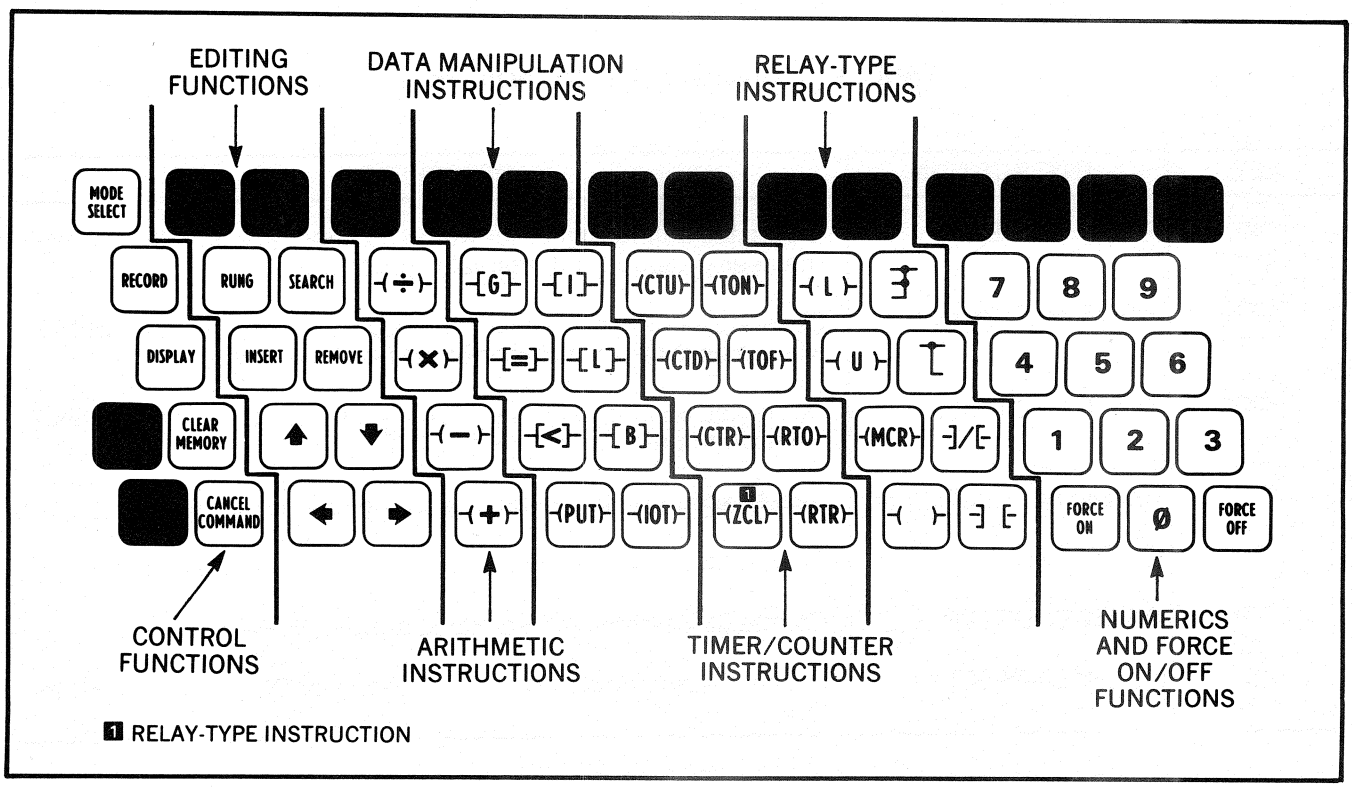



**FIGURE 7 — Industrial Terminal Keyboard (for use with Mini-PLC-2 Controller)**

**TABLE A — Relay-Type Instructions**

| KEY | INSTRUCTION | DESCRIPTION |
|---|---|---|
| ⊣ ⊢ | EXAMINE ON | Examine an input terminal for an energized (ON) condition. |
| ⊣/⊢ | EXAMINE OFF | Examine an output terminal for a de-energized (OFF) condition. |
| ⊣( )⊢ | OUTPUT ENERGIZE | Energize an output terminal if preceding conditions are TRUE. |
| ⊣(L)⊢ | OUTPUT LATCH | Energize an output terminal if preceding conditions are TRUE and keep it energized until an unlatch is programmed. |
| ⊣(U)⊢ | OUTPUT UNLATCH | De-energize a latched output when preceding conditions are TRUE. |
| ⊤ | BRANCH START | Program parallel logic paths (OR-logic) similar to those available with relay logic. |
| ⊥ | BRANCH END | |
| ⊣(MCR)⊢ ⊣(ZCL)⊢ | MASTER CONTROL/ ZONE CONTROL | Isolate a block of user program and specify output behavior under certain overriding conditions. |

**TABLE B — Timer and Counter Instructions**

| KEY | INSTRUCTION | DESCRIPTION |
|---|---|---|
| ⊣(TON)⊢ | TIMER ON-DELAY | Dedicates an internal timer which can energize an output when the user-programmed interval is timed out. |
| ⊣(TOF)⊢ | TIMER OFF-DELAY | Dedicates an internal timer which can de-energize an output when a user-programmed interval has timed out. |
| ⊣(RTO)⊢ | RETENTIVE TIMER | Dedicates an internal timer which retains its accumulated value even when preconditions are FALSE. |
| ⊣(RTR)⊢ | RETENTIVE TIMER RESET | Resets accumulated value of a retentive timer to zero. |
| ⊣(CTU)⊢ | UP-COUNTER | Counts up to 999 selected events in the user's application. |
| ⊣(CTD)⊢ | DOWN-COUNTER | Counts down from a preset value of up to 999. |
| ⊣(CTR)⊢ | COUNTER RESET | Resets the accumulated value of an UP- or DOWN-COUNTER to 000. |

timers or counters. Some of the more exceptional advantages include the following:

- Preset timer/counter values can be changed during operation of the Mini-Processor in order to allow an application or process to be speeded up, slowed, or modified with respect to quantity by supervisory personnel.
- Accumulated timer/counter values may be displayed or reported at a selected location, thereby allowing easy readability and instant reporting of conditions.
- Comparison of timer/counter values with a selected limit or another timer/counter value. This permits control of a process within certain tolerances determined by the user.
- Arithmetic operations using values chosen by the user. This allows the Mini-Processor to adapt to varying operation parameters.

The 3 types of Data Manipulation instructions are listed in Table C.

## BLOCK TRANSFER

To these programming capabilities, the Cat. No. 1772-LN3 Mini-Processor Module adds Block Transfer communication capability. This powerful feature enables bidirectional data transfer between the Mini-Processor and microprocessor-based I/O modules, such as analog I/O, thermocouple input, and position-sensing and control modules. Block Transfer capability both simplifies programming for communication with these modules and speeds data transfer between them and the Mini-Processor.

**TABLE C — Data Manipulation Instructions**

| KEY | INSTRUCTION | DESCRIPTION |
|---|---|---|
| | **Transfer** | |
| -[G]- | GET | Accesses a specified 16-bit memory word for a subsequent operation. |
| -(PUT)- | PUT | Transfers a 16-bit memory word to a location in memory specified by the PUT Instruction (retentive). |
| -[B]- | GET BYTE | Accesses one byte (8 bits) for subsequent comparison. |
| -[I]- -(IOT)- | IMMEDIATE I/O | Immediately updates 1 word of selected input or output data before normal I/O scan. |
| | **Comparison** | |
| -[<]- | LESS THAN | Compares BCD values from specified memory locations for "less than" relationship. |
| -[=]- | EQUAL TO | Compares BCD values from specified memory locations for equality. |
| -[L]- | LIMIT TEST | Compares one byte (8 bits) with upper and lower limit values chosen by the user for the specific application. |
| | **Arithmetic** | |
| -(+)- | ADD | Performs addition with 2 selected values. |
| -(−)- | SUBTRACT | Performs subtraction with 2 selected values. |
| -(×)- | MULTIPLY | Performs multiplication with 2 selected values. (Cat. No. 1772-LN3 Module only) |
| -(÷)- | DIVIDE | Performs division with 2 selected values (Cat. No. 1772-LN3 Module only) |

## CONTROLLER STRUCTURE

The Mini-Processor Module is the controlling logic component of the Mini-PLC-2 Programmable Controller. A knowledge of the hardware structure of the complete Mini-PLC-2 Controller aids in understanding the function of the Mini-Processor.

The Mini-PLC-2 Programmable Controller is composed of a Mini-Processor Module and the following Bulletin 1771 equipment:

- 1 I/O Chassis (Cat. No. 1771-A1, -A2, or -A4)
- A number of I/O modules
- 1 System Power Supply (Cat. No. 1771-P1)

A complete Mini-PLC-2 Programmable Controller is shown in Figure 8.

The Bulletin 1771 equipment used with the Mini-Processor Module must be specified and ordered separately. The following Paragraphs give a general description of each of these Bulletin 1771 units and show its relationship to the Mini-Processor Module.

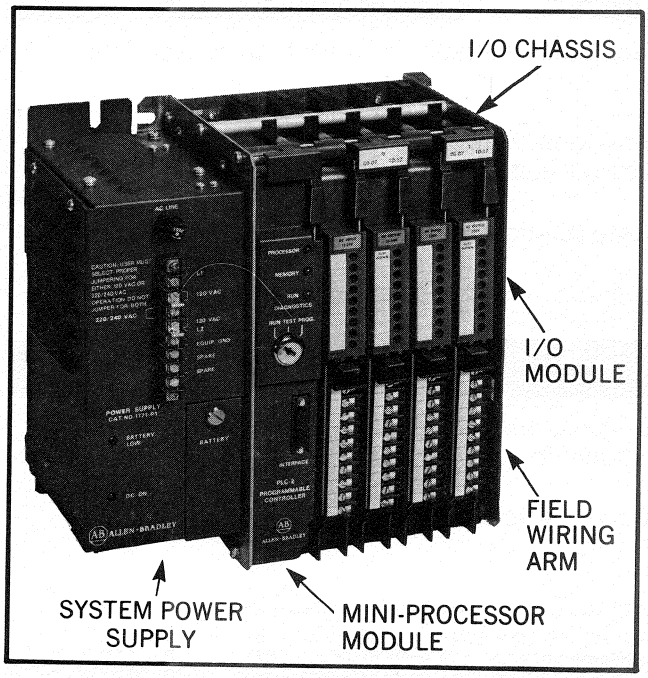



**FIGURE 8 — Mini-PLC-2 Programmable Controller**

### I/O CHASSIS

All modules which make up a Mini-PLC-2 Programmable Controller fit into one compact I/O Chassis. Slots in the I/O Chassis guide modules into connectors on the Chassis backplane. For the Mini-PLC-2 Controller, the left-most I/O Chassis slot must contain the Mini-Processor Module. All other I/O Chassis slots hold I/O modules.

There are 3 I/O Chassis sizes, distinguished by I/O module capacity. These sizes are:

- 32-I/O (Cat. No. 1771-A1) which contains 4 I/O Module slots
- 64-I/O (Cat. No. 1771-A2) which contains 8 I/O Module slots
- 128-I/O (Cat. No. 1771-A4) which contains 16 I/O Module slots

The Mini-PLC-2 Controller shown in Figure 8 uses a 32-I/O Chassis.

The I/O Chassis has a socket for Power Supply conection. It also has a Switch Group Assembly, which requires setting by the user. (Refer to LAST-STATE SWITCH.)

The I/O Chassis is shipped with one Field Wiring Arm (Cat. No. 1771-WA) for each I/O module slot. These Wiring Arms are used with most AC and DC I/O Modules. (When required, a different Wiring Arm is shipped with some Module assemblies.)

The Bulletin 1771 I/O Chassis allows convenient expansion of a Mini-PLC-2 Programmable Controller. If a Mini-Processor Module is used with a 32-I/O or 64-I/O Chassis and more interfacing capability is needed, a larger I/O Chassis may be installed. Rewiring of devices is not necessary, since Field Wiring Arms, with all wiring intact, can be removed from the smaller Chassis and snapped onto corresponding positions on the larger Chassis. In addition, when Wiring Arms and I/O modules are placed in exactly corresponding slots, the original programming addresses of user I/O devices need not be changed.

### KEYING

A package of plastic keying bands is provided as standard with the I/O Chassis. These bands provide the user with a convenient method to assure that only one type of module is seated into a specific slot of the Bulletin 1771 I/O Chassis.

The Mini-Processor Module is slotted in 2 places at the rear edge. Positioning of keying bands on the backplane connector must correspond to these slots to allow insertion of this Module.

Needle-nosed pliers may be used to insert keying bands onto the upper 56-terminal backplane connector. Bands are positioned on the connector in the area between the numbers to the right of the connector. For the Mini-Processor Module, position

bands in these two locations on the upper backplane connector:

- Between 40 and 42
- Between 54 and 56

Refer to Figure 9.

Keying information for I/O modules is included in literature for each module. Keying bands may be repositioned by the user if later system change is required.

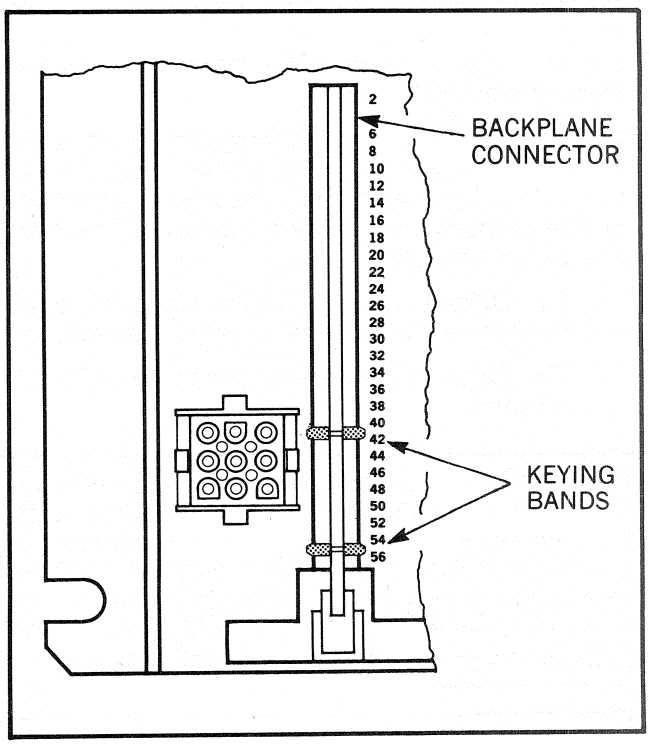



**FIGURE 9 — Keying Diagram**

## I/O MODULES

Through Bulletin 1771 I/O modules, the Mini-Processor Module can monitor and control the various devices in the user's application. These I/O modules are available for several different voltage levels. (Refer to Table D.)

In general, I/O modules function as follows:

- Input modules provide the Mini-Processor with logic-level information on the status of input devices.
- Output modules receive logic-level commands from the Mini-Processor Module and energize or de-energize output devices based on these commands.

**TABLE D — Bulletin 1771 I/O Modules**

| MODULE | CAT. NO. |
|---|---|
| AC/DC (120V) Input | 1771-IA |
| DC (12-24V) Input | 1771-IB |
| DC (48V) Input | 1771-IC |
| Isolated AC/DC (120V) Input | 1771-ID |
| Analog (8 bit) Input | 1771-IE |
| Analog (12 bit) Input | 1771-IF |
| TTL Input | 1771-IG |
| DC (24-48V) Input | 1771-IH |
| Encoder/Counter (5V) | 1771-IJ |
| Encoder/Counter (12-24V) | 1771-IK |
| AC/DC (220/240V) Input | 1771-IM |
| Fast Response DC (12-24V) Input | 1771-IT |
| DC (12-24V) Driver Logic Input | 1771-IV |
| AC (120V) Output | 1771-OA |
| DC (12-24V) Output | 1771-OB |
| DC (48V) Output | 1771-OC |
| Isolated AC (120V) Output | 1771-OD |
| Analog (12 bit) Output | 1771-OF |
| TTL Output | 1771-OG |
| AC (220/240V) Output | 1771-OM |
| Contact Output | 1771-OY |
| Thermocouple Input | 1771-IX |
| Thermocouple Expander | 1771-IY |
| Absolute Encoder Input (8 bit) | 1771-DL |

On each I/O circuit, optical-electrical isolation separates Controller logic circuitry from the voltage levels in the user's application. This also guards against the possibility of damage to I/O modules or to the Mini-Processor Module from high-voltage transients along the user's line.

User devices are wired to terminals on a Field Wiring Arm for each I/O module. The Field Wiring Arm pivots on the I/O Chassis to allow for convenient insertion or removal of an I/O module without the need for rewiring.

## SYSTEM POWER SUPPLY

The required Power Supply for the Mini-PLC-2 Programmable Controller is the System Power Supply (Cat. No. 1771-P1). (Refer to Figure 10.) This Supply powers the Mini-Processor Module and the logic circuity of the I/O modules contained in the same Bulletin 1771 I/O Chassis.

The System Power Supply can operate on 120 or 220/240V AC, depending on the user's placement of terminal strip jumpers.

Battery backup for the user memory is provided by the Battery Pack (Cat. No. 1771-BB). Shipped as standard with the System Power Supply, the Battery Pack guards against the loss of user memory should line power fail or the Supply shut down. Two alkaline "D"-size cells for the Battery Pack are

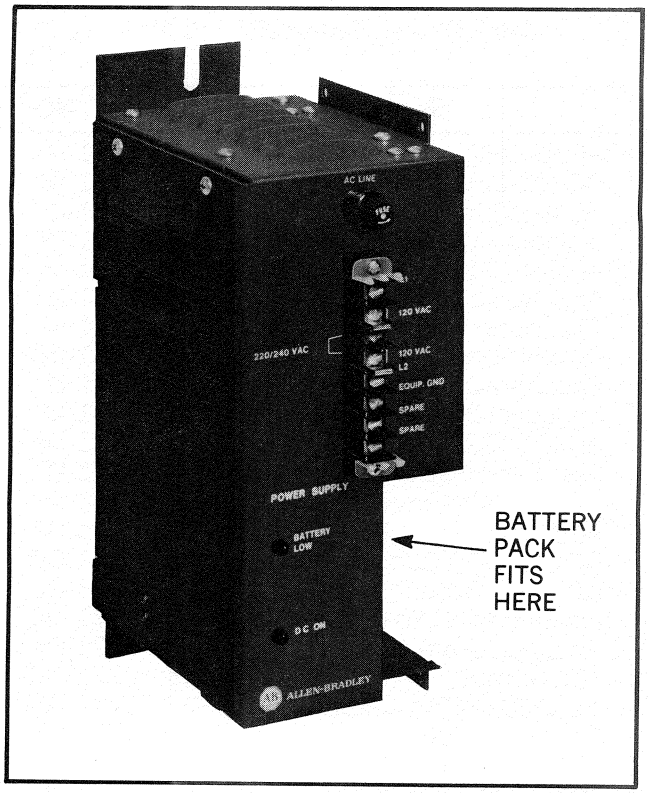



**FIGURE 10 — System Power Supply (without Battery Pack)**

standard with the Supply. An optional Lithium Battery (Cat. No. 1771-BL) can also be ordered for extended backup life.

The Battery Pack provides memory backup power while the Mini-Processor Module is seated in the I/O Chassis. Therefore, it is recommended that a copy of the user's program be made on punched or magnetic tape. If the Module is removed from the I/O Chassis, there will be a quick, convenient means of reloading the program.

The System Power Supply monitors the Battery Pack voltage for proper levels. When replacement batteries are needed, the BATTERY LOW indicator on the front of the Supply flashes continuously ON and OFF. In addition, the Power Supply signals the Mini-Processor Module upon detection of battery undervoltage. The Mini-Processor Module then turns bit 02700 alternately ON and OFF when it receives this signal. This bit can be examined in the user's program in order to energize an annunciator, warning light, or other device connected as an output.

The Battery Pack mounts conveniently on the left side-plate of the I/O Chassis with the Mounting Hardware Set (Cat. No. 1771-BX) provided as standard with the Supply. The Supply itself can also be mounted on the Chassis side-plate or, optionally, 5 cable-feet from the I/O Chassis.

The user must order the proper Power Cable, based on his mounting arrangement. Available cables are:

- Cat. No. 1771-CL Cable (1 ft/30.5 cm)
- Cat. No. 1771-CM Cable (5 ft/1.5 m)

Either mounting configuration permits the installation of the Mini-PLC-2 Programmable Controller within an enclosure of 8-inch working depth.

## LAST-STATE SWITCH

If diagnostic circuitry detects a fault in Mini-Processor operation, the Mini-Processor stops communication with its I/O modules for protection of the user's application. The behavior of output terminals in this situation is user-selectable.

There is a Switch Group Assembly on the left side of the I/O Chassis backplane. (Refer to Figure 11.) Switch No. 1 must be set by the user to determine output response to a faulted condition. These are the switch settings:

- ON - Outputs remain in their last state, energized or de-energized, when a fault is detected.
- OFF - Outputs are de-energized when a fault is detected.

**WARNING:** For reasons of personal safety, Switch No. 1 should be set to the OFF position in most applications. This allows the Mini-Processor to turn controlled devices OFF when a fault is detected. If this switch setting is not used and machine motion continues after fault detection, personnel or equipment may be endangered.

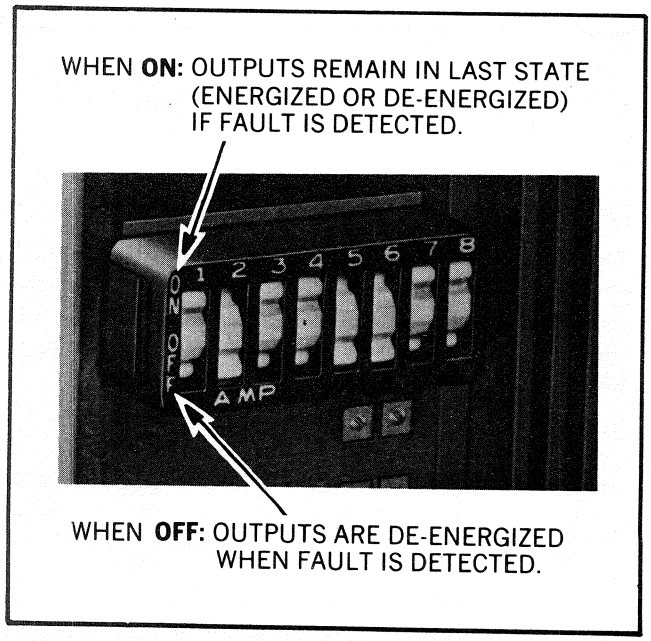



**FIGURE 11 — Switch Group Assembly**

It may be useful to set Switch No. 1 to the ON position in some applications. Such types of applications might include control of non-mechanical devices such as heaters or pilot lights, or control of mechanical devices, such as mixers or conveyors, whose continued operation may not be hazardous.

It should be noted, however, that Switch No. 1 determines the status of all output devices controlled by the Mini-Processor Module. With this switch ON, any output device which is ON when a fault is detected will be held ON by the Mini-Processor. Applications where this is desirable are the exception rather than the rule.

Switch No. 1 does not determine the response of controller outputs if user AC line power fails. The Mini-Processor turns all outputs OFF as soon as the user's line power drops below 92V AC.

Switch No. 1 does not determine the response of controller outputs when the Mode Select Switch is changed from the RUN position. Outputs are turned OFF when the Mode Select Switch is turned to TEST or PROGRAM positions.

When the I/O Chassis is used as part of a Mini-PLC-2 Programmable Controller, Switches No. 2 thru 8 may be in any position. The switch settings are of no significance.

## DOCUMENTATION

The following Manuals describe the installation, programming, and operation of the Mini-PLC-2 Programmable Controller and its associated Bulletin 1771 I/O Equipment:

- 1772-820 Assembly and Installation Manual
- 1772-821 Programming and Operations Manual
- 1772-820-1 Support Documentation

These Publications are available through your Allen-Bradley representative.

ALLEN-BRADLEY
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P/N 635221-50

# PROGRAMMING 0.01-SECOND TIMERS with the Mini-PLC-2 CONTROLLER

**Introduction —** The Bulletin 1772 Mini-PLC-2 programmable controller permits the user to enter On Delay Timer (TON), Off Delay Timer (TOF) and Retentive Timer (RTO) Instructions [1] with a 0.01-second time base. These are also referred to as 10 millisecond (10-msec) timers.

Timers with a 10-msec time base provide the user with greater timing resolution and accuracy than is possible with a 0.1-second time base. Ten-msec timers are used when time delays from 0.02 to 9.99 seconds are required.

**Time Base Selection —** When a timer Instruction is entered into a program, the programmer must specify:

- Timer word address
- Time base
- Preset value
- Accumulated value (for RTO **only**)

Note that the user selection of preset value and time base are closely related. The Processor executes the time-delay functions by incrementing the timer accumulated value one unit for each time base unit that elapses. In other words, the preset value represents a specific number of increments of the time base.

Note, however that the preset value is **not** an absolute length of time. For example, if the preset value is 010, the time delay will be:

- 10 seconds if a 1.0-second time base is entered
- 1.0 second if a 0.1-second time base is entered
- 0.10 second if a 0.01-second (10-msec) time base is entered

The smaller the time base, the larger the preset value must be to obtain the same time delay. To obtain a 5-second time delay, the program could contain:

- 1.0-second time base and preset = 005
- 0.1-second time base and preset = 050
- 0.01-second time base and preset = 500

**Timer Accuracy —** Given any preset value, a Mini-PLC-2 controller timer is accurate to within one interval of its time base. Specifically, the timed interval does not exceed the preset interval, but it may be as much as 1 time-base unit shorter than the preset. These examples illustrate this accuracy:

- **TON:** Time base 1.0-second; preset value 100. This time interval will be greater than 99 seconds, but less than or equal to 100 seconds as given in the equation below.

  $99 \text{ seconds} < \text{TON timed out} \leq 100 \text{ seconds}$

- **TON:** Time base 0.1-second; preset value 100. This time interval will be greater than 9.9 seconds, but less than or equal to 10.0 seconds as given in the equation below.

  $9.9 \text{ seconds} < \text{TON timed out} \leq 10.0 \text{ seconds}$

- **TON:** Time base 10-msec; preset value 100. This time interval will be greater than 0.99 seconds, but less than or equal to 1.00 second as given in the equation below.

  $0.99 \text{ seconds} < \text{TON timed out} \leq 1.00 \text{ second}$

Note that special programming techniques are required to use the 10-msec timer in a program. These techniques are explained in this publication.

Programmed timers examine internal timing pulses of the Mini-Processor. (Refer to Figure 1.) A change in the state of this internal clock causes the timer to in-

[1] In order to enter these Instructions, a Series B, or later, Bulletin 1772 PLC-2 Program Panel must be used. Alternately, a Series B, or later, Bulletin 1772 PLC/PLC-2 Program Panel Adapter **and** a Series C, or later, Bulletin 1774 PLC Program Panel may be used.

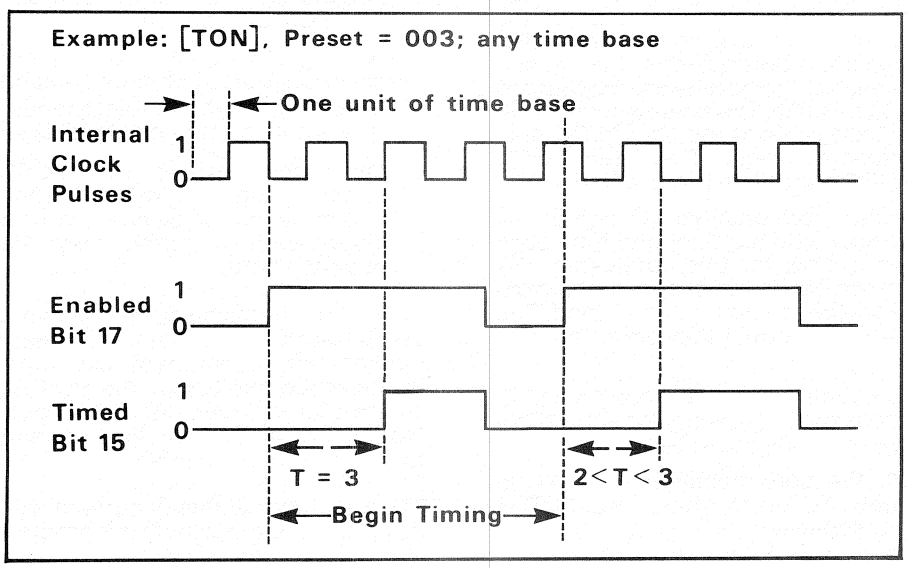



**Figure 1 — Timing Diagram**

crement its accumulated value. Note, however that the timing pulses are continuous and are **only** examined by the Mini-Processor when a timer Instruction is being executed in the program. As Figure 1 shows, when the Mini-Processor **initially** examines this internal clock, the clock may have just changed state or may be just about to change state. This variable makes it possible for the inaccuracy of up to 1 time-base increment.

Note that these timing accuracies refer **only** to internal Mini-Processor operation. That is, these intervals refer to the length of time which occurs between the moment that a timer is initialized (bit 17 set) and the moment that the timed interval is complete (bit 15 set). Other factors add to this timer inaccuracy. Chief among these are the response time of the actual hardware devices controlled and monitored by the Mini-PLC-2 controller. (Refer to the Paragraph concerning Hardware and Mini-Processor considerations, later in this Publication.)

The user is urged not to overspecify timing accuracy. In many applications timing within 0.1 second will provide accuracy comparable to, or better than, typical electromechanical timing relays. In general, these rules may be applied:

- For delays of 99 to 999 seconds, use the 1.0-second time base
- For delays of 2.00 to 99.9 seconds, use a 0.1-second time base
- For delays of 0.02 to 2.00 seconds, use the 10-msec time base

When time delays are incorporated in a program to provide a warmup or initializing period, or to prevent the simultaneous application of power to high-current devices, inaccuracies on the order of 50 to 250 msec are probably insignificant. The 1.0- or 0.1-second time bases are more than adequate for these uses. Applications for the 10-msec timer are discussed below.

**Typical Applications** — In general, 10-msec timers are used for these functions:

- Monitor events on a high-speed assembly or transfer line, such as that used in canning and bottling machines
- Generate short-duration pulses for accurate positioning control

For example, on a bottling or canning line, photoelectric sensors or electromagnetic proximity switches can be used to detect the movement of bottles. Each time a bottle passes a detector, an On Delay or Off Delay timer can be started. The next bottle down the line will turn the sensor on (or off), thereby resetting the timer. Once the second bottle is past the sensor, the timer is started again. If the bottles are moving too slowly, or if a bottle is missing, the timer will time out. The timed bit in the Data Table of the Mini-PLC-2 controller can be programmed to set off an alarm, or to stop the machine until the problem is corrected.

With the speeds encountered on a typical high-speed bottling machine, a timer with a 0.1-second time base would probably be too slow for this application. By computing the minimum bottle travel speed, the maximum time between bottles could be determined. The time in 10-msec increments could then be entered as the timer preset.

As another typical example 10-msec timers could also be used to operate sorting mechanisms for high-speed machines. Two methods could be used.

In the first method, the sort mechanism could be energized, for example, 60 msec after a REJECT is sensed by a particular sensor.

In the second method, the REJECT sense switch could immediately apply a 40-msec pulse to the sort mechanism. In this case, the pulse is just long enough for the mechanism to pull only one rejected bottle off the line.

Yet another example for the generating of short- duration pulses can also be found in machine tools and similar applications requiring accurate positioning control. Typically, 10-msec timers are used to generate one short duration pulse, or a series of pulses, when a limit switch or proximity switch detects end of travel, depth reached, or similar data. Detection that machining depth has been reached could, for example, generate a 130-msec pulse to the motor reverse circuit, thus plugging or braking the spindle with great accuracy.

Programmable control offers additional advantages in these applications. For example, consider a bottling machine capable of filling and capping 12-ounce and 16-ounce bottles. The larger bottles may move more slowly, or the spacing between bottles may be different. Detection of 16-ounce bottles could cause the Mini-PLC-2 Processor to GET different timer preset values and PUT them into monitoring and sorting timers such as those discussed above.

Changing the timer presets in this manner also enables the programmer to fine-tune the system without physically adjusting the locations of detection devices.

**Hardware, Processor Considerations** — When considering use of the 10-msec timer, the user must consider other timing factors, both within the programmable controller and in the hardware devices:

- Every input device requires a length of time to change state. Photoelectric devices and electromagnetic proximity switches typically operate in the range of 3 to 50 msec. Mechanical switches and magnetic control relays can require longer times for operation.
- Some Input Modules may provide a slight delay resulting from the input filter time constant (typically 10-25 msec).
- The execution of each program Instruction requires a certain length of time. Instruction execution times are discussed below in relation to program scan time computation.
- Scan time (I/O scan + program scan) depends on the number and type of Instructions, as discussed below. Incorporation of Immediate Input and Immediate Output Instructions can compensate for the length of scan time.
- DC Output Modules typically respond from 1 to 5 msec. AC Output Modules respond in 3 to 10 msec, depending on the instantaneous value of the AC wave when the turn-on signal is applied.
- User output devices may take 50 to 100 msec or longer to operate after current is applied. Inductive loads, or devices with substantial surge suppression circuitry, may also have longer response time.

Each of the items discussed above will have an impact on the actual time delay obtained from a programmable timer. Selection of fast-response input devices is the responsibility of the user, and is beyond the scope of this document. For selection of suitable I/O Modules contact your local Allen-Bradley representative for further assistance.

The remainder of this document will discuss programming techniques which the programmer must use to

effectively program the 10-msec timer. The required programming is based on 2 concepts:

- Scan time
- Sequential program scan

**Scan Time —** The Mini-PLC-2 Processor performs an I/O scan and then a program scan, in sequence. Scan time is the **sum** of the times required for both these scans. (Note that the Processor does not scan unused memory, nor does it scan that portion of the memory used to store Messages.)

During an I/O scan, the Processor examines Output Image Table [1] bits, and updates or corrects the ON/OFF signals applied to the Output Modules. It also examines the ON/OFF signals from the Input Modules and updates the ON/OFF status of the corresponding Input Image Table bits.

During a program scan, the Processor scans each Instruction in the Program, one at a time. It executes Examine and Branching Instructions, but it executes Output Instructions only if the rung is TRUE. The sequential nature of this scan is discussed further below.

Scan time **cannot** be specified exactly for all Processors because each user program is different. The length of the scan time depends on both the number and the type of Instructions the program contains. (Actual scan time computation is discussed below.) For purposes of discussion, scan time is generally assumed to be about 25 msec, though in practice it will range from about 15 msec to 50 msec, or more in certain extreme cases.

**Program Execution —** The second consideration for 10-msec timer programming is the sequential nature of the program scan. The Processor executes one program Instruction at a time. After it executes an Instruction, it cannot examine that Instruction again until the next scan of memory. With respect to timer Instructions, particularly, the Processor cannot increment the accumulated value except when it is executing that Instruction.

Furthermore, the only states of any memory bits that affect the execution of any single Instruction are the states those bits have at the instant the Processor executes the Instruction. If a bit changes state after the Instruction is executed, the change of state will **not** affect the Instruction until it is executed the next time.

For example, suppose one program Instruction is Examine On 11013. If the device is open, the Processor will detect an OFF signal from the Input Module during the I/O scan, and will clear (reset to "0") the corresponding Input Image Table bit. After the I/O scan, the program scan begins.

Suppose, in this case, that the input device wired to a terminal at address 11013 closes when the program scan begins. The corresponding Image Table bit will remain "0" (device is **open**) until the **next** I/O scan **after** the current program scan is finished, **or** until the Processor executes an Immediate Input Instruction addressed to word 110.

The Processor can also update a timer **only** at the instant it is executing that timer Instruction. Remember that an integral timing clock (see **Timer Accuracy**, above) puts out pulses for the 1.0-second, 0.1-second and 10-msec timers. When 1.0-second and 0.1-second timers are used in a program, the timing pulses are always longer than the Processor scan time. No special programming is required; these timers will not miss a timing pulse.

Timing pulses for the 10-msec time base, however, are usually **shorter** than the program scan time. Since the Processor can only increment a timer while it is executing that Instruction, the 10-msec timer could miss one or more timing pulses on each program scan. The solution is to instruct the Processor to execute the timer Instruction often enough that it will not miss a pulse.

**Programming Compensation —** In order to compensate for the length of the scan time and to assure accurate timing, 10-msec timer programming must be repeated several places in the program.

A typical program using the total memory can nominally be assumed to have a scan time of less than 30 msec. (See **Scan Time Computation**, below.) In such a program, enter the **same timer rung** at 3 different places in the program: once near the beginning of the program, once near the middle, and once near the end. The Processor will update the timer accumulated value each time it scans that timer Instruction. Refer to Figure 2 and note the following:

- The rung **must be identical each time** it is used: the same Examine Instructions to condition the rung, the same timer word address, the same time base, and the same preset value.
- Use this technique **only for 0.01-second timers.** (The program scan is fast enough to assure accurate operation of the 1.0-second and 0.1-second timers with only one timer rung per program.)

Multiple entry of the timer rung will help to assure that the accuracy of the timer accumulated value is within the accuracy limits discussed above. Additional programming techniques can help to assure that output devices controlled by the timer are energized or de-energized after as precise a time delay as possible. The programmer may want to include:

- Multiple entries of rungs which examine the timed bit of the timer to condition an Output Energize Instruction.
- Immediate Input Instructions to help assure that the timer is enabled as quickly as possible after the external event occurs.
- Immediate Output Instructions to help assure that the output device is energized/de-energized as quickly as possible after the Mini-Processor sets the Output Image Table bit to "1" or clears it to "0".

Typical 10-msec timer rungs are shown in Figure 3. In Rung No. 1, Immediate Input Instructions precede Examine Instructions addressed to bits in Input Image Table words 110 and 113. When used near the middle or end of a program, the Immediate Input Instructions help to assure that the Processor will be executing Instructions based on accurate data.

In Rungs No. 2, 3, and 4, Output Energize Instructions conditioned by timer bits should also be repeated in the program. When used near the beginning or middle of the program, the Immediate Output Instruction addressed to Output Image Table word 014 will help to assure that the Output Modules respond quickly to timer cycling.

By repeating the timer Instructions and related rungs, the programmer can assure that the Processor will update timer accumulated value more frequently than the timing pulses change state. As shown in Figure 2, repetition within 8 or 9 msec will be adequate for this purpose.

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[1] For a discussion of memory areas, refer to Publication 1772-700, The Organization and Structure of the Mini-PLC-2 Memory.

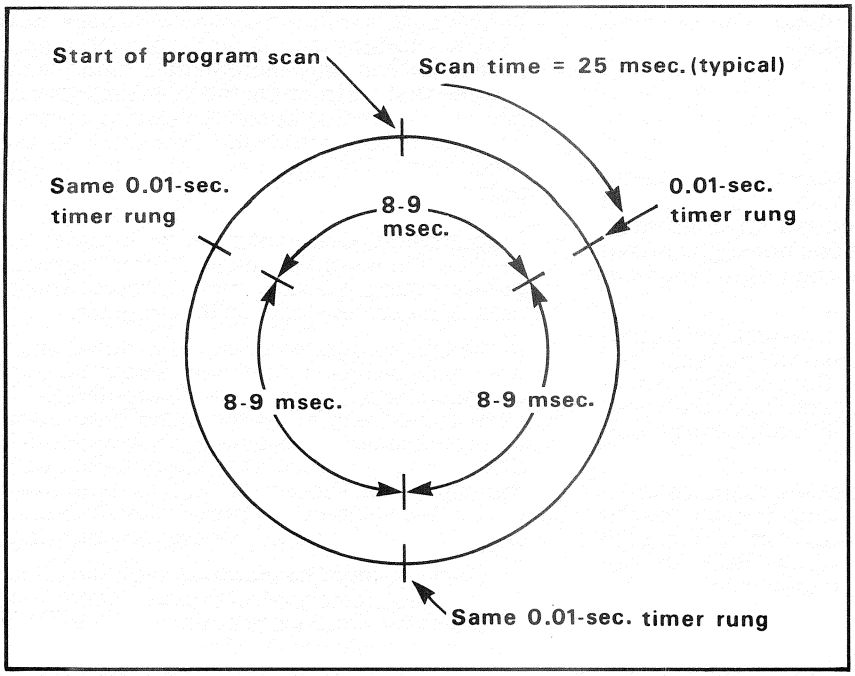



**Figure 2 — Typical Timing Diagram for 0.01-Second Timer**

**1** Rung No.

```
     !  110      113     11005   11006                          030    !
  2 1 +-[ I ]---[ I ]---]  [-+-]  [-------+-------------- (TON)-+
     !                      !          !                    0.01   !
     !                      ! 11014  11300 !                PR025  !
     !                      +-]  [---[ / ]-+                AC000  !
     !                                                             !
     ! 03017                                                 01405  !
  2  +-]  [-------------------------------------------- ( )---+
     !                                                             !
     ! 03015                                                 01410  !
  3  +-]  [-------------------------------------------- ( )---+
     !                                                             !
     ! 03015   11002                                         01404  !
  4  +-]  [---]  [-------------------------------------- ( )---+
     !                                                             !
     !                                                       014    !
  3 5 +-------------------------------------------------(IOT)-+
     !                                                             !
```

Legend:

**1** Repeat these 5 rungs (typical) 3 or more places in the program.

**2** For rung No. 1, when used near the beginning of the program, [ I ] Instructions may be omitted.

**3** For rung No. 5, when used near the end of the program, (IOT) Instruction may be omitted.

**Figure 3 — Typical 0.01-Second Programming**

**Program Scan Time Computation** — In order to evaluate programming needs, the user may wish to calculate approximate scan time. An exact computation is not practical, but a reasonable approximation can be obtained using the approximate execution times listed in Table A. Enter the 10-msec timer rungs 3 times per 1K (1024) words or program, then compute the scan time. A sample computation follows:

Assume the Processor is using a 128-word Data Table and has 1024 words of memory. If all memory words are used, the program will contain 896 Instructions. A program of this size might typically have the following distribution:

| | | |
|---|---|---|
| • 546 Instructions x 18 μsec | = | 9.8 ms |
| • 306 Instructions x 28 μsec | = | 8.6 ms |
| • 44 Instructions x 83 μsec | = | 3.7 ms |
| Total (rounded): | = | 22.0 ms |
| The I/O scan time adds approximately 1.0 ms. | + | 1 ms |
| Program Panel interaction requires about 3.0 ms. | + | 3 ms |
| Total: | | 26 ms |

If a 10-msec timer is used in a program of this duration, the rung used to initialize the timer must occur at least 3 times in the program at evenly spaced intervals. For longer programs, it may be necessary to repeat the timer instruction and related rungs several more times to assure that timing is accurate.

Table A

**INSTRUCTION EXECUTION TIMES (Approx.)** [1]

| INSTRUCTIONS | | TIME |
|---|---|---|
|  | RTR<br>GET BYTE | 18 μs |
|  | CTR<br>GET<br>MCR | 28 μs |
| PUT<br>EQU | LES<br>LIMIT TEST | 38 μs |
| + | | 60 μs |
| TOF<br>TON<br>RTO | CTU<br>CTD<br>– | 83 μs |
| IMMEDIATE I/O | | 105 μs |
| ZCL | | 130 μs |

[1] These execution times are approximate, but are sufficient for the purpose of programming one or more 0.01-second timers.

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# MEMORY EXPANSION OPTION

## Cat. No. 1772-MH

**Introduction** — The standard memory capacity of the Mini-Processor Module (Cat. No. 1772-LN1) can be expanded from 512 words to 1024 words with the Memory Expansion (Cat. No. 1772-MH) option.

This increased memory capacity allows more complex machines or processes to be controlled than was possible with the 512 word memory. Report generation capabilities can also be expanded.

The Memory Expansion option includes the following items:

| Quantity | Item |
|---|---|
| 2 | CMOS RAM ICs in carrier sockets |
| 1 | Identification label |
| 1 | Product Data instruction sheet |

**Installation Precautions** — Complementary Metal Oxide Semiconductor (CMOS) devices can be damaged during routine handling and installation if proper precautions are not taken to reduce static electricity discharges.

Recommended precautions include:

- Use only carriers provided [1]
- Handle the CMOS device by the case or carrier without touching its pins
- Ground tools prior to contacting the CMOS device
- Use static-free work station [2]
- Connect static-free work station to ground through a minimum 200K ohm resistance [3]
- Wear a conductive wrist strap which has minimum 200K ohms resistance and is connected to earth ground [3]
- Control the relative humidity of the installation area — ideal conditions are 40% to 60% relative humidity

The following is a list of things that should **not** be done:

- Do Not handle styrofoam, plastic, or cellophane-covered articles such as combs, cigarette packages, and candy
- Do Not hand the CMOS IC to someone who is not antistatic protected
- Do Not install the ICs in carpeted areas or in areas which might contaminate or foul the pins of the CMOS device or its carrier
- Do Not handle the CMOS IC by its pins or the pins of the carrier
- Do Not slide the CMOS device across any surface
- Do Not place the CMOS IC in a non-conductive plastic bag

When these precautions are followed, the potential difference between the CMOS device's pins is reduced thereby reducing the problems associated with static discharges.

**Installation Procedure** — The following paragraphs describe a recommended procedure for increasing the 512-word Mini-Processor memory capacity to 1024 words.

**Disassembly** — Mini-Processor Module disassembly is described in the following steps.

Step 1 — Before removing power from the Mini-PLC-2 programmable controller, be sure a current copy of the user program has been recorded. Punched tape and magnetic tape records provide convenient means of program storage.

Step 2 — Remove power from the Mini-PLC-2 controller.

Step 3 — Remove the Mini-Processor Module (Cat. No. 1772-LN1) from the chassis.

Step 4 — Place the Mini-Processor Module label side down on the workbench. Remove the key from the Mode Select Switch.

Step 5 — Remove the four outermost mounting screws on the Module's metal cover. (Refer to Figure 1.)

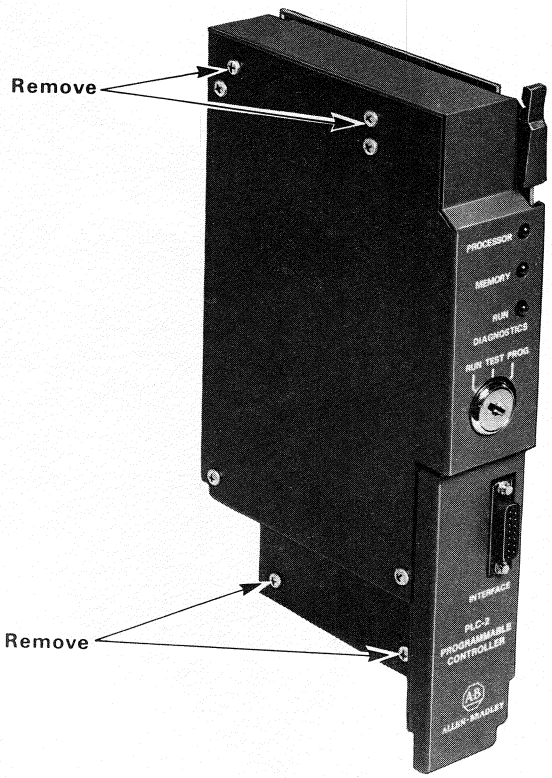



**Figure 1 — Disassembly of the Mini- Processor Module**

[1] The term carrier, as used throughout this Publication, refers to the pin-protecting device into which the CMOS IC is inserted. The pins on these carriers are more rigid than those on the CMOS device and are therefore less susceptible to bending.

[2] A portable static-free work station is available from 3M Nuclear Products, 3M Center, St. Paul, MN 55101. Order Type: 8005, Portable Field Service Grounding Kit.

[3] Minimum 200K ohms is specified; larger values decrease even further the amount of current that would flow through this path.

Step 6 – Turn the Module over while holding the metal cover in place. The identification label now faces up.

Step 7 – Carefully separate the two sections of the Module. Be sure the metal cover clears the LED indicators and the Mode Select Switch. The larger printed circuit (pc) board can be positioned as shown in Figure 2 so that the CMOS IC memory chips can be easily inserted.

**CAUTION:** Although the ribbon cable may be stiff, the larger pc board can be "balanced" off one side of the metal cover. However, do not exert excessive tension or pressure on the ribbon cable or the cable connectors. Circuit continuity may be broken if this caution is not observed.

**CAUTION:** The mounting assembly for the Mode Select Switch has sharp corners. Be sure that these corners do not damage the Module during disassembly. Sheet metal may be scratched or printed circuit board damage may result if this caution is not observed.

**Handling, Inserting CMOS IC** – The following steps describe handling and inserting the CMOS IC devices into the sockets on the Mini-Processor Module.

Step 1 – Follow the recommended precautions for handling CMOS devices as described earlier.

Step 2 – Locate the empty IC sockets on the smaller pc board. (Refer to Figure 3.)

Step 3 – Remove the conductive foam which carries the CMOS IC devices from the special conductive plastic bag provided with the Memory Expansion option.

Step 4 – Remove only one CMOS device and its carrier, as a unit, from the conductive foam. Do not remove the CMOS device from the carrier socket. Do not touch or contact the pins.

Step 5 – Inspect the carrier leads for correct alignment. If any pins have been bent, gently straighten them with needle-nosed pliers that have been properly grounded.

Step 6 – Locate the dot on the top surface of the CMOS IC or the notch on the case of the CMOS de-

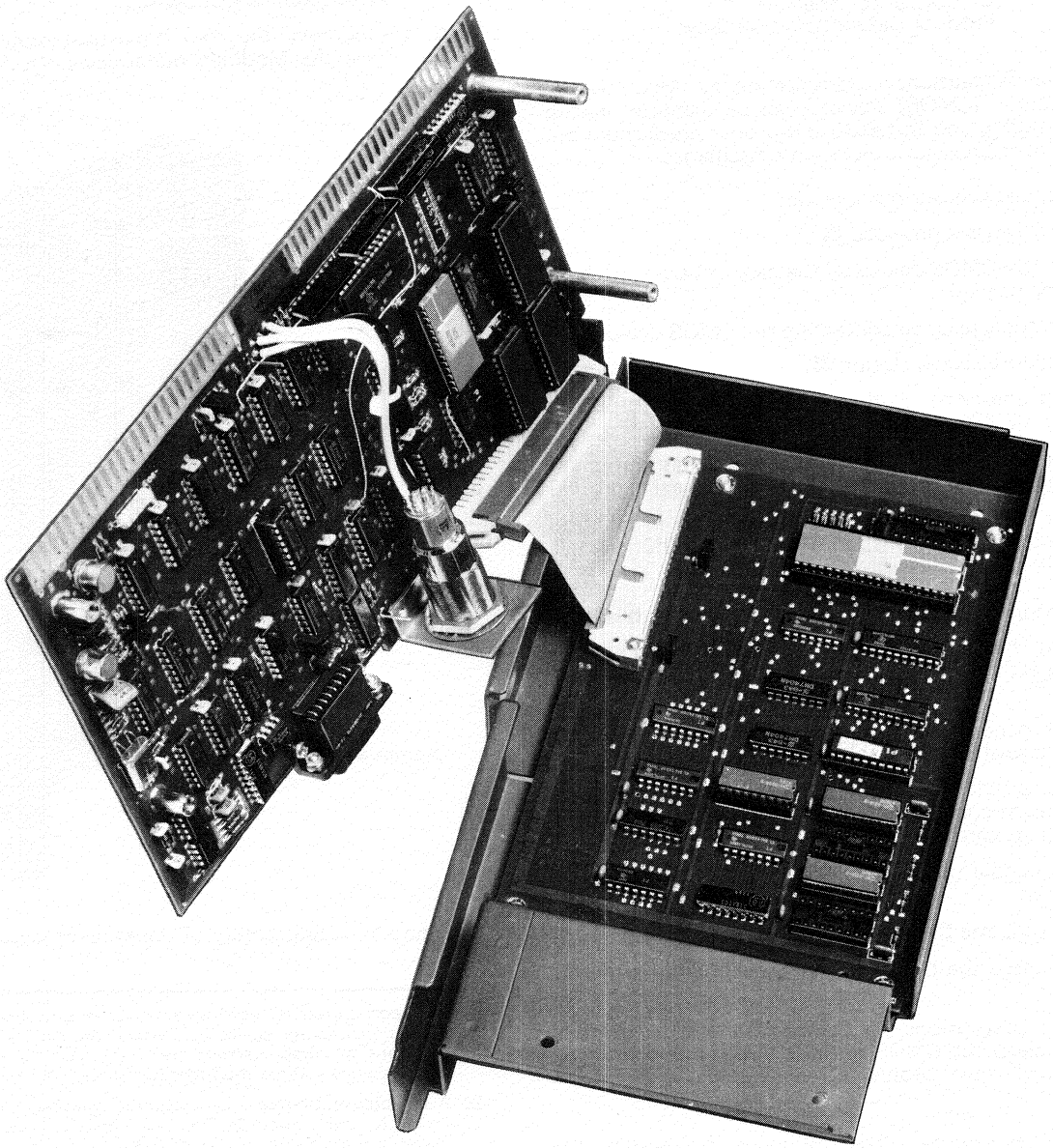


**Figure 2 – Positioning of Module Sections for CMOS IC Insertion**

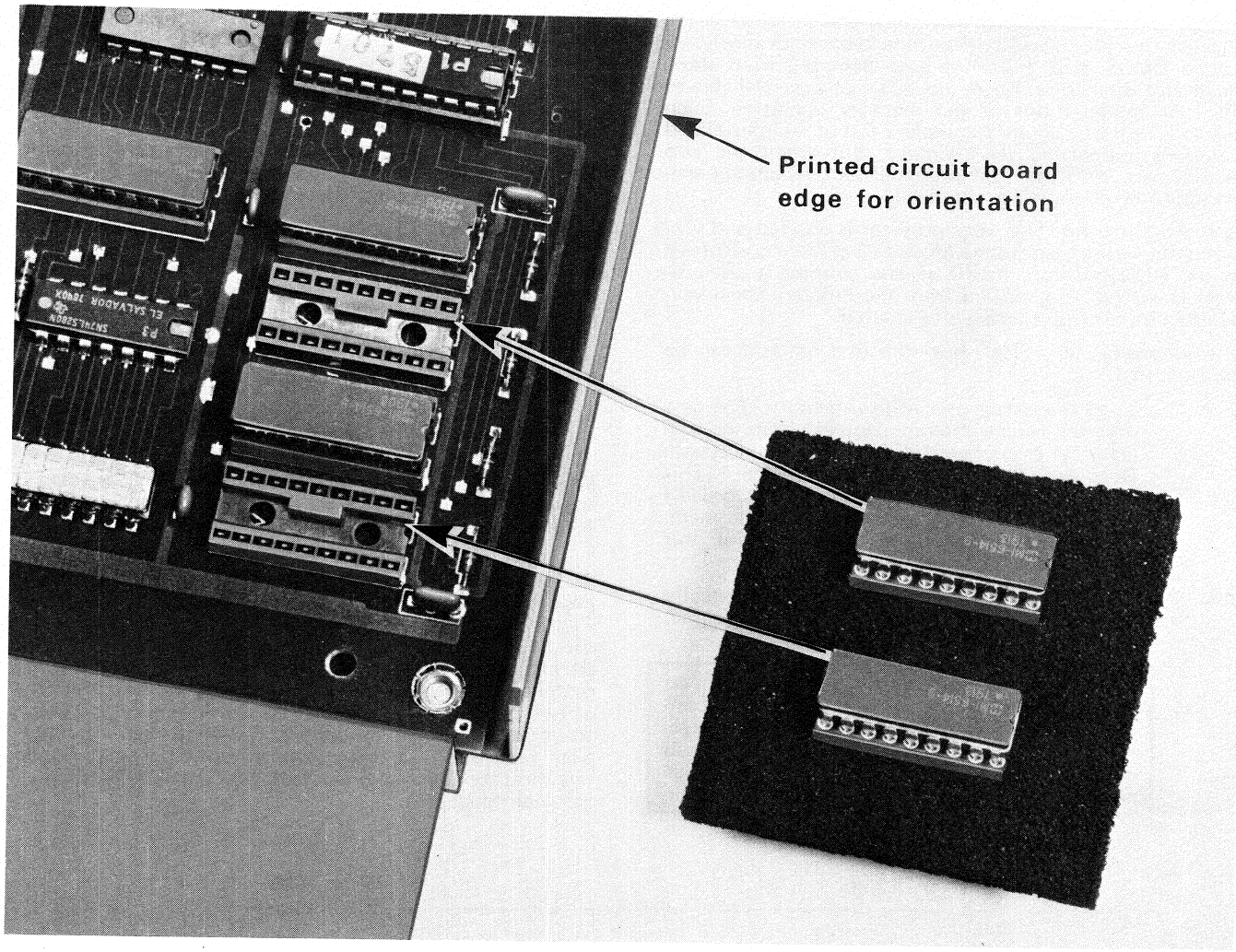



**Figure 3 — Location of Memory Chip Sockets**

vice. These are used later for proper orientation of the chip.

Step 7 — Grasp the carrier by the ends.

Step 8 — Place the chip and carrier, as a unit, on the empty socket with the dot or the notch on the IC near the edge of the pc board. Note that the orientation of the dot or notch must match that of the CMOS memory chips already installed on the Mini-Processor Module. Do not insert the carrier pins into the socket at this time.

Step 9 — Visually inspect all the pins for correct alignment with the pin receptacles on the socket. If a pin does not mate correctly with the socket's receptacle, gently straighten the pin with needle-nosed pliers that have been properly grounded.

Step 10 — Gently press on the center of the CMOS IC until the pins on the carrier socket are fully seated in the socket on the Mini-Processor Module.

Step 11 — Repeat these steps for the remaining CMOS IC device. Note that both memory chips must be properly installed—the user does not have a 768-word memory option.

**Re-assembly** — The following steps describe re-assembly and related operations which must be performed before the Mini-PLC-2 controller is used for control purposes.

Step 1 — Carefully pivot the larger pc board onto the smaller pc board.

> **CAUTION:** The mounting assembly for the Mode Select Switch has sharp corners. Be sure that these corners do not damage the Module during re-assembly. Sheet metal may be scratched or printed circuit board damage may result if this caution is not observed.

Step 2 — Affix the Mini-Processor Module's new label to the module cover. Completely cover the previous label (Cat. No. 1772-**LN1**) with the new label (Cat. No. 1772-**LN2**).

Step 3 — Turn the Module over while holding the metal cover in place.

Step 4 — Replace the four mounting screws. Tighten them securely.

Step 5 — Be sure power is not applied to the Mini-PLC-2 controller. If power is applied, remove power before proceeding with Step 6.

Step 6 — Insert the Mini-Processor Module into the chassis. Apply gentle pressure to the front of the Module to properly seat the printed circuit board into the backplane connector.

Step 7 — Re-apply power to the Mini-PLC-2 controller.

**Program Entry, Verification** — After the Mini-Processor Module has been disassembled, the CMOS IC devices in-

serted, and the Module re-assembled and installed in the chassis, the user should determine that both newly installed CMOS chips have not been damaged from static electricity discharges. There are two methods available to the user to determine proper memory operation. Each method, in itself, is not a complete test of all interrelated functions supporting the memory, but when the two methods are both used, the probability of detecting possible improper operation is improved.

In the first method, the user program is entered and subsequently verified before the Mode Select Switch is turned to the RUN position. In the second method, a test program is entered and verified from the Program Panel keyboard before the user program is entered.

The following steps detail how the first method can be implemented.

Step 1 – Load the user program into memory. The user program can be entered manually from the Program Panel keyboard or from a Digital Cassette Recorder or punched tape device. (This assumes the program was previously recorded.) The larger the user program in relation to memory capacity, the more comprehensive this method becomes.

Step 2 – Verify that the data stored in memory **exactly matches** the data from the user's program documentation or the data stored on tape.

> **CAUTION:** Program verification must be performed to guard against inaccuracies or improper operation of the CMOS memory chips. Failure to verify the contents of memory can cause unintended machine or process operation.

The following steps detail implementation of the second method (test program):

Step 1 – Manually enter the test program rung shown in Figure 4 as many times as necessary to completely fill the last 512 words of memory.

Step 2 – Verify that the test program has been stored in memory exactly as it was entered. Each rung must be checked.

Step 3 – Remove the last rung of the test program.

Step 4 – From the Program Panel keyboard insert the Instructions ☒ 065 ☒ 065 immediately before the test program. This step moves all Instructions after it two Instructions closer to the end of memory.

Step 5 – Verify that the test program stored in memory is an accurate representation of the modified test program. Each rung must be checked.

While the second method may seem a tedious process, it need only be done once – after inserting the two CMOS IC devices.

Should ERR 1 or ERR 8 appear on the Bulletin 1772 Program Panel, or the message ERROR 1 – MEMORY FULL or ERROR 8 – NO USER PROGRAM appear on the Bulletin 1774 Program Panel during program entry or during verification from tape, the user should follow recommended troubleshooting procedures to determine the error's probable cause. (Refer to the Assembly and Maintenance Manual for the Mini-PLC-2 controller – Publication 1772-820.) If these troubleshooting procedures do not indicate the cause, contact your local Allen-Bradley Representative.




**Figure 4 – Test Program Rung**

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P/N 635384-60

# PROCESSOR
## (Cat. No. 1772-LR)




**SPECIFICATIONS**

**Nominal Input Voltages to Processor Modules**
+5V, +12V, -5V

**Input Power Requirements to Processor Modules**
+5V — 20.0 VA
+12V — 3.0 VA
-5V — 0.45 VA

**Scan Time**
17 msec (nominal)/1K of memory

**Memory Capacity**
2K words (16 data bits each) in 512-word Segments

**Ambient Temperature Rating**
0°C to 60°C (operational)
-40°C to +85°C (storage, excluding Memory Battery)

**Humidity Rating**
5 to 95%
(without condensation)

**Keying**
Processor modules keyed at factory

**Introduction** — The Processor (Cat. No. 1772-LR) is the control processing unit of the PLC-2 programmable controller. In it, a user program, stored in the PLC-2 memory, is sequentially scanned, the status of inputs and outputs is tested, and appropriate action is initiated. Having examined the status of the inputs and/or outputs, the Processor is capable of energizing or de-energizing outputs and latches, performing counting and timing instructions, doing data comparisons and transfers, and executing 4-function arithmetic operations. The electronic circuitry necessary to accomplish these functions is based in the Processor.

**Description** — The PLC-2 Processor contains the following modules:

- Processor Interface Module (Cat. No. 1772-LC)
- Processor Control Module (Cat. No. 1772-LB)
- Memory Module (Cat. No. 1772-MG)
- System Power Supply Module (Cat. No. 1772-P1)

Two types of module tracks are located in the Processor Chassis. The metal track on the left side guides the System Power Supply Module into place. Each of the three plastic tracks on the right side of the Processor Chassis accepts one of the three Processor modules. To access the modules, the metal plate at the front right side of the Processor must be removed. (Refer to Figure 1.)

When the three Processor modules are in place they make electrical contact with the printed circuit chassis backplane. (Refer to Figure 2.)

This backplane, or "motherboard," carries electrical signals among Processor modules. As the modules are inserted, care must be taken to insure that they are properly seated into the motherboard connectors.

**WARNING:** Never insert or remove modules from the Processor while AC power is applied. Remove the external AC power before replacing any module. Failure to observe this warning could result in personal/property damage.

**Processor Chassis** — The Processor Chassis (Cat. No. 1772-LA), when all modules are in position, measures approximately 12 x 13.5 x 9 inches (WxHxD), or 30.5 x 34.3 x 22.4 cm. It is of rugged construction with louvers cut into the sides and top, and holes in the bottom to allow convection cooling.

**Processor Interface Module** — The Processor Interface Module (Cat. No. 1772-LC) occupies the left-most plastic slot in the Processor Chassis. (Refer to Figure 2.) This Module contains signal-conditioning circuitry for communication between the Processor and I/O system, Program Panel, or PLC/PLC-2 Program Panel Adapter.

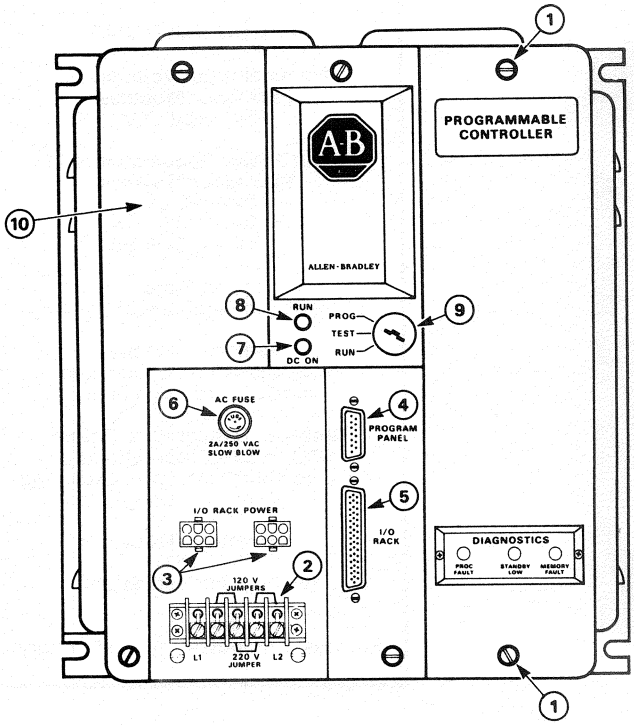
Attached to the front of the Processor Interface Module is a front panel which contains several user connectors, indicators, and controls. Their function is described in the Processor front panel paragraphs later in this Publication. (Refer to Figure 1.)

**Processor Control Module** — The Processor Control Module (Cat. No. 1772-LB) is located in the middle slot of the three plastic slots in the Processor Chassis. (Refer to Figure 2.) Once inserted and seated properly into the motherboard connector, it is covered with a front panel which is secured to the Processor Chassis by means of two thumb screws. This panel then forms part of the Processor enclosure.

Diagnostic indicators are provided on this Module. These indicators are often helpful in isolating Processor

malfunctions which could develop. The indicator located near the top of the Module is the HALT indicator. (Refer to Figure 2.) It illuminates when certain logic signals on the Processor Control Module are faulty.

Another indicator, the PROCESSOR FAULT indicator, is the lower of the two indicators on the Processor Control Module. (Refer to Figure 2.) This indicator is illuminated when the logic controlling the Processor scan fails. This fault can usually be corrected by replacing the Module.




Legend:

1. Access Memory and Processor Modules here
2. User AC connections
3. I/O RACK POWER socket
4. Program Panel socket
5. I/O Rack socket
6. AC input fuse
7. DC ON indicator
8. RUN indicator
9. Mode Select Switch
10. System Power Supply Module located here

**Figure 1 — PLC-2 Processor (front panel)**

**Memory Module** — The Memory Module (Cat. No. 1772-MG) occupies the far right slot position. (Refer to Figure 2.) It contains read/write solid-state Random Access Memory (RAM) and support circuitry needed to store and retrieve information. This information includes user program instructions, I/O status, and values of timers, counters, and operating data.

One Memory Segment (Cat. No. 1772-MR) is provided as standard with each Memory Module. Each Memory Segment provides for storage of a maximum of 512 words. The first 128 words of the first Segment of each PLC-2 system are set aside by the Processor for use as Data Table storage, assuming the maximum number of timers/counters is not changed. This leaves 384 words for user program instructions. Subsequent Segments each provide storage for 512 words of user program instructions.

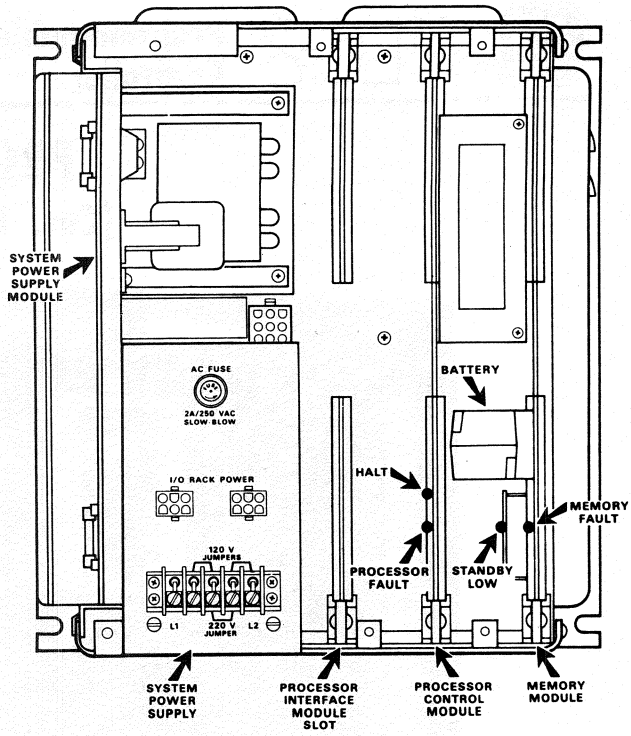



**Figure 2 — Processor Module Locations**

Up to three incremental additions to the standard first Memory Segment may be used in a single PLC-2 system. Depending on the needs, 512; 1,024; 1,536; or 2,048 words may be used.

The optional segments are designed to be user-installed into sockets on the Memory Module. (Refer to Figure 3.) This is to be done after power (AC input power **and battery stand-by**) has been removed from the system, and the Memory Module has been removed from the Processor Chassis. Additional Memory Segments are inserted in the next available socket. Sockets are marked A, B, C and D. Insert Memory Segments according to an alphabetical sequence, and do not leave blank sockets between Segments.

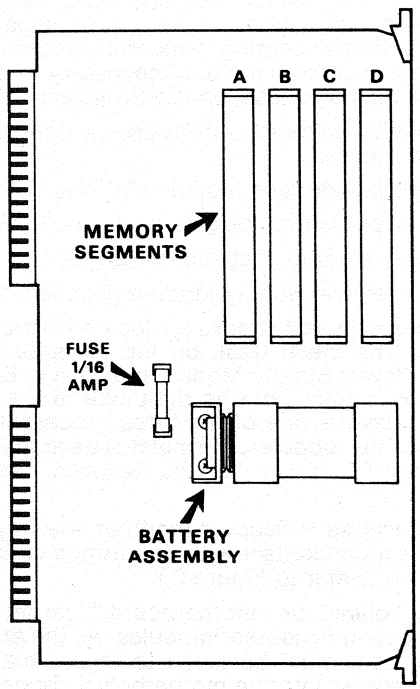



**Figure 3 — Memory Module (side view)**

A Memory Battery is supplied as part of the Memory Module. (Refer to Figure 3.) This feature provides stand-by power to the Memory Module should power from the System Power Supply Module be interrupted, due to either a Module failure or the removal of AC input power. The battery will provide approximately 2 months of stand-by power to the memory segments. (See Table A.) The on-card battery back-up allows Memory Modules to be removed from the Processor without losing memory contents.

**CAUTION:** Power from the System Power Supply Module must be disconnected before removing or inserting modules. Damage may result if this procedure is not followed.

The Memory Battery fits into a socket located below the Memory Segment sockets. The battery socket is keyed to assure proper battery orientation. Exchanging the battery is possible while DC power is applied to the Memory Module. Exchanging the battery without the System Power Supply Module power to the Processor will cause loss of memory contents.

**Table A**
**MEMORY STAND-BY TIME**

| Temperature (max.) | | Stand-by Time (weeks)* | |
|---|---|---|---|
| °F | °C | Typical | Minimum |
| 80 | 27 | 32 | 8 |
| 100 | 38 | 16 | 4 |
| 120 | 49 | 8 | 2 |
| *Based on maximum memory capacity (2048 words) | | | |

**CAUTION:** If the battery is drained while it is providing stand-by power to the memory, the contents of the memory will be lost. All information must be re-entered by a PLC Program Panel System (Cat. No. 1774-T1, -T15, -T6, or -T65) or a PLC-2 Program Panel System (Cat. No. 1772-T1), Digital Tape Cassette Recorder System (Cat. No. 1774-T2) or punched paper tape-loading device.

A MEMORY FAULT indicator is located on the front edge of the Memory Module, just below the Memory Battery. (Refer to Figure 2.) This indicator, when illuminated, indicates an error in the parity of data retrieved from memory. Changing the Mode Select Switch to the PROGRAM mode resets this test circuit. The memory should be reloaded and checked in the TEST mode for another MEMORY FAULT indication.

Another diagnostic indicator is associated with the Memory Module. It is the STANDBY LOW indicator and is located on a small, offset, printed circuit board below the Memory Battery. This indicator illuminates when the Memory Battery is low at the moment of system power-up. It services as an indication that the memory contents have been altered due to loss of power. Memory contents must then be re-entered.

When illuminated, these diagnostic indicators (PROCESSOR FAULT, MEMORY FAULT, and STANDBY LOW) are easily viewed through a diagnostic window on the Processor front panel.

**System Power Supply** — The System Power Supply Module (Cat. No. 1772-P1) forms part of the Processor Chassis. This Supply occupies the left half of the Chassis. (Refer to Figure 2.) It slides into the Chassis on runners that accept only the System Power Supply. (The three Processor modules **cannot** be inserted on these runners.)

All necessary and normal electrical power requirements for the Processor and 2 I/O Racks are provided by this Supply. (A single connector terminates in a wire bundle that extends from the System Power Supply Module and provides power to all Processor modules. Refer to Figure 4.) The connector mates with a socket on the Processor motherboard, and must be connected before the System Power Supply is fully inserted into the Chassis.

Fuses are provided in the System Power Supply Module circuitry. (Replacement fuses and additional information concerning the System Power Supply Module is presented in Publication 1772-902, PLC-2 Power Supplies.)

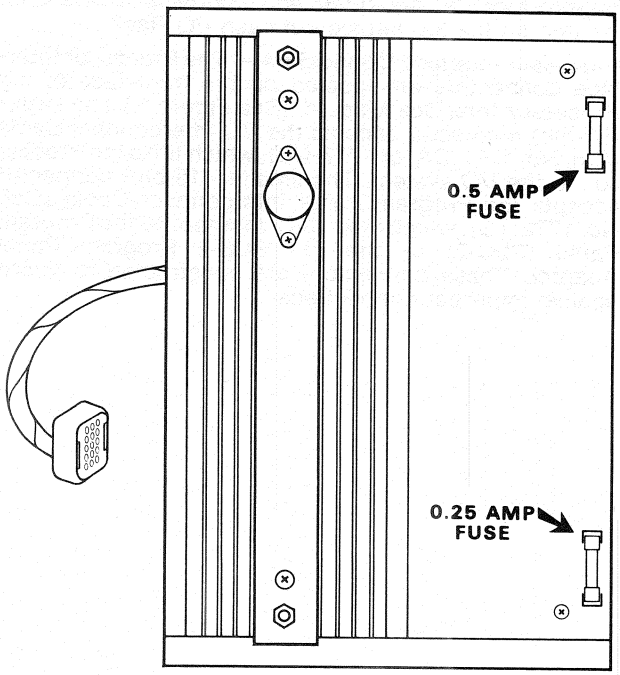



**Figure 4 — System Power Supply Module**

**Processor Front Panel** — The Processor front panel contains termination for AC input power, I/O power, I/O communication, and Program Panel connections. (Refer to Figure 1.) In addition to these terminations, a system Mode Select Switch, fuse holder, and status indicators are provided. The following sections describe the purpose of each of these functions.

**AC Input Power Fuse** — The AC Input Power Fuse is located in a fuse holder at the top of the recessed section of the System Power Supply. (See Figure 1.) This 2 ampere, slo-blo fuse protects the System Power Supply Module from excessive current drain on the AC line.

**DC ON Indicator** — The DC ON indicator is the lower of two indicators on the front panel; both are adjacent to the Mode Select Switch. (Refer to Figure 1.) This red indicator is illuminated when the Power Supply is operating properly. It is extinguished when the AC input power to the System Power Supply Module or any of the DC output voltages from the System Power Supply Module are not within specified tolerances, or when one of the three Processor modules is not plugged in completely.

**RUN Indicator** — The green RUN indicator is directly above the DC ON indicator. (See Figure 1.) The indicator is designed to be illuminated when the Mode Select Switch is in the RUN position and outputs are enabled. If not on, a malfunction has occurred.

**External Power Terminal Strip** — The External Power Terminal Strip is located near the bottom of the System Power Supply Module. (Refer to Figure 1.) AC line connections to the System Power Supply Module are made at this terminal strip. Most domestic applications use 120V AC voltage; therefore factory-installed jumpers are made at this terminal strip for 120V AC operation.

Systems requiring 220/240V AC line must reconnect these jumpers, as shown on the front face of the System Power Supply Module.

**I/O Power Connectors** — The I/O Power Connectors are located below the AC input power fuse holder on the front face of the System Power Supply Module. (Refer to Figure 1.) I/O Rack logic circuitry is powered through the I/O Power Cable (Cat. No. 1777-AD, 3 feet, or 1777-AC, 8 feet). One end of this cable connects to a socket marked I/O RACK POWER on the System Power Supply Module; the other end connects to a socket located on the top left side of each I/O Rack.

**Processor Interface Connectors** — The Processor Interface connectors are located on the front face of the Processor Interface Module. (See Figure 1.) The larger (50-pin) connector accepts the I/O Interconnect Cable (Cat. No. 1777-CA, or 1777-CB), which links the Processor to the I/O system. The smaller (15-pin) connector accepts the Program Panel Interconnect Cable (Cat. No. 1772-TC), which links the Processor to the Program Panel (PLC-2) or the PLC/PLC-2 Program Panel Adapter. These connectors are constructed to guard against improper connections.

**Mode Select Switch** — The Mode Select Switch (keylock) is located on the front face of the Processor Interface Module. (See Figure 1.) It is a three-position keylock switch. With it, three modes may be selected: PROGRAM, TEST, and RUN.

When the Program Panel is used to enter the user control program into memory, the Mode Select Switch must be in the PROGRAM mode. In this position all outputs connected to the I/O system are disabled.

The system and program can be tested for proper operation by changing the Mode Select Switch to the TEST mode. The PLC-2 system operates as it would during normal operation, except that all outputs are disabled. This allows the program to be tested under simulated operation conditions without risking damage to controlled equipment or personnel.

Changing the Mode Select Switch to the RUN mode allows for normal system operation. The Processor continuously scans inputs and outputs and user program; it executes the program accordingly. This is the only position that allows for the removal of the key from the Mode Select Switch.

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# PLC-2 MEMORY ORGANIZATION AND STRUCTURE

**1.0 General** – This Publication is written to describe the organization and structure of a Bulletin 1772 PLC-2 Processor containing a Processor Control Module with the Cat. No. 1772-LB, **Series B.**[1] The Series B version of this Module was introduced in September, 1978, and it provided certain enhanced features which are **not** available to Processors which have a Series A Module. For example, of the features which directly affect the explanation of the memory, there are:

- A Data Table, expandable to 256 words, which optionally provides a user with a maximum of 104 internal programmable Timers and/or Counters.
- Programmable report generation, which allows a maximum of 6 user-written messages to be stored in the memory for playout on a peripheral device at user-selected times.
- Circuitry allowing either of 2 Program Panels to access the Processor in order to generate functions such as Contact Histogram, additional Instructions, to name a few.

Along with the introduction of the Series B Processor Control Module, a **Series B** PLC Program Panel (Cat. No. 1772-T1) and **Series B** PLC/PLC-2 Program Panel Adapter (Cat. No. 1772-T4) were introduced. Explanations of them are not relevant to this document, but it should be noted that a Series B version of the Program Panel or a PLC/PLC-2 Program Panel Adapter is required to fully implement the enhanced features of the **Series B** Processor Control Module.[2]

This Publication has two functions:

- To serve as an introduction to the basic concepts and terminology necessary for a general understanding of the programmable controller memory.
- To detail the memory organization principles of the Allen-Bradley Bulletin 1772 PLC-2 programmable controller.

No attempt is made here to explain solid state memory operation beyond what is necessary for an understanding of the PLC-2 controller. (Fundamentals and detailed explanations of solid state memory operation are available in the technical section of many libraries.)

**2.0 Bulletin 1772, PLC-2** – The memory of the Bulletin 1772 PLC-2 programmable controller is solid-state, read/write Random Access Memory (RAM). These solid-state memory components, the support circuitry needed to store and retrieve information, and a battery back-up system are all mounted on a common printed circuit board. The on-card battery back-up allows the memory to be removed from the Processor for a period of time without losing memory contents.

**2.1 Basic Structural Units** – The memory of the Bulletin 1772 PLC-2 controller can be thought of as a large array of storage points, each of which is called a "bit." (Bit is an acronym for BInary digiT.) A bit is the smallest unit of information a memory is capable of retaining.

A group of bits form a single "byte." A byte is defined as the smallest complete unit of information that can be transmitted to or from the Processor at a given time.

Bytes are made up of varying numbers of bits, the exact number of which depends on the specific hardware requirements of the individual system. The PLC-2 byte is composed of 8 data bits and 1 parity bit.

A group of 18 bits make up a "word," or PLC-2 Instruction, which is to say 16 data bits and 2 parity bits. This word can also be thought of as being made up of two 9-bit bytes. (PLC-2 documentation generally does not discuss parity bits, since they are transparent to most users.)

In this and most other PLC-2 documents, the 16 data bits of the PLC-2 word are the subject of detailed discussion.

Because of its function in the memory, one PLC-2 word may also be thought of as a memory location: when a word is being used, an actual physical address in the memory is being accessed.

Note that in PLC-2 controller documentation it is a convention to show bits with the most significant bit (MSB) at the left and the least (LSB) at the right. PLC-2 bits are numbered 00 thru 07 and 10 thru 17. (Refer to Figure 1.)

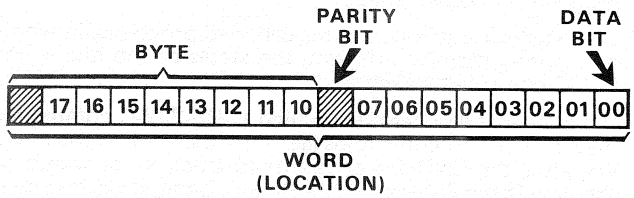



**Figure 1 – PLC-2 Word Structure**

**2.2 Memory Capacity** – The capacity of a memory is measured in thousands (abbreviated K) of words. The maximum memory configuration in the PLC-2 controller is 2048 words, or 2K. One Memory Segment (Cat. No. 1772-MR) is provided as standard with each Memory Module (Cat. No. 1772-MG). Incremental additions to the standard 512 words of memory are available. Since each Memory Segment contains 512 words, total memory capacity is expandable from 512 to 1024, 1536, or 2048 words.

The entire memory is **not** available for user program. The first 128 words of the first Memory Segment are set aside by the Processor for Data Table use. (An assumption is made here that the number of words set aside for Timer and/or Counter use has not been changed from the 80 words which may be considered as the "standard" number set aside for this use. Refer to Paragraph 2.3.1.5.)

This leaves 384 words for user program Instructions in the first Memory Segment. Performing a simple addition, it can be seen that a controller with 2 Memory Segments could have 896 program Instructions; a controller with 3 Memory Segments could have 1408 Instructions; a controller with 4 Memory Segments could have 1920 Instructions.

---

[1] For information concerning the memory of PLC-2 Processors with a Series A Processor Control Module, refer to Publication 1774-921.

[2] The Series A versions of the Module, Program Panel and Adapter may be returned to Allen-Bradley for optional upgrading in Series levels. Equipment Series level upgrading at the customer's site by an Allen-Bradley Customer Service Representative is also possible.

**2.2.1 Data Entry** – The nature of the information stored in the memory is very simple: a bit is either energized or de-energized, ON or OFF. These states can be represented as "1" or "0." (Literature for the PLC-2 controller does not use the equally common phrases "high level voltage" and "low level voltage.")

In order to store anything more complex than ON and OFF, groups of bits, in the form of a PLC-2 word, must be grouped together.

How are individual bits energized or de-energized, placed into the ON or OFF state, set to "1" or cleared to "0"? The state of inputs from PLC-2 controlled devices determines the state of some bits. The Processor, using the Instructions in the user program logic, changes others. Lastly, user programs, in whole or in part, can be loaded into the memory by means of either the PLC-2 Program Panel (Cat. No. 1772-T1) or the Bulletin 1774 Program Panel (Cat. No. 1774-TA) along with a PLC/PLC-2 Program Panel Adapter (Cat. No. 1772-T4).

There are other means of energizing and de-energizing bits, or entering data, but these also require the use of one of the Program Panels as an intermediate device. A user-supplied RS-232-C compatible punched paper tape-reading device, such as the type provided on Teletypewriters, can be used to enter a program. (When the Bulletin 1774 Program Panel is used in this way, the Program Panel Adapter is also required.)

Another means of entering data is the Digital Cassette Recorder (Cat. No. 1770-SA), which can be used to load a program into memory. (It is also used to verify or copy a program previously entered.)

Optionally a user's computer can load programs, in whole or in part, thereby affecting the states of the bits in the PLC-2 controller's memory.

A keyboard/data terminal which is RS-232-C compatible may be used to enter messages into the area of the memory after the END (of program) Instruction, as would be the case if the Programmable Report Generation feature is being used.

All of these devices are means with which data can be entered into the PLC-2 controller's memory.

**2.2.2 Ending A Program** – The PLC-2 controller does not require that an END (of program) Instruction be entered by the user after the last program Instruction. An END Instruction is generated by the Processor. It is present before any program steps are entered and is automatically positioned after the last programmed Instruction, once program entry is begun. (An additional END Instruction can be entered, although its use is not mandatory.)

Starting with the first program Instruction, the Processor scans the program and executes all Instructions in the sequence called for by the program. The END Instruction stops the Processor from scanning unused memory, and, in effect, shortens the scan time by returning to the first Instruction of the user program.

In normal operation, an END Instruction is displayed on the Program Panel when the cursor is moved past the last user program Instruction. The END Instruction also appears before program steps are entered. When a user-supplied Teletypewriter or keyboard/printer is used, the END Instruction is also printed on the hardcopy printout. At the right of the END Instruction, a 3- or 4-digit number also appears. This number indicates the number of words, in decimal, actually entered into memory **before** the END Instruction. (Note that the size of the Data Table, automatically set by the Processor for 128 words, must be subtracted from the number displayed in order to determine the exact number of user program words.)

Should a user attempt to enter more Instructions than the maximum capacity of the available memory, the message ERR 1 is displayed on the Program Panel screen. Additional program Instructions cannot be entered.

PLC-2 Instructions take an average of 10 to 20 μsec for the Processor to scan and execute each word. The execution time for different Instructions varies considerably and is dependent on the exact Instruction and, in some cases, its TRUE/FALSE state. A typical program using 1024 words of memory (including the Data Table) would have a scan time of approximately 17 msec, or nearly 50 scan cycles per second, assuming a distribution with approximately 80% common PLC-2 Instructions, such as Examine Input Open, Closed, Examine Output Open, etc.

**2.3 Memory Organization** – The PLC-2 memory can be divided into two major parts:

- Data Table
- User Program

All input/output status and user program Instructions are stored in one of these parts. Each of these is discussed in subsequent paragraphs. (Refer to Figure 2.)

In certain applications, the PLC-2 memory can be divided into three parts. The third area of memory is Message Storage. Functionally, this area stores messages for the Report Generation feature. (Additional information concerning Report Generation is given in Paragraph 2.3.3.)

**2.3.1 Data Table** – As was stated earlier, the Data Table area of the PLC-2 memory does not store user program Instructions. Data Table words, and/or the 16 bits in each word, are controlled and utilized directly by the Processor. The Processor **does not** directly control the Instructions in the user program. The state (ON/OFF) of input devices wired to the I/O Racks directly controls certain Instructions in the user program. Other user program Instructions are directly controlled by the user-written application program. User program Instructions are repeatedly and sequentially scanned and executed by the Processor according to the control logic established in the user program.

The Processor automatically reserves the first 128 words in the first Memory Segment for use as the Data Table. A user has the option to reduce the size of the Data Table to a minimum of 48 words. A user also has the option to increase the size of the Data Table to 256 words. (Refer to Paragraph 2.3.1.5.)

The Data Table of the PLC-2 controller can be divided into six distinct areas, assuming the size of the Data Table has not been altered. These are:

- Processor Work Area No. 1
- Output Image Table
- Timer and/or Counter Accumulated Values, or bit and/or word storage
- Processor Work Area No. 2
- Input Image Table
- Timer and/or Counter Preset Values, or bit and/or word storage

These Data Table areas are discussed in following paragraphs; Output Image Table in Paragraph 2.3.1.1; Input Image Table in Paragraph 2.3.1.2; Timer and Counter Accumulated Values in Paragraph 2.3.1.3; Timer and Counter Preset Values are covered in Paragraph 2.3.1.4; both Processor Work Areas in Paragraph 2.3.1.5; and the expanded Data Table in Paragraph 2.3.1.6.

The function of the Data Table may be explained in relation to inputs and outputs. The PLC-2 input and output modules cannot store information; they contain interface circuits only. Information in the form of input/output status (ON/OFF) is actually stored in the memory in areas called Image Tables. (An image is defined as an exact

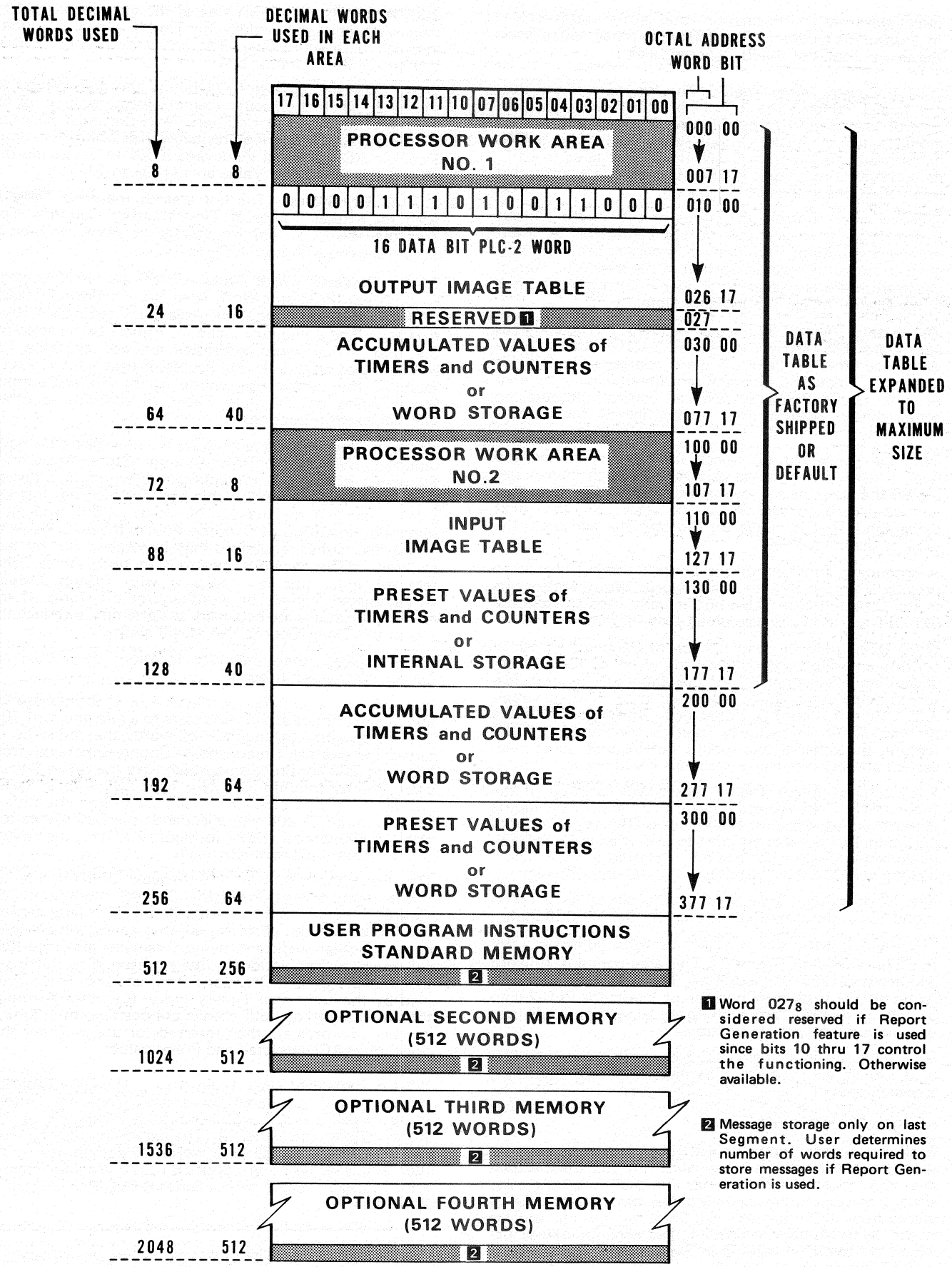



**Figure 2 — PLC-2 Memory Organization with Series B Processor Control Module**

duplicate array of information—that is, the states—stored in a different medium.) The following paragraphs discuss the Image Tables of the PLC-2 controller.

**2.3.1.1 Output Image Table** – The function of the Output Image Table in the PLC-2 controller is primarily to control the status of outputs wired from the output modules. If a bit in the Output Image Table is set to ON, its corresponding output is ON. If a bit is cleared to OFF, its corresponding output is OFF. These bits are controlled by Instructions in the user's program.

The Processor controls the status of bits in the Output Image Table as it generates output commands by interpreting Instructions from the user program. (The user program is stored in another portion of the memory.) Actual hardware outputs change state only if corresponding bits in the Output Image Table change state.

The Output Image Table begins with word $010_8$ and ends with word $027_8$.[1] (Refer to Figure 2.) The Output Image Table therefore contains 16 word addresses, or 256 bit addresses. These 256 bits represent the maximum number of outputs the PLC-2 system can control, although no actual system would ever be configured for outputs exclusively.

Each bit in the Output Image Table may be associated with a hardware terminal address, although this is not always the case, since a corresponding output module may not actually be placed in an I/O Rack slot. (See next paragraph.) If it is, however, the terminal address is the **same** as the bit address.

A secondary function of the Output Image Table is to provide a storage area for bits or words. Words and/or bits in the Output Image Table not actually used to store the ON/OFF status of devices can be used for data storage.

Word $027_8$ may or may not be available to a user to control an output module or for word or bit storage, depending on whether or not the Report Generation feature is being used. This is explained in detail in Paragraph 2.3.3. Here it should be noted that, although only 8 bits of word $027_8$ are actually used as control bits of the feature, the other 8 bits should **not** be used since inadvertent alteration of the control bits could occur.

**2.3.1.2 Input Image Table** – The single function of the Input Image Table is to duplicate the status of the inputs wired to input modules. If an input is ON, its corresponding Input Image Table bit is set to ON. If an input is OFF, its corresponding bit in memory is cleared to OFF. These bits are monitored by Instructions in the user program.

The Input Image Table is constantly changing to correspond to the information supplied by the input modules.

The Input Image Table is bound by word addresses $110_8$ to $127_8$. (Refer to Figure 2.) This area contains 16 word addresses, or 256 bit addresses. These 256 bit addresses represent the maximum number of inputs the PLC-2 controller can monitor, although no actual system would ever be configured for inputs exclusively.

Note however, in a single PLC-2 controller, the **total bits used**, which represent actual hardware inputs and outputs, **together cannot** exceed 256. This figure represents the maximum I/O capability of the PLC-2 controller and is equivalent to 64 I/O modules.

Each bit in the Input Image Table may have a corresponding real hardware terminal on the I/O Rack associated with it, although this may not always be the case, since a corresponding Input Module may not actually be placed in an I/O Rack slot. If it does, the terminal address is the same as the bit address. The correspondence between the two is illustrated in Figure 3. For more details, refer to Publication 1777-900.

Note that the Input Image Table **cannot** be used for bit and/or word storage.

**2.3.1.3 AC, Stores** – This area of the memory is used to store ACcumulated Values of Timers and/or Counters internal to the controller. The area may also be used as storage for words and/or bits.

Word addresses $030_8$ to $077_8$ bound this area. (Refer to Figure 2.) There are enough memory locations here for 40 internal Timers and/or Counters. Note that each Timer or Counter used actually requires **two** words of memory: one from the ACcumulated Value area ($030_8$ to $077_8$) and the other from the PReset Value area ($130_8$ to $177_8$).

**2.3.1.4 PR, Stores** – The last area of the Data Table is used for PReset Values of Timers and/or Counters. The area may also be used for storage of words or bits. It occupies word addresses $130_8$ to $177_8$.

**2.3.1.5 Processor Work Areas** – There are two Processor Work Areas: Processor Work Area No. 1 (addresses $000_8$ to $007_8$) and Processor Work Area No. 2 (addresses $100_8$ to $107_8$). These memory locations **cannot** be accessed by the user. Their word addresses **are not** available for addressing of any kind. The Processor uses both Areas to establish the number of words in the Timer/Counter, Stores Areas of the Data Table, in addition to other internal control functions.

Through programming techniques the user may optionally reduce the size of the Timer/Counter, Stores Areas from 80 words down to a minimum of 0 words in order to make additional space available for user program Instructions. Changing the number of words in this Area to a minimum condition of 0 words reduces the Data Table to 48 words. Other reductions may be worked out by subtraction. (The memory locations in both Areas being reduced must not be occupied with PReset Values, ACcumulated Values, or word and/or bit stores. If the memory locations are occupied, the attempt to reduce the size of the Timer/Counter Areas will abort.)

Once reduced, these memory locations cannot be addressed by the user program.

This same programming technique is used to increase the number of Timers and/or Counters to a maximum of 104. This means that the number of words that must be reserved for internal Timers and/or Counters increases from 80 up to 208 for Processors which have the **Series B** Processor Control Module (Cat. No. 1772-LB). Increasing the number of words reserved for Timers and/or Counters to the maximum of 208 words expands the Data Table to a total of 256 words. (Refer to Figure 2.) Other increments can be determined mathematically.

The Processor performs a self-check to determine the Series level of the Processor Control Module. If the Module is determined to be the Series B, or later version, the Processor then performs another check, which determines whether sufficient memory remains after the END (of program) Instruction for the corresponding shifting of the user program Instructions from the area to be occupied by the additional Timers and/or Counters. Assuming that the results of both checks are positive, the required number of words are then reserved for use as Timer and/or Counter ACcumulated and Preset values.

**2.3.1.6 Expanded Data Table Area** – The Data Table can be optionally expanded by a user from the factory-shipped size of 128 words up to a maximum of 256 words. (Refer to Figure 2.) (The expansion may be made in increments as small as 2 words, as determined by the user, and is set by using a **Series B** PLC-2 Program Panel or a PLC Program Panel with a **Series B** PLC/PLC-2 Program Panel Adapter.)

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[1] The subscript $_8$ indicates that an octal numbering system is being used. Thus no numbers larger than 7 are used. Counting begins at 0. The subscript $_{10}$ indicates that a decimal numbering system is being used. The decimal numbering system, being most common, is implied if no subscript is used.

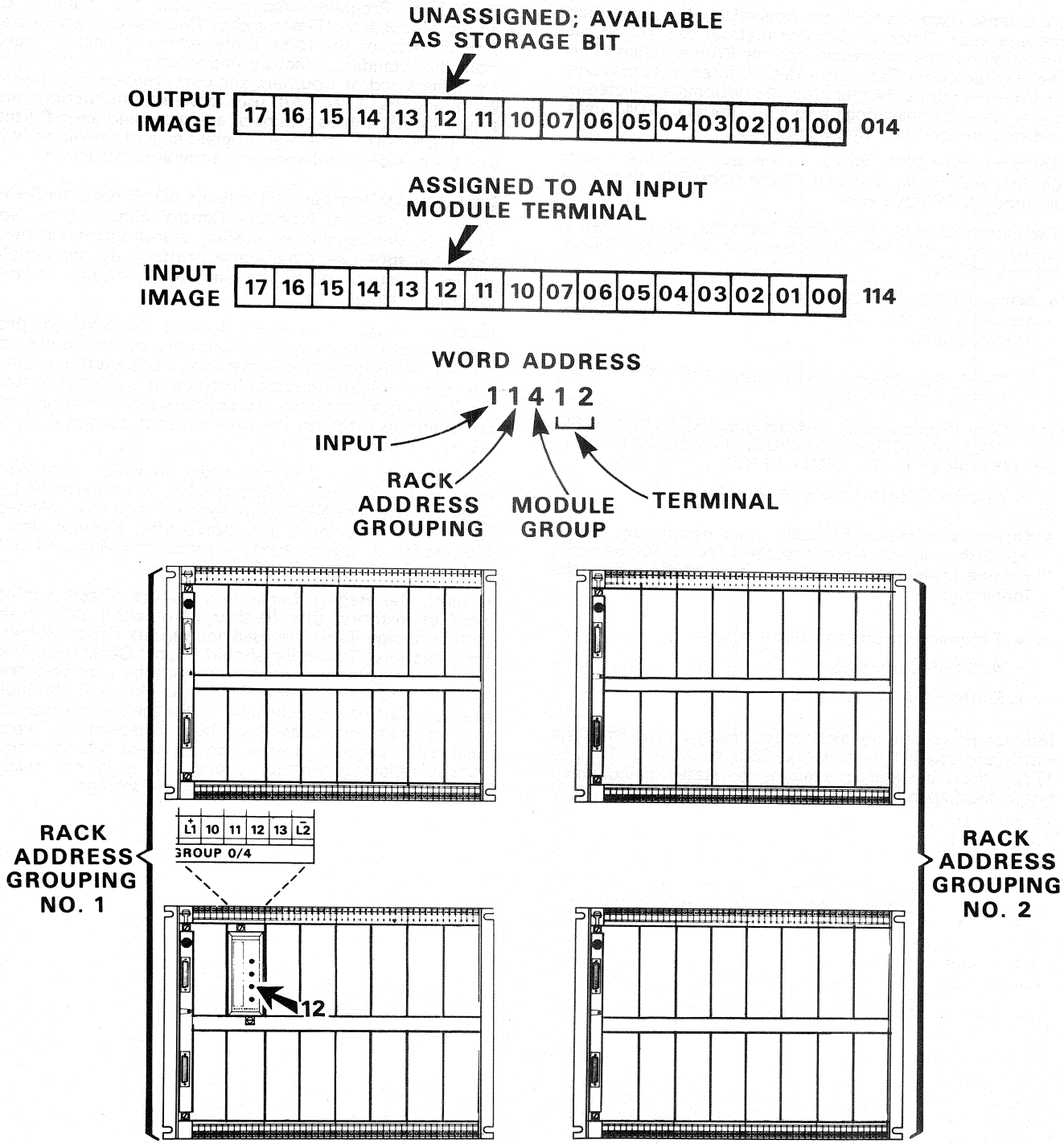



Figure 3 — Relation of Word Address to Hardware

In a sense, two "areas" are opened by this expansion, because each Timer or Counter requires two words, one for ACcumulated values and one for PReset values. Since the standard Data Table provides 40 internal Timers and/or Counters, up to 64 more may be optionally selected by a user, thereby providing up to a maximum of 104 Timers and/or Counters for a single controller.

Addresses from $200_8$ thru $277_8$ are used for Timer and/or Counter ACcumulated values. Those from $300_8$ thru $377_8$ are used for PReset values.

The expanded area of the Data Table may also be used as storage for certain PLC-2 Instructions within the following restrictions:

- Many PLC-2 Instructions can be directly assigned addresses in the expanded area of the Data Table. These include:
  - Timer and Counter Instructions: TON, TOF, RTO, RTR, CTU, CTD, CTR
  - Data Manipulation Instructions: GET, PUT, LES, EQU, IMMEDIATE INPUT, IMMEDIATE OUTPUT, GET BYTE, LIMIT TEST
  - Arithmetic Instructions: +, −, x, ÷
- Direct examination of Instructions which have 5-digit addresses beyond word address $177_8$ is **not** possible. Among these Instructions are those that examine the following:
  - Timer and/or Counter status bits
  - Addition Carry Bits
  - Subtraction Borrow Bits

Indirect programming techniques, using an intermediate word (addressed $010_8$ to $027_8$, $030_8$ to $077_8$, or $130_8$ to $177_8$), must be used to examine the status of individual bits in the Expanded Areas.

**2.3.2 User Program** – Assuming that the number of words reserved for Timer and/or Counter use, and therefore the size of the Data Table, have not been changed from the "standard," factory-shipped number of 80 words for Timers and/or Counters, the user program begins after word address $177_8$. All user program Instructions are stored in this area as groups of energized and de-energized bits. Each word in the user program area of the memory is capable of storing only one user program Instruction.

**2.3.3 Message Storage** – Processors which have the Series B, or later version, Processor Control Module (Cat. No. 1772-LB) are capable of storing user-programmed messages for subsequent hardcopy printout by compatible RS-232-C data terminals. As many as 6 messages of varying length can be stored.

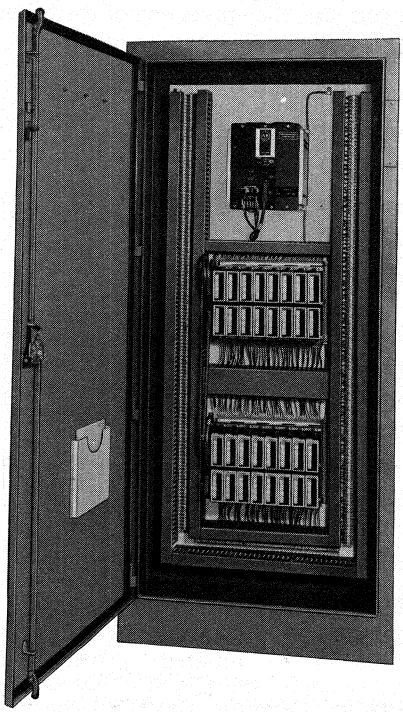
Message storage immediately follows the END (of program) Instruction, and is limited only by the number of unused words remaining in memory. Each word remaining after the END (of program) Instruction is capable of storing 2 message characters. (Characters are defined as keyboard entries made on the data terminal, such as A, 1, M, ., 8, space, etc.)

Messages are stored in the order in which they were entered. For example, if Message No. 1 is entered first, it is stored after the END (of program) Instruction. Message No. 4 is then entered and stored after Message No. 1. Message No. 2, entered next, is stored after Message No. 4, and **not** after Message No. 1.

If used, the Report Generation feature affects another word of memory. Bits 10 thru 17 of word $027_8$ in the Output Image Table are used for various Report Generation functions. Therefore, should Report Generation functions be programmed, no **output** modules may be placed in Rack Address Grouping 2, Module Group 7. (An input module may be used, however.) Furthermore, since the user program examines these bits to determine Report Generation status and may also set these bits to initiate various report generation operations, it is **not** recommended that bits 00 thru 07 be used for storage.

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# SERIES B FEATURES
## PLC-2 programmable controller



**PLC-2 controller (typical installation)**

**1.0 Introduction** – Beginning in August, 1978, the Bulletin 1772 PLC-2 programmable controller began shipping with a Series B version of certain components. In general, these may be seen as normal developments which may be expected in any product life. Users with Series A versions may wish to have these product updates made available to them; this is possible, as is described in Paragraph 11.0.

As the result of the enhancements, the PLC-2 controller now offers these additional features:

- Firmware Series and Revision levels display on Program Panels
- Data Table optionally expandable up to 256 words to provide as many as 104 timers and counters
- New additions to basic Instruction set
- Peripheral baud rate and/or functions selected from Program Panel keyboard
- Report generation
- Contact histogram (display or hardcopy)
- Processor-Modem-Processor links

The purpose of this Publication is to give a quick explanation of these enhancements. The PLC-2 programmable controller Operator's Manual (Cat. No. 1772-UM) dated December, 1978, or later, explains most of these features in detail. Subsequent editions will contain Processor-Modem-Processor link information.

**2.0 Series B Features** – Several major components in the PLC-2 controller product line have been enhanced to the Series B l vel. These are:

- Processor Control Module (Cat. No. 1772-LB)
- PLC-2 Program Panel (Cat. No. 1772-T1)
- PLC/PLC-2 Program Panel Adapter (Cat. No. 1772-T4)

As a direct result, new features are now available as standard when users purchase this equipment. (Users with components of the Series A versions may optionally update the units. Refer to the "New Feature Update" section of Publication 1772-47, dated July, 1978, or later, for prices and arrangements.)

An entirely new data sheet explaining the memory is available. This is PLC-2 Memory Organization and Structure (Publication 1772-907).

**3.0 Series/Revision Display** – Both the Series B PLC-2 Program Panel and Series B PLC/PLC-2 Program Panel Adapter allow the user to visually display the Series and Revision level of the unit's firmware. This feature allows a quick, convenient means of determining the identification of units being used.

When power is applied – either by the main disconnect switch or by the unit's ON/OFF toggle switch – the Bulletin 1772 PLC-2 Program Panel displays, for several seconds, the numeric equivalents of the Series and Revision levels after the message STA. (Numeric equivalent here means that A equals 1, B equals 2, etc.) Thus the display for the Series B, Revision A units would be:

**STA 2.1**

After several seconds the display is replaced either by the first program Instruction or by a message that indicates the Data Table size.

In the case of a PLC Program Panel used with a Series B PLC/PLC-2 Program Panel Adapter, at power-up the user can manually call up the firmware Series/Revision display by entering the commands [TTY] [CANCEL COMMAND]. The following message then appears on the CRT:

**READY (SER.B/REV.A)**

Press [DISPLAY] to enable keyboard operation.

**4.0 Expandable Data Table** – Assuming a Series B Processor Control Module, the Data Table may be expanded, according to application needs, up to a maximum of 256 words. (The Series A Module provided a maximum Data Table of 128 words.) The value of this enhancement is the flexibility it gives in tailoring to specific requirements the number of words reserved as internal timers and/or counters. The user now has a maximum of 208 words available for this purpose.

Since each timer and/or counter used requires 2 words of memory, up to a total of 104 of them can now be programmed into the PLC-2 Processor. The Data Table addresses that are expanded into are $200_8$ – $277_8$ for Accumulated Values, and $300_8$ – $377_8$ for Preset Values. (Refer to Publication 1772-907.)

The Module automatically "defaults" to a Data Table of 40 timers and counters, or to address $177_8$, if the user does not make a programming change subsequent to placing it in operation. (This occurs both on the Series B and A versions.)

Alternately, the area may also be used for storage within restrictions described later.

**Publication 1772-908 – August, 1979**
Supersedes Publication 1772-908 – Dated January, 1979

The procedure to expand the Data Table is common to both the PLC-2 Program Panel and the PLC/PLC-2 Program Panel Adapter, and is as follows:

- Select the PROGRAM mode of operation.
- Enter the command [SEARCH] [5] [0].
- Enter the desired number of Timers and/or Counters. (This number may be between 000 and 104. Selecting 000 removes **all** memory locations for Timers and/or Counters.)

It should be kept in mind that **increasing** the number of Timer and/or Counter Instructions beyond 40 automatically **decreases** by a factor of 2 the number of words available for program Instructions.

As with the Series A version of the Module, the Series B allows a user to **decrease** the size of the Data Table, thereby **increasing** words available for program Instructions. Any number from 039 to 000 may be used. Note that the 000 entry removes **all** memory locations for Timers and/or Counters.

**5.0 Additional Storage** – Addresses from $200_8$ thru $277_8$ are used for Timer and/or Counter Accumulated values. Those from $300_8$ thru $377_8$ are used for Preset values.

The expanded area of the Data Table may also be used as storage for certain PLC-2 controller Instructions within the following restrictions:

- Many PLC-2 controller Instructions can be directly assigned addresses in the expanded area of the Data Table. These include:
  - Timer and Counter Instructions: TON, TOF, RTO, RTR, CTU, CTD, CTR
  - Data Manipulation Instructions: GET, PUT, LES, EQU, IMMEDIATE INPUT, IMMEDIATE OUTPUT, GET BYTE, LIMIT TEST
  - Arithmetic Instructions: +, –, x, ÷
- Direct examination of Instructions which have 5-digit addresses beyond word address $177_8$ is **not** possible. Among these Instructions are those that examine the following:
  - Timer and/or Counter Status Bits
  - Addition Carry Bits
  - Subtraction Borrow Bits

Indirect programming techniques, using an intermediate word (addressed $010_8$ to $027_8$, $030_8$ to $077_8$, or $130_8$ to $177_8$), must be used to examine the status of individual bits in the Expanded Areas.

**6.0 Additional Instructions** – Two additional Instructions have been added to the PLC-2 controllers's Instruction set. These are GET BYTE and LIMIT TEST. The GET BYTE Instruction "gets" or duplicates either the lower 8 bits (00 to 07) or the upper 8 bits (10 to 17) of a 16-bit word in the PLC-2 Data Table. A mathematical comparison of this binary coded octal value can be made with the binary coded octal values of the LIMIT TEST Instruction.

The LIMIT TEST Instruction is logically TRUE if the value of the GET BYTE Instruction is greater than or equal to the LIMIT TEST lower limit and less than or equal to the LIMIT TEST upper limit.

**7.0 Keyboard Peripheral Selections** – Users may now enter new keyboard commands when a Series B PLC-2 Program Panel or the PLC Program Panel with a PLC/PLC-2 Program Panel Adapter is used. These commands are related to peripheral terminal operation.

The first group of commands allows a user to vary the communication rate at which the Program Panel is operating. Since the range of compatible peripherals available for use with the PLC-2 controller begins at 110-baud printers and moves up to 9600-baud computers, these simple commands do much to enhance the flexibility of the Program Panels. (Obviously, no rewiring or patching is required, as may be the case with some other units.)

The Program Panel entry sequence is as follows:

- Press [RECORD].
- Select baud rate, then press one of the following:

  [2] for 110 baud

  [3] for 300 baud

  [4] for 600 baud

  [5] for 1200 baud

  [6] for 2400 baud

  [7] for 4800 baud

  [8] for 9600 baud

Note that although a print or dump (copy memory) operation can be carried on at any baud rate up to 9600, the maximum baud rate for a load or verify operation is 1200.

The second group of new keyboard commands have three distinct areas of use:

- With peripheral load/dump/verify operations
- With automatic, program-initiated report generation feature
- With the contact histogram feature

Each of these is described separately.

In general, load/dump/verify operations carried on with a peripheral device are initiated by commands from the device. For example, the Digital Cassette Recorder or a user's computer transmits signals to the Program Panel prior to a selected operation. However some peripherals such as tape punches and high-speed line printers do not have keyboards integral to the unit. For those cases, 3 new commands are being introduced to aid the user to initiate operations to or from a wider variety of devices. These are to be used in the PROGRAM mode.

The commands, as entered from a Program Panel, are:

- [SEARCH] [4] [1] which initiates a binary dump
- [SEARCH] [4] [2] which initiates a binary load
- [SEARCH] [4] [3] which initiates a binary verify

Note that the qualifier "binary" here implies that the complete contents of the Data Table are available to the operation. Thus these commands would be used with RS-232-C compatible storage devices such as tape punches, computers and floppy discs which require the **entire** memory contents for subsequent use.

Since the Digital Cassette Recorder does not transmit to the Program Panel according to the RS-232-C Standard, the commands noted here are **not** to be used with it. Follow those outlined in Publication 1770-800, User's Guide, Digital Cassette Recorder.

Because the ladder diagram printout on hardcopy does **not** require a complete binary dump, a separate command is used to initiate this operation. It is:

[SEARCH] [4] [4]

The new command used to initiate an automatic Message Report operation initiated by the user program is:

[SEARCH] [4] [0]

This command is entered in the PROGRAM mode, but

the actual execution is in the RUN mode. A full explanation of this Report is given at Paragraph 8.0.

Finally, there are 2 commands for use with the Contact Histogram feature. These are:

- [SEARCH] [6] for a continuous display and automatic scroll/advance
- [SEARCH] [7] for a manual advance once the maximum display is reached.

These commands may be entered in any mode, although for a Histogram display the Processor must be in the RUN or TEST mode. A full explanation of the Contact Histogram feature is given in Paragraph 9.0.

**8.0 Report Generation** – The Series B PLC-2 Processor, along with a Program Panel, is capable of performing certain Report Generation functions. The printing of a Report can be either program-initiated or manually initiated by the operator with a compatible RS-232-C data terminal/keyboard able to produce hardcopy printouts. In order to display the Message on a CRT, the Bulletin 1774 Program Panel or a compatible CRT display terminal must be used. [1]

Messages [2] can be any combination of words, numbers, or data received from memory. As many as 6 Messages can be stored and printed/displayed. However, the length of each Message and number of characters therein are limited by the number of words remaining after the END (of program) Instruction. Data table values can be included in the reports by entering an asterisk (*) before and after the appropriate 3, 4, or 5-digit address.

There are 4 Report Generation functions, as listed in Table A. Note that in all examples the fourth key entry is the digit 1. This could also be 2 thru 6, depending on message number desired. The functions are illustrated here for Message No. 1.

**Table A**

**REPORT GENERATION COMMANDS**

| FUNCTION | COMMAND |
|---|---|
| Message Store | [M] [S] [,] [1] [RETURN] |
| Message Delete | [M] [D] [,] [1] [RETURN] |
| Message Print (for verification only) | [M] [P] [,] [1] [RETURN] |
| Message Report (operator-initiated) | [M] [R] [,] [1] [RETURN] |
| Message Report (program-initiated) | [M] [R] [RETURN] |

The enhanced Series B Processor Module has the capability to **automatically** initiate up to 6 separate user-programmed Reports when one of 6 directly corresponding bits in "reserved" word address $027_8$ changes state from de-energized to energized ("0" to "1"). (These are bits 02710, 02711, 02712, 02713, 02714, or 02715.) Word $027_8$ must be reserved **only** if the user-program-initiated Report Generation feature is used. In this case it is recommended that the remaining bits in the word **not** be used for other purposes.

If the program-initiated capability is not used – as may be the case with an operator-initiated Report –, word $027_8$ is available for normal use.

**9.0 Contact Histogram** – Contact Histograms of many PLC-2 controller Instructions can be displayed on either the Series B Bulletin 1772 Program Panel, or on the Bulletin 1774 Program Panel (CRT) connected to a Series B PLC/PLC-2 Program Panel Adapter. Hard-copy printouts can be generated by compatible RS-232-C data terminals.

Two modes of operation are available: continuous and non-continuous. The continuous mode Contact Histogram display, one using [ ⊣⊢ ] 12312 as an example, is initiated in the following manner:

**Step 1** – Press [SEARCH] [6].

**Step 2** – Enter the Contact Histogram Instruction [ ⊣⊢ ].

**Step 3** – Enter the Instruction's 3- or 5-digit address [1] [2] [3] [1] [2].

**Step 4** – Press [DISPLAY] to start timing.

The non-continuous mode for [ ⊣⊢ ] 12312 is initiated as follows:

**Step 1** – Press [SEARCH] [7].

**Step 2** – Enter the Contact Histogram Instruction [ ⊣⊢ ]

**Step 3** – Enter the Instruction's 3- or 5-digit address [1] [2] [3] [1] [2].

**Step 4** – Press [DISPLAY] to start timing.

PLC-2 controller Instructions that can have a Contact Histogram generated are listed in Table B.

**Table B**

**CONTACT HISTOGRAM DISPLAYABLE INSTRUCTIONS**

| INSTRUCTION | DISPLAYABLE? YES | DISPLAYABLE? NO |
|---|---|---|
| ⊣⊢ ⊣/⊢ (L) TON | X | |
| TOF RTO CTU CTD | X | |
| (U) CTR RTR | | X |
| GET PUT LES EQU | | X |
| + − × ÷ | | X |
| IMMED INPUT / IMMED OUTPUT / GET BYTE / LIMIT TEST | | X |

**10.0 Processor-Modem-Processor** – Processor-to-Processor data transfer by means of an intermediate modem can be carried out with the Series B Program Panels and/or PLC/PLC-2 Program Panel Adapters. This feature permits binary data in the **entire** memory to be dumped, loaded and verified over telephone lines from one PLC-2 Processor to another.

---

[1] The Bulletin 1774 Program Panel screen can display 16 lines of Message data. When the Program Panel is used for this purpose, it is recommended that certain ASCII Control Characters (such as FORM FEED, CARRIAGE RETURN LINE FEED, ERASE TO END OF PAGE) be included in the Message text to clear the screen before another Message is displayed.

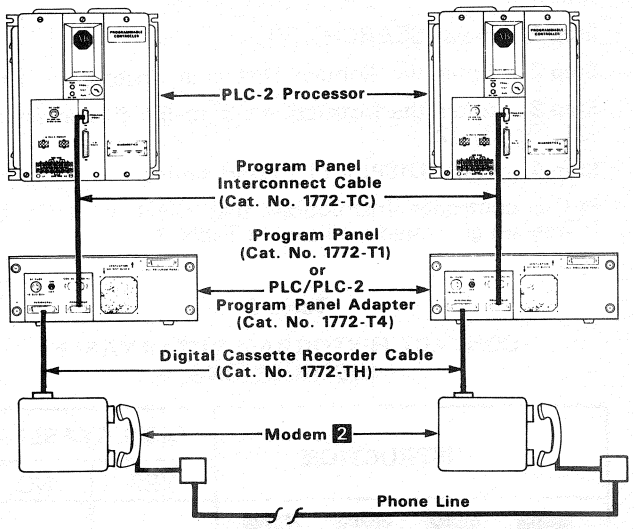
Certain compatible CRT display terminals are capable of displaying more than 16 lines and also may offer a display scroll feature. These features make the CRT display terminal a more flexible means of displaying Report Generation Messages.

[2] Reports and Messages are here used synonymously, although a small operational difference exists.

The modem must satisfy the following requirements:

- RS-232-C compatible
- Capable of full-duplex, asynchronous, serial communication at 110 or 300 baud
- Setting HI the CLEAR TO SEND (CB) signal before data transfer is begun.

One acceptable modem is the OMNITEC Model 703B. [1] Equivalent modems may also be used.




[2] Modem must be capable of setting the CLEAR TO SEND signal (pin 5 on PERIPHERAL connector) to HI before transmission is begun.

**Figure 1 — Processor-Modem-Processor Connections for PLC-2 Controllers**

The following steps establish the proper link for Processor-to-Processor data transfer.

**Step 1** — Make connections, as shown in Figure 1. However, also follow directions supplied by the manufacturer of the specific modem chosen.

**Step 2** — Select PROGRAM position on Mode Select Switch for **both** Processors.

**Step 3** — Establish communication baud rate of either 110 or 300 baud at **receiving** Processor. Press [RECORD] [2] for 110 baud, **or** press [RECORD] [3] for 300 baud.

**Step 4** — Establish binary load operation at **receiving** Processor. Press [SEARCH] [4] [2].

**Step 5** — Establish communication baud rate of either 110 or 300 baud at **transmitting** Processor. Press [RECORD] [2] for 110 baud, **or** press [RECORD] [3] for 300 baud.

**Step 6** — Establish binary dump operation at **transmitting** Processor. Press [SEARCH] [4] [1].

The memory contents of the **transmitting** Processor are then transmitted to and duplicated in the memory of the **receiving** Processor.

When the operation is complete, the message EXC 1 is displayed on the PLC-2 Program Panel. Alternately, the message RECORD 1 VERIFY MAGNETIC TAPE appears on the PLC Program Panel display screen. In both cases, the messages appear on the Program Panel connected to the **receiving** Processor.

If no data is sensed on the **receiving** end after 30 seconds have elapsed, the message ERR 2 appears on the Program Panel, or the message PERIPHERAL ERROR is displayed on the Bulletin 1774 Program Panel (CRT) which is connected to the **receiving** Processor. (The 30-second time delay does not limit the duration allowed to establish proper operation at the **transmitting** Processor. The Program Panel message indicates **only** that the expected data transmission has not yet been received.)

When the data is finally received, the Program Panel message at the receiving Processor is cleared. Pressing [CANCEL COMMAND] on the keyboard of the Program Panel connected to the receiving Processor also clears the display. However this command terminates the "receive data" mode at this unit.

**Step 7** — Verify that the data transfer is free of errors. Press [SEARCH] [4] [3] on the Program Panel keyboard for the unit which is connected to the **receiving** Processor.

Press [SEARCH] [4] [1] on the Program Panel keyboard for the unit which is connected to the **transmitting** Processor.

A verification process is initiated. Should errors be detected, it is recommended that a new copy operation be initiated along with a second verification process. (No error recovery techniques, as used with the Digital Tape Recorder, are included with this PLC-2 controller feature.)

The modem link, one transmitted over local phone lines only, must be relatively noise free and "solid." Users should be familiar with the basic principles of modem transmissions in order to determine quality of transmissions in given circumstances.

**11.0 Enhancing Series A Units** — Users with Series A PLC-2 controller units may optionally retrofit the enhanced features either at the factory or in the field. Prices and Catalog Numbers are noted in Publication 1772-47, dated July, 1978 (and in subsequent editions).

Requests for **factory firmware updates** (Cat. No. 1772-U01, -U41, -U11) should be sent to the **Service Order Department**. Mark the request to the attention of the Service Order Coordinator.

All requests for product updates made at the customer's site (Cat. No. 1772-U02, -U42, -U12) should be sent to the **Customer Service Department** (formerly called Field Service).

**WARNING:** The Series B PLC-2 Processor is not to be used with a Series A PLC/PLC-2 Program Panel Adapter (Cat. No. 1772-T4). Hazardous operation could result. Use only Series B, Revision A or later Program Panel Adapters, or use the PLC-2 Program Panel (Cat. No. 1772-T1).

In cases where more information is needed, contact your local Allen-Bradley representative. Copies of Publication 1772-907, PLC-2 Memory Organization and Structure, are available upon request.

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[1] OMNITEC Model 703B is available from:

OMNITEC Corporation
2405 South 20th Street
Phoenix, Arizona 85034

A-B QUALITY
ALLEN-BRADLEY
Cleveland, Ohio 44143

# Section 2
# MINI-PLC-2/15 AND PLC-2/20 PROGRAMMABLE CONTROLLERS

1770-915 EPROM Programming with Mini-PLC-2/15 Processor
1772-901 PLC-2/20 Processor
1772-909 Memory Organization and Structure of PLC-2/20 Processors
1772-911 Mini-PLC-2/15 Processor Module
1772-912 Memory Organization and Structure of Mini-PLC-2/15 Processor

# EPROM PROGRAMMING WITH A MINI-PLC-2/15 PROCESSOR

## Cat. No. 1770-XP

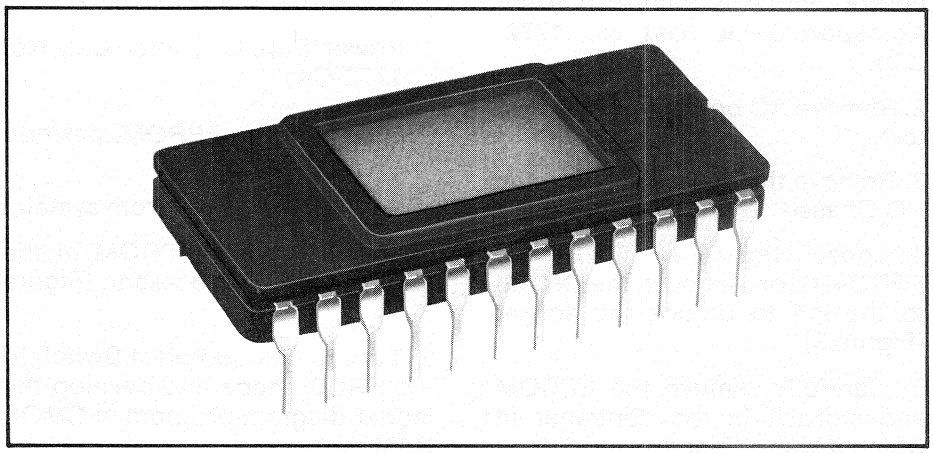


FIGURE 1 — EPROM (Cat. No. 1770-XP)

**SPECIFICATIONS**

**Programming Temperature**
20° C to 30° C

**Nominal Storage Temperature**
—65° to 125° C

**Programming Time**
Approx. 5 min/2K

**UV Exposure Dose**
Minimum of 15 W-sec/cm²

**UV Power Rating**
(UV Intensity)
Minimum of 5000 μW/cm²
at 253.7 nm

### DESCRIPTION

The EPROM (Erasable Programmable Read Only Memory)(Cat. No. 1770-XP) is a 24-pin, UV erasable memory chip that provides the user of a Mini-PLC-2/15 Processor (Cat. No. 1772-LV) with a 2K nonvolatile backup memory system (Figure 1). Although EPROM memory is retained until erased, it is recommended that battery backup still be used. This will ensure that data table values are not reset to their initial start-up values after a power loss.

The EPROM fits into a 28-pin ZIF (zero insertion force) socket, which is located under a hinged door at the lower side of the Mini-PLC-2/15 Processor (Figure 2). The user fully develops the ladder diagram program in the Processor's 2K CMOS RAM memory and then initiates the EPROM programming sequence to duplicate the data onto the EPROM. Any time power to the system is restored, the EPROM will automatically transfer the program back into RAM memory when battery backup is not used or the RAM memory is invalid.

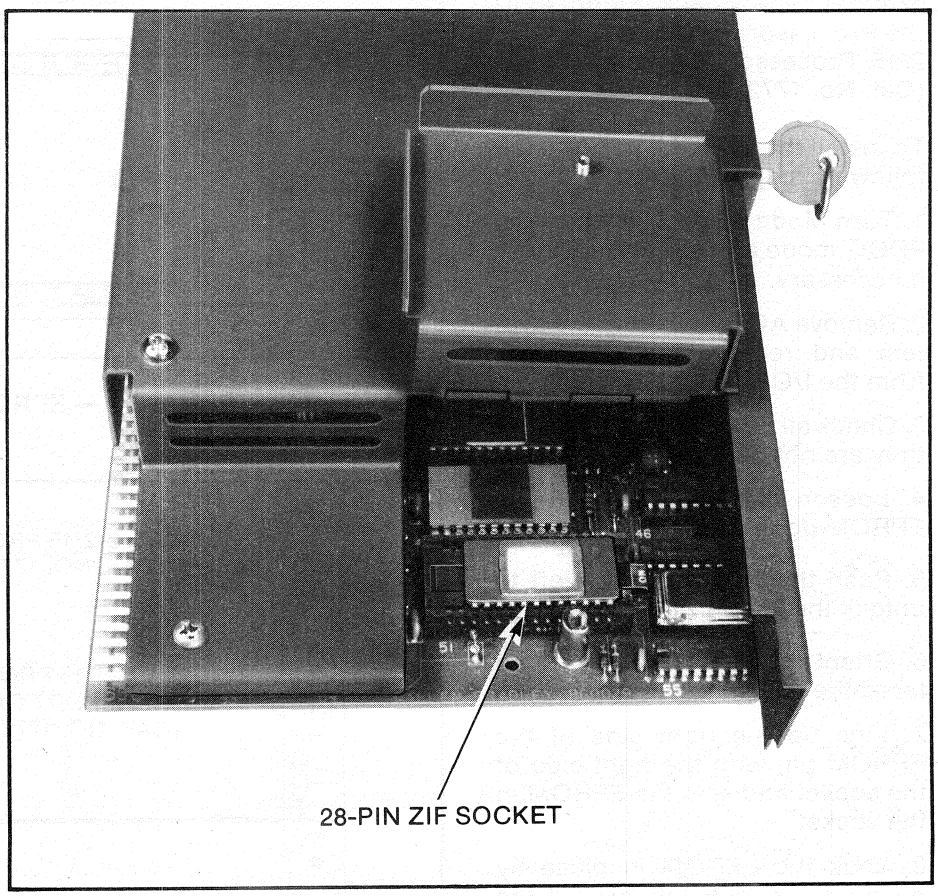



FIGURE 2 — EPROM Socket

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Publication 1770-915 — February, 1981

## HANDLING

Special care in handling the EPROM must be taken to ensure the pins do not become bent or accumulate dirt. Bent or dirty pins can interfere with proper EPROM programming and use. It is recommended that the EPROM be stored in the container in which it was shipped. It is also recommended that the user cover the transparent window on the EPROM with an opaque material to avoid undesirable alteration of memory.

## INSTALLATION/REMOVAL

On the underside of the EPROM door on the Mini-PLC-2/15 Processor is a label that illustrates EPROM installation methods (Figure 3). To access the EPROM socket, the Mini-PLC-2/15 Processor Module must be removed from the I/O Chassis. To maintain memory content in the Processor, connect an external battery pack (Figure 4) to the Processor with the Mini-PLC-2/15 Processor Transport Cable (Cat. No. 1772-CD).

To install the EPROM, perform the following steps (Figure 3):

1. Turn Mode Select Switch to the PROG mode and support memory if necessary.

2. Remove AC power from the system and remove the Processor from the I/O Chassis.

3. Check all EPROM pins to ensure they are not bent and dirty.

4. Loosen the screw and lift the EPROM door.

5. Push the ON tab to the left to unlock the 28-pin ZIF socket.

6. Orient the EPROM so its notch faces the left side.

7. Line up the right side of the EPROM pin with the right side of the socket and seat the EPROM in the socket.

8. Lock the EPROM in place by pushing the OFF tab toward the right.

9. Close the EPROM door and tighten the screw.

To remove the EPROM, perform the following steps:

1. Turn the Processor's Mode Select Switch to the PROG mode. To maintain memory content in the Processor, connect an external battery pack (Figure 4) to the Processor with the Mini-Processor Transport Cable (Cat. No. 1772-CD).

2. Remove AC power from the system.

3. Remove the Processor from the I/O Chassis.

4. Loosen the screw, lift up the EPROM door and push the ON tab to the left to unlock the socket (Figure 3).

5. Carefully remove the EPROM and store it in the container in which it was shipped.

## EPROM PROGRAMMING

The EPROM is programmed using the Power Supply Assembly (Cat. No. 1772-PA or -PAA) which consists of a:

- 25.5V DC Power Supply (Cat. No. 1770-P3 or -P3A)
- Power Supply Cable (Cat. No. 1772-CA)

To program the EPROM, perform the following steps:

1. Remove AC power from system.

2. Install a blank EPROM in the Mini-PLC-2/15 Processor (Figure 3).

3. Turn the Mode Select Switch to the PROG mode and develop the ladder diagram program in CMOS RAM memory.

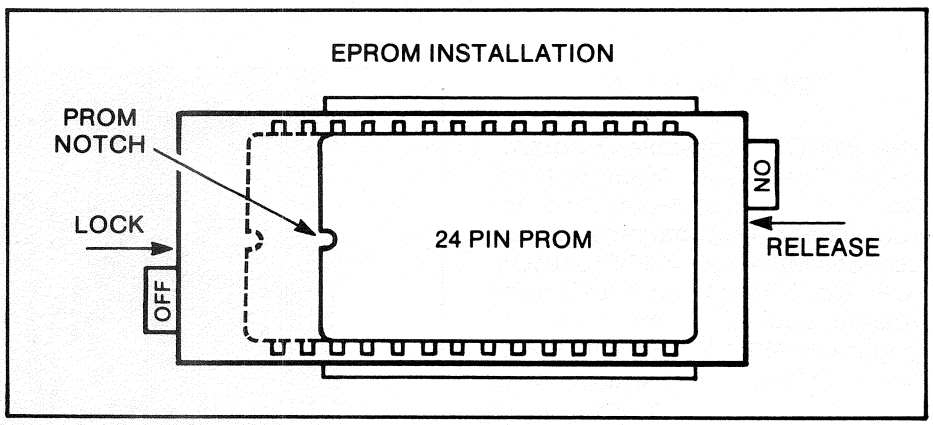



**FIGURE 3 — EPROM Installation Label**

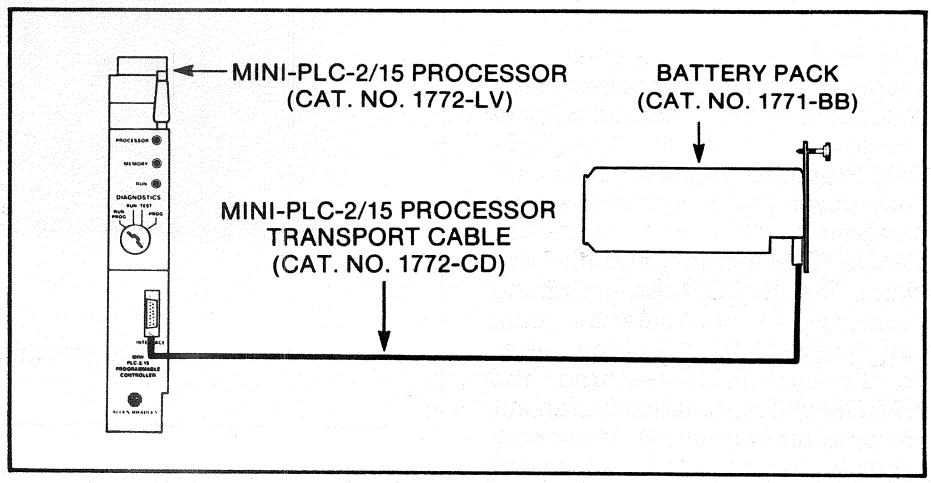



**FIGURE 4 — External Battery Backup**

4. Test program operation.

5. Connect one end of the Power Supply Cable to the 1770-P3 Power Supply (Figure 5) if disconnected.

6. Connect the Power Supply's AC power cord to a grounded AC outlet.

7. Place the 1770-P3 Power Supply on a level surface such as the bottom of the enclosure.

8. Connect the 15-pin D-shell connector of the Power Supply Cable to the INTERFACE socket on the Mini-Processor Module. As soon as this connection is made, EPROM programming will begin.

During EPROM programming, the Memory LED on the Mini-PLC-2/15 Processor will blink ON and OFF. EPROM programming typically takes 5 minutes/2K memory. When EPROM programming is successfully completed, the Memory LED will turn OFF. If the Memory LED stays ON after programming, either the EPROM is faulty or an error has occurred during EPROM programming.

**CAUTION:** When removing the EPROM from the Mini-Processor, be sure CMOS RAM memory is supported with an external battery pack to avoid memory loss.

To correct the memory fault, remove the EPROM and either erase the EPROM with a UV light source and reinstall it or install another blank EPROM in the Processor.

If the user attempts EPROM programming when an EPROM is not installed or a programmed EPROM is installed, the Memory LED will turn ON and stay ON.

It should be noted that when a programmed EPROM is installed and a different program exists in the Processor's CMOS RAM memory, the EPROM program will be automatically transferred to RAM memory upon power up.

## ERASING

The EPROM for the Mini-PLC-2/15 Processor is erased by exposing it window-side up to a UV light source with a power rating of at least 5000 $\mu W/cm^2$. A recommended UV erasing system, the S-11E UV lamp by Ultra-Violet Products, [1] has a power rating of 5000 $\mu W/cm^2$. Using this system, the EPROM is erased in approximately 50 minutes. This system also ensures that the UV exposure dose (UV power rating x exposure time) is at least 15 W-sec/$cm^2$.

**CAUTION:** The UV light source should be checked periodically to ensure adequate intensities are maintained.

Shorter exposure times can be achieved using UV light sources that have a higher power rating. The user must ensure that the UV exposure dose is at least 15 W-sec/$cm^2$. The following formula is used to calculate the exposure time (in seconds) with UV light sources that have different power ratings:

$$\text{EXPOSURE TIME} = \left(\frac{15\ \text{W-sec/cm}^2}{X\ \mu\text{W/cm}^2}\right)\left(\frac{10^6 \mu\text{W}}{\text{W}}\right)$$

where X is the power rating of the UV light source.

[1] Ultra-Violet Products, Inc.
5100 Walnut Grove Ave.
San Gabriel, CA 91778

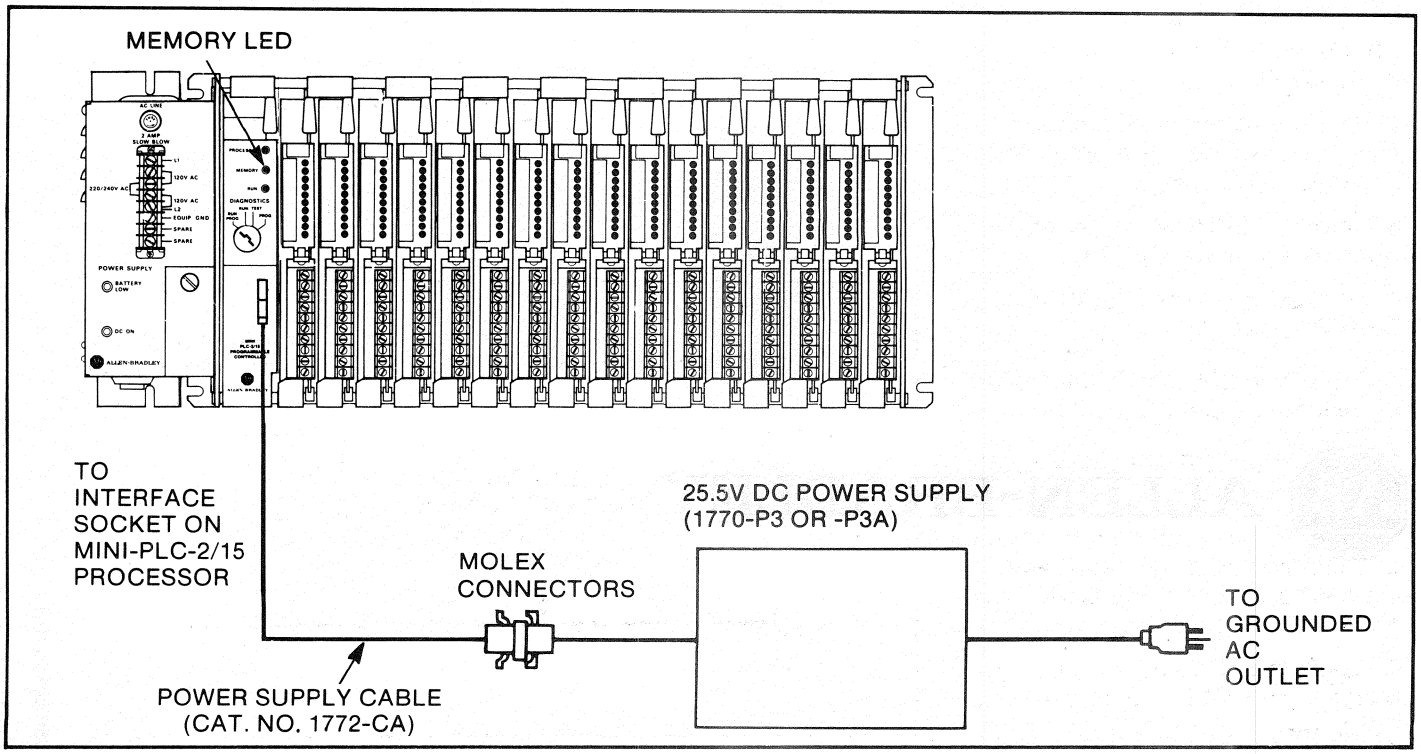



**FIGURE 5 — EPROM Programming Setup**




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747 Alpha Drive, Cleveland, Ohio 44143

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# PLC-2/20 PROCESSOR

## Cat. No. 1772-LP1




### INTRODUCTION

The PLC-2/20 Processor (Cat. No. 1772-LP1) is the control processing unit of the PLC-2/20 Programmable Controller. In it, a user program, stored in the PLC-2/20 memory is sequentially scanned, the status of inputs and outputs is tested, and appropriate action is initiated. Having examined the status of the inputs and/or outputs, the Processor is capable of energizing or de-energizing outputs and latches, performing counting and timing functions, doing data comparisons and transfers, and executing four-function arithmetic operations. The electronic circuitry necessary to accomplish these functions is based in the Processor.

### SPECIFICATIONS

**Nominal Input Voltages to Processor Modules**
+5.1V, +12V, −5.1V

**Input Power Required for Processor**
(no I/O Racks)
25 VA

**Maximum Input Power Required for Processor**
(and 128 digital I/O)
75 VA

**Scan Time**
(nominal)
5 ms/1K of memory

**Memory Capacity**
8K words (16 data bits each) with four 2048-word Segments

**Ambient Temperature Rating**
0°C to 60°C (operational)
−40°C to +85°C (storage, excluding Battery)

**Humidity Rating**
5 to 95%
(without condensation)

**Keying**
Processor modules slotted to mate with keyed Chassis sockets

### PROCESSOR FEATURES

PLC-2/20 Processors (Cat. No. 1772-LP1) can be programmed to perform relay-type functions and other functions not possible with relay control systems. These functions/features include:

- Basic relay-type functions
- Forced I/O capabilities
- Data transfer, comparison
- Four-function arithmetic (+, −, ×, ÷)
- Timing functions, both on-delay and off-delay, retentive and nonretentive
- Three timer time bases (one second, one tenth second, ten milliseconds)
- Bidirectional counting (up or down count)
- Self-monitoring/diagnostic capabilities
- Variable size Data Table, user selectable from 48 to 256 words
- Memory capacity of 8192 words when used with Industrial Terminal Systems
- Memory capacity of 4096 words when used with PLC-2 Program Panel (Series B, Revision D, or later) or PLC Program Panel and PLC/PLC-2 Program Panel Adapter (Series B, Revision D, or later)

**Publication 1772-901 — October, 1980**
Supersedes Publication 1772-901 Dated February, 1980

- 512 input/output device capacity when used with Industrial Terminal Systems and with Bulletin 1771 I/O
- 256 input/output device capacity when used with PLC-2 Program Panel or PLC Program Panel and PLC/PLC-2 Program Panel Adapter
- Scan time of 5 ms/1K words (includes both program and I/O scan)
- Block transfer capability

## DESCRIPTION

The PLC-2/20 Processor contains the following modules:

- Processor Interface Module (Cat. No. 1772-LF)
- Processor Control Module (Cat. No. 1772-LE)
- Memory Module (Cat. No. 1772-ME)
- System Power Supply Module (Cat. No. 1772-P1)

The left-most module track guides the System Power Supply Module into place. Each of the three tracks on the right side of the Processor Chassis accepts one of the three Processor modules. To access the modules, remove the metal plate at the front right side of the Processor (Figure 1).

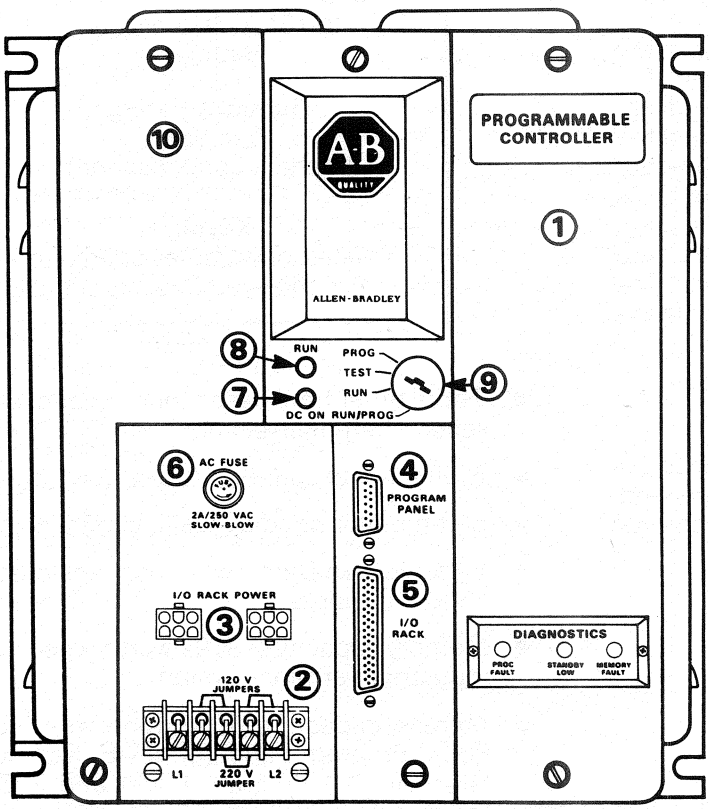
When the three Processor modules are in place they make electrical contact with the printed circuit chassis backplane (Figure 2).

This backplane, or "motherboard," carries electrical signals among Processor modules. As the modules are inserted, care must be taken to ensure that they are properly seated into the motherboard connectors. If not seated properly, modules will not make electrical contact and system malfunction could result.

**WARNING:** Never insert or remove modules from the Processor while AC power is applied. Remove the external AC power before replacing any module. Failure to observe this WARNING could result in personal/property damage.

## PROCESSOR CHASSIS

The Processor Chassis (Cat. No. 1772-LA), when all modules are in position, measures approximately 12 x 13.5 x 9 inches (WxHxD), or 30.5 x 34.3 x 22.4 cm. It is of rugged construction with louvers cut into the sides and top, and holes in the bottom to allow convection cooling.




Legend:

1. Access Memory and Processor Modules by removing panel
2. User AC connections
3. I/O RACK POWER socket
4. PROGRAM PANEL socket
5. I/O RACK socket
6. AC input fuse
7. DC ON indicator
8. RUN indicator
9. Four-position Mode Select Switch
10. System Power Supply Module located here

**FIGURE 1 - PLC-2/20 Processor (front panel)**

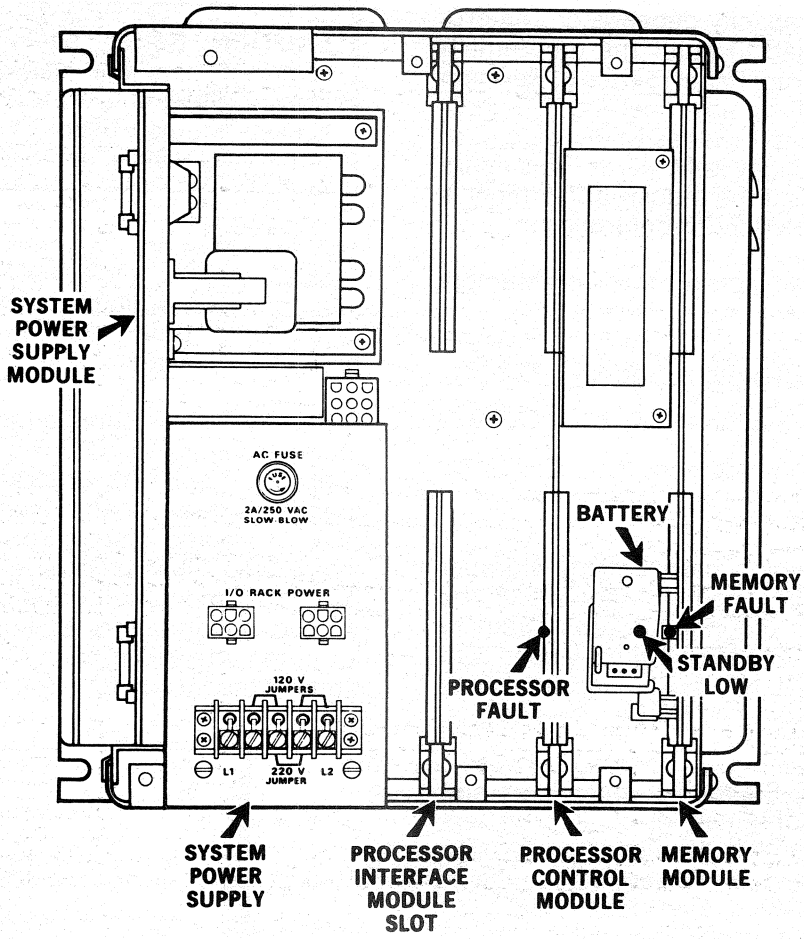



**FIGURE 2 - Processor Module Locations**

## PROCESSOR INTERFACE MODULE

The Processor Interface Module (Cat. No. 1772-LF) is the third Module from the right in the Processor Chassis (Figure 2). This Module contains signal-conditioning circuitry for communication between the Processor and I/O system, Program Panel, PLC/PLC-2 Program Panel Adapter, or Industrial Terminal.

Attached to the front of the Processor Interface Module is a front panel which contains several user connectors, indicators and controls. Their function is described in the Processor front panel paragraphs later in this Publication.

## PROCESSOR CONTROL MODULE

The Processor Control Module (Cat. No. 1772-LE) is the second Module from the right in the Processor Chassis (Figure 2). Control of system operation and various timing functions is provided by this Module. Once inserted and seated properly into the mother-board connector, it is covered with a panel which is secured to the Processor Chassis by means of two thumb screws. This panel then forms part of the Processor enclosure.

Located along the front edge of each Processor Control Module is a diagnostic indicator labeled PROCESSOR FAULT. As seen in Figure 2, PROCESSOR FAULT is located in the same horizontal line as STANDBY LOW and MEMORY FAULT indicators. Should logic controlling the Processor scan fail, PROCESSOR FAULT illuminates. The illuminated indicator can be seen through the Processor front panel diagnostic window.

## MEMORY MODULE

The Memory Module (Cat. No. 1772-ME) occupies the far right slot position (Figure 2). It contains read/write solid state Random Access Memory (RAM), and support circuity needed to store and retrieve information. This information includes user program instructions, I/O status, and values of Timers, Counters, and operating data.

Maximum memory capacity depends on the programming device used to enter the program. If either the PLC-2 Program Panel (Series B, Revision D, or later)or the PLC Program Panel and PLC/PLC-2 Program Panel Adapter (Series B, Revision D, or later) is used, the capacity is 4K words. This figure increases to 8K words if the Industrial Terminal is used to program the PLC-2/20 Controller.

The Memory Module accepts the following Memory Segments:

- 512 word Memory Segment (Cat. No. 1772-MT)
- 512 word Memory Segment (Cat. No. 1772-MR)
- 2048 word Memory Segment (Cat. No. 1772-MS)

Memory Segments which have Catalog Number 1772-MS and 1772-MT can be secured to the Memory Module with mounting screws. Memory Segments (Cat. No. 1772-MR) originally used with earlier Processors (Cat. No. 1772-LR) can also be installed on the Cat. No. 1772-ME Memory Module.

Users order Memory Segments which best suit application needs. Combinations of all three Segments are possible with the Memory Module (Cat. No. 1772-ME). However, an 8K memory configuration can only be achieved when four 2048 word Memory Segments are properly installed, and the Controller is programmed/edited/monitored with the Industrial Terminal.

The first 128 words of the first Segment of each PLC-2/20 Controller system are set aside by the Processor for use as Data Table storage, assuming the maximum number of Timers/Counters is not changed. This allows 80 words for Timers/Counters or bit and word storage. Users may tailor Data Table size from 48 to 256 words, as required by the application. When the Data Table is set to 256 words, 104 Timers/Counters can be programmed. By using an Industrial Terminal, user can also tailor Data Table input/output capacity from 256 to 384 (three Cat. No. 1771-A4 I/O Racks) or 512 I/O (four Cat. No. 1771-A4 I/O Racks). Expanding I/O capacity beyond 256 does not change Data Table size. Additional input/output words are merely taken from previous Timer/Counter Accumulated and Preset Value areas of memory. When Data Table I/O capacity is set to 512, as many as 88 Timers/Counters can be programmed.

Memory Segments are designed to be user-installed into sockets labeled A, B, C, and D on the Memory Module (Figure 3). This is done after power (AC input power **and battery standby**) has been removed from the system, and the Memory Module has been removed from the Processor Chassis.

**CAUTION:** Battery backup power must be removed from the Memory Module before Memory Segments are removed/inserted into sockets. Memory Segment damage may occur if this CAUTION is not followed.

The first Memory Segment is inserted into the socket labeled A. Additional Segments are inserted into the next available socket in an ascending alphabetical order. Do not leave blank sockets between Segments.

A Battery Pack is supplied as part of the Memory Module (Figure 3). Two D-size Alkaline Batteries (Cat. No. 1771-BA), ordered separately, provide standby power to the Memory Module should power from the System Power Supply Module be interrupted. Alkaline Batteries (Panasonic) can support 8K of memory for approximately six months. Should longer battery backup time be required, a Lithium Battery (Cat. No. 1771-BL) can be ordered. Consult the factory for Lithium Battery availability.

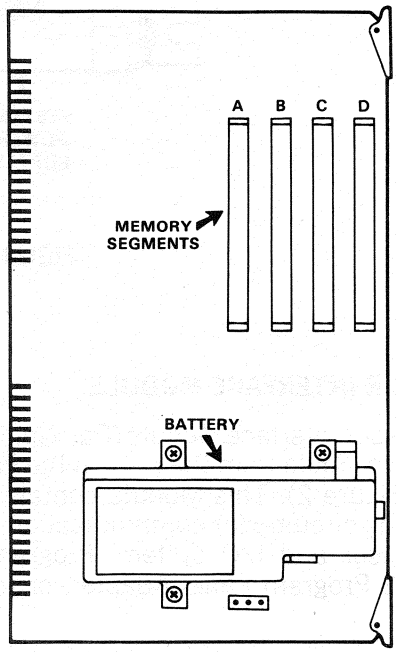



**FIGURE 3 - Memory Module (side view)**

A secondary function provided by battery backup is maintaining memory contents when the Memory Module is removed from the Processor Chassis.

**CAUTION:** Power to the System Power Supply Module must be disconnected before removing or inserting modules. Damage may result if this CAUTION is not observed.

Batteries can be replaced while system power is applied and the Controller is monitoring/controlling user I/O devices. Replacing the Batteries without power from the System Power Supply Module will cause loss of memory contents (user program, I/O status, etc.).

**CAUTION:** If the Battery is drained while providing standby power to the memory, the contents of memory will be lost. The user program must be re-entered after a replacement Battery is installed.

A Battery Low Bit, bit 02700, alternately cycles ON, then OFF when the Battery voltage is detected as being low. This Bit can be examined in the user program to sound an alarm or annunciator in the event of a Battery Low condition.

Two diagnostic indicators are associated with the Memory Module. One is the STANDBY LOW indicator which is located on the Battery Pack (Figure 2). This indicator flashes when the Memory Battery is detected as being low. It serves as an indication that approximately one week of standby power is available.

The second indicator, MEMORY FAULT, is located on the front edge of the Memory Module, adjacent to the Memory Battery (Figure 2). This indicator, when illuminated, indicates an error in the parity of data retrieved from memory. Changing the Mode Select Switch to the PROG position resets this test circuit.

When illuminated, these diagnostic indicators (MEMORY FAULT and STANDBY LOW) are easily viewed through a diagnostic window on the Processor front panel.

## SYSTEM POWER SUPPLY

The System Power Supply Module (Cat. No. 1772-P1) forms part of the Processor Chassis. It occupies the left half of the Chassis (Figure 2) and slides on runners designed to accept only the System Power Supply.

All necessary and normal electrical power requirements for the Processor and up to 128 digital I/O are provided by this Supply. Should the I/O requirements exceed 128 digital I/O, or should more than two I/O Racks be needed, an additional Power Supply must be used. A single connector terminates a wire bundle that extends from the System Power Supply Module and provides power to all Processor modules (Figure 4). The connector mates with a socket on the Processor motherboard, and must be connected before the System Power Supply is fully inserted into the Chassis.

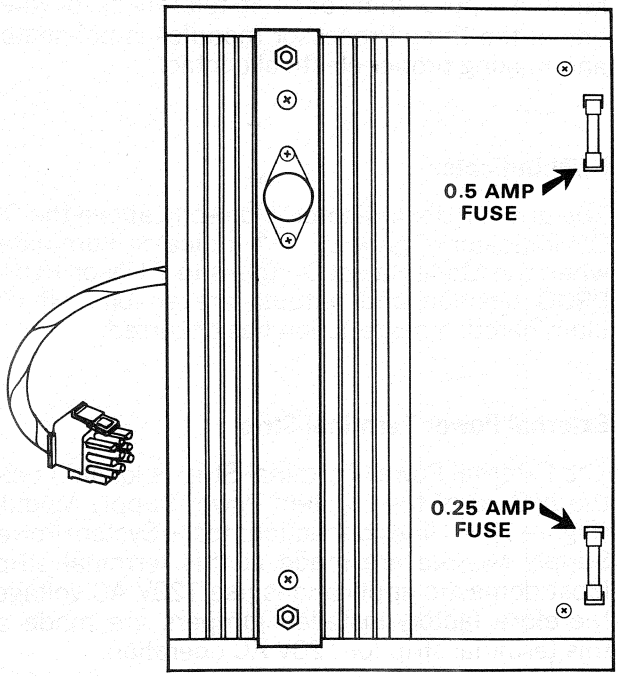



**FIGURE 4 - System Power Supply Module**

Fuses are provided in the System Power Supply Module circuitry. (Additional information concerning System Power Supply Module replacement fuses is presented in Publication 1772-902, PLC-2 Power Supplies.)

## PROCESSOR FRONT PANEL

The Processor front panel contains termination for AC input power, I/O power, I/O communication, and Program Panel/Industrial Terminal connections (Figure 1). In addition to these terminations, a four-position Mode Select Switch, fuse holder, and status indicators are located on the front panel.

### AC Input Power Fuse

The AC input power fuse is located in a fuse holder at the top of the recessed section of the System Power Supply (Figure 1). This 2 ampere slow-blow fuse protects system wiring from excessive current drain on the AC line.

### DC ON Indicator

The DC ON indicator is the lower of two indicators on the front panel; both are adjacent to the Mode Select Switch (Figure 1). This red indicator illuminates when the Power Supply is operating properly. It is extinguished when the AC input power to the System Power Supply Module or any of the DC output voltages from the System Power Supply

Module is not within specified tolerances, or when one of the three Processor modules is not seated and making proper electical contact.

### RUN Indicator

The green RUN indicator is directly above the DC ON indicator (Figure 1). The indicator illuminates when the Mode Select Switch is in RUN or RUN/PROG position and outputs are enabled. If not illuminated, a malfunction has occurred.

### External Power Terminal Strip

The External Power Terminal Strip is located near the bottom of the System Power Supply Module (Figure 1). AC line connections to the System Power Supply Module are made at this terminal strip. Most domestic applications use 120V AC voltage; therefore factory-installed jumpers are made at this terminal strip for 120V AC operation.

Users must reconnect the External Power Terminal Strip jumpers for 220/240V AC operation. Jumper positions are shown at the Terminal Strip.

### I/O Power Connectors

The I/O Power Connectors are located below the AC input power fuse holder on the front face of the System Power Supply Module (Figure 1). Each connector accepts a cable, which in turn, connects to the socket on a Bulletin 1777 or Bulletin 1771 I/O Rack. Bulletin 1777 I/O module logic circuitry is powered through an I/O Power Cable having Catalog Number 1777-AD (3 feet) or 1777-AC (8 feet). Bulletin 1771 I/O module logic circuitry is powered through an I/O Power Cable having Catalog Number 1771-CK (3 feet) or 1771-CJ (8 feet). One end of the appropriate cable connects to a socket marked I/O RACK POWER on the System Power Supply Module; the other end connects to each I/O Rack.

### Processor Interface Connectors

The Processor Interface connectors are located on the front face of the Processor Interface Module (Figure 1). The larger (50-pin) connector accepts the I/O Interconnect Cable (Cat. No. 1777-CA, or 1777-CB), which links the Processor to the I/O system. The smaller (15-pin) connector accepts the Program Panel Interconnect Cable (Cat. No. 1772-TC), which links the Processor to the PLC-2 Program Panel, PLC/PLC-2 Program Panel Adapter, or Industrial Terminal. These cables have connectors that are constructed to guard against improper connections.

### Mode Select Switch

The Mode Select Switch (keylock) is located on the front face of the Processor Interface Module (Figure 1). It is a four-position keylock switch. With it, four modes may be selected: PROGRAM, TEST, RUN, RUN/PROGRAM mode. The key can be removed with the Mode Select Switch in any of the four positions.

When the Program Panel is used to enter the user control program into memory, the Mode Select Switch must be in the PROG position. In this position all inputs and outputs connected to the I/O system are disabled.

The system and program can be tested for proper operation by changing the Mode Select Switch to the TEST position. The PLC-2/20 Controller operates as it would during normal operation, however, outputs are disabled. This allows the program to be tested under simulated operating conditions.

Changing the Mode Select Switch to the RUN or RUN/PROG position allows for normal system operation. The Processor continuously scans inputs, executes the program, and energizes appropriate outputs. If an Industrial Terminal is used to enter the commands for On-line Data Change or FORCE ON/FORCE OFF, the Processor's Mode Select Switch must be in the RUN/PROG position.

## 1772-LR UPGRADE

Earlier version PLC-2 Processors (Cat. No. 1772-LR) can be upgraded to PLC-2/20 Processors by the following module substitutions:

- Replace Processor Interface Module, Cat. No. 1772-LC, with Cat. No. 1772-LF
- Replace Processor Control Module, Cat. No. 1772-LB, with Cat. No. 1772-LE
- Replace Memory Module, Cat. No. 1772-MG, with Cat. No. 1772-ME

The 8K word memory capacity can only be used when the Industrial Terminal interfaces with the PLC-2/20 Processor. A Series B, Revision D PLC/PLC-2 Program Panel Adapter (when used with the Bulletin 1774 Program Panel) or PLC-2 Program Panel allows a maximum memory size of 4K words.

Programs which were entered with either the PLC-2 Program Panel or PLC Program Panel can be edited or monitored with one of the Program Panels or with the Industrial Terminal. However, programs developed with the Industrial Terminal which exceed 4K words can only be edited or monitored with the Industrial Terminal.

Users may increase memory capacity of Cat. No. 1772-LR Processors to 4K words. This is done by exchanging the earlier style Memory Module (Cat. No. 1772-MG) with its enhanced counterpart (Cat. No. 1772-ME). In such an application, the maximum memory configuration is limited to 4K words.

## COMPATIBILITY

Processor Control Module (Cat. No. 1772-LE) and Processor Interface Module (Cat. No. 1772-LF) can replace earlier style Modules (Cat. No. 1772-LB and Cat. No. 1772-LC) in PLC-2 Processors having Catalog Number 1772-LR. However, both Processor Modules (Cat. No. 1772-LE and Cat. No. 1772-LF) must be used as a pair.

The Memory Module (Cat. No. 1772-ME) is compatible with the earlier Processor Control Module (Cat. No. 1772-LB) and Processor Interface Module (Cat. No. 1772-LC). Earlier style Memory Modules (Cat. No. 1772-MG) in a PLC-2 Processor are simply replaced with the enhanced Memory Module (Cat. No. 1772-ME). In this application only the first 4K words of installed memory capacity can be used.

Memory Segments having Catalog Number 1772-MR can be installed on the enhanced Memory Module (Cat. No. 1772-ME). Newer style segments (Cat. No. 1772-MS, -MT) however, cannot be installed on the earlier Memory Module (Cat. No. 1772-MG).

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# MEMORY ORGANIZATION and STRUCTURE of PLC-2/20 PROCESSORS

## Cat. No. 1772-LP1

### GENERAL

This Publication is written for use with PLC-2/20 Processors having Cat. No. 1772-LP1. It has two purposes:

- To serve as an introduction to concepts and terminology necessary for a general understanding of programmable controller memory.
- To detail memory organization and structure of the PLC-2/20 Programmable Controller.

No attempt is made to explain solid state memory operation beyond what is necessary for understanding the PLC-2/20 Controller. (Fundamentals and detailed explanations of solid state memory operations are available in the technical section of many libraries.)

PLC-2/20 Processors having Catalog Number 1772-LP1 are easily identified by nameplate data. (Nameplate located on the right side of Processor Chassis.) These Processors contain the following modules:

- System Power Supply Module, Series B (Cat. No. 1772-P1)
- Processor Interface Module (Cat. No. 1772-LF)
- Processor Control Module (Cat. No. 1772-LE)
- Memory Module (Cat. No. 1772-ME)

Features which relate to memory use that are available with these Processors include:

- Control of 256 inputs/outputs when used with a PLC-2 Program Panel or PLC Program Panel (and PLC/PLC-2 Program Panel Adapter)
- Control of 512 inputs/outputs when used with Industrial Terminal Systems and with Bulletin 1771 I/O
- Variable size Data Table, user selectable from 48 to 256 words (in some cases from 32 to 256 words)
- Number of Timers/Counters expandable to 104 (in some cases to 111)
- Memory capacity of 4K words when used with a PLC-2 Program Panel or PLC Program Panel (and PLC/PLC-2 Program Panel Adapter)
- Memory capacity of 8K words when used with Industrial Terminal Systems
- Additional user program instructions using a 10 millisecond Timer time base
- Contact Histogram functions for various instructions
- Programmable report generation, which allows a maximum of 6 user-written messages to be stored in memory for output to a peripheral device at user-selected times, or as commanded by the program

Certain features listed above can only be implemented when a Series B, Revision D, or later, PLC-2 Program Panel (Cat. No. 1772-T1) or a Series B, Revision D, or later, PLC/PLC-2 Program Panel Adapter (Cat. No. 1772-T4) interfaces the Processor with additional equipment. Other features can only be implemented when the Industrial Terminal System (Cat. No. 1770-T1, -T2) is used to program the PLC-2/20 Controller.

### BULLETIN 1772-PLC-2/20

The memory of the Bulletin 1772 PLC-2/20 Programmable Controller is solid state, read/write Random Access Memory (RAM). These solid state memory components, the support circuitry needed to store and retrieve information, and battery backup are all mounted on a common printed circuit board. The on-card battery backup allows the memory to be removed from the Processor Chassis for 6 months without losing memory contents.

### STRUCTURAL UNITS

The memory of the Bulletin 1772 PLC-2/20 Controller can be thought of as a large array of storage points, each of which is called a "bit." (Bit is an acronym for Binary DigiT.) A bit is the smallest unit of information a memory is capable of retaining.

A group of bits form a single "byte." A byte is defined as the smallest complete unit of information that can be transmitted to or from the Processor at a given time.

Bytes are made up of varying numbers of bits, the exact number of which depends on the specific hardware requirements of the individual system. The PLC-2/20 byte has 8 bits.

A group of 16 bits makes up a "word," or PLC-2/20 Instruction. This word can also be thought of as being made up of two 8-bit bytes.

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Because of its function in memory, one PLC-2/20 word may also be thought of as a memory location; when a word is being used, an actual physical location in memory is being accessed.

Note that in PLC-2/20 Controller documentation, it is convention to show bits with the most significant bit (MSB) at the left and the least (LSB) at the right (Figure 1). PLC-2/20 bits are numbered 00 thru 07 and 10 thru 17.

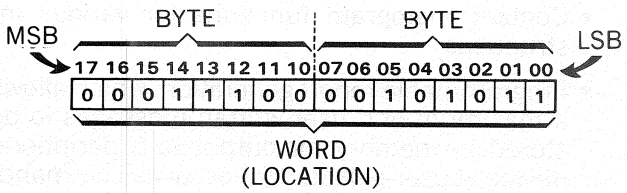



**FIGURE 1 — PLC-2/20 Word**

## MEMORY CAPACITY

The capacity of a memory is measured in words. Memory capacity for the PLC-2/20 Controller is provided by three different Memory Segments. The Cat. No. 1772-MR, -MT Segments have 512 word capacity; Cat. No. 1772-MS Segments, 2048 word capacity.

Maximum memory capacity depends on the type and quantity of Memory Segments installed, and on the programming terminal used to enter the user program. If either the PLC-2 Program Panel (Cat. No. 1772-T1) or the PLC Program Panel (Cat. No. 1774-TA, -TH) and the PLC/PLC-2 Program Panel Adapter (Cat. No. 1772-T4) is used, the capacity is 4K words. (One K words equals 1024 words.) Note that the PLC-2 Program Panel and the PLC/PLC-2 Program Panel Adapter must be Series B, Revision D, or later; the PLC Program Panel, Series C or later. Maximum memory capacity increases to 8K words if the Industrial Terminal is used to program the PLC-2/20 Controller.

The entire memory is not available for user program. The first 128 words of the first Memory Segment are set aside by the Processor for Data Table use. (An assumption is made here that the number of words set aside for Timer and/or Counter use has not been changed from the 80 words which may be considered as "standard." Additionally, it is assumed that the size of the Input and Output Image Tables has not been changed.) Depending on the specific memory configuration, the number of words remaining in memory for user program instructions is therefore 128 words less. As a specific example, there are 6528 words available for program instructions when the Memory Module has three 2048 word Segments and one 512 Segment.

### Data Entry

The nature of the information stored in the memory is very simple: a bit is either energized or de-energized, ON or OFF. These states can be represented as "1" or "0."

In order to store anything more complex than ON and OFF, bits must be grouped together in the form of a PLC-2/20 word.

How are individual bits energized or de-energized, placed into the ON or OFF state, set to "1" or cleared to "0"? The various means are listed here:

- From the state of inputs monitored by the PLC-2/20 Processor (input bits)
- By the Processor as it executes the user program (output bits)
- By programming devices such as the PLC-2 Program Panel (user program, Data Table)
- Punched tape devices (user program, Data Table)
- Digital Cassette Recorder (Cat. No. 1770-SA) (user program, Data Table)
- By a user's computer (user program, Data Table)
- By an RS-232-C compatible data terminal (messages)

### Ending a Program

The PLC-2/20 Controller does not require that an END (of program) Instruction be entered by the user after the last program instruction. An END Instruction is generated by the Processor. It is present before any program steps are entered and is automatically positioned after the last programmed instruction, once program entry is begun. (An additional END Instruction can be entered, although its use is not mandatory.)

Starting with the first program instruction, the Processor scans the program and executes all instructions in the sequence called for by the program. The END Instruction stops the Processor from scanning unused memory. Inputs and outputs are then scanned. The Processor returns to the first program instruction and begins another program scan.

In normal operation, an END Instruction is displayed on the Program Panel when the cursor is moved past the last user program instruction. The END Instruction also appears before program steps are entered. When a user-supplied Teletypewriter or keyboard/printer is used, the END Instruction is also printed on the hardcopy printout. At the right of the END Instruction, a 3 or 4-digit number appears. These digits indicate the number of decimal words actually entered into memory before the END

Instruction. (Note that the size of the Data Table must be subtracted from the number displayed in order to determine the exact number of user program words.)

Should a user attempt to enter more instructions than the maximum capacity of the available memory, an appropriate message is displayed on the programming terminal screen. Additional program instructions cannot be entered.

PLC-2/20 Instructions take an average of 3 to 6 μsec for the Processor to scan and execute each word. The execution time for different instructions varies considerably and is dependent on the exact instruction and, in some cases, its TRUE/FALSE state. A typical program using 1024 words of memory (including the Data Table) would have a scan time of approximately 5 msec, or nearly 200 scan cycles per second, assuming a distribution with approximately 80% common instructions, such as EXAMINE ON, EXAMINE OFF, OUTPUT ENERGIZE.

## MEMORY ORGANIZATION

The memory of the PLC-2/20 Controller can be divided into two major parts:

- Data Table
- User Program

All input/output status and user program instructions are stored in one of these parts (Figure 2).

In certain applications, the PLC-2/20 memory can be divided into three parts. The third area of memory is Message Storage. Functionally, this area stores messages for the Report Generation feature.

Memory organization shown in Figure 2 illustrates various addressing boundaries for a memory configuration having 256 I/O (2 Rack Address Groupings) and 40 addresses for Timer/Counter Instruction use.

### DATA TABLE

The Data Table area of the PLC-2/20 memory does not store user program instructions. Data Table words, and/or the 16 bits in each word, are controlled and utilized directly by the Processor. The Processor uses the status of input devices and the control logic established in the user program to determine the status of output devices. Transfer of input data from input devices and transfer of output data to output devices occurs during the I/O scan. If the Output Instruction's status changed in the program, the actual output device's ON/OFF status is updated during the I/O scan to reflect this change.

The Processor automatically reserves the first 128 words in the first Memory Segment for use as the Data Table, assuming the number of Timers/Counters (40 reserved) and I/O (256 reserved) is not changed. Users may tailor Data Table size from 32 to 256 words, as required by the application.

When the Data Table is set to 256 words, 104 Timer/Counter Instructions can be programmed. By using an Industrial Terminal, users can also tailor Data Table input/output capacity to 128 (one Cat. No. 1771-A4 I/O Rack), to 256 (two Cat. No. 1771-A4 I/O Racks), to 384 (three Cat. No. 1771-A4 I/O Racks), or to 512 I/O (four Cat. No. 1771-A4 I/O Racks).

By setting Data Table I/O capacity to 512, as many as 88 Timer/Counter Instructions can be programmed. When an Industrial Terminal is used to establish a Data Table I/O capacity of 128, Timer/Counter Instruction capacity may be increased to 111.

The Data Table of the PLC-2/20 Controller can be divided into six distinct areas, assuming Data Table size (128 words) and its composition (Timer/Counter Instructions and I/O addresses) have not been changed. These areas are:

- Processor Work Area No. 1
- Output Image Table
- Timer and/or Counter Accumulated Values, or bit and/or word storage
- Processor Work Area No. 2
- Input Image Table
- Timer and/or Counter Preset Values, or bit and/or word storage

The function of the Data Table may be explained in relation to inputs and outputs. The PLC-2/20 input and output modules cannot store information; they contain interface circuits only. Information in the form of input/output status (ON/OFF) is actually stored in the memory in areas called Image Tables. (An image is defined as an exact duplicate array of information, that is, the states stored in a different medium.) The following paragraphs discuss the Data Table areas of the PLC-2/20 Controller.

#### Output Image Table

The primary function of the Output Image Table in the PLC-2/20 Controller is to control the status of outputs wired from the output modules. If the Output Image Table bit is set to ON, its corresponding output will be ON. If the bit is cleared to OFF, its corresponding output will be OFF. These bits are controlled by instructions in the user program.

The Processor controls the status of bits in the Output Image Table as it generates output commands by interpreting instructions from the user

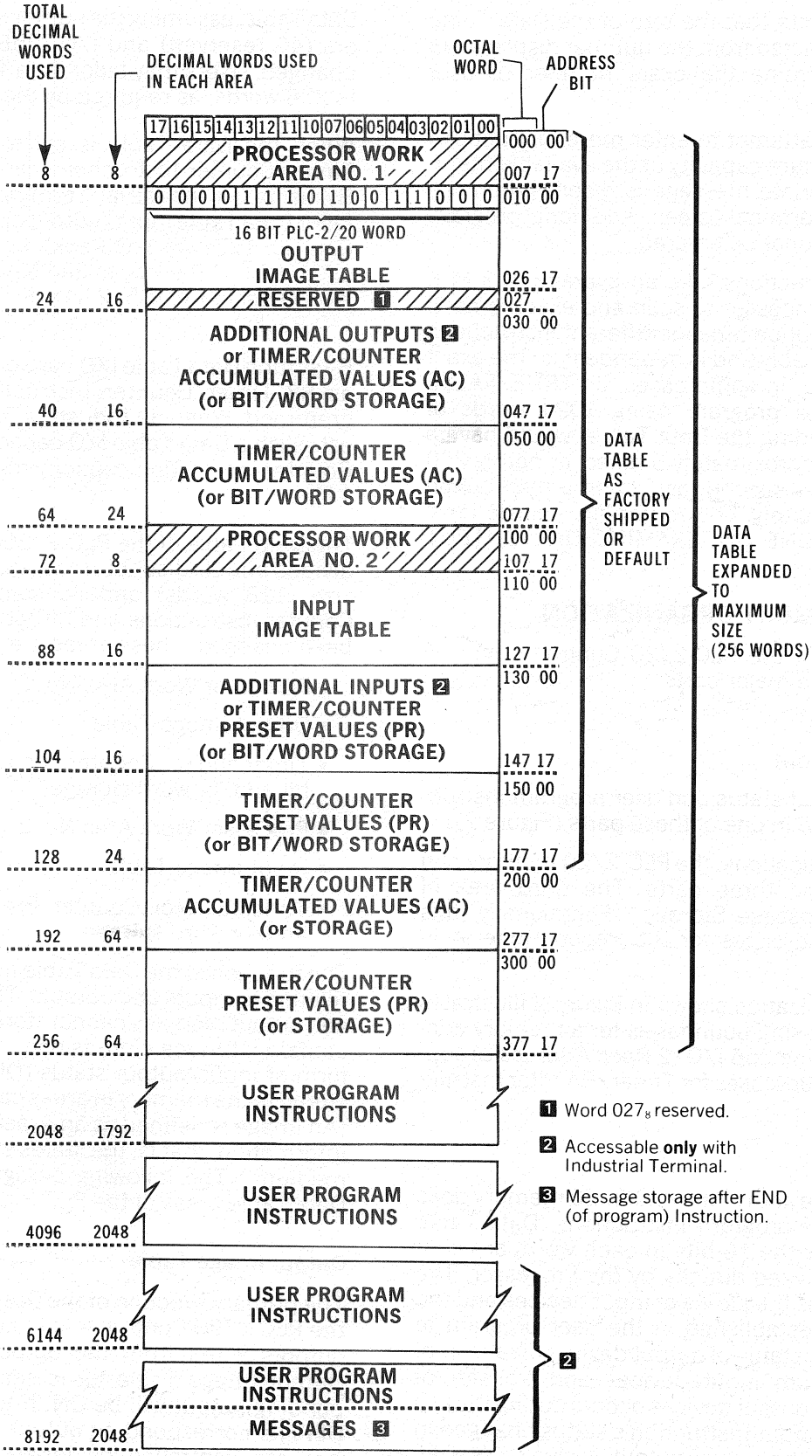



**FIGURE 2 — PLC-2/20 Memory Organization**

program. (The user program is stored in another portion of memory.) Actual hardware outputs change state only if corresponding Output Image Table bits change state.

The Output Image Table begins with word $010_8$ [1] and ordinarily ends with word $027_8$ (Figure 2). The Output Image Table therefore contains 16 word addresses, or 256 bit addresses. When the Industrial Terminal is used to program the PLC-2/20 Controller, the Output Image Table can be reduced to 8 word addresses (128 bit addresses), or increased from 16 word addresses to 24 (384 bit addresses) or to 32 word addresses (512 bit addresses). By changing memory configuration to 512 I/O (four Cat. No. 1771-A4 I/O Racks), the 512 bit addresses represent the maximum number of outputs the PLC-2/20 Processor can control. (In practice, no actual system would be configured for outputs exclusively.)

Each bit in the Output Image Table may be associated with a hardware terminal address, although this is not always the case, since a corresponding output module may not actually be placed in this I/O Rack slot. If it is, however, the terminal address is the **same** as the bit address.

A secondary function of the Output Image Table is to provide a storage area for bits or words. Words and/or bits in the Output Image Table not actually used to store the ON/OFF status of devices can be used for data storage.

All 16 bits of word $027_8$ are not available to control outputs or for storage. Note that, although only 9 bits of word $027_8$ are actually used as control bits, the remaining bits should **not** be used since inadvertent alteration of the control bits could occur. The Processor uses bit address $02700_8$ to indicate, when ON, a Battery Low condition. Although not available for storage, $02700_8$ can be examined by instructions in the user program.

### Input Image Table

The primary function of the Input Image Table is to duplicate the status of the inputs wired to input modules. If an input is ON, its corresponding Input Image Table bit is set to ON. If an input is OFF, its corresponding bit in memory is cleared to OFF. These bits are monitored by instructions in the user program.

Input Image Table bits are updated each scan cycle to correspond to the information supplied by input modules.

The Input Image Table is bound by word addresses $110_8$ to $127_8$ (Figure 2). This area contains 16 word addresses, or 256 bit addresses. When the Industrial Terminal is used to program the PLC-2/20 Controller, the Input Image Table can be reduced to 8 word addresses (128 bit addresses), or increased from 16 word addresses to 24 (384 bit addresses) or to 32 word addresses (512 bit addresses). By changing memory configuration to 512 I/O (four Cat. No. 1771-A4 I/O Racks), the 512 bit addresses represent the maximum number of inputs the PLC-2/20 Processor can monitor. (In practice, no actual system would be configured for inputs exclusively.)

Note however, in a single PLC-2/20 Controller, the total bits used, which represent actual hardware inputs and outputs, together cannot exceed 512. This figure represents the maximum I/O capability of the PLC-2/20 Controller and is possible only when programmed with the Industrial Terminal and by using four 128 I/O Racks (Cat. No. 1771-A4).

Each bit in the Input Image Table may have a corresponding real hardware terminal on the I/O Rack associated with it, although this may not always be the case, since a corresponding Input Module may not actually be placed in an I/O Rack slot. If it does, the terminal address is the same as the bit address. The correspondence between the two is illustrated in Figure 3.

Bit and/or word storage is not possible in the Input Image Table. Input bits which do not have an actual input module in the I/O Rack corresponding to the bit's address are cleared to zero during each I/O scan.

### Accumulated Values, Storage

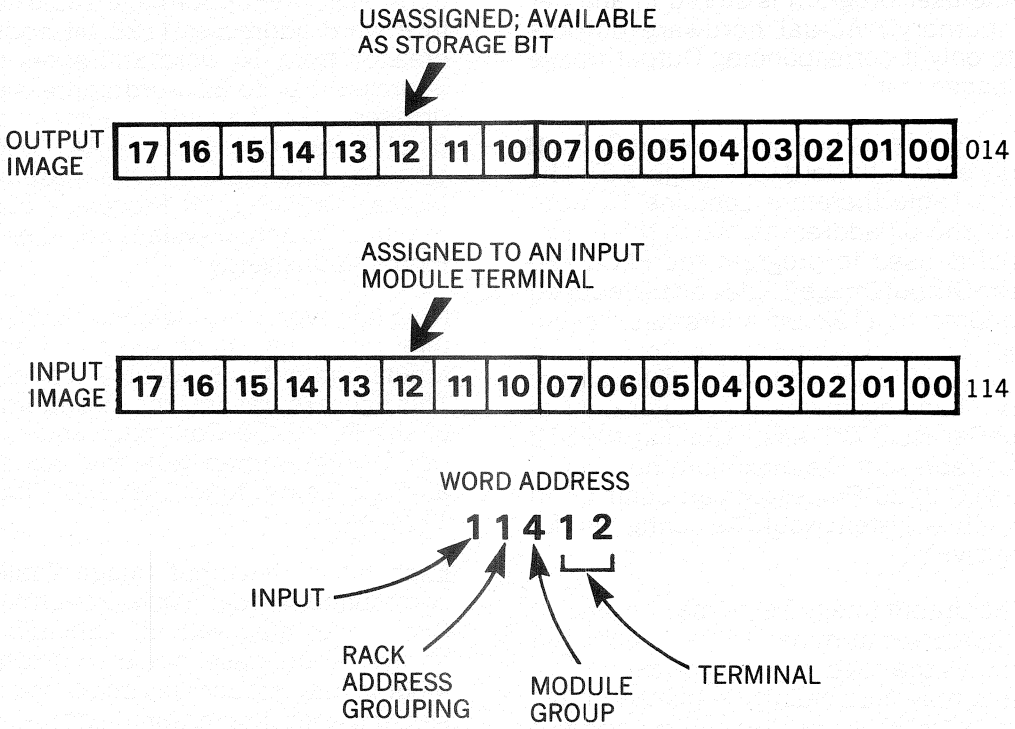
This area of memory is used to store Accumulated Values of Timer/Counter Instructions. The area may also be used as storage for words and/or bits.

Word addresses $030_8$ to $077_8$ bound this area when memory is configured for 256 I/O (maximum) and 40 Timer/Counter Instructions (Figure 2). Note that each Timer or Counter used actually requires **two** words of memory: one from the Accumulated Value area ($030_8$ to $077_8$) and the other from the Preset Value area ($130_8$ to $177_8$).

### Preset Values, Storage

Another area of the Data Table is used for Preset Values of Timer/Counter Instructions. The area may also be used for bit or word storage. It occupies word addresses $130_8$ to $177_8$ when memory is configured for 256 I/O (maximum) and 40 Timer/

[1] The subscript$_8$ indicates that an octal numbering system is being used. Counting begins at 0; no digits larger than 7 are used. The decimal numbering system, being most common, is implied if no subscript is used.




1 On Bulletin 1771 I/O Rack equals one Rack Address Grouping.

**FIGURE 3 — Relation of Word Address to Hardware**

Counter Instructions. A Timer or Counter having address $030_8$ has its Preset Value automatically stored at address $130_8$.

### Processor Work Areas

There are two Processor Work Areas: Processor Work Area No. 1 (addresses $000_8$ to $007_8$) and Processor Work Area No. 2 (addresses $100_8$ to $107_8$). These memory locations cannot be accessed by the user. Their word addresses are not available for addressing of any kind. The Processor uses both Areas for internal control functions.

### Expanded Data Table Area

The Data Table can be expanded by a user from the factory-shipped size of 128 words up to a maximum of 256 words (Figure 2). The expansion may be made in increments as small as 2 words, as determined by the user, and is set from keyboard entries on a Series B or later PLC-2 Program Panel, a PLC Program Panel with a Series B or later PLC/PLC-2 Program Panel Adapter, or from the keyboard of an Industrial Terminal.

In a sense, two areas are opened by this expansion, because each Timer or Counter requires two words; one for Accumulated Values and one for Preset Values. Since the standard Data Table provides 40 Timer/Counter Instruction addresses and 256 I/O capacity, an additional 64 Timers/Counters may be selected by a user, thereby providing up to 104 Timer/Counter Instructions.

Addresses from $200_8$ to $277_8$ are used for Timer Counter Accumulated Values. Those from $300_8$ to $377_8$ are used for Preset Values.

Depending on the programming terminal used to program the Controller, certain restrictions exist for instruction addressing in the expanded areas of memory. If the Industrial Terminal is used, any PLC-2/20 Instruction can be assigned an address from the expanded areas of memory.

When the PLC-2 Program Panel or PLC Program Panel (used with a PLC/PLC-2 Program Panel Adapter) is used to program the Controller, the following instructions can be assigned addresses from the expanded areas of memory:

- Timer/Counter Instructions — TON, TOF, RTO, RTR, CTU, CTD, CTR
- Data Manipulation Instructions — GET, PUT, LES, EQU, GET BYTE, LIMIT TEST
- Arithmetic Instructions — ADDITION, SUBTRACTION, MULTIPLICATION, DIVISION

Direct examination/control of bits in words $200_8$ to $377_8$ in the expanded areas is not possible when the PLC or PLC-2 Program Panel is used. Among these instructions are those that examine the following:

- Timer/Counter status bits
- Addition Carry Bits
- Subtraction Borrow Bits

Indirect programming techniques, using an intermediate word (addresses $010_8$ to $026_8$, $030_8$ to $077_8$, or $130_8$ to $177_8$), must be used to examine the status of individual bits in the expanded areas.

### User Program

Assuming that the number of words reserved for Timer/Counter and I/O use, and therefore the size of the Data Table, has not been changed from the "standard," factory-shipped values, the user program begins after word address $177_8$. User program instructions are stored in this area as groups of energized and de-energized bits. Each word in the User Program area of the memory is capable of storing one user program instruction.

### Message Storage

Processors which have the Series B, or later, Processor Control Module having Cat. No. 1772-LB or the Cat. No. 1772-LE Processor Control Module are capable of storing user-programmed messages for subsequent hardcopy printout by compatible RS-232-C data terminals. As many as 6 messages of varying length can be stored.

Message storage immediately follows the END (of program) Instruction, and is limited only by the number of unused words remaining in memory. Each word remaining after the END (of program) Instruction is capable of storing 2 message characters. (Characters are defined as keyboard entries made on the data terminal, such as A, 1, M, ., 8, space, etc.)

Messages are stored in the order in which they were entered. For example, if Message No. 1 is entered first, it is stored after the END (of program) Instruction. Message No. 4 is then entered and stored after Message No. 1. Message No. 2, entered next, is stored after Message No. 4, and not after Message No. 1.

Bit addresses $02710_8$ to $02717_8$ are used for various Report Generation functions. Therefore, should Report Generation functions be programmed, no output modules may be placed in Rack Address Grouping 2, Module Group 7. An input module may be placed there. Furthermore, since the user program examines these bits to determine Report Generation status and may also set these bits to initiate various Report Generation operations, it is recommended that the remaining bit addresses of word $027_8$ not be used for storage. In

fact, bit address $02700_8$ should never be used for storage. It is the Battery Low Bit.

## CHANGING DATA TABLE AREAS

Users can closely tailor Data Table areas to individual application needs. Data Table size (the number of Timer/Counter Instruction addresses) can be changed from the keyboard of a PLC-2 Program Panel, PLC Program Panel, or Industrial Terminal. Input and Output Image Table size can also be changed, however, only by using the Industrial Terminal.

Data Table size is **reduced** from the standard or default value of 128 words (assuming 16 words reserved in Input Image Table and 16 words reserved in Output Image Table) to 48 words when all Timer/Counter areas are removed. This can be done to make additional space available for user program instructions. Incremental reductions as small as one Timer/Counter can be made.

If the memory locations are occupied, the attempted reduction fails.

Data Table size is **increased** from 128 words (assuming 16 Input Image Table words and 16 Output Image Table words) to 256 words when memory is configured for 104 Timer/Counter Instructions. Users therefore gain the use of an additional 128 words (64 Timer/Counter Instruction addresses, 128 words for storage, or combination of both). Incremental additions as small as one Timer/Counter can be made.

The Processor determines whether sufficient unused memory remains for the corresponding shifting of user program instructions from the area to be addressed by the additional Timer/Counter Instructions. If sufficient memory exists, the required number of words are then reserved.

When an Industrial Terminal is used to program the PLC-2/20 Controller, users may optionally alter the number of words reserved for Input/Output Image Tables. Memory can be configured for up to 128, 256, 384, or 512 I/O.

By **reducing** memory areas required for inputs/outputs from **256 to 128**, Data Table size remains unchanged, but an additional 7 Timer/Counter Instructions become available. The previous Output Image Table addresses $020_8$ to $026_8$ are now reserved for Timer/Counter Accumulated Values; previous Input Image Table addresses $120_8$ to $126_8$, for Timer/Counter Preset Values.

When I/O requirements are **increased** from the standard value of **256 to 384**, Data Table size does not change. Instead, Timer/Counter areas (in the default memory configuration) are each reduced by 8 words. Previous Timer/Counter Accumulated Value addresses $030_8$ to $037_8$ are now reserved for Output Image Table; previous Timer/Counter Preset Value addresses $130_8$ to $137_8$, for Input Image Table.

When I/O Image Table size is **increased to 512**, Timer/Counter areas are reduced by another 8 words. Previous Timer/Counter Accumulated Value addresses $030_8$ to $047_8$ are reserved for Output Image Table; previous Timer/Counter Preset Value addresses $130_8$ to $147_8$, for Input Image Table.

## COMPATIBILITY

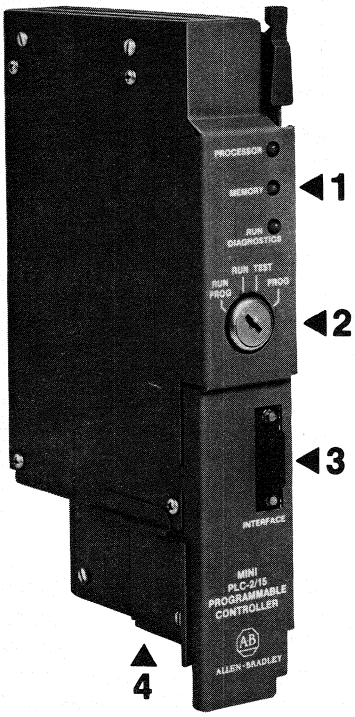
Earlier style Processors (Cat. No. 1772-LR) can be enhanced. To do so, several Processor modules must be replaced with their enhanced counterparts. Installations can therefore be upgraded to take advantage of larger memory capacity and other benefits made possible with the new equipment.

ALLEN-BRADLEY
Cleveland, Ohio 44143

P/N 63487-3-70

# ALLEN-BRADLEY MINI-PLC-2/15 PROCESSOR MODULE

## Cat. No. 1772-LV




1. Diagnostic Indicators
2. Mode Select Keylock Switch
3. INTERFACE Socket
4. EPROM Access Door

### SPECIFICATIONS

**Location**
Bulletin 1771-I/O Chassis
Left-Most Slot

**Input Voltage**
(Supplied by System Power Supply)
5.1V DC (logic)
5.0V DC (memory)

**Memory Size**
2048 (2K) 16-bit words RAM
(Optional 2048 (2K) 16-bit words of EPROM Backup)

**Data Table Size**
Up to 2048 (2K) words

**Memory Word Length**
16 data bits
(8 data bits per byte)

**I/O Compatibility**
Bulletin 1771 I/O Family
(up to 128 discrete I/O points)

**Ambient Temperature Range**
0° to 60° C (operating)
—40° to 85° C (storage)

**Humidity**
5% to 95% (without condensation)

**Keying Band Locations**
Between 40 — 42
and
Between 54 — 56

**Execution Time (Nominal)**
12 msec/1K (typical)

### FEATURES

The Mini-PLC-2/15 Processor, one of the latest developments in the PLC-2 Family of Allen-Bradley Programmable Controllers, has a 2K memory capacity and the capability of monitoring and controlling up to 128 I/O devices. Because of its small size, the Mini-PLC-2/15 Programmable Controller can be installed in an 8-inch working depth enclosure.

The Mini-PLC-2/15 Processor Module has the following features:

- Programmed in ladder diagram and functional block display format
- 2K CMOS RAM memory supported by 2K on-board user programmable EPROM backup
- Four function math (+, —, ×, ÷)
- Fully Expandable Data Table
- On-line Programming
- Remote Mode Selection
- Up to 488 Timers/Counters
- Complete I/O Forcing Capability
- Ladder Diagram Jumps and Subroutines
- Battery Backup
- Optional External Battery Backup when Mini-PLC-2/15 Processor Module is Removed
- Expanded Instruction Set (includes File, Sequencer, and Jump/Subroutine Instructions)
- Data Highway Compatible
- Block Transfer Capability
- Diagnostic Indicators

### DESCRIPTION

The Central Processing Unit (CPU) and memory of the Bulletin 1772 Mini-PLC-2/15 Programmable Controller is the Mini-PLC-2/15 Processor Module (Cat. No. 1772-LV). The Mini-PLC-2/15 Processor Module examines data from user input

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devices wired to Input Modules in the I/O structure, processes this data in accordance with the user entered program, and sets bits in the Data Table to control the user output devices via the Output Modules. In addition to controlling user output devices, the Mini-PLC-2/15 Processor Module is capable of performing timing/counting functions, data transfers and comparisons, arithmetic operations, program control functions, file transfer functions, special operation functions, and on-board EPROM (Erasable Programmable Read Only Memory) programming.

The Mini-PLC-2/15 Processor Module monitors the status of its own operation, of data in memory, and of power supplied from the System Power Supply. Orderly shutdown is provided to protect the user's application if a malfunction from any of the above mentioned points is detected. Visual indicators illuminate to show that the Mini-PLC-2/15 Processor Module is operating normally or that a malfunction has been detected.

A Mini-PLC-2/15 Programmable Controller is composed of:

- One Mini-PLC-2/15 Processor Module (Cat. No. 1772-LV)
- One I/O Chassis (Cat. No. 1771-A1, -A2, or -A4)
- One System Power Supply (Cat. No. 1771-P1)
- Up to 16 I/O Modules for up to 128 discrete I/O points

The Mini-PLC-2/15 Processor Module is placed in the left-most slot of a Bulletin 1771 I/O Chassis. A complete Mini-PLC-2/15 Programmable Controller with 128 I/O capacity is shown in Figure 1.

## MODES OF OPERATION

### SWITCH MODES

On the front of the Mini-PLC-2/15 Processor Module is a four position Mode Select Keylock Switch (Figure 2). This switch permits the selection of four operating modes:

- PROG — In this switch position the Mini-PLC-2/15 Processor Module is placed into the PROGRAM mode of operation which allows the user to enter the program into the Mini-PLC-2/15 Processor's memory. The instructions that make up the user program can be entered from either the Industrial Terminal (Cat. No. 1770-T3), Data Cartridge Recorder (Cat. No. 1770-SB), or Digital Cassette Recorder (Cat. No. 1770-SA) connected to the above mentioned Industrial Terminal. In this switch position, outputs are disabled.
- TEST — In this switch position, the user's program can be tested and controller behavior observed without enabling the outputs. This allows de-bugging of the user's program without

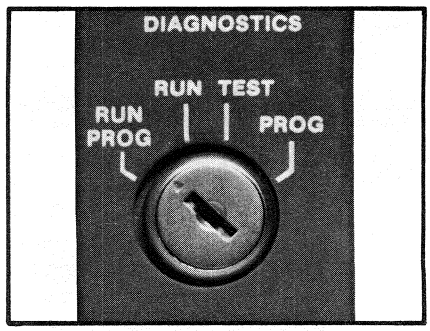



**FIGURE 2 — Mode Select Keylock Switch**

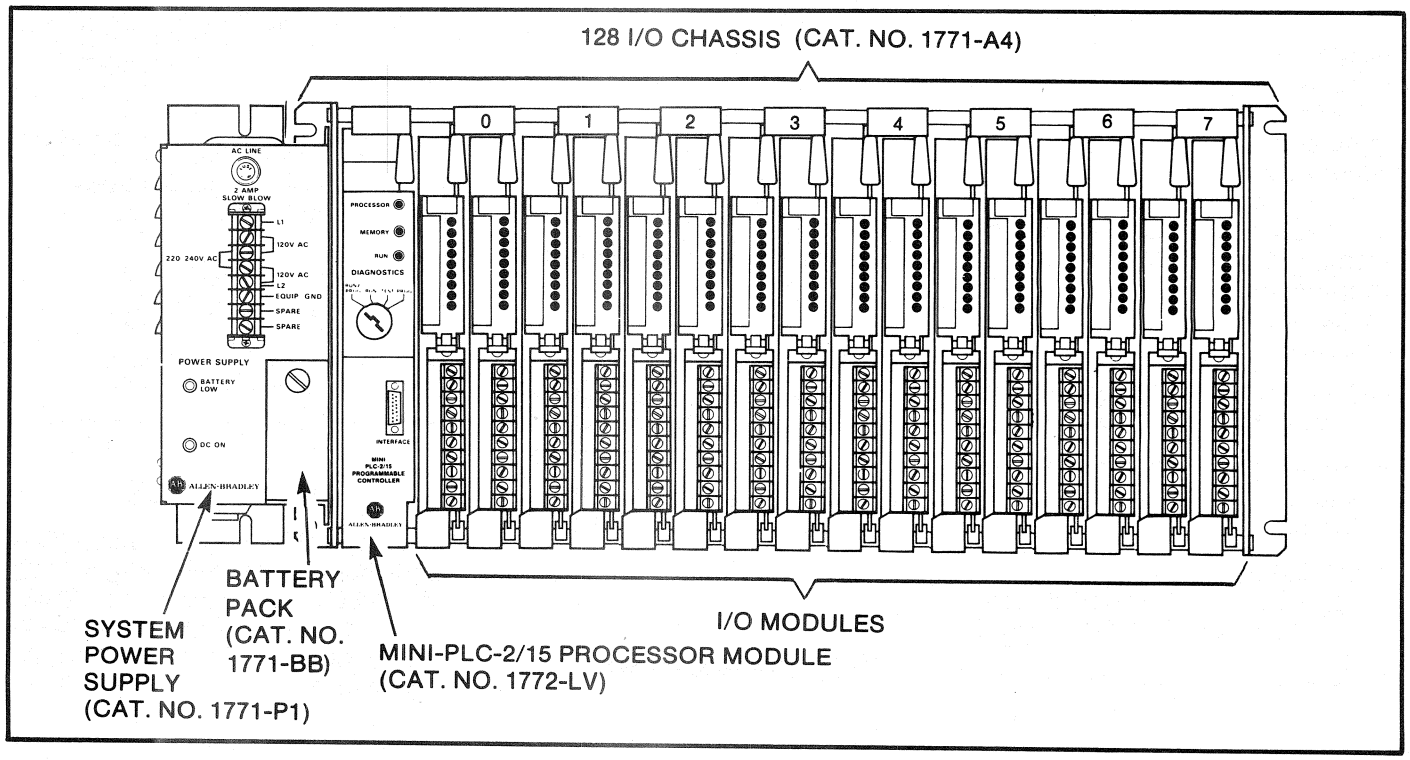



**FIGURE 1 — Mini-PLC-2/15 Programmable Controller (128 I/O capacity)**

risking damage to user controlled equipment or injury to personnel. In this switch position, outputs are disabled.

- RUN — In this switch position, the Mini-PLC-2/15 Processor continuously scans and executes the user's program. No change to the program or data table is allowed in this switch position. Outputs are energized according to the user's program.

- RUN/PROG — In this switch position, the Mini-PLC-2/15 Processor functions as it does in the RUN position. In this position the user can also remotely cause the Mini-PLC-2/15 Processor to go into the PROGRAM or TEST mode without having to physically turn the keyswitch to that position. On-line changes to the program and/or data table are allowed in this position.

## REMOTE MODES

When the keyswitch is in the RUN/PROG position, the user can enter character sequences from the Industrial Terminal or Data Highway that will place the Mini-PLC-2/15 Processor into any one of three remote modes of operation:

- REMOTE PROGRAM — identical to the PROGRAM mode. The program scan and I/O scan will be halted. All outputs are disabled. Going into this mode from REMOTE RUN/PROGRAM will reset an I/O fault, and clear a memory parity error.

- REMOTE TEST — identical to the TEST mode. The program scan will be running, but all outputs are disabled. Going into this mode from REMOTE RUN/PROGRAM will reset an I/O fault as does physically changing the keyswitch position from RUN/PROG or RUN to TEST.

  REMOTE RUN/PROGRAM — the default mode. Whenever the keyswitch is turned to the RUN/PROG position the Processor automatically enters this mode. On-line changes to the program and/or data table are allowed in this mode.

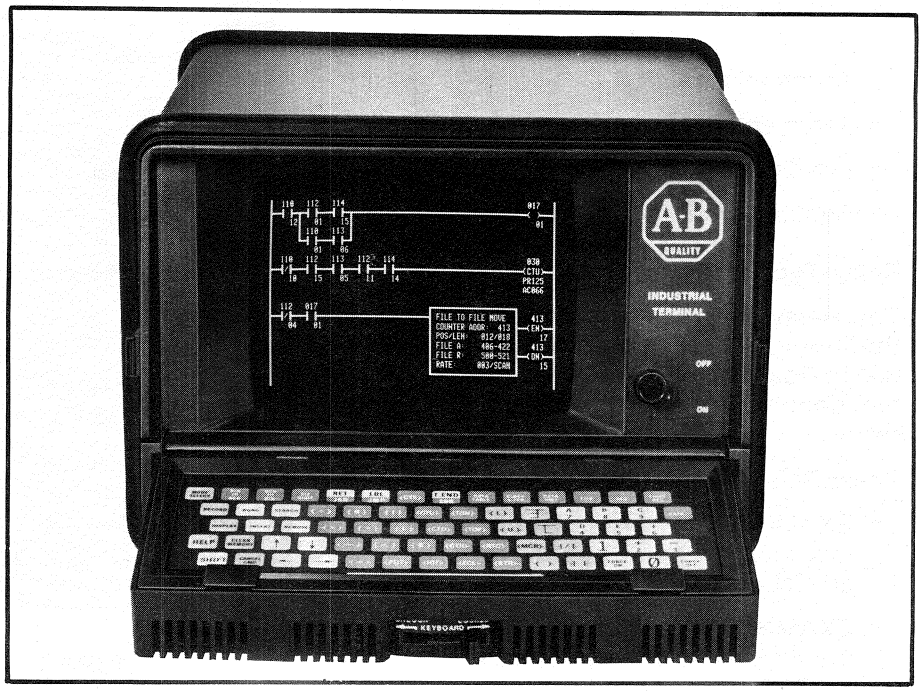



**FIGURE 3 — Industrial Terminal (Cat. No. 1770-T3)**

## PROGRAMMING

The Mini-PLC-2/15 Processor Module requires a user written program. A program is a listing of things to be done, in the order they are to be done, and under what conditions they are to be done.

Programming the Mini-PLC-2/15 Processor is relatively simple and straight-forward. The user enters the program by pressing clearly marked keys on the Industrial Terminal keyboard (Cat. No. 1770-T3) or by using a peripheral device, i.e. Data Cartridge Recorder (Cat. No. 1770-SB) or Digital Cassette Recorder (Cat. No. 1770-SA). The Industrial Terminal automatically sets up the user's instructions in ladder diagram and functional block display format for easy readability and troubleshooting.

Knowledge of the memory structure of the Mini-PLC-2/15 Processor is also helpful in understanding addressing and programming. Refer to "Memory Organization and Structure of the Mini-PLC-2/15 Processor", Publication 1772-912.

## PROGRAMMING TERMINAL

The Industrial Terminal (Cat. No. 1770-T3) (Figure 3) is used to program the memory of the Mini-PLC-2/15 Processor. It connects to the INTERFACE socket on the front edge of the Mini-PLC-2/15 Processor Module. (Figure 4). The cable for this connection is shipped as a standard item with the 1770-T3 Industrial Terminal System. The keys on the Industrial Terminal keyboard are clearly labeled for easy programming of the Mini-PLC-2/15 Processor (Figure 5).

## INSTRUCTION SET

The control capability of the Mini-PLC-2/15 Processor Module is best illustrated by its instruction set. Instructions used to program the Mini-PLC-2/15 can be divided into seven groups:

- Relay-Type
- Timers and Counters

- Data Manipulation and Comparison
- Arithmetic
- Jump and Subroutines
- File Transfer
- Sequencer

### Relay-Type Instructions

The Relay-Type Instructions give the Mini-PLC-2/15 Processor Module the capability to perform the functions available with hard-wired relays.

These Relay-Type Instructions are:

- EXAMINE ON — examines an input terminal or output bit for an ON condition.
- EXAMINE OFF — examines an input terminal or output bit for an OFF condition
- OUTPUT ENERGIZE — energizes an output bit if preceding rung conditions are TRUE.
- OUTPUT LATCH — energizes an output bit if preceding rung conditions are TRUE and remains energized until it is unlatched in the program.
- OUTPUT UNLATCH — de-energizes a latched output bit when preceding rung conditions are TRUE.
- BRANCH START and BRANCH END — initiates and ends parallel logic paths similar to those available with relay logic.
- MASTER CONTROL and ZONE CONTROL — isolates a block of user program and specifies output behavior under certain conditions.

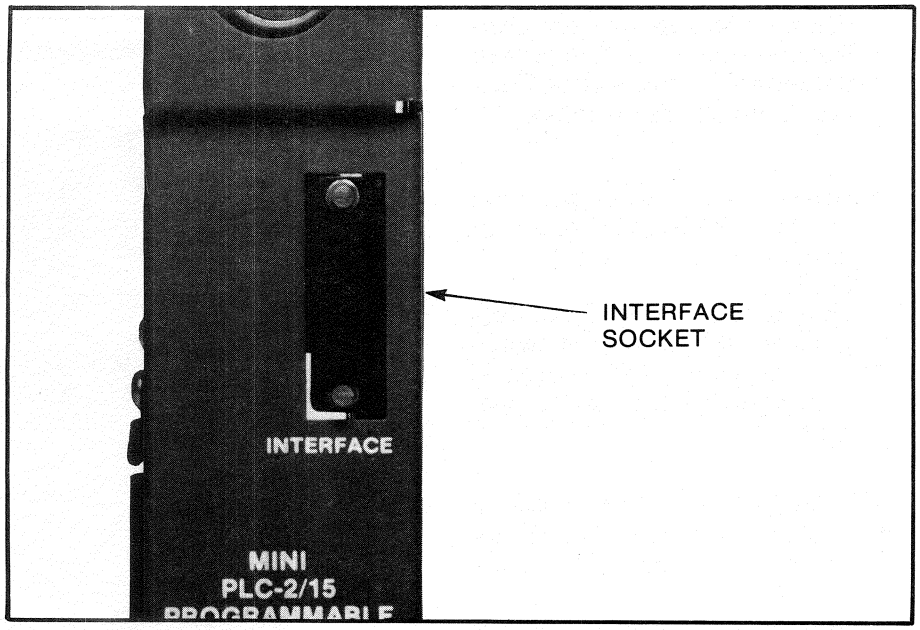



**FIGURE 4 — Interface Socket**

### Timer and Counter Instructions

The Mini-PLC-2/15 Processor makes available up to 488 internal timers and counters. Timers can be used where the measurement of specific time intervals is important.

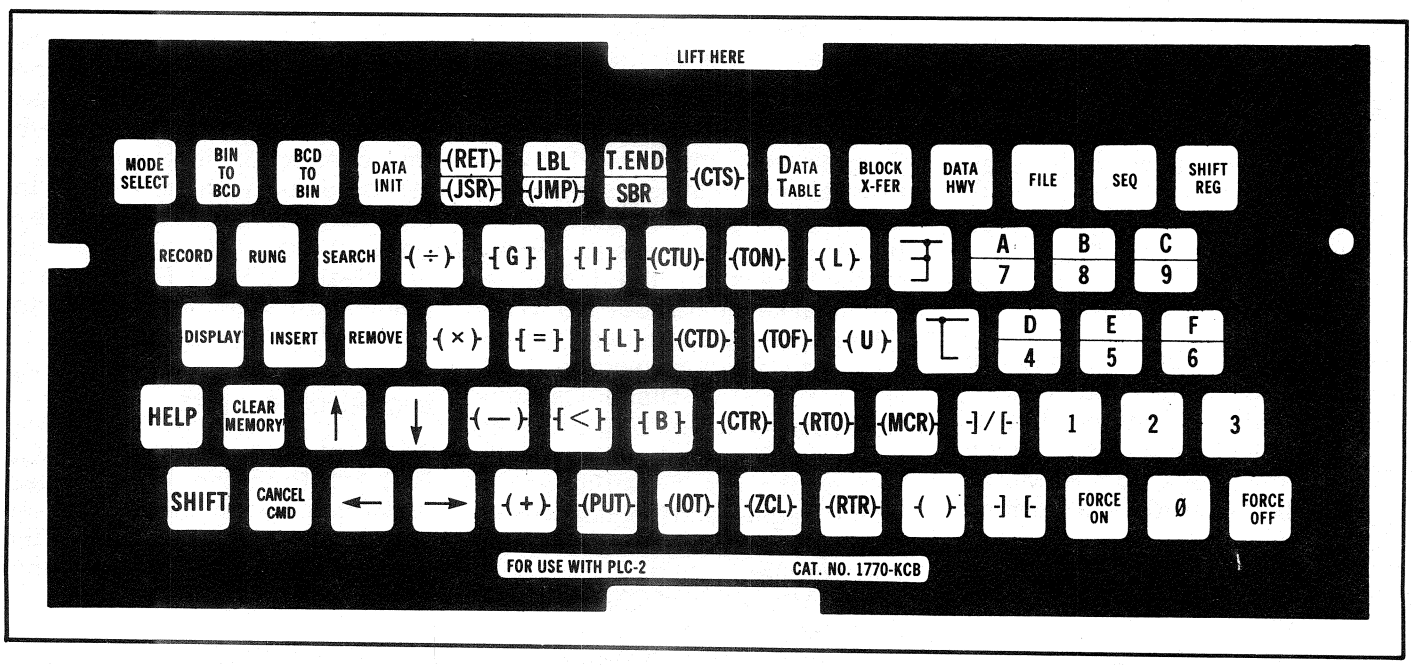



**FIGURE 5 — Industrial Terminal PLC-2 Family Keytop Overlay**

Timers can be individually set for 1 second, 0.1 second, or 0.01 second time base. Each timer is capable of timing up to 999 timed increments. For timing beyond 999 timed increments, timers can be "cascaded" together.

Counters allow the Mini-PLC-2/15 Processor Module to count repetitive action or selected events either in ascending or decending counts. Each counter is capable of 999 counts. For counts higher than 999 counters can be "cascaded" together.

The Timer and Counter Instructions are:

- TIMER ON-DELAY — begins to time when its preceding rung conditions are TRUE. When user programmed Preset Value equals Accumulated Value, timer stops, and timed contact energizes.
- TIMER OFF-DELAY — begins to time when its preceding rung conditions are FALSE. When user programmed Preset Value equals Accumulated Value, timer stops, and timed contact de-energizes.
- RETENTIVE TIMER — functions as a TIMER ON-DELAY except Accumulated Value is retained when preceding rung conditions are FALSE.
- RETENTIVE TIMER RESET — resets the Accumulated Value of a RETENTIVE TIMER to zero.
- UP-COUNTER — adds 1 to the Accumulated Value for each FALSE to TRUE transition of its rung.
- DOWN-COUNTER — subtracts 1 from Accumulated Value for each FALSE to TRUE transition of its rung.
- COUNTER RESET — resets the Accumulated Value of an UP-COUNTER or DOWN-COUNTER to zero.

**Data Manipulation Instructions**

Data Manipulation Instructions access a word in the Mini-PLC-2/15 Processor's memory. Using either all 16 bits, 12 bits or 8 bits of the word addressed, the data or value contained in these bits will be manipulated, transferred or compared and the resulting data or value is available for program use. Such data or value may include the Preset Value of a Timer or Counter, the Accumulated Value of a Counter, tolerance values selected from within the user's program, or value from a thumbwheel switch or similar input device.

The Data Manipulation Instructions that transfer data are:

- GET — accesses a specific 16-bit word in memory for a subsequent operation.
- PUT — receives a 16-bit word from a GET instruction and stores it at the memory address of the PUT instruction.
- IMMEDIATE INPUT — immediately updates one selected word of input data as determined by its address.
- IMMEDIATE OUTPUT — immediately updates one selected word of output data as determined by its address.

The Data Manipulation Instructions that compare data are:

- LESS THAN — compares values from user specified memory locations for a less than relationship.
- EQUAL TO — compares values from user specified memory locations for an equal to relationship.
- GET BYTE — accesses one byte (8 bits) of a 16-bit word for a subsequent comparison.
- LIMIT TEST — used in conjunction with the GET BYTE instruction to compare one byte with an upper and lower byte limit value chosen by the user for a specific application.

**Arithmetic Instructions**

The Mini-PLC-2/15 Processor has the capability of performing four function math.

The Arithmetic Instructions are:

- ADD — adds two values stored in the Data Table.
- SUBTRACT — subtracts two values stored in the Data Table.
- MULTIPLY — multiplies two values stored in the Data Table.
- DIVIDE — divides two values stored in the Data Table.

**Jump and Subroutine Instructions**

Jump and Subroutine Instructions provide the user with the capability to program jumps and subroutines in the ladder diagram program of the Mini-PLC-2/15 Processor.

The Jump and Subroutine Instructions are:

- JUMP — instructs the Processor to jump forward to a new location in the program as specified by its associated LABEL instruction. The program scan will continue from that point.
- JUMP TO SUBROUTINE — instructs the Processor to jump to a user established subroutine area as specified by its associated LABEL instruction. Up to eight subroutines are permitted.
- LABEL — indicates where the Processor is to jump to in the program or subroutine area. Up to eight LABELS are permitted.
- RETURN — instructs the Processor when to exit the subroutine area and return to the program at the point where the JUMP TO SUBROUTINE instruction was encountered.

**File Transfer Instructions**

File Transfer Instructions provide the user with the capability to set up adjacent Data Table addresses of user specified length up to 999 16-bit words. The data in this area can be transferred by the following instructions:

- FILE TO FILE TRANSFER — moves the contents from one File to another at a user determined rate.
- WORD TO FILE TRANSFER — moves the contents of a word

from outside a File to a word location within the File.

- FILE TO WORD TRANSFER — moves the contents of a word inside a File to a word location outside the File.

**Sequencer Instructions**

Sequencer Instructions enable the user to emulate a drum controller by setting up adjacent data table addresses organized in groups of columns and steps. The number of columns is user specified up to four 16-bit words. The user can set up a maximum of 999 steps per Sequencer Table. The Sequencer Instructions used to sequentially step thru the user established Sequencer Table are:

- SEQUENCER LOAD — loads a Sequencer Table with one to four words from an independent I/O address. These words will be loaded into the Sequencer Table at the location specified by the step counter.
- SEQUENCER INPUT — compares data in one to four 16-bit words at independent I/O addresses specified with the selected words and associated mask in the Sequencer Table. If the comparisons are equal, the rung is TRUE.
- SEQUENCER OUTPUT — sends data as specified by the mask from the Sequencer Table as indicated by the step counter to an independent I/O address specified in the instruction.

## DIAGNOSTIC INDICATORS

The Mini-PLC-2/15 Processor Module has diagnostic circuitry that continuously monitors its operation. Indicators on the front of the Mini-PLC-2/15 Processor Module (Figure 6) show the status of its operation. These indicators are:

- PROCESSOR — When the keyswitch is in the RUN/PROG, RUN, or TEST position this red indicator illuminates if the Mini-PLC-2/15 Processor is unable to scan the user's program and Data Table in memory. This indicator is normally OFF.
- MEMORY — In the RUN or RUN/PROGRAM mode this red indicator illuminates if the Mini-PLC-2/15 Processor detects no user memory, a discrepancy in memory data, or a parity error. This indicator is normally OFF. This indicator will flash if EPROM transfer at power-up is bad.

  In the PROGRAM mode this red indicator is used during the EPROM programming sequence. While EPROM programming is actually in progress, this indicator will blink ON and OFF. When the EPROM programming process has been successfully completed without error this indicator will stay OFF. If an error in the EPROM programming process occurs this indicator will come ON and stay ON.
- RUN — This green indicator illuminates when the Mini-PLC-2/15 Processor is operating with the Mode Select Switch in the RUN or RUN/PROG position and the outputs are enabled.

## ON-BOARD EPROM PROGRAMMING

An optional EPROM (Cat. No. 1770-XP) (Figure 7) and Power Supply Asembly (Cat. No. 1772-PA or -PAA) are needed to use the on-board EPROM programming feature of the Mini-PLC-2/15 Processor. The user fully develops the program in the Mini-PLC-2/15 Processor's 2K RAM memory. After the program has been fully developed, the user initiates the EPROM programming sequence.

The entire RAM area is programmed into the EPROM. If for some reason battery backup is low or lost while at the same time main power to the Mini-PLC-2/15 Processor Module is interrupted, the contents of EPROM memory will automatically be loaded into CMOS RAM memory when power to the Mini-PLC-2/15 Processor Module is restored.

### KEYING

A package of plastic keying bands is provided as standard with the I/O Chassis. These bands provide the user with a convenient method to ensure that only one type of module is seated into a specific slot of the Bulletin 1771 I/O Chassis.

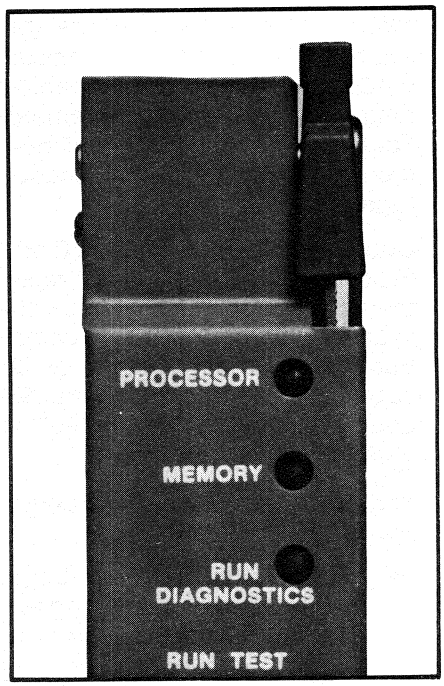



**FIGURE 6 — Diagnostic Indicators**

The Mini-PLC-2/15 Processor Module is slotted in two places on its rear edge. Positioning of keying bands on the backplane socket must correspond to these slots to allow insertion of this Module.

Needle-nosed pliers may be used to insert keying bands onto the upper, 56-terminal backplane socket. Bands are positioned between the numbers to the right of the connector. For the Mini-PLC-2/15 Processor Module, position bands in the following two locations on the upper backplane socket:

- Between 40 and 42
- Between 54 and 56

Refer to Figure 8.

## PORTABILITY

Battery backup for the user memory is provided by the Battery Pack (Cat. No. 1771-BP). Shipped standard with the System Power Supply, the Battery Pack guards against the loss of user memory should line

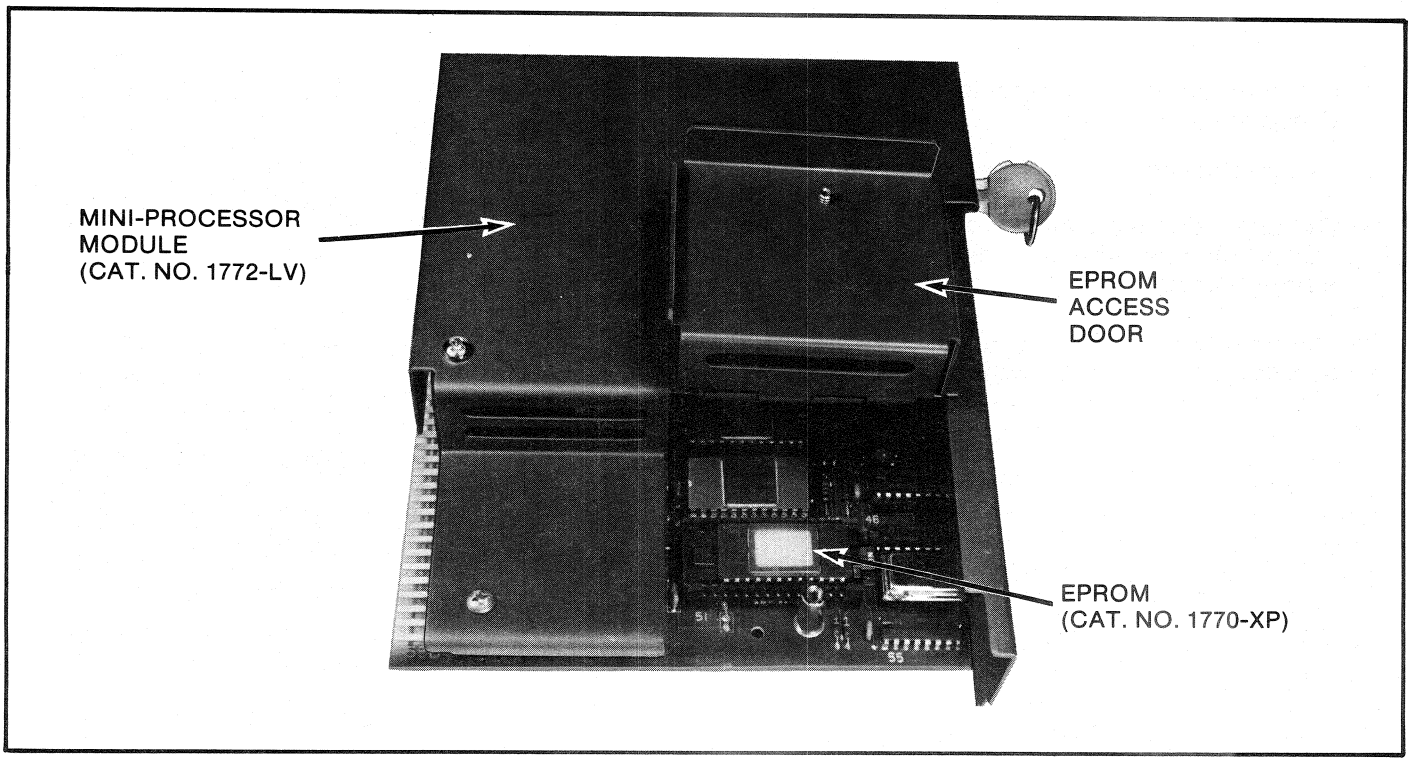



**FIGURE 7 — Location in Mini-PLC-2/15 Processor Module**

power fail or the Power Supply shut down. Two alkaline "D" size cells for the Battery Pack are standard with the Power Supply. An optional Lithium Battery (Cat. No. 1770-XO) can also be ordered if preferred. The Battery Pack provides memory backup power while the Mini-PLC-2/15 Processor Module is seated in the I/O Chassis.

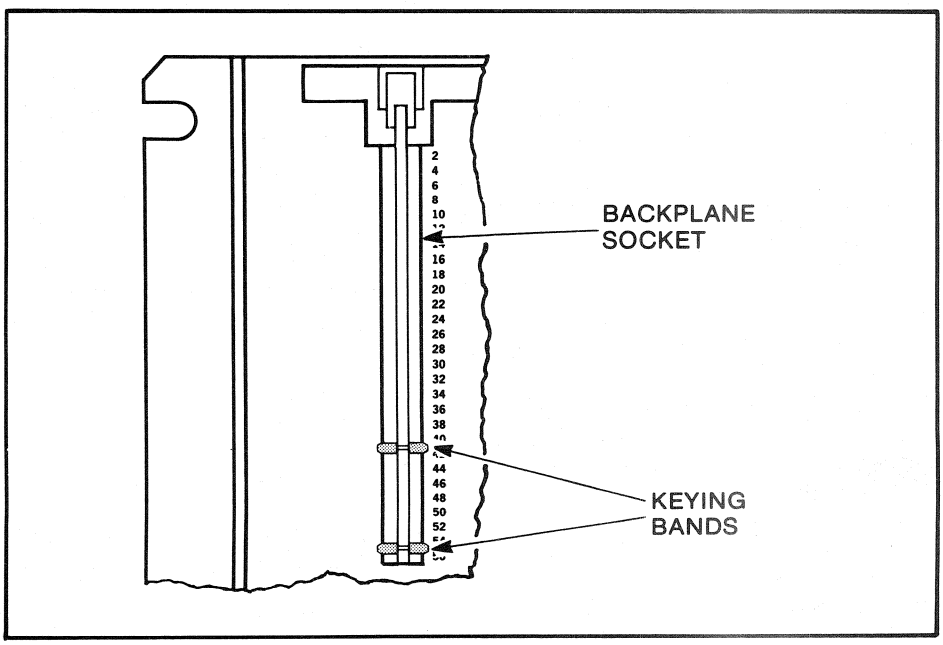



**FIGURE 8 — Mini-Processor Module Keying Band Locations**

This Battery Pack (Cat. No. 1771-BP) can also be removed from its mounting assembly on the I/O Chassis to provide external backup to the Mini-PLC-2/15 Processor Module so that it can be removed from the I/O Chassis without the loss of memory. The Mini-PLC-2/15 Processor Transport Cable (Cat. No. 1772-CD) is used to connect the Mini-PLC-2/15 Processor Module to the Battery Pack for external use (Figure 9).

## COMPATIBILITY

The Industrial Terminal (Cat. No. 1770-T1 or -T2) can be used on a limited basis to program the Mini-PLC-2/15 Processor. When using a 1770-T1 or -T2 Industrial Terminal the following features of the Mini-PLC-2/15 Processor are available:

- Ladder Diagram Programming
- 2K CMOS RAM memory supported by 2K user programmable EPROM backup
- Four function math (+, —, ×, ÷)
- Up to 256 word Data Table

- Up to 104 Timers/Counters
- I/O Forcing in one Module Group at a time
- Battery Backup
- Optional removable Mini-Processor Module with external Battery Backup
- Standard Mini-PLC-2 Instruction Set (Cat. No. 1772-LN3)
- Diagnostic Indicators
- Data Highway Compatible
- Block Transfer Capability

When using a 1770-T1 or -T2 Industrial Terminal to monitor an instruction or function that was originally programmed with the 1770-T3 Industrial Terminal, an "ERR" message will be displayed on the screen in place of the instruction or function.

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# MEMORY ORGANIZATION AND STRUCTURE OF THE MINI-PLC-2/15 PROCESSOR

## GENERAL

This data sheet will introduce the concepts and terminology of the Mini-PLC-2/15 Processor memory and describe its memory structure and organization.

This data sheet will not explain solid state memory. Detailed explanations of solid state memory operations are available in the technical section of many libraries.

## MEMORY STRUCTURE AND CAPACITY

The memory of the Mini-PLC-2/15 Processor is solid state, read/write Random Access Memory (RAM). The solid state memory components, the support circuitry needed to store and retrieve information, and the Processor control circuitry are all mounted on a pair of printed circuit boards contained in the module. An external battery pack is needed for memory backup power during AC power loss or power supply shutdown.

The memory of the Mini-PLC-2/15 Processor is made up of an arrangement of storage points called bits (Figure 1). Bit is an abbreviation for BInary digiT and is the smallest unit of memory.

Information is stored in each bit and is represented as a "1" or "0." When a "1" occupies a bit, that bit is ON; when a "0" occupies a bit, that bit is OFF.

A group of eight bits forms a single byte. The information in a byte is the smallest complete unit the Processor can transmit or receive at a given time. A group of 16 bits or two 8-bit bytes makes up a word, where each word is a memory location.

Memory capacity of a processor is measured by the total number of words in memory. The maximum memory capacity of the Mini-PLC-2/15 Processor is 2048 (2K) words.

## MEMORY ORGANIZATION

All Mini-PLC-2/15 Processor memory words are identified by their word address: either a three or four-digit number using the octal numbering system (Figure 1).

Similarly, each bit that makes up a word is identified by a two-digit number using the octal numbering system. All Mini-PLC-2/15 Processor memory bits are numbered 00 through 07 and 10 through 17 with the most significant bit (MSB) at the left and the least significant bit (LSB) at the right (Figure 1).

The word address and bit number can be combined to form the bit address, such as 03010.

The Mini-PLC-2/15 Processor memory words are organized by word

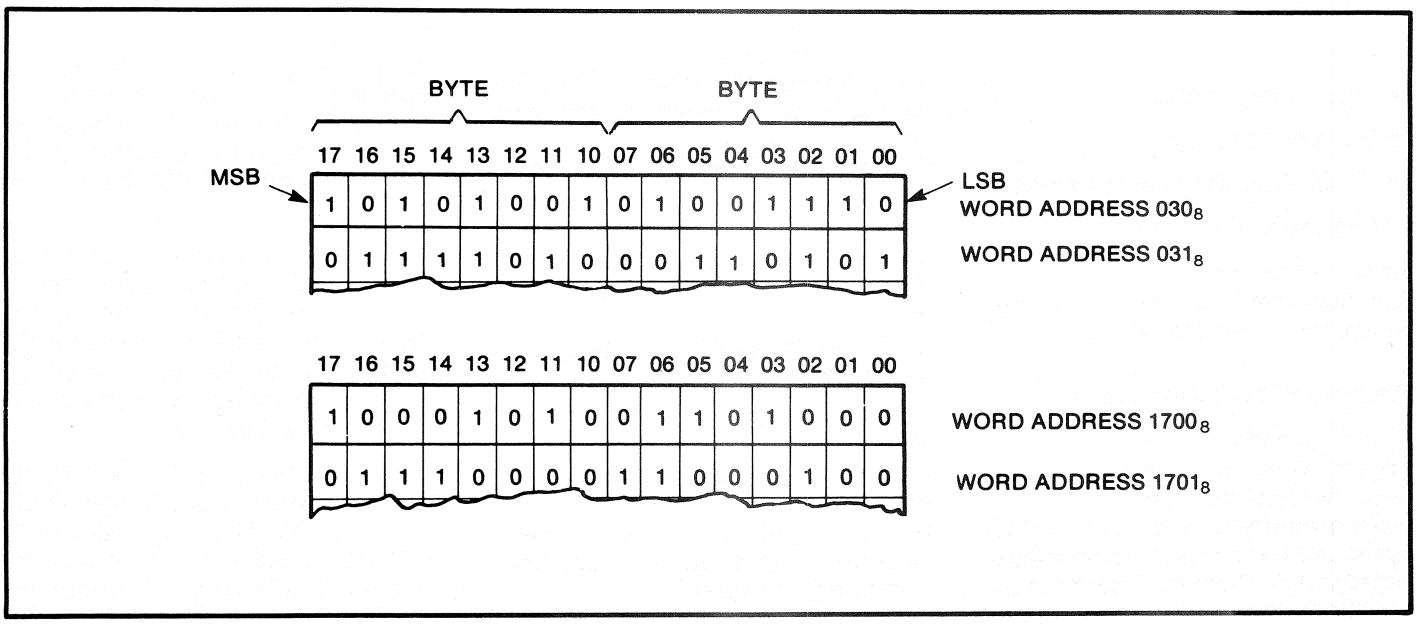



**FIGURE 1 — Memory Word Structure**

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Supersedes Publication 1772-912 Dated February, 1981

address and can be divided into three major parts:

- Data Table
- User Program
- Message Storage, if used

NOTE: Not all of the 2048 words in memory are accessible to the user. Some words are reserved by the Processor for internal use.

## DATA TABLE

The Data Table is the first part of memory and is used to store information needed in the execution of the user program. Refer to Figure 2 for the Data Table organization.

The Data Table size is automatically set to 128 words by the Processor but can be increased to 1920 words or reduced to 48 words using the Industrial Terminal (Cat. No. 1770-T3).

The Data Table contains functional areas that are arranged by octal word address:

- Processor Work Area No. 1
- Output Image Table
- Bit/Word Storage
- Timer/Counter Accumulated Values
- Processor Work Area No. 2
- Input Image Table
- Bit/Word Storage
- Timer/Counter Preset Values
- Expanded Data Table Area

Each of these areas has a special function that relates to the overall operation of the Processor.

### Processor Work Area No. 1

The Processor Work Area No. 1 begins at word address $000_8$ and ends at word address $007_8$. These eight memory locations cannot be accessed by the user. The Processor reserves them for internal control functions.

### Output Image Table

The Output Image Table, bounded by word addresses $010_8$ and $017_8$, has two functions:

1. Indicate the status of the outputs wired to the output modules.

2. Provide a storage area for bits and/or words.

The 16 bits in one word of the Output Image Table correspond to the 16 terminals on the front of two output modules (Figure 3). The 5-digit terminal address directly corresponds to the 5-digit bit address.

The 128 bits represent the maximum number of output devices the Mini-PLC-2/15 Processor can control. It is unlikely, however, that a system would be configured exclusively for output devices because there would be no I/O Rack space left for input modules.

The Mini-PLC-2/15 Processor controls the status of output bits in the Output Image Table by interpreting instructions in the user program. When an Output Image Table bit is ON and there is a corresponding output device, that output device will be ON. If the bit is OFF and there is a corresponding output device, that output device will be OFF.

### Bit/Word Storage

A bit/word storage area is located between word addresses $020_8$ and $027_8$. As the name implies, this area is used to store single bits and words. Timer and Counter Accumulated Values cannot be stored in this area.

Word $027_8$ is reserved for control functions. Although some bits are not used, do not use the remaining bits in word $027_8$ to avoid programming problems.

Bits $02710_8$ through $02715_8$ are automatically reserved for generating stored messages. Bits $02716_8$ and $02717_8$ are used to indicate message generation status (busy and done, respectively).

Bit $02700_8$ is used to indicate a BATTERY LOW condition. Bit $02701_8$ is used by the Processor during EPROM transfer and bit $02707_8$ is used for Data Highway.

### Accumulated Values and Storage

This area of memory starts at word address $030_8$ and ends at word address $077_8$. It is used to store Accumulated Values of Timer/Counter instructions, and can also be used to store words and/or bits. Up to 40 Timers and/or Counters can be stored in this area.

NOTE: Each Timer or Counter instruction actually requires two words of Data Table memory: one for the Accumulated Value and the other for the Preset Value. When an Accumulated Value is assigned a word address, the Processor automatically reserves a word address for the Preset Value $100_8$ words from the Accumulated Value.

### Processor Work Area No. 2

The Processor Work Area No. 2 begins at word address $100_8$ and ends at word address $107_8$. These eight memory locations cannot be accessed by the user. The Processor reserves them for internal control functions.

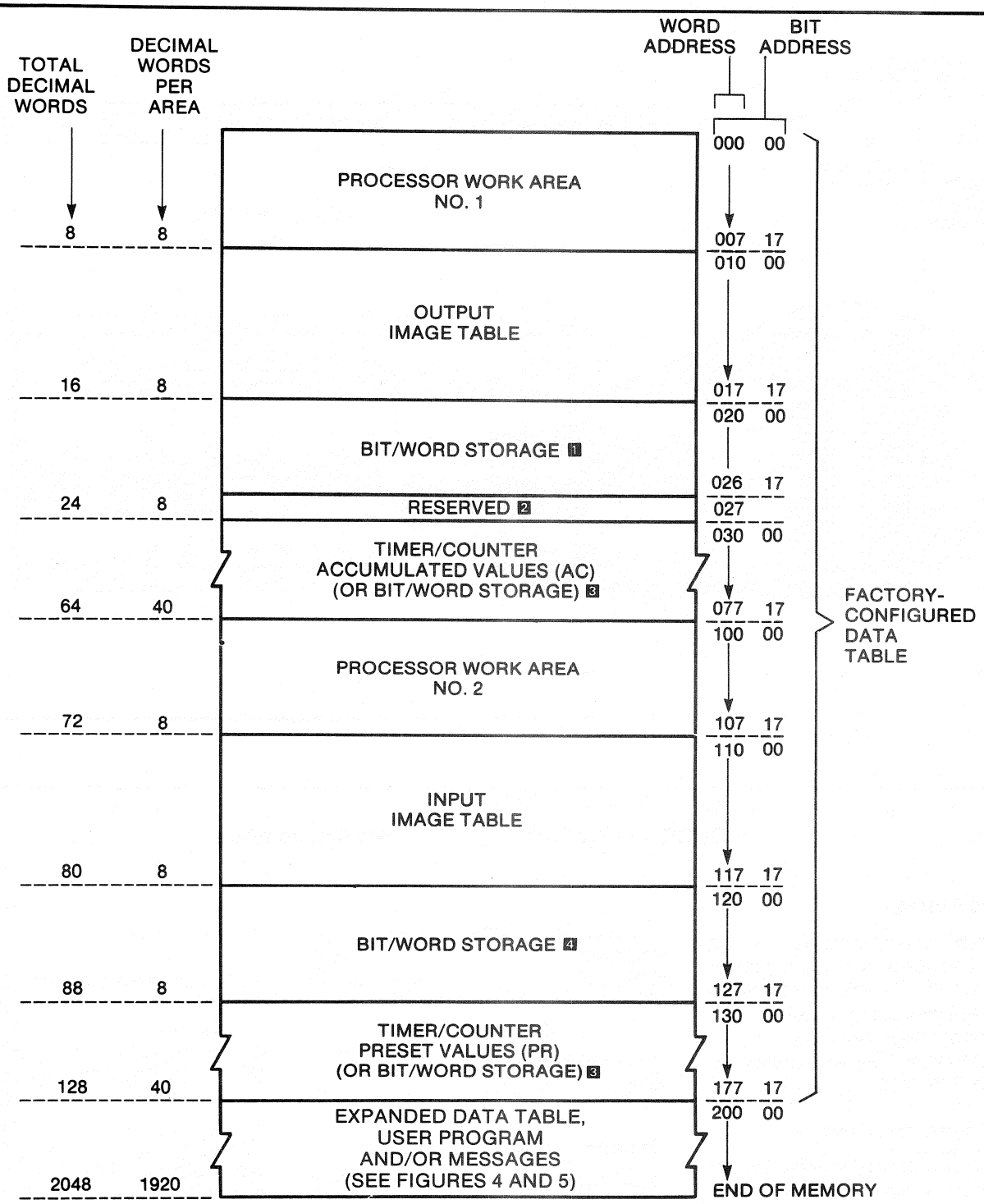
### Input Image Table

The Input Image Table, bounded by word addresses $110_8$ and $117_8$, is used to store the status of the input devices wired to the input modules. Although the Processor can monitor up to 128 input devices, it is unlikely that a system would be configured exclusively for input devices because there would be no I/O Rack space left for output modules.

All 16 bits in each Input Image Table word, when used, correspond to the 16 terminals on the front of two input modules. Just like the Output Image Table, each 5-digit terminal address corresponds to the 5-digit bit address.

When an input device is ON, its corresponding Input Image Table bit is set ON. If an input device is OFF, its corresponding bit in memory is set OFF. The Processor examines these bits according to instructions in the user program.

Because Input Image Table bits are cleared to zero during each I/O scan, bit/word storage is not possible in the Input Image Table.




1 MAY NOT BE USED FOR ACCUMULATED VALUES.

2 NOT AVAILABLE FOR BIT/WORD STORAGE. BITS IN THIS WORD ARE USED BY THE PROCESSOR FOR BATTERY LOW CONDITION, MESSAGE GENERATION, EPROM TRANSFER AND DATA HIGHWAY.

3 UNUSED TIMER/COUNTER MEMORY WORDS CAN REDUCE DATA TABLE SIZE AND INCREASE USER PROGRAM AREA.

4 MAY NOT BE USED FOR PRESET VALUES.

**FIGURE 2 — Data Table Organization**

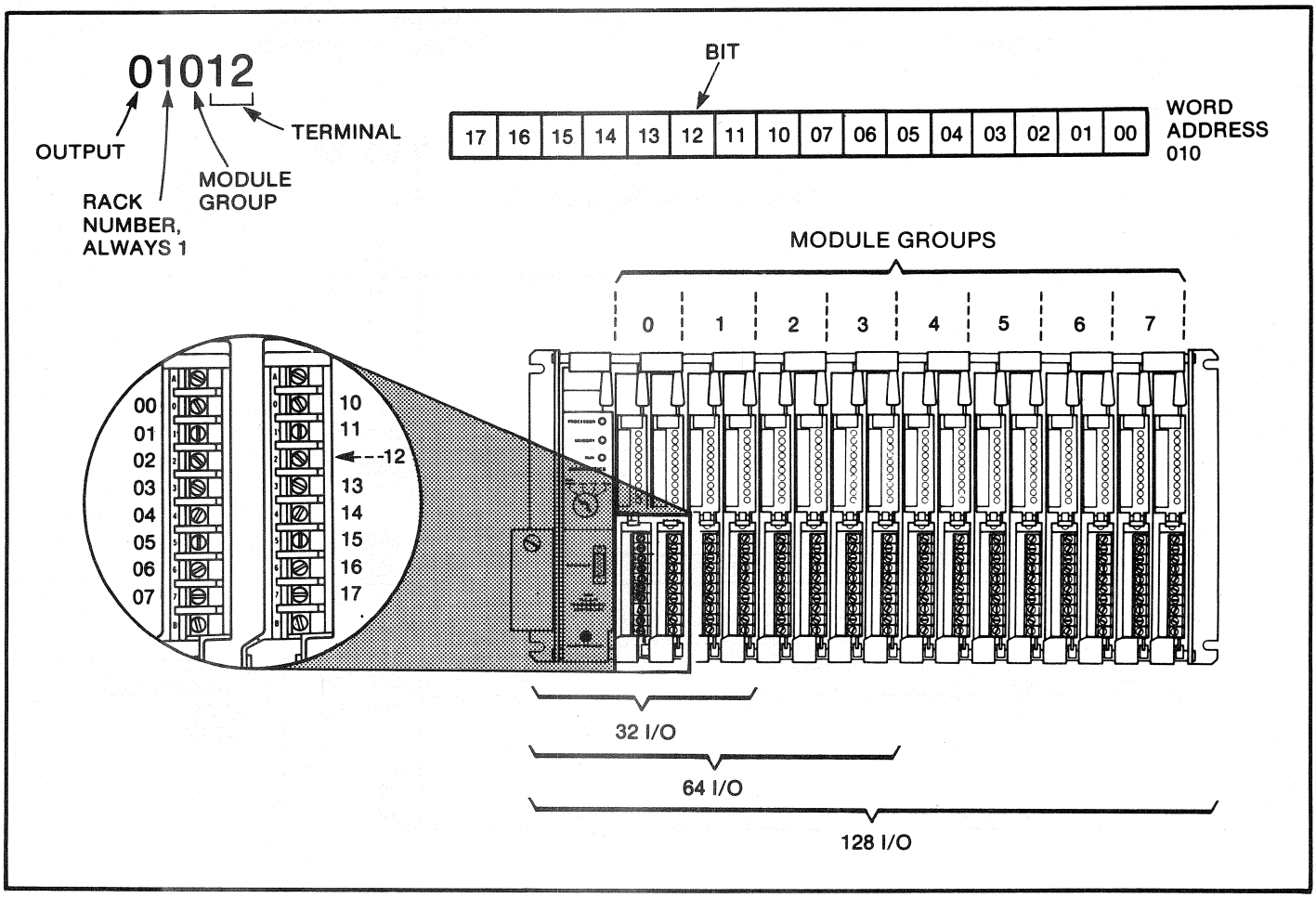



**FIGURE 3 — Bit Address to Hardware Relationship**

### Bit/Word Storage

Another bit/word storage area is located between word addresses $120_8$ and $127_8$. These memory locations are available for single bit and word storage only. Timer and Counter Preset Values cannot be stored in this area.

### Preset Values and Storage

This area of memory starts at word address $130_8$ and ends at word address $177_8$. It is used to store Preset Values of Timer/Counter instructions, and can also be used for bit or word storage.

A Timer or Counter Accumulated Value stored at word address $030_8$ will automatically have its Preset Value stored at word address $130_8$.

### Memory Write Protect

When a "programmed" EPROM is in place in the Mini-PLC-2/15 Processor, Data Table values can be changed between word addresses $010_8$ and $177_8$. These values can be changed only when the Processor is in the RUN or RUN/PROG mode.

The remaining words in memory, from $200_8$ to end of memory, are protected and cannot be altered.

### Expanded Data Table Area

The Data Table can be expanded from its factory-configured size of 128 words to a maximum of 1920 words. It is impractical, however, to expand the Data Table to 1920 words since there would be little memory available for the User Program.

The user can expand the Data Table to 256 words (word address $377_8$) in two-word increments using any programming terminal (Figure 4). Timer/Counter instructions and bit/word storage are possible in this expanded area.

The user can also expand the Data Table from 256 words up to 1920 words (word address $400_8$ to $3677_8$) using the Industrial Terminal (Cat. No. 1770-T3). The expansion in this area is made in 128-word sections only (Figure 5). Timer/Counter instructions and file/bit/word storage are possible in this expanded area. A file is defined as a group of consecutive Data Table words up to 999 words long. When Timers/Counters are used and do not fill up a 128-word section, it is recommended that a new 128-word section be used for file storage (refer to Figure 5). This will guard against writing over Timer/Counter Preset Values with file instructions. Thus, all Timer/Counter instructions should be stored in memory ahead of file instructions.

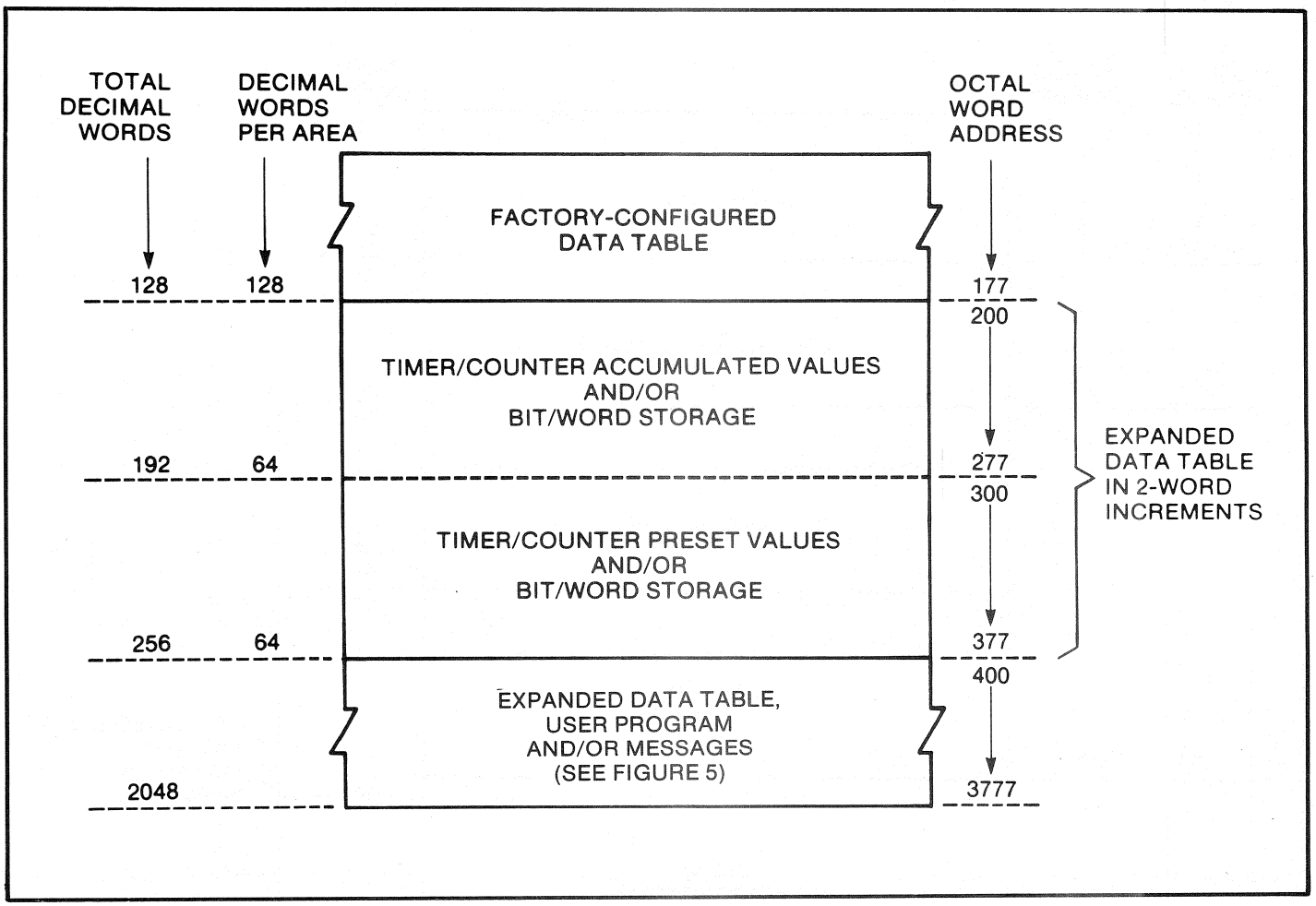



**FIGURE 4 — Expanded Data Table (2-word increments)**

There are limitations for addressing Timers and Counters in the Expanded Data Table. The last word address for Timers and Counters is $1677_8$.

## USER PROGRAM

The User Program is a group of ladder diagram and functional block instructions that are used to control an application. The User Program is initially entered in memory using an Industrial Terminal and consists of the main program and subroutines, if used. It directly follows the Data Table in memory, provided Data Highway instructions are not used. When used, the Data Highway instructions will appear at the beginning of the User Program Area.

Some of the simple program instructions, such as "EXAMINE ON," use one word of memory. Others, such as file instructions, are more complex and can use two or more words of user program memory. As the user program is entered from the Industrial Terminal, the number of words used is indicated at the right of the END statement (including Data Table words). The number of words remaining in memory can be determined by subtracting that number from 2048.

When subroutines are used, they are entered at the end of the User Program. The END statement then appears after the last subroutine. Up to eight subroutines are permitted with the Mini-PLC-2/15 Processor. The JUMP TO SUBROUTINE (JSR) instruction is located in the User Program. When the Processor encounters the JSR instruction, it jumps to the designated subroutine to begin executing the subroutine instructions. Upon completion of the subroutine, the Processor returns to the point where it left off in the main program and continues executing the main program.

Should a user attempt to enter more instructions than the maximum capacity of the available memory, a MEMORY FULL message is displayed on the Industrial Terminal. Additional program instructions cannot be entered.

The Mini-PLC-2/15 Processor execution time is typically 12 msec per 1024 (1K) words of memory. The execution time will vary depending on the types of instructions used and their true/false state.

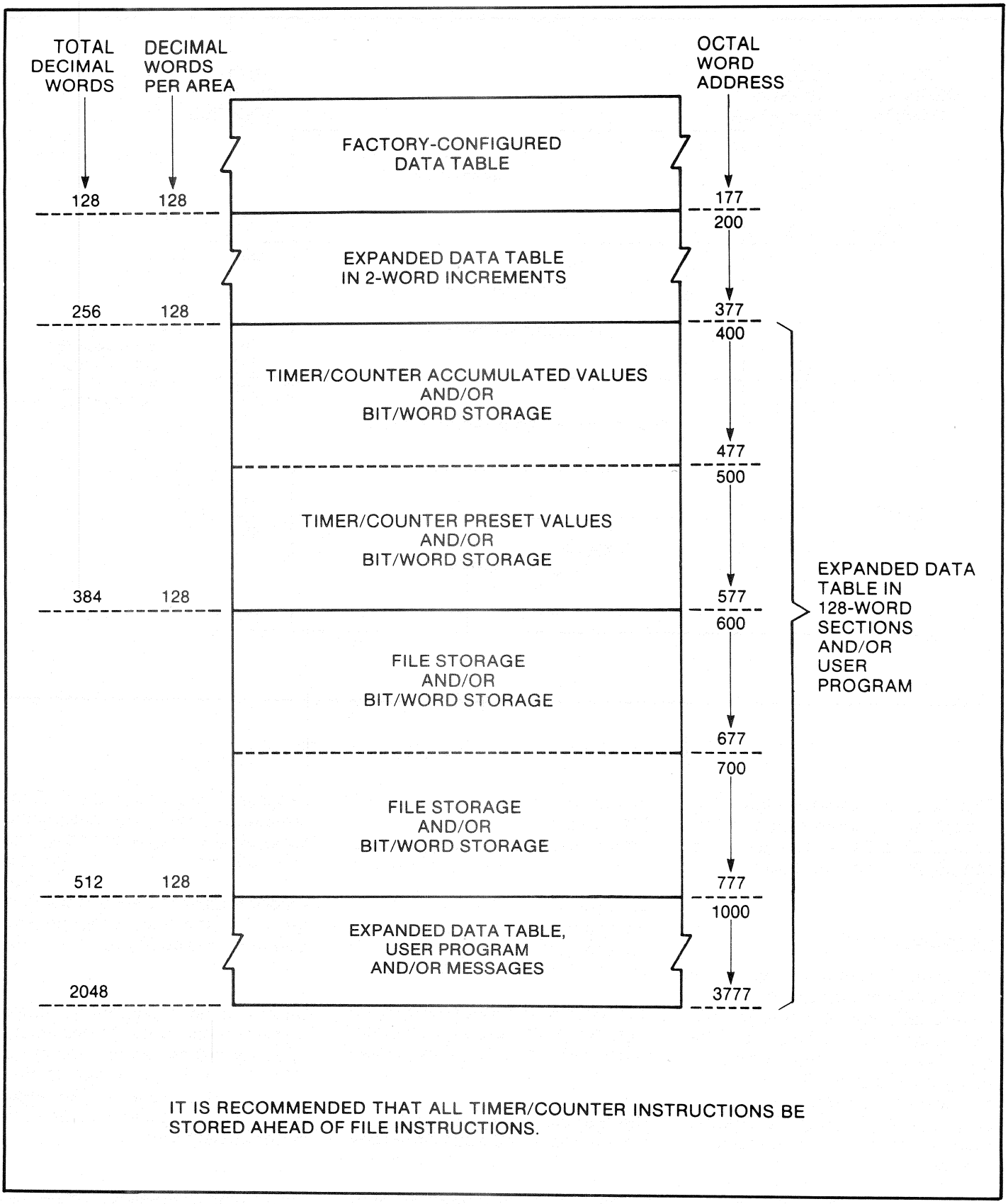



**FIGURE 5 — Expanded Data Table (128-word sections)**

### Message Storage

The Message Storage area immediately follows the END statement. It is limited only by the number of unused words remaining in memory. Two alphanumeric characters can be stored in each word of memory and are entered from a data terminal or Industrial Terminal keyboard. Memory permitting, up to 70 messages can be stored in the Message Storage area.

Bits $02710_8$ through $02717_8$ are used to generate six stored messages and to indicate message status.

The user must select four other consecutive words (16 bits per word) in the Data Table to generate the remaining 64 messages. They can be located anywhere in the Data Table, excluding the Processor Work Areas and the Input Image Table.

## COMPATIBILITY

When using the Industrial Terminal (Cat. No. 1770-T1 or -T2), the following features are available with the Mini-PLC-2/15 Processor:

- 256 word Data Table
- Up to 104 Timers/Counters
- Standard Mini-PLC-2 Processor (Cat. NO. 1772-LN3) instruction set
- Up to 6 messages
- Data Highway compatible
- Block Transfer capability



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# Section 3
# PLC-2/30 PROGRAMMABLE CONTROLLERS

1772-913 PLC-2/30 Processor
1772-914 Memory Organization and Structure of the PLC-2/30 Processor

# ALLEN-BRADLEY PLC-2/30 PROCESSOR

## Cat. No. 1772-LP3




### SPECIFICATIONS

**Voltages**
Nominal Input Voltages to Processor Modules
+5.1V, +12V, - 5.1V

**Maximum Input Power**
75VA
(Processor with CMOS RAM Memory and 128 digital I/O or Processor with CORE Memory and no I/O)

**Execution Time (nominal)**
5 ms/1K of memory

**Memory Capacity**
8K words (16 data bits each)

**Ambient Temperature Rating**
0° C to 60° C (operational)
– 40° C to +85° C (storage, excluding Battery)

**Humidity Rating**
5 to 95%
(without condensation)

**Keying**
Processor module slotted to mate with keyed Chassis sockets

### INTRODUCTION

The PLC-2/30 Programmable Controller, with up to 8K memory and many sophisticated programming functions, can handle the more complex, medium scale applications.

The PLC-2/30 Processor (Cat. No. 1772-LP3) is the control processing unit of the PLC-2/30 Programmable Controller. In it, a user program stored in the PLC-2/30 memory is scanned, the status of inputs and outputs is tested, and appropriate action is initiated. Having examined the status of the inputs and/or outputs, the Processor is capable of energizing or de-energizing outputs and latches, performing counting and timing functions, doing data comparisons and transfers, executing four-function arithmetic operations and performing the functions listed below. The electronic circuitry necessary to accomplish these functions is based in the Processor.

### PROCESSOR FEATURES

PLC-2/30 Processors (Cat. No. 1772-LP3) can be programmed to perform relay-type functions and other functions not possible with relay control systems. These functions/features include:

- Data transfer comparison
- Three digit, four function arithmetic (+, —, ×, ÷).
- Timing functions; on-delay and off-delay; retentive and non-retentive; with time bases of 1.0, 0.1, and 0.01 seconds can be addressed in the expandable Data Table area. Their number is limited by the memory remaining after the user program is entered.
- Bidirectional counting (up or down)
- Self monitoring/diagnostic capabilities
- The Data Table can be expanded to use the entire area unoccupied by the user program when the Industrial Terminal System (Cat. No. 1770-T3) is used.
- Memory capacity of 8192 words when used with Industrial Terminal System (Cat. No. 1770-T3)
- 896 input/output device capacity is available in both local and remote configurations. Remote configuration requires use of Remote I/O Scanner/Distribution Panel (Cat. No. 1772-SD) and Remote I/O Adapter (Cat. No. 1771-AS).

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**Publication 1772-913 — July, 1981**
Supersedes Publication 1772-913 Dated January, 1981

- Block Transfer Instructions
- Jump, Subroutines
- Sequencer Instructions
- Shift Register Instructions
- File-File and Word-File Instructions
- File-File, Word-File, and File-Word Transfers
- Bin-BCD, BCD-Bin Conversions
- Relay Type functions
- Full Forced I/O
- On-line programming
- Data Highway compatible

## DESCRIPTION

The PLC-2/30 Processor (Cat. No. 1772-LP3) package consists of:

- Processor Chassis (Cat. No. 1772-LA)
- Processor Control Module (Cat. No. 1772-LG)
- Processor Interface Module (Cat. No. 1772-LH)
- Power Supply (Cat. No. 1772-P1 Ser. C)

A Memory Module (not included in the Cat. No. 1772-LP3 package) is also required. Two Memory Modules are available: a RAM Memory Module (Cat. No. 1772-ME) which uses 1772-MS or MT Memory segments and has a maximum 8K capacity or a core Memory Module (Cat. No. 1772-M8) with 8K capacity.

The left-most module track guides the System Power Supply Module into place (Figures 1 and 2). Each of the three tracks on the right side of the Processor Chassis accepts one of the three Processor modules. To access the modules, remove the metal plates at the front of the Processor (Figure 1).

When the three Processor modules are in place they make electrical contact with the printed circuit chassis backplane (Figure 2).

This backplane carries electrical signals among Processor modules. As the modules are inserted, care must be taken to ensure that they are properly seated into the motherboard connectors. If not seated properly, modules will not make electrical contact and system malfunction could result.

**WARNING:** Never insert or remove modules from the Processor while AC power is applied. Remove the external AC power before replacing any module. Failure to observe this WARNING could result in personal/property damage.

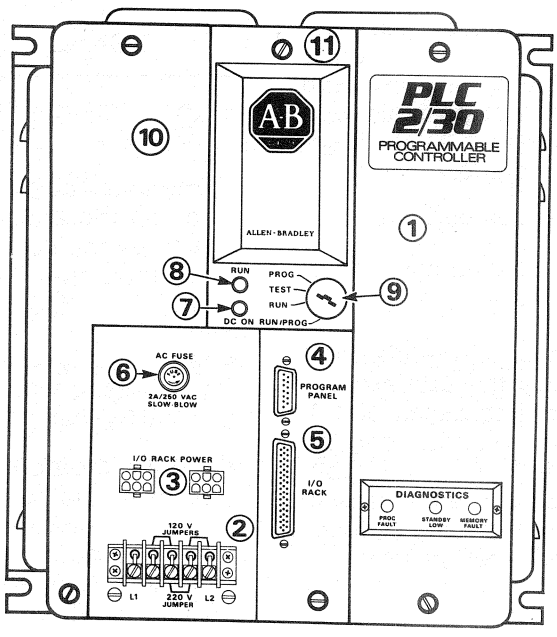
## PROCESSOR CHASSIS

The Processor Chassis (Cat. No. 1772-LA), when all modules are in position, measures approximately 12 × 13.5 × 9 inches (W×H×D), or 30.5 × 34.3 × 22.4 cm. It is of rugged construction with louvers cut into the sides and top, and holes in the bottom to allow convection cooling.

## PROCESSOR INTERFACE MODULE

The Processor Interface Module (Cat. No. 1772-LH) is the third Module from the right in the Processor Chassis (Figure 2). This Module contains signal-conditioning circuitry for communication between the Processor and I/O system or Industrial Terminal.

Attached to the front of the Processor Interface Module is a front




LEGEND:

1. ACCESS MEMORY AND PROCESSOR CONTROL MODULE BY REMOVING PANEL
2. USER AC CONNECTIONS
3. I/O RACK POWER SOCKETS
4. PROGRAM PANEL SOCKET
5. I/O RACK SOCKET
6. AC INPUT FUSE
7. DC ON INDICATOR
8. RUN INDICATOR
9. FOUR-POSITION MODE SELECT SWITCH
10. SYSTEM POWER SUPPLY MODULE LOCATED HERE
11. PROCESSOR INTERFACE MODULE FRONT PANEL

**FIGURE 1 — PLC-2/30 Processor (Front Panel)**

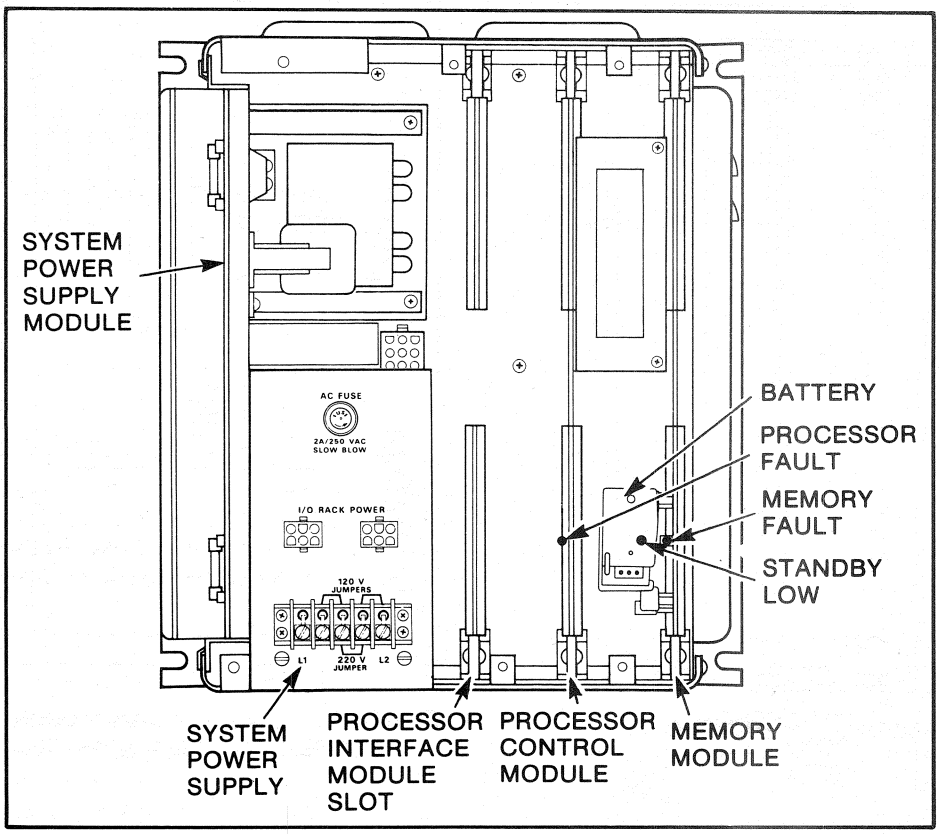



**FIGURE 2 — Processor Module Locations. The RAM Memory Module (Cat.No. 1772-ME) Is Shown**

panel which contains several user connectors, indicators, and controls. Their function is described under "Processor Front Panel."

## PROCESSOR CONTROL MODULE

The Processor Control Module (Cat. No. 1772-LG) is the second Module from the right in the Processor Chassis (Figure 2). Control of system operation and various timing functions is provided by this Module. Once inserted and seated properly into the mother board connector, it is covered with a panel which is secured to the Processor Chassis by means of two thumb screws. This panel then forms part of the Processor enclosure.

A diagnostic indicator, the PROCESSOR FAULT indicator, is on the Processor Control Module (Figure 2). This indicator illuminates if the logic controlling the Processor scan fails. With the Industrial Terminal (Cat. No. 1770-T3), the user can usually determine if this fault is in the Module or in the user's program.

## MEMORY MODULES

The PLC-2/30 Processor can use either the 8K Core Memory Module (Cat. No. 1772-M8) or the RAM Memory Module (Cat. No. 1772-ME). The RAM Memory Module is used with Cat. No. 1772-MS or MT RAM Memory Segments.

### Core Memory

If the user chooses the Core Memory (Cat. No. 1772-M8) with 8K capacity, it is inserted in the right slot position (Figure 3). The Core Memory Module is self contained.

A MEMORY FAULT indicator is visable through a diagnostic panel on the Processor front panel (Figure 1). This indicator, when illuminated, indicates an error in the parity of data received from memory. Changing the Mode Select Switch to the PROG position or remotely changing from RUN/PROG to Remote PROGRAM, resets this test circuit.

### Ram Memory

If the RAM Memory Module (Cat. No. 1772-ME) is selected, it occupies the right slot position (Figure 2). The 1772-ME Memory Module contains read/write solid state Random Access Memory (RAM), and support circuitry needed to store and retrieve information. Its memory capacity is 8K.

The Memory Module (Cat. No. 1772-ME) accepts the following Memory Segments:

- 512 word Memory Segment (Cat. No. 1772-MT)
- 2048 word Memory Segment (Cat. No. 1772-MS)

Memory Segments which have Catalog Number 1772-MS and 1772-MT can be secured to the Memory Module with mounting screws.

Users order Memory Segments which best suit application needs. Combinations of both Segments are possible with the Memory Module (Cat. No. 1772-ME). However, an 8K memory configuration can only be achieved when four 2048 word Memory Segments are properly installed.

Memory Segments are designed to be user-installed into sockets labeled A, B, C, and D on the Memory Module, Cat. No. 1772-ME, (Figure 4). This is done after power (AC input power and battery standby) has been removed from the system, and the Memory Module has been removed from the Processor Chassis.

**CAUTION:** Battery backup power must be removed from the Memory Module before Memory Segments are removed/inserted into sockets. Memory Segment damage may occur if this CAUTION is not followed.

The first Memory Segment is inserted into the socket labeled A. Additional Segments are inserted into the next available socket in an ascending alphabetical order. Do not leave blank sockets between Segments.

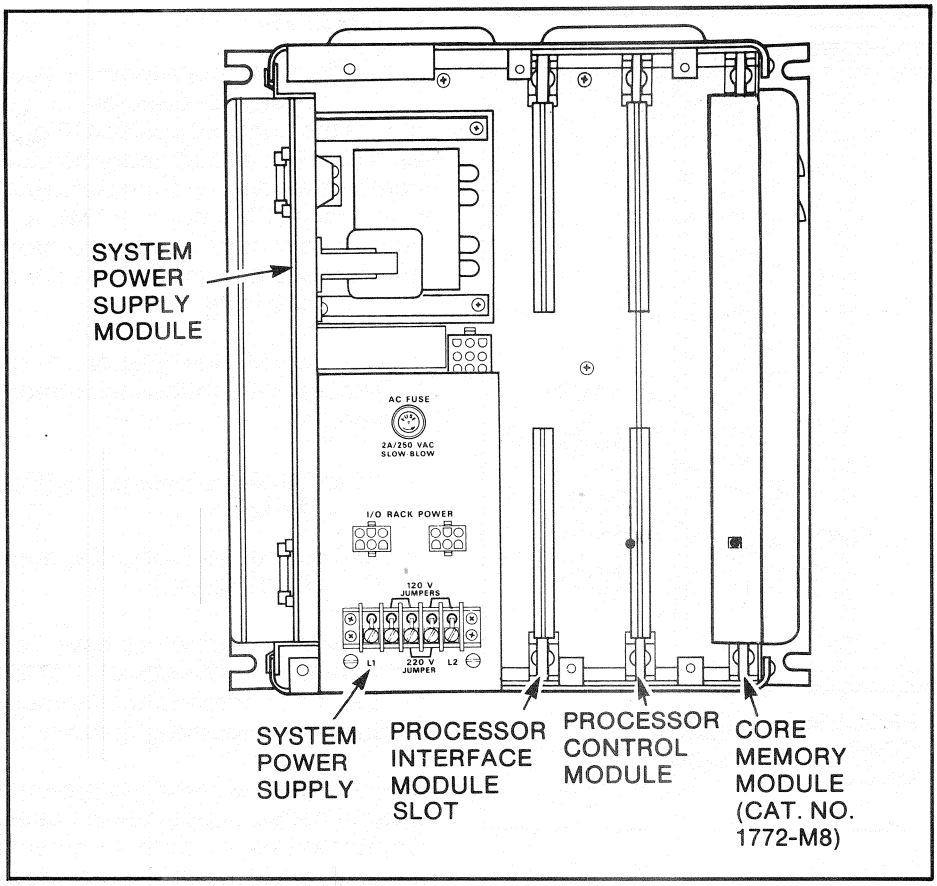



**FIGURE 3 — The Processor With The Core Memory Module (Cat.No. 1772-M8) Installed**

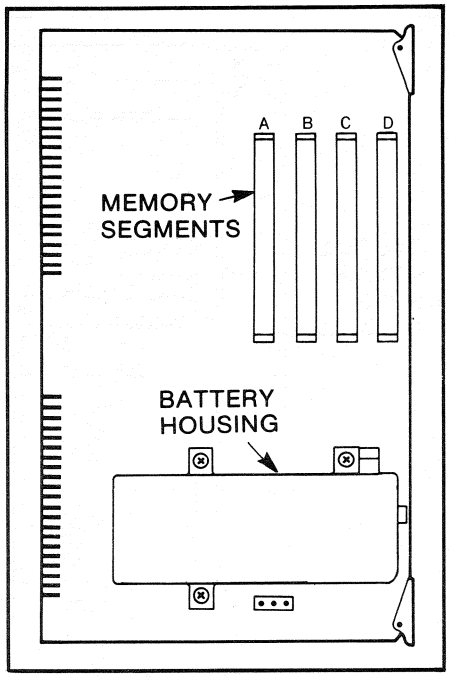



**FIGURE 4 — RAM Memory Module (Cat. No. 1772-ME) Side View**

A Battery Pack is supplied as part of the RAM Memory Module (Figure 4). Two D-size Alkaline Batteries (Cat. No. 1771-BA), ordered separately, provide standby power to the Memory Module should power from the System Power Supply Module be interrupted. Alkaline Batteries (Panasonic) can support 8K of memory for approximately six months. Should longer battery backup time be required, a Lithium Battery (Cat. No. 1770-XO) can be ordered.

A secondary function provided by battery backup is maintaining memory contents when the Memory Module is removed from the Processor Chassis.

**CAUTION:** Power to the System Power Supply Module must be disconnected before removing or inserting modules. Damage may result if this CAUTION is not observed.

Batteries can be replaced while system power is applied and the Controller is monitoring/controlling user I/O devices. Replacing the Batteries without power from the System Power Supply Module will cause loss of memory contents (user program, I/O status, etc.)

**CAUTION:** If the Battery is drained while providing standby power to the memory, the contents of memory will be lost. The user program must be re-entered after a replacement Battery is installed.

A Battery Low Bit, bit 02700, alternately cycles ON, then OFF when the Battery voltage is detected as being low. This Bit can be examined in the user program to sound an alarm or annunciator in the event of a Battery Low condition.

Two diagnostic indicators are associated with the RAM Memory Module. One is the STANDBY LOW indicator which is located on the Battery Pack (Figure 2). This indicator flashes when the Memory Battery is detected as being low. It serves as an indication that approximately one week of standby power is available.

The second indicator, a MEMORY FAULT, is located on the front edge of the Memory Module, adjacent to the Memory Battery (Figure 2). This indicator, when illuminated, indicates an error in the parity of data retrieved from memory. Changing the Mode Select Switch to the PROG position resets this test circuit.

When illuminated, these diagnostic indicators (MEMORY FAULT, and STANDBY LOW) are easily viewed through a diagnostic window on the Processor front panel.

## SYSTEM POWER SUPPLY

The System Power Supply Module (Cat. No. 1772-P1 Ser. C) forms part of the Processor Chassis. It occupies the left half of the Chassis (Figure 2) and slides on runners designed to accept only the System Power Supply.

With RAM memory, all necessary and normal electrical power requirements for the Processor and 3A for up to 128 digital I/O are provided by this Supply. Should the I/O requirements exceed 3A, 128 digital I/O, or should more than two I/O Racks be needed, an additional Power Supply must be used. A single connector terminates a wire bundle that extends from the System Power Supply Module and provides power to all Processor modules (Figure 5). The connector mates with a socket on the Processor motherboard, and must be connected before the System Power Supply is fully inserted into the Chassis.

With Core Memory in use, the System Power Supply cannot supply power to any I/O Racks. I/O Racks in a Core System must be powered by auxiliary power supplies.

Fuses are provided in the System Power Supply Module circuitry. (Additional information concerning System Power Supply Module replacement fuses is presented in Publication 1772-902, PLC-2 Power Supplies.)

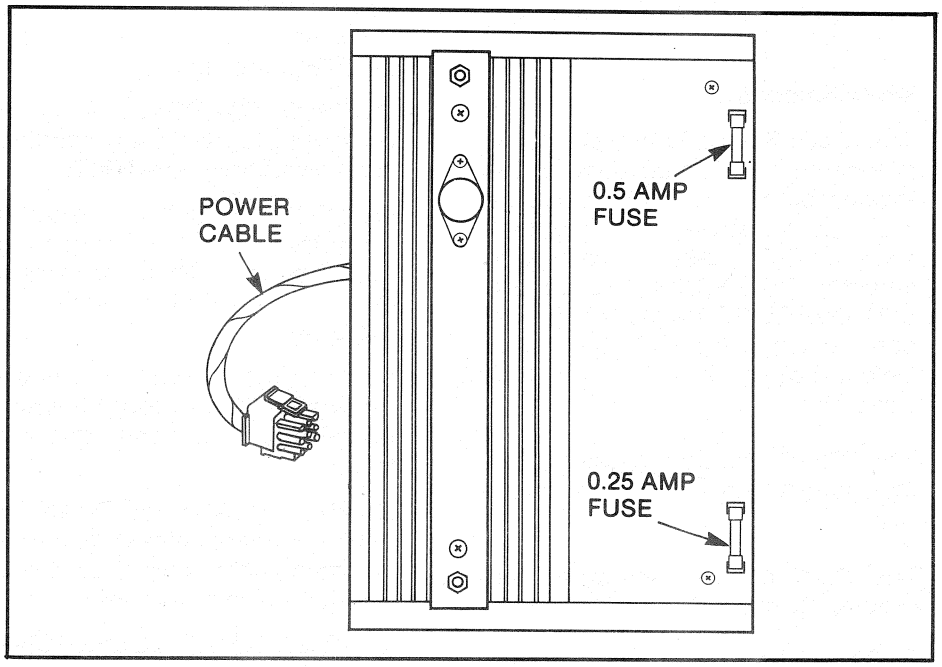



**FIGURE 5 — System Power Supply Module**

## PROCESSOR FRONT PANEL

The Processor front panel contains termination for AC input power, I/O power, I/O communication, and Program Panel/Industrial Terminal connections (Figure 1). In addition to these terminations, a four-position Mode Select Switch, fuse holder, and status indicators are located on the front panel.

### AC Input Power Fuse

The AC input power fuse is located in a fuse holder at the top of the recessed section of the System Power Supply (Figure 1). This 2 ampere slow-blow fuse protects system wiring from excessive current drain on the AC line.

### DC ON Indicator

The DC ON indicator is the lower of two indicators on the front panel; both are adjacent to the Mode Select Switch (Figure 1). This red indicator illuminates when the Power Supply is operating properly. It is extinguished when the AC input power to the System Power Supply Module or any of the DC output voltages from the System Power Supply Module is not within specified tolerances, or when one of the three Processor modules is not seated and making proper electrical contact.

### RUN Indicator

The green RUN indicator is directly above the DC ON indicator (Figure 1). The indicator illuminates when the Mode Select Switch is in RUN or RUN/PROG position and outputs are enabled. If not illuminated, a malfunction has occurred.

### External Power Terminal Strip

The External Power Terminal Strip is located near the bottom of the System Power Supply Module (Figure 1). AC line connections to the System Power Supply Module are made at this terminal strip. Most domestic applications use 120V AC voltage; therefore factory-installed jumpers are made at this terminal strip for 120V AC operation.

Users must reconnect the External Power Terminal Strip jumpers for 220/240V AC operation. Jumper positions are shown at the Terminal Strip.

### I/O Power Connectors

The I/O Power Connectors are located below the AC input power fuse holder on the front face of the System Power Supply Module (Figure 1). Each connector accepts a cable, which in turn, connects to the socket on a Bulletin 1771 I/O Rack. Bulletin 1771 I/O module logic circuitry is powered through an I/O Power Cable having Catalog Number 1771-CK (3 feet) or 1771-CJ (8 feet). One end of the appropriate cable connects to a socket marked I/O RACK POWER on the System Power Supply Module; the other end connects to each I/O Rack.

### Processor Interface Connectors

The Processor Interface connectors are located on the front face of the Processor Interface Module (Figure 1). The larger (50-pin) connector accepts the I/O Interconnect Cable (Cat. No. 1777-CA, or 1777-CB), which links the Processor to the I/O system. The smaller (15-pin) connector accepts the Program Panel Interconnect Cable (Cat. No. 1772-TC), which links the Processor to the Industrial Terminal (Cat. No. 1770-T3). These cables have connectors that are construct-

ed to guard against improper connections.

### Mode Select Switch

The Mode Select Switch (keylock) is located on the front face of the Processor Interface Module (Figure 1). It is a four-position keylock switch. With it, four modes may be selected: PROGRAM, TEST, RUN, or RUN/PROGRAM mode. The key can be removed with the Mode Select Switch in any of the four positions.

The PROG position is used when instructions are entered into memory.

The RUN position executes the program to control user equipment.

TEST — The system and program can be tested for proper operation by changing the Mode Select Switch to the TEST position. The PLC-2/30 Controller operates as it would during normal operation, however, outputs are disabled. This allows the program to be tested under simulated operating conditions.

RUN/PROG — In this position the PLC-2/30 Processor functions as it does in the RUN position. However, in this position, the user can also remotely cause the Processor to go into the PROGRAM or TEST mode without having to physically turn the keyswitch to that position. On-line changes to the program and/or Data Table are allowed in this position with the Industrial Terminal (Cat. No. 1770-T3).

## INSTRUCTION SET

The versatility of the PLC-2/30 Processor is best shown through a brief summary of the programming instructions it provides.

### Relay-Type Instructions

Relay-Type Instructions give the PLC-2/30 Processor Module the ability to perform the functions of hard-wired relays.

These Relay-Type Instructions are:

- EXAMINE ON — examines an input terminal or output bit for an ON condition.
- EXAMINE OFF — examines an input terminal or output bit for an OFF condition.
- OUTPUT ENERGIZE — energizes an output bit if preceding rung conditions are TRUE
- OUTPUT LATCH — energizes an output bit if preceding rung conditions are TRUE and remain energized until it is unlatched in the program.
- OUTPUT UNLATCH — de-energizes a latched output bit when preceding rung conditions are true.
- BRANCH START and BRANCH END — initiates and ends parallel logic paths similar to those available with relay logic
- MASTER CONTROL and ZONE CONTROL — isolates a group of rungs of user program and specifies output behavior under certain conditions.

### Timer and Counter Instructions

The PLC-2/30 Processor makes internal Timers and Counters available. Timers can be individually set for a 1, 0.1 or 0.01 second time base.

Timer and Counter Instructions are:

- TIMER ON-DELAY — begins to time when its preceding rung conditions are TRUE. When user programmed Preset Value equals Accumulated Value, timer stops.
- TIMER OFF-DELAY — begins to time when its preceding rung conditions are FALSE. When user programmed Preset Value equals Accumulated Value, timer stops.
- RETENTIVE TIMER — functions as a TIMER ON-DELAY except Accumulated Value is retained when preceding rung conditions are FALSE.
- RETENTIVE TIMER RESET — resets the Accumulated Value of a RETENTIVE TIMER to zero.
- UP-COUNTER — counts up to 999 selected events in the user's application
- DOWN-COUNTER — subtracts 1 from Accumulated Value for each FALSE to TRUE transition of its rung.
- COUNTER RESET — resets the Accumulated Value of an UP-COUNTER or DOWN-COUNTER to zero.

### Data Manipulation Instructions

Data Manipulation Instructions access a word in the PLC-2/30 Processor's memory. Using either all 16 bits or only 8 bits (an upper or lower byte) of the word addressed, the data or value contained in these bits will be manipulated, transferred or compared and the resulting data or values are available for program use. Such data or value may include the Preset Value of Timers or Counters, the Accumulated Value of a Counter, tolerance values selected from within the user's program, or value inputted from a thumbwheel switch or similar device.

The Data Manipulation Instructions that transfer data are:

- GET — accesses a specific 16 bit word in memory for a subsequent operation.
- PUT — receives a 16 bit word from a GET instruction and stores it at the memory address of the PUT instruction.
- IMMEDIATE INPUT — immediately updates one word of selected input data as determined by its address.
- IMMEDIATE OUTPUT — immediately updates one word of selected output data as determined by its address.

The Data Manipulation Instructions that compare data are:

- LESS THAN — compares values from user specified memory locations for a less than relationship.
- EQUAL TO — compares values from user specified memory locations for an equal to relationship.
- GET BYTE — accesses one byte (8 bits) of a word for a subsequent comparison.

- LIMIT TEST — used in conjunction with the GET BYTE instruction to compare one byte with an upper and lower byte limit value chosen by the user for a specific application.

**Arithmetic Instructions**

The PLC-2/30 Processor has the capability of performing four function, three digit mathematics.

The Arithmetic Instructions are:

- ADD and SUBTRACT — 3 digit add and subtract output instructions operate on two 3 digit BCD values to produce a 3 digit answer.
- MULTIPLY and DIVIDE — are output instructions that operate on two 3 digit BCD values to produce a third 6 digit BCD answer.

**Jump and Subroutine Instructions**

Jump and Subroutine Instructions provide capability to program jumps and subroutines in the ladder diagram program.

The Jump and Subroutine Instructions are:

- JUMP — instructs the Processor to jump to a new location in the program as specified by its associated LABEL instruction. The program scan will continue from that point. The Instruction can only jump down in the program.
- JUMP TO SUBROUTINE — instructs the Processor to jump to a user established subroutine area as specified by its associated LABEL instruction. Up to eight nested subroutines are permitted.
- LABEL — indicates where the Processor is to jump to in the program or subroutine area. Up to 64 LABELS are permitted.
- RETURN — instructs the Processor when to exit the subroutine area and return to the program at the point where the JUMP TO SUBROUTINE instruction was encountered. It is recommended that this instruction be unconditional.

**File Transfer Instructions**

File Transfer Instructions provide the user with the capability to set up adjacent Data Table addresses of user specified length up to 999 16-bit words. The data in this area can be transferred by the following instructions:

- FILE-TO-FILE TRANSFER — moves the contents from one File to another at a user determined rate.
- WORD-TO-FILE TRANSFER — moves the contents of a word from outside a File to a word location within the File.
- FILE-TO-WORD TRANSFER — moves the contents of a word inside a File to a word location outside the File.

**Sequencer Instructions**

Sequencer Instructions provide the user with the capability to set up adjacent data table addresses organized in groups of columns and steps. The number of columns is user specified (maximum 64 bits wide). The user can set up a maximum of 999 steps per Sequencer Table. The Sequencer Instructions used to sequentially step thru the user established Sequencer Table are:

- SEQUENCER LOAD — loads a Sequencer Table with one to four words from an independent I/O address. These words will be loaded into the Sequencer Table at the location specified by the step counter.
- SEQUENCER INPUT — compares data in one to four words at independent I/O addresses specified with the selected words in the Sequencer Table. If the comparisons are equal, the rung is TRUE.
- SEQUENCER OUTPUT — sends data at the sequencer step indicated by the step counter to an independent output address specified in the instruction.

**File Operations**

File Operations logically manipulate data in the Data Table.

- FILE-TO-FILE AND, FILE-TO-FILE OR, and FILE-TO-FILE XOR — are output instructions that compare the contents of two data files. They then place the results of their respective logical operations into corresponding words of a third file specified in the instruction.
- FILE COMPLIMENT — takes the logical compliment of one file and stores it in another.
- FILE SEARCH — instruction compares the input word to the data in a file for equality each false-true transition. If equality is found, the counter accumulated value points to that word in the file.
- DIAGNOSTIC FILE — instruction searches for 1's in a file. It will be used most often with the FILE-TO-FILE XOR instruction. The XOR produces a file containing any discrepancies between actual and desired I/O states. The FILE DIAGNOSTIC instruction then operates on this file to locate discrepancies and report actual I/O addresses to an error file.
- WORD-TO-FILE AND, WORD-TO-FILE OR, and WORD-TO-FILE XOR — are output instructions that operate on a Data Table word and a word from a file, placing the result of the logical operation into the corresponding word of a second file.

**Shift Register Operations**

The PLC-2/30 has the following Shift Register instructions:

- FIFO LOAD and FIFO UNLOAD instructions construct an asynchronous shift register. Upon false-true transition of rung decision, the input word will be transferred into the stack (FIFO LOAD) at the location described by the load pointer, or the contents of the word designated by the unload pointer will be transferred to the output word (FIFO UNLOAD).
- SHIFT FILE UP and SHIFT FILE DOWN instructions construct a synchronous word shift register. Upon false-true transition of

rung decision, the shift register file will be shifted up or down one word.

- SHIFT BIT RIGHT and SHIFT BIT LEFT instructions construct a synchronous bit shift register and move the shift register contents one bit in the chosen direction upon false-true transitions of rung decision.
- EXAMINE SHIFT BIT OFF and EXAMINE SHIFT BIT ON are input instructions that examine bits in the shift file for an open or closed state. They can be used to affect rung decisions.
- SET SHIFT BIT and RESET SHIFT BIT are input instructions that set or reset a user specified bit number in a shift register. The user specifies bit number and the files starting address.

**Scan Counter**

SCT — instruction causes a counter to increment by one count each scan as long as the rung is true. If you set PReset to one, this instruction serves as a one shot output.

**Conversions**

CONVERT BCD-BIN and CONVERT BIN-BCD instructions will convert data between 12 bit binary and BCD integer (000000-004095) formats.

**Block Transfer Instruction**

BLOCK TRANSFER — instruction is a Block Instruction which simplifies the user programming of Block Transfer to I/O Modules. The user can send and/or receive 64 words to or from Block Transfer I/O Modules.

**Data Highway Instructions**

DATA HIGHWAY — instruction is a block instruction which simplifies the user programming of Data Highway communication rungs.

## SPECIAL FEATURES

**On-Line Programming**

The PLC-2/30 permits on-line programming, that is it can be programmed while the program is executing and the I/O is active. The keyswitch must be in the RUN/PROG position.

**Forced I/O**

The user can force all input bits and/or all output devices to an ON or OFF state.

**Data Table Configuration**

The PLC-2/30 Processor can expand the Data Table into any portion of the 8K memory not used by the user's program when using the Industrial Terminal System (Cat. No. 1770-T3).

The first 128 words of PLC-2/30 Processor Memory are set aside for Data Table storage. This number includes 80 words for Timers/Counters and 32 words for I/O Image Tables. If no Timers/Counters are required the Data Table can be reduced to 32 words with one I/O Rack. Users may tailor the Data Table from 32 words to include all remaining portions of the memory not occupied by user's program. The expansion is in increments of two words until a table of 256 is reached and then in increments of 128 words.

Users can tailor Data Table input/output capacity from 128 to 896 I/O points in increments of 128 I/O.

## COMPATIBILITY

The Industrial Terminal (Cat. No. 1770-T1 or-T2) can be used on a limited basis to program the PLC-2/30 Processor. When using a 1770-T1 or-T2 Industrial Terminal the following features of the PLC-2/30 Processor are available:

- Ladder Diagram Programming
- 8K RAM or Core memory
- 512 input/output device capacity
- 3 digit four function math (+, —, ×, ÷)
- 256 word Data Table
- I/O Forcing in one Module Group at a time
- Battery Backup for RAM Memory
- Standard PLC-2/20 Instruction Set (Cat. No. 1772-LP1 Processor)
- Six Report Generation Messages
- Diagnostic Indicators
- Data Highway Compatible
- Block Transfer Capability

When using an Industrial Terminal (Cat. No. 1770-T1 or -T2) to monitor an instruction or function that was originally programmed with the Industrial Terminal (Cat. No. 1770-T3), an "ERR" message will be displayed on the screen in place of the instruction or function.

The 512 word Memory Segment (Cat. No. 1772-MR), originally used with earlier Processors (Cat. No. 1772-LR), can also be installed on the Cat. No. 1772-ME Memory Module.

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# MEMORY ORGANIZATION AND STRUCTURE OF THE PLC-2/30 PROCESSOR

## Cat. No. 1772-LP3

### GENERAL

This Publication is written for use with the PLC-2/30 Processor (Cat. No. 1772-LP3). It has two purposes:

- Detail memory organization and structure of the PLC-2/30 Programmable Controller
- Introduce concepts and terminology necessary for a general understanding of programmable controller memory

Two types of memory are available with the PLC-2/30 Processor: either the 8K Core Memory Module (Cat. No. 1772-M8) or the 8K CMOS RAM Memory Module (Cat. No. 1772-ME).

Features include:

- 896 input/output device capacity is available in both local and remote configurations; remote configuration requires use of Remote Distribution Panel (Cat. No. 1772-SD) and Remote I/O Adapter Module (Cat. No. 1771-AS)
- Variable size Data Table
- An instruction set which includes Relay-type functions, Timers/Counters, Data Manipulation, 3 digit Arithmetic (+, —, x, ÷), Jump/Subroutine, Sequencers, File Transfers, File Operations, Shift Registers, Scan Counter and Number Conversions. This Processor also has Block Transfer capability and is Data Highway compatible.

In addition, the PLC-2/30 also includes the following advanced capabilities: Unlimited Forced I/O and On-Line Programming.

### STRUCTURAL UNITS

The memory of the PLC-2/30 Processor can be thought of as a large arrangement of storage points, each called a BInary digiT, or "bit". A bit is the smallest unit of information a memory is capable of retaining.

Information stored in each bit is represented as a "1" or "0". When a bit is ON, it is represented by a logic "1". When a bit is OFF, it is represented by a logic "0".

A group of 8 PLC-2/30 bits form a single "byte." A byte is defined as the smallest complete unit of information that can be transmitted to or from the Processor at a given time.

A group of 16 bits makes up a "word." This word can also be thought of as being made up of two 8-bit bytes.

Because of its function in memory, one PLC-2/30 word may also be thought of as a memory location: when a word is being used, an actual physical location in memory is being accessed.

In PLC-2/30 Processor documentation, it is convention to show bits with the most significant bit (MSB) at the left and the least (LSB) at the right (Figure 1). PLC-2/30 bits are numbered octally 00 thru 07 and 10 thru 17.

### MEMORY CAPACITY

The memory of the PLC-2/30 Processor is either solid state, read/write RAM or Core Memory. These solid state memory components and the support circuitry needed to store and retrieve information are all mounted on printed circuit boards. The on-card battery back-up, provided for the RAM Memory, preserves memory contents through system power losses, or module removal from the Processor. The Core module provides non-volatile memory.

The capacity of a memory is measured in words. The Core Memory Module provides 8192 words of memory. It is self contained and does not require extra Memory Segments.

The RAM Memory Module can use two sizes of Memory Segments: the 512 word (Cat. No. 1772-MT) or the 2048 word (Cat. No. 1772-MS). Combinations of these two Memory Segments may be inserted in the four available slots of the Memory Module (Cat. No. 1772-ME), depending upon application needs. Maximum 8K memory can only be achieved when four 2048 word Memory Segments are used.

The entire memory is not available for user program. The first 128 words of the memory are set aside for Data Table use. (An assumption is made here that the number of words set aside for Timer/Counter

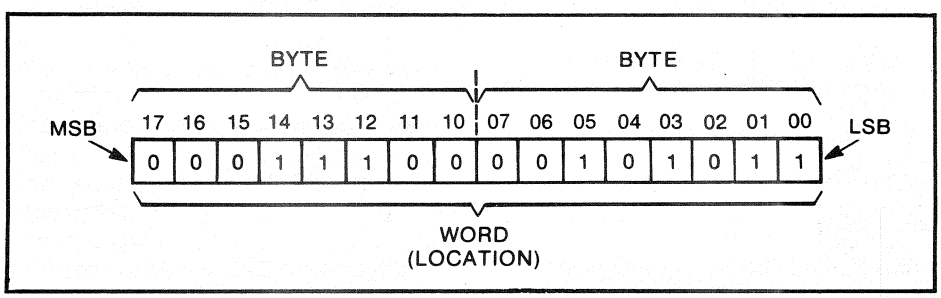



**FIGURE 1 — PLC-2/30 Word**

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use, plus file/word and bit storage, has not been changed from the 80 words which may be considered as "standard." Additionally, it is assumed that the size of the Input and Output Image Tables has not been changed.) Depending on the specific memory configuration, the number of words remaining in memory for user program instructions is therefore 128 words less. As a specific example, there are 6528 words available for program instructions when the Memory Module has three 2048 word Segments and one 512 Segment.

### Data Entry

The nature of the information stored in the memory is very simple: a bit is either energized or de-energized, ON or OFF. These states can be represented as "1" or "0."

In order to store anything more complex than ON and OFF, bits must be grouped together in the form of PLC-2/30 words or bytes.

How are individual bits energized or de-energized, placed into the ON or OFF state, set to "1" or cleared to "0"? The various ways are listed here:

- From the state of inputs monitored by the PLC-2/30 Processor
- By the Processor as it executes the user program
- By programming devices such as the Industrial Terminal (user program, Data Table)
- Digital Cassette Recorder (Cat. No. 1770-SA, Data Cartridge Recorder Cat. No. 1770-SB), (user program, Data Table)
- By a user's computer (user program, Data Table)
- By an RS-232-C compatible data terminal (messages)
- Through Data Highway (Data Table)

### Ending a Program

The PLC-2/30 Controller does not require that an END (of program) statement be entered by the user after the last program instruction. An END statement is generated by the Processor. It is present before any program steps are entered and is automatically positioned after the last programmed instruction, once program entry is begun. An additional END statement can be entered, although its use is not mandatory.

Starting with the first program instruction, the Processor scans the program and executes all instructions in the sequence called for by the program. The END statement stops the Processor from scanning unused memory. Inputs and outputs are then scanned. The Processor returns to the first program instruction and begins another program scan.

In normal operation, an END statement is displayed on the Industrial Terminal when the cursor is moved past the last user program instruction. The END statement also appears before program steps are entered. When a user-supplied teletypewriter or keyboard/printer is used, the END statement is also printed on the hardcopy printout. At the right of the END statement, a 3 or 4-digit number appears. These digits indicate the number of decimal words actually entered into memory before the END statement. (Note that the size of the Data Table must be subtracted from the number displayed in order to determine the exact number of user program words.)

Should a user attempt to enter more instructions than the maximum capacity of the available memory, a "memory full" message is displayed on the Industrial Terminal screen. Additional program instructions cannot be entered.

Most PLC-2/30 Instructions take an average of 3 to 6 $\mu$sec for the Processor to scan and execute. The execution time for different instructions varies considerably and is dependent on the exact instruction, its TRUE/FALSE state, and the amount of data associated with certain instructions. A typical program using 1024 words of memory (including the Data Table) would have an execution time of approximately 5 msec, assuming a distribution with approximately 80% relay-type instructions, such as EXAMINE ON, EXAMINE OFF, OUTPUT ENERGIZE, etc.

## MEMORY ORGANIZATION

The memory of the PLC-2/30 Controller can be divided into three major parts:

1) Data Table

2) User Program

3) Message Storage, if used

All input/output status and user program instructions are stored in one of these parts (Figure 2).

### DATA TABLE

The Data Table area of the PLC-2/30 memory does not store user program instructions. Data Table words, and/or the 16 bits in each word, are controlled and utilized directly by the Processor. The Processor uses the status of input devices and the control logic established in the user program to determine the status of output devices. Transfer of input data from input devices and transfer of output data to output devices occurs during the I/O scan. If the Output Instruction's status changed in the program, the actual output device's ON/OFF status is updated during the I/O scan to reflect this change.

The Processor automatically reserves the first 128 words in the first Memory Segment for use as the Data Table, assuming the number of storage words for Timers/Counters, files, bit and word storage, and I/O size is not changed. The Data Table size is increased in two word increments up to 256 and in increments of 128 word sections thereafter.

NOTE: The Data Table expansion capability should be utilized practically. The user should allow sufficient room for both Data Table and User Program.

When the Data Table is set to 256 words, up to 111 Timer/Counter instructions can be programmed or 222 storage words are available.

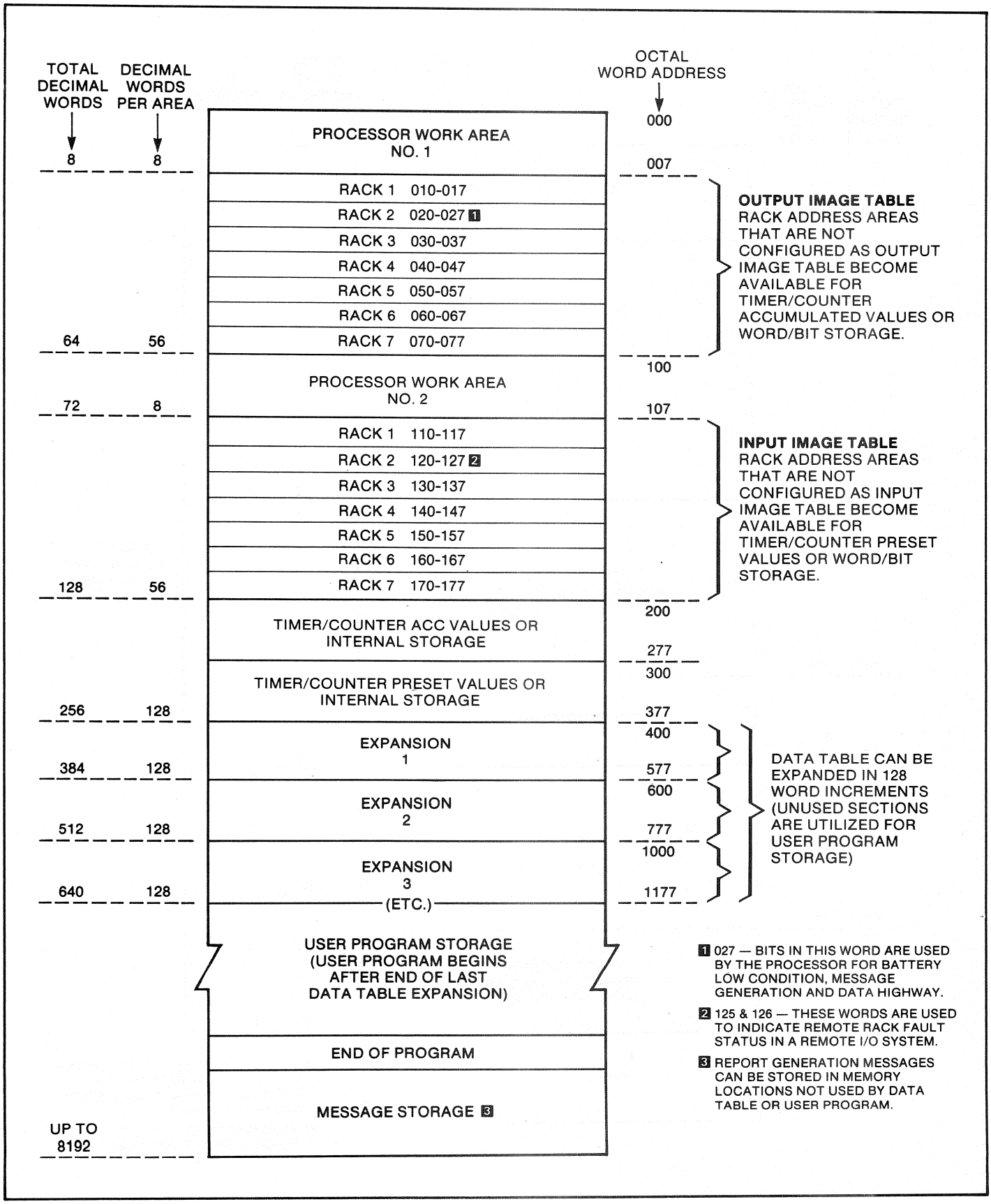



**FIGURE 2 — PLC-2/30 Memory Organization**

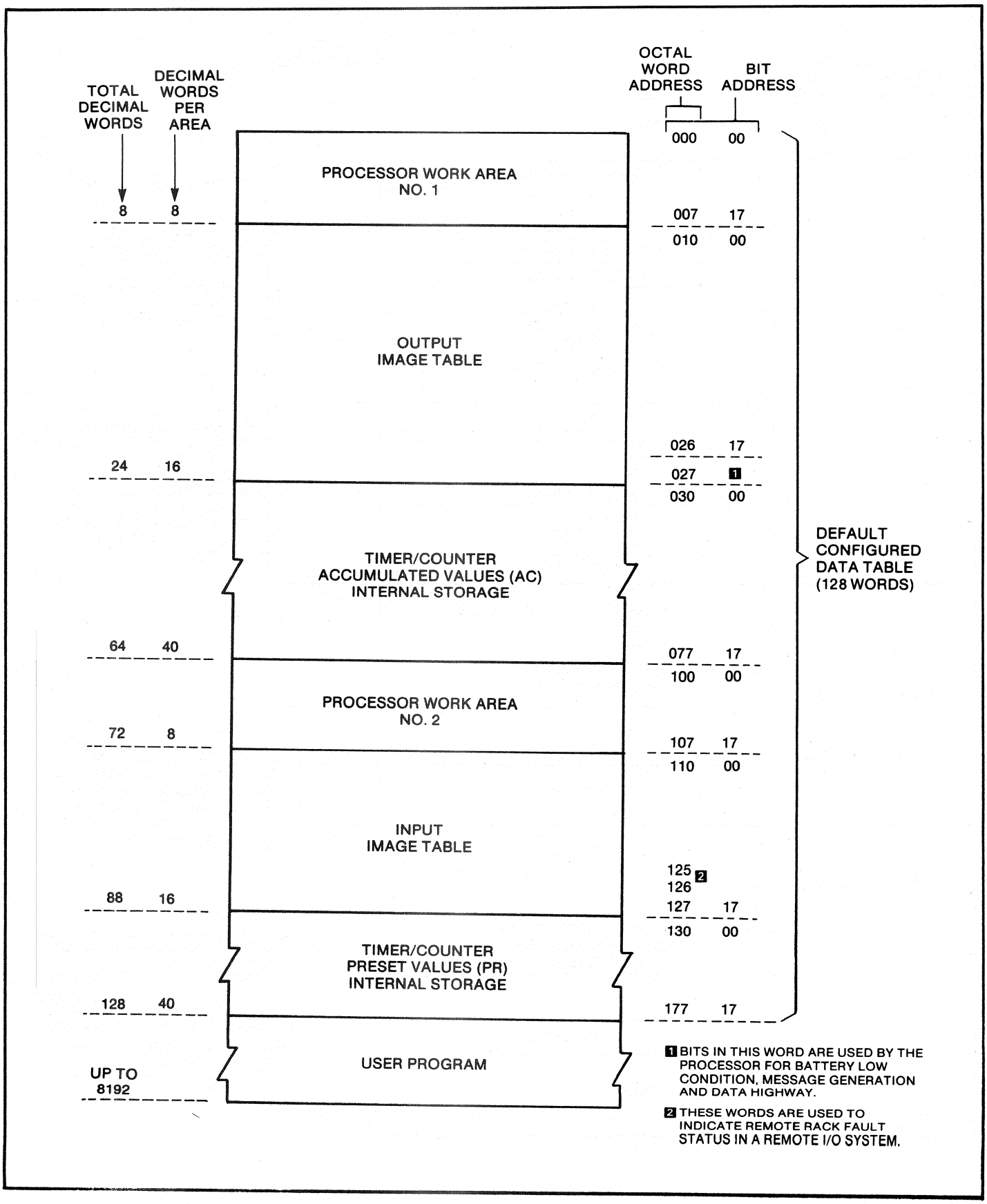



**FIGURE 3 — PLC-2/30 Memory Organization (Default Configuration)**

Users can also tailor Data Table input/output capacity in increments of 128 I/O (one Cat. No. 1771-A4 I/O Rack) up to 896 I/O (seven Cat. No. 1771-A4 I/O Racks).

The Data Table of the PLC-2/30 Controller can be divided into six distinct areas, assuming Data Table size has not been changed. These areas are:

- Processor Work Area No. 1
- Output Image Table
- Timer/Counter Accumulated Values, or bit/word storage
- Processor Work Area No. 2
- Input Image Table
- Timer/Counter Preset Values, or bit/word storage

The function of the Data Table may be explained in relation to inputs and outputs. The PLC-2/30 input and output modules cannot store information; they contain interface only. Input/output status information (ON/OFF) is actually stored in memory areas called I/O Image Tables. (An image is defined as an exact duplicate array of information, that is, the states stored in a different medium.) The following paragraphs discuss the Data Table areas of the PLC-2/30 Processor.

**Processor Work Areas**

There are two Processor Work Areas: Processor Work Area No. 1 (addresses $000_8$[1] to $007_8$) and Processor Work Area No. 2 (addresses $100_8$ to $107_8$). These memory locations cannot be accessed by the user. Their word addresses are not available for addressing of any kind. The Processor uses both Areas for internal control functions.

**Output Image Table**

The primary function of the Output Image Table in the PLC-2/30 Processor is to control the status of outputs wired from the output modules. If the Output Image Table bit is set to ON, its corresponding output will be ON. If the bit is cleared to OFF, its corresponding output will be OFF. These bits are controlled by instructions in the user program.

The Processor controls the status of bits in the Output Image Table as it generates output commands. Actual hardware outputs change state only if corresponding Output Image Table bits change state or they are forced.

Note: PLC-2/30 output bits can be forced on or off through the Industrial Terminal. The Output Image Table bits, corresponding to bits which are forced, do not change state.

The Output Image Table ordinarily begins with word $010_8$ and ordinarily ends with word $027_8$. The Output Image Table therefore contains 16 word addresses, or 256 bit addresses. Using the Industrial Terminal, the Output Image Table can be reduced to 8 word addresses (128 bit addresses), or increased from 16 word addresses to 56 (896 bit addresses). By changing memory configuration to 896 I/O (seven Cat. No. 1771-A4 I/O Racks), the 896 bit addresses represent the maximum number of outputs the PLC-2/30 Processor can control.

Each bit in the Output Image Table may be associated with a hardware terminal address, although this is not always the case, since a corresponding output module may not actually be placed in this I/O Rack slot. If it is, however, the terminal address is the same as the bit address.

A secondary function of the Output Image Table is to provide a storage area for bits or words. Words and/or bits in the Output Image Table not actually used to store the ON/OFF status of devices can be used for data storage.

Although only 9 bits of word $027_8$ are actually used as control bits, the remaining bits still shouldn't be used since inadvertent alteration of the control bits could occur. The Processor uses bit address $02700_8$ to indicate, when ON, a Battery Low condition. Although not available to control outputs or for storage, $02700_8$ can be examined by instructions in the user program.

**Accumulated Values, Storage**

This area of memory is used to store Accumulated Values of Timer/Counter Instructions. The area may also be used as storage for words and/or bits.

Word addresses $030_8$ to $077_8$ bound this area when memory is configured for 256 I/O (maximum) and 40 Timer/Counter Instructions (Figure 3). Note that each Timer or Counter used actually requires two words of memory: one from the Accumulated Value area ($030_8$ to $077_8$) and the other from the Preset Value area ($130_8$ to $177_8$).

**Input Image Table**

The Input Image Table duplicates the status of the inputs wired to input modules. If an input is ON, its corresponding Input Image Table bit is set to ON. If an input is OFF, its corresponding bit in memory is cleared to OFF. These bits are monitored by instructions in the user program.

Input Image Table bits are updated each scan cycle to correspond to the information supplied by input modules.

The Input Image Table is bounded by word addresses $110_8$ to $127_8$ (Figure 3). This area contains 16 word addresses, or 256 bit addresses. With the Industrial Terminal, the Input Image Table can be reduced to 8 word addresses (128 bit addresses), or increased from 16 word addresses to 56 (896 bit addresses). By changing memory configuration to 896 I/O (seven Cat. No. 1771-A4 I/O Racks), the 896 bit addresses represent the maximum number of inputs the PLC-2/30 Processor can monitor.

In a single PLC-2/30 Controller, the total bits used, which represent actual hardware inputs and outputs, together cannot exceed 896. This figure represents the maximum I/O capability of the PLC-2/30 Processor and is possible only

[1] The subscript $_8$ indicates that an octal numbering system is being used. Counting begins at 0; no digits larger than 7 are used. The decimal numbering system is implied if no subscript is used.

when the system is programmed with the Industrial Terminal (Cat. No. 1770-T3) and by using seven 128 I/O Racks (Cat. No. 1771-A4).

Note: If a remote I/O configuration is being used, words $125_8$ and $126_8$ may be used to store remote I/O fault bits. If this is the case, input modules should not be placed in these slots. Unwarranted machine operation may result.

Each bit in the Input Image Table may have a corresponding real hardware terminal on the I/O Rack associated with it, although this may not always be the case, since a corresponding Input Module may not actually be placed in an I/O Rack slot. If it does, the terminal address is the same as the bit address. The correspondence between the two is illustrated in Figure 4.

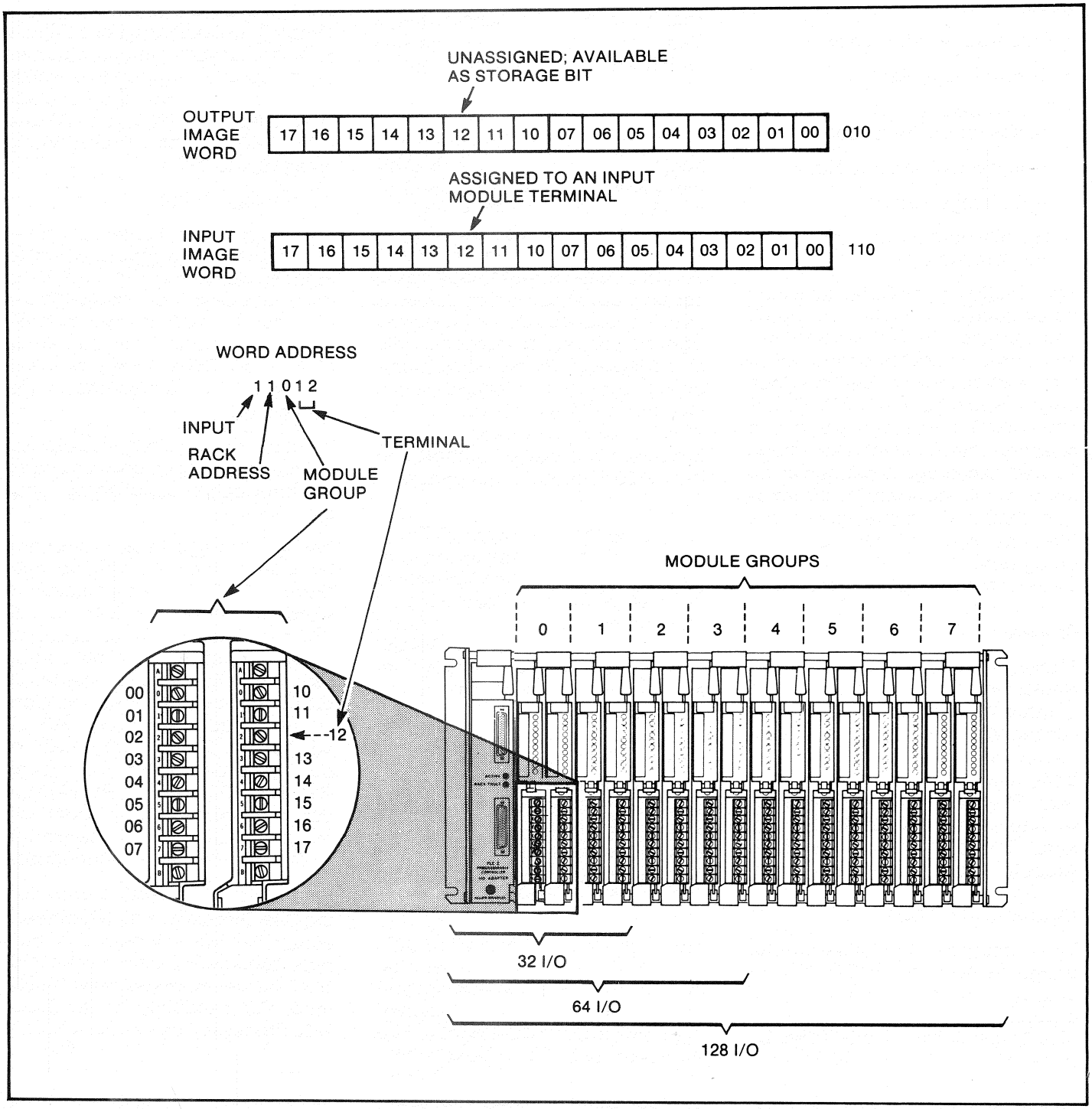



**FIGURE 4 — Relation of Word Address to Hardware**

**CAUTION:** Bit and/or word storage is not possible in the Input Image Table. Input bits which do not have an actual input module in the I/O Rack corresponding to the bit's address are cleared to zero during each I/O scan.

### Preset Values, Storage

Another area of the Data Table is used for Preset Values of Timer/Counter Instructions. The area may also be used for bit or word storage. It occupies word addresses $130_8$ to $177_8$ when memory is configured for 256 I/O (maximum) and 40 Timer/Counter Instructions. A Timer or Counter having address $030_8$ has its Preset Value automatically stored at address $130_8$.

### Configurable Data Table Area

The Data Table can be reconfigured by a user from the factory-configured size of 128 words (Figure 2). The reconfiguration is set from the keyboard entries of an Industrial Terminal. Data Table size can be decreased to as small as 32 words or expanded to a limit determined by the total amount of memory in the system. Expanding the Data Table provides additional Timers/Counters and space for files. In any area of the Data Table, any bit or word can be addressed.

Files are defined as a group of consecutive word addresses, length specified by the user. In expanded areas, care must be taken to prevent files from writing over Timer/Counter Preset Values or the User Program. It is recommended that all Timers/Counters be programmed in the first expanded areas and that files be programmed after them in a separate expanded area.

### Changing Data Table Areas

Data Table size is reduced from the standard or default value of 128 words to 32 words when all Timer/Counter areas are removed and one I/O rack is being used. This assumes 16 words are reserved in each Input and Output Image Table. Additional space is then made available for user program instructions. Reductions can be made in decrements as small as two words (one Timer/Counter).

If the memory locations are occupied, the attempted reduction fails.

Data Table size can be increased to 256 words, also in increments of two words (one Timer/Counter). This provides up to 104 Timers/Counters with 16 words reserved for each Input/Output Image Table. Above 256, Data Table size is increased in sections of 128 words. Users therefore gain the use of an additional 128 words (64 Timer/Counter Instruction addresses, 128 words for bit/word or file storage) for each expansion.

The Processor determines whether sufficient unused memory remains for the corresponding shifting of user program instructions from the area to be addressed by the additional address area. If sufficient memory exists, the required number of words are then reserved.

Users may optionally alter the number of words reserved for Input/Output Image Tables. Memory can be changed from 128 to 896 I/O's, in increments of 128 I/O's.

By reducing memory areas required for inputs/outputs from 256 to 128, Data Table size remains unchanged, but an additional 7 Timer/Counter Instructions become available. The previous Output Image Table addresses $020_8$-$026_8$ are now reserved for Timer/Counter Accumulated Values; previous Input Image Table addresses $120_8$-$126_8$, for Timer/Counter Preset Values.

When I/O requirements are increased from the standard value of 256 to 384, Data Table size does not change. Instead, Timer/Counter areas (in the default memory configuration) are each reduced by 8 words. Previous Timer/Counter Accumulated Value addresses $030_8$-$037_8$ are now reserved for Output Image Table; previous Timer/Counter Preset Value addresses $130_8$-$137_8$, for Input Image Table.

When I/O Image Table size is increased to 512, Timer/Counter areas are reduced by another 8 words. Previous Timer/Counter Accumulated Value addresses $040_8$-$047_8$ are reserved for Output Image Table; previous Timer/Counter Preset Value addresses $140_8$-$147_8$, for Input Image Table.

This same progression continues, as follows: when the I/O increases to 640, Accumulated address limits become $060_8$ to $067_8$ and the Preset address limits become $160_8$ to $167_8$; I/O increases to 768, Accumulated address limits are $070_8$ to $077_8$ and Preset address limits are $170_8$ to $177_8$; and with the maximum I/O increase to 896, Accumulated address limits are $070_8$ to $077_8$ and Preset address limits are $170_8$ to $177_8$.

### Memory Write Protect

In the PLC-2/30 Processor, the inhibit feature is used when the user removes a jumper from the Interface Module (Cat. No. 1772-LH). This prohibits alteration of the user program in any Processor mode. The alteration of Data Table words $400_8$ and above is also prohibited except through the user program. Only Data Table values between word addresses $010_8$ and $377_8$ can be changed either in RUN/PROG or PROG modes.

### User Program

The user's program is a group of ladder diagram and functional block instructions used to control an application. It is initially entered in memory using an Industrial Terminal.

Assuming that the Data Table size has not been changed from the "standard," factory-configured values, the user program begins after word address $177_8$.

In certain applications, this area of PLC-2/30 memory can further be divided into Data Highway Instructions, Main Ladder Diagram Program and Subroutine Area.

Some of the simple program instructions, such as "EXAMINE ON," use one word of memory. Others, such as file instructions, are more complex and can use two or more words of user program memory. As

the user program is entered from the Industrial Terminal, the number of words is indicated at the right of the END statement (including Data Table words). The words remaining in memory can be determined by subtracting that number from the total memory available.

**Subroutine Area**

The JUMP TO SUBROUTINE (JSR) instruction is an output instruction enabling the user to jump to a defined ladder diagram subroutine when desired. In this way, he will be able to perform ladder diagram subroutines. By pressing the SBR key on the Industrial Terminal (Cat. No. 1770-T3), the user defines the beginning of the subroutine area. This may not be removed once inserted except by clearing memory. The subroutine area is not scanned unless a JSR has been energized.

**Data Highway**

Data Highway commands are programmed in a special format. When a ladder diagram dump is requested, these instructions appear at the beginning of the user program area. They are followed by the first rung of the ladder diagram logic. These instructions can only be monitored/accessed with use of the DATA HWY key on the Industrial Terminal (Cat. No. 1770-T3).

**Message Storage**

The PLC-2/30 Processor is capable of storing user-programmed messages for hardcopy printout by compatible RS-232-C data terminals. As many as 70 messages of varying length can be stored.

Message storage immediately follows the END (of program) statement, and is limited only by the number of unused words remaining in memory. Each word remaining after the END statement is capable of storing 2 message characters. (Characters are defined as keyboard entries made on the data terminal, such as A, 1, M, ., 8, space, etc.)

Messages are stored in numerical order. Messages 1 through 6 are stored in word $027_8$ and have the highest priority. The next 16 messages are stored in the first user designated message control word, the next 16 in the second control word, etc. Four consecutive words can be reserved as message control words.

Bit addresses $02710_8$ thru $02715_8$ and all the bits in the message control words may be used for automatic report generation functions. Since the user program examines these bits to determine report generation status and may also set them to initiate various report generation operations, these bits should not be used for other functions. These words should also be reserved.

## COMPATIBILITY

The Industrial Terminal Systems (Cat. No. 1770-T1 or T2) may also be used with the PLC-2/30 Processor. However, only features supportable by these terminals may be entered or monitored. Refer to the PLC-2/20 (Cat. No. 1772-LP1) documentation for details on the features available with PLC-2/30 when used with these terminals.

The PLC-2/30 Processor utilizes an I/O communication protocol identical to the PLC-2/20. This enhances compatibility with all I/O systems currently available or under development for the PLC-2/20 processor, including:

- 1771 I/O (896 points max.) Local or Remote
- 1777 Local I/O (256 points max.)
- 1777-1771 Local I/O combination (as presently allowed in PLC-2 or PLC-2/20 systems, 256 points max.)
- 1778 Remote I/O (via Cat. No. 1772-SD Distribution Panel and Cat. No. 1778-AS Remote I/O Adapter)

When upgrading existing PLC-2/20 Processors to the PLC-2/30, it is necessary to replace two modules: the Processor Interface and the Processor Control Module. If Core memory is used, the System Power Supply must be a Cat. No. 1772-P1, Series C or later.

The 512 word Memory Segment (Cat. No. 1772-MR), originally used with earlier Processors (Cat. No. 1772-LR), can also be installed on the RAM Memory Module (Cat. No. 1772-ME).

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# Section 4
# GENERAL

## 4.0 APPLICATION CONSIDERATIONS AND FIELD WIRING PRACTICES

This section contains application data sheets for application and field wiring practices. The sheets appear in publication number order as listed in Table of Contents on the tab divider.

## 4.1 POWER SUPPLIES

This section contains product data sheets for power supplies. The data sheets appear in publication number order as listed in Table of Contents on the tab divider.

## 4.2 PROGRAMMING TERMINALS AND PERIPHERAL DEVICES

This section contains product data sheets for a programming terminal and two peripheral devices. The data sheets appear in publication number order as listed in Table of Contents on the tab divider.

## 4.3 I/O RACKS

This section contains product data sheets for 1771 I/O racks. The data sheets appear in publication number order as listed in Table of Contents on the tab divider.

## 4.4 I/O MODULES

This section contains data sheets for I/O modules that can be used with PLC-2 family programmable controllers. The data sheets appear in publication number order as listed in Table of Contents on the tab divider.

# 4.0 APPLICATION CONSIDERATIONS AND FIELD WIRING PRACTICES

SGI-1.1 Application Considerations for Solid State Controls
1770-980 General Grounding and Field Wiring Practices for Allen-Bradley Programmable Controllers

# APPLICATION CONSIDERATIONS FOR SOLID STATE CONTROLS

**INTRODUCTION** — The use of solid state components in industrial control applications is rapidly expanding and replacing many of the functions previously carried out by relay logic. While solid state controls and electromechanical relay controls are basically capable of conducting identical machine operations, there are a number of significant differences between these devices requiring some special application considerations. Solid state devices provide many advantages such as high speed, small size, ability to handle extremely complex functions, and have low power consumption, but differ primarily in electrical ruggedness and are sensitive to certain environmental influences such as elevated temperature and electromagnetic interference. They are less "forgiving" than relays when overstressed. In addition, they exhibit unique failure mechanisms which must be taken into account in critical or potentially hazardous applications. This guide is intended as an aid to the user of solid state controls who has considerable familiarity with relay type controls but may have limited electronic experience and knowledge.

In the discussion which follows, it will be noted that numerous potential problems are presented. However, relatively few, if any, will be encountered in an actual application using a well-designed and properly installed control system in the usual industrial environment. The discussion presented here is intended to point out areas in which solid state controls are unique, point out various operating limits, and provide some application guides where solid state is employed. The input and output stages are the areas of the control system most vulnerable to damage since they are directly exposed to external influences and thus are discussed separately. This is followed by more general considerations relative to the overall control system.

The following listing of topics covered may be used as a rapid guide to subjects requiring attention, or as a table of contents. As a subsequent reference, it will serve as a convenient reminder of areas of possible concern.

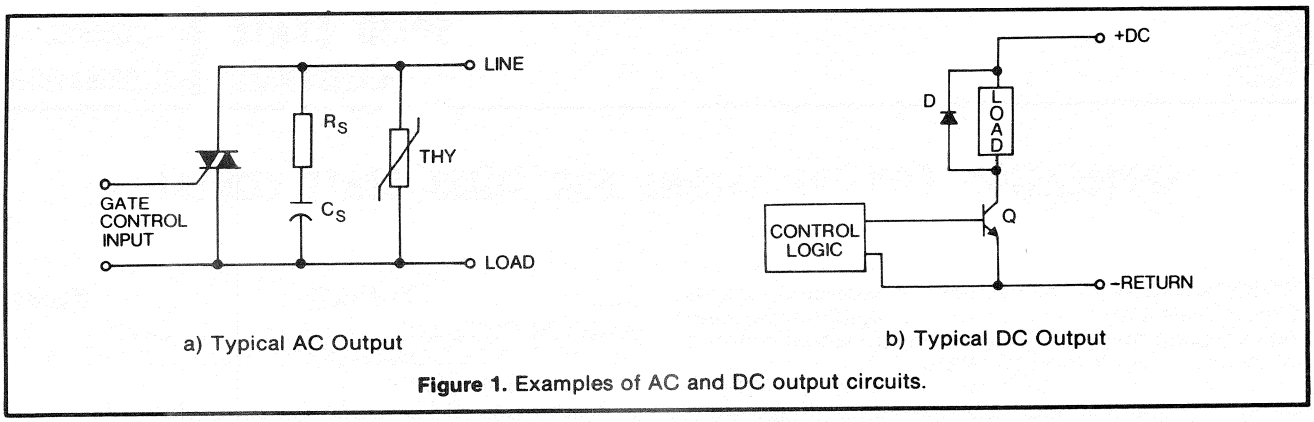

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**SOLID STATE OUTPUT CIRCUITS** — Typical output circuits of solid state controls are shown on Page 2 in Figure 1. The *AC OUTPUT* usually consists of a Triac (in some instances a SCR) protected by an RC "snubber" ($R_sC_s$) and often a varistor (THY). Proper application of the control is associated with the observance of a number of absolute maximum ratings and awareness of various electrical characteristics of the output Triac. Carefully following the recommendations on the control manufacturer's product data sheets allows operation below the absolute maximum ratings.

Unlike relay contacts, the Triac is a *SOLID* block of crystalline material and is more sensitive to applied voltages, currents, and internal power dissipation. The Triac is limited to a maximum peak "off-state" voltage. Exceeding this AC peak voltage results in a "dielectric type breakdown" which may result in a permanent short circuit failure. In the case of an electromechanical contact, an arc-over might occur, but usually, the contacts would not be seriously damaged and the device could continue to be used. These peak voltages may be the result of transients and noise on an output line. Often a varistor is placed across the Triac to limit the peak voltage to some value below the maximum rating and in some instances, the RC "snubber" alone may adequately protect the Triac.

Triacs are capable of carrying *SURGE CURRENTS* an order of magnitude larger than their continuous rating but only for short duration and under non-repetitive conditions. This rating, referred to as the peak non-repetitive on-state current must not be exceeded in magnitude (usually given for one cycle at 60Hz) since the device may overdissipate resulting in a permanent short

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a) Typical AC Output

b) Typical DC Output

**Figure 1.** Examples of AC and DC output circuits.

circuit failure. Special precautions must be taken as for example when driving lamp loads where the cold resistance of a lamp is often one-tenth of the hot resistance. The turn-on current surge must be within the maximum peak non-repetitive on-state current. There is also a maximum RMS on-state current which can safely be carried continuously. This is the rating by which the various Triacs are categorized by their Manufacturer. Exceeding the continuous on-state current rating can also result in a permanent short circuit failure due to overdissipation.

Under certain conditions where load resistances are low, stray circuit inductances are low, and power line impedance is low, it may be necessary to limit the *RATE OF TURN-ON* of the Triac. This parameter, as given in Triac data sheets, is the rate of change of the turn-on current (di/dt) expressed in amperes/microsecond. If conditions are available to allow exceeding this rating, localized heating occurs within the Triac resulting in degradation of the Triac. Subsequent operation generally results in overdissipation under normal loading conditions and early short circuit failures. When found necessary, a small inductance of a few microhenries in series with the Triac will limit the rate of change of current to within the maximum rating. This parameter is sometimes exceeded due to improper selection of an RC "snubber," where one is not internally provided. Selection of the proper "snubber" is beyond the scope of this discussion and sources of information are readily available. [1]

Of considerable importance where loads may be highly *INDUCTIVE* is the critical rate of rise of commutation voltage (dv/dt), expressed in Triac data sheets in volts/microsecond. Solid state output circuits are generally designed to be able to drive inductive loads such as electromechanical starter coils, but under certain loading conditions, (for example, very large coils), it may be found that the Triac is not able to turn off as current passes through zero (commutation). In these instances, additional RC "snubbing" must be incorporated as selected from the available references [1] to prevent against loss of gate controlled Triac operation. Such loss of control generally does not degrade the Triac.

Solid state outputs are often *FUSED* by the manufacturer and the particular fuse employed or recommended has been carefully selected based on the fusing current rating of the Triac expressed as amperes squared-seconds ($I^2T$). This rating is seen to incorporate a fuse opening time along with a current rating. For a particular overload current, it is necessary to open the circuit within a certain time to avoid damage to the Triac, and thus, fuses must be selected which have the proper current-time characteristic. The recommendations in the control's product data sheet must be followed when replacing fuses, or in instances where outputs are not provided with a fuse, the Triac rating must be determined and taken into consideration. Fusing of solid state devices is effective only in protecting the semiconductor in the event of a load failure or accidental short circuit. It must be noted that, if for example, the load is a properly working motor starter and a Triac failure results, a fuse will not be effective in removing power from the load. Certain types of indicating fuses can have system diagnostic value in warning of a load malfunction.

Triacs have several characteristics which are not observed in electromechanical contacts. Since the solid state "contact" is a solid block of material, its on and off states are actually low and high resistance levels respectively. A small *LEAKAGE* current flows through the Triac and RC "snubber" network in its off state. This is usually on the order of a few microamperes to a few milliamperes and should present little problem except in the case where sensitive instruments, such as a volt-ohm meter, are used to check for "contact continuity" where false indications are likely or instrument damage could occur. When the Triac is on, there is an on-state voltage developed across it of up to 1.5 volts. The product of this voltage and the rms current being carried is approximately the power dissipation within the device which is the prime factor used in the determining current-carrying capability of the "contact." The on-state voltage divided by the rms load current can be considered a "contact resistance." Triacs also exhibit a *MINIMUM HOLDING CURRENT* presented as the "DC holding current." When the instantaneous load current (each ½ cycle) falls below this value (e.g. 25-100ma), the Triac ceases conduction and passes only its leakage current until again triggered. Thus, it may not be possible to turn on or commutate full power for very light loads. In these instances, a bleeder resistor may be used to provide a minimum load. In some systems, special circuitry is provided to overcome this problem.

The *DC OUTPUT* shown in Fig. 1(b) consists of a power transistor protected by a free wheeling diode against inductive loads. Here again, proper application of the control is associated with observance of absolute maximum ratings and awareness of various electrical characteristics of the transistor. In all instances, the recommendations on the product data sheets must be followed and take precedence over any ratings which may be published for the particular transistor used as the output device.

*TRANSISTORS*, like Triacs, are sensitive to *EXCESSIVE APPLIED VOLTAGES* and heavy surge currents. One of the most critical parameters requiring attention in a transistor output stage is the absolute maximum collector to emitter voltage. This is generally referred to as a breakdown voltage or the collector-to-emitter sustaining voltage and appears across the solid state "contact" when open. When this voltage is exceeded, the transistor can be destroyed often resulting in a permanent short circuit type

[1] RCA Thyristors/Rectifiers, SSD-206C, 1975 Data Book Series, p. 442, "Power Switching Using Solid State Relays." Also, pp. 421-425, "Analysis and Design of Snubber Networks for dv/dt Suppression in Thyristor Circuits."

of failure. The most common cause of excessive collector-to-emitter voltage is transients on the output load line and on the power supply line, and switching of inductive loads. In the latter case, as load current is interrupted during switching, extremely high voltages appear across the inductive load if the load is not protected and provided with a means to allow the discharge of the electromagnetic field. In most cases, protection is provided by the control manufacturer in the form of a free wheeling diode, Zener diode, or RC network across the load terminals. If this diode is not present, protection must be provided by the user when inductive loads are anticipated. The diode must be capable of withstanding full rated load current and have a reverse breakdown voltage in excess of the DC supply voltage.

Transistors are also sensitive to heavy *SURGES* of collector or load *CURRENT*, more so than the Triac used in the AC output. Excessive collector currents result in overdissipation and failure to a shorted condition.

Transistor switches also exhibit certain characteristics not encountered in electromechanical or "hard contact" switches. When turned on, a small *FORWARD VOLTAGE DROP*, $V_{ce\ sat}$ (typically .35V) appears across the transistor. This must be taken into account where supply voltages are low, and it is also this voltage which is responsible for transistor heat dissipation under load. The maximum load current given in product data sheets for a particular control takes into account the product of load current and the forward voltage drop of the transistor used which determines the internal heat generated. This rating is also based on the heat sink capabilities and heat generated by adjacent components, and is usually lower than the maximum current rating of the particular transistor being used. This recommendation must be followed in all instances.

As in the case of the Triac, transistors exhibit a small *LEAKAGE CURRENT* when in the off state. This current is generally much lower than that of the Triac, usually in the microamp range, and must be taken into account when switching low currents or when using sensitive instruments during setup and checkout.

Transistor outputs are sometimes *FUSED*. This fuse, as in the case of the Triac, is generally used to protect the transistor during moderate overloads. This fuse must be capable of opening very quickly, before excessive heat can build up within the transistor. Here again, a fuse does not disconnect the load in the event of a transistor failure. When used, the control manufacturer's recommendations of fuse type must be observed. Fuses are of particular value in system diagnostics where indicating type fuses are used to provide information on the load condition.

Unlike Triacs, transistors are not as easily turned on inadvertently by electrical *TRANSIENTS* since base current must be applied continuously to maintain the output in an on-state. Transistors may, however, be turned off or turned on momentarily by such transients. Thus, these effects should be evaluated for possible problems in a particular application.

Transistors, as Triacs, exhibit finite turn-on and turn-off times which must be considered where "contact" overlap problems could occur.

**SOLID STATE INPUT CIRCUITS** — Typical input circuits of solid state controls are shown in Figure 2. There are numerous methods of designing input stages. The few shown here are typical but can vary considerably. In the case of Figure 2a, the AC input, the bridge rectifier can be replaced by a simple half wave rectifier. The isolation provided by the opto-isolator could be accomplished by means of a pulse transformer, or in some cases, isolation could be omitted entirely resulting in a considerably different input circuit. The two typical DC input circuits shown in Figures 2b and 2c can also vary depending on special requirements for filtering, isolation, and voltage levels. The AC input circuit shown in Figure 2a basically performs the function of converting a 120V, 60Hz signal arriving from an input sensing device, such as a push button, limit switch, relay contact, etc., to a DC logic level signal used in performing the "control" function. The DC input circuits of Figures 2b and 2c perform a similar function of supplying a logic signal to a transistor control circuit. Here conversion is less complex, consisting only of voltage scaling as in Figure 2c and possibly isolation as in Figure 2b.

Well-designed input circuits are less *SUSCEPTIBLE TO DAMAGE* than the output circuits discussed earlier. Semiconductor devices are present, however, and some precautions must be taken. These can be damaged by over-voltages and the effects of the environment, specifically temperature and certain atmospheric contaminants. Input circuits can respond to transients and noise on the input line and special precautions must be taken to reduce these sources of interference.

In addition to external signals influencing the operation of an input circuit, *FAILURES* of the circuits themselves are possible. If this occurs, a *FALSE INPUT* may be sensed by the control circuit. The various outputs will then respond accordingly, and depending on the application within a system could place the system in a hazardous condition. In such applications, an external means of monitoring critical inputs should be provided or redundant inputs should be used.

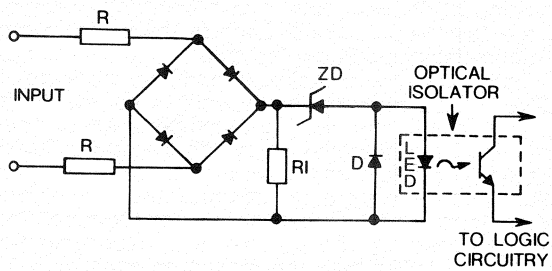



**Figure 2a.** Typical AC input circuit with opto-isolation.

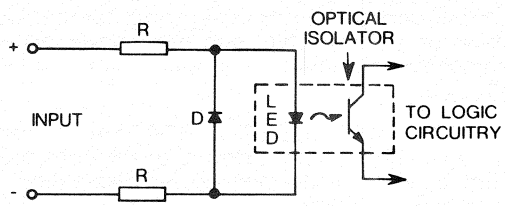



**Figure 2b.** Typical DC input circuit with isolation.

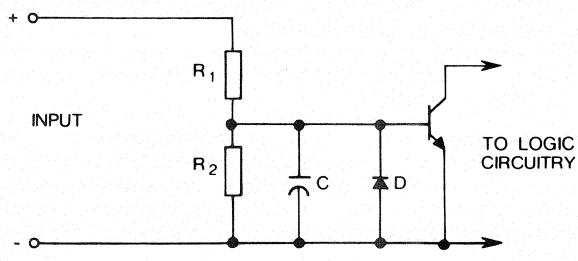



**Figure 2c.** Typical DC input circuit with voltage scaling and no isolation.

**THE EFFECTS OF TEMPERATURE ON SOLID STATE CONTROLS** — The greatest enemy of the solid state control is *EXCESSIVE TEMPERATURE,* both in operation and in storage. The failure rate of semiconductor devices increases rapidly as temperatures are raised. A significant increase in the semiconductor device's lifetime can be realized by reducing operating temperatures, even when operation is within recommended limits. Normally encountered failures of solid state devices are due to thermal degradation which can be viewed as the counterpart of wear in electromechanical devices. Thus, special precautions must be taken to operate the control within certain recommended temperature limits. There are also instances where nuisance type malfunctions can be encountered as a result of elevated ambient temperature. These malfunctions, when they occur, are usually temporary and normal operation resumes when temperatures are again lowered.

The main *SOURCE OF HEAT* applied to a semiconductor device is its internal power dissipation. Unlike electromechanical devices which exhibit a few millivolts across their contacts, a Triac or power transistor exhibits between .4 and 1.5 volts. This voltage multiplied by the load current represents an appreciable power loss appearing as heat. To remove this heat, the power device is mounted on a heat sink. Heat sinks are capable of removing only a limited but sufficient amount of heat depending on their size, shape and available air flow. There are also two thermal bonds between the heat sink and silicon chip consisting of the heat sink to semiconductor case bond and the case to chip bond. Each of the bonds exhibit a thermal resistance placing the chip at a known temperature higher than the heat sink. In addition, there are other passive and active components within a control dissipating heat which can raise the temperature of the air surrounding the heat sink on which the power device is mounted. These factors are taken into consideration in a particular design when a "maximum ambient temperature" is presented in a product data sheet. This temperature has been selected by the control manufacturer to be considerably lower than the maximum capability of the semiconductor device. The ambient air temperature is meant to be the temperature of the air surrounding the control, specifically the temperature of the air which provides the necessary cooling. The control should always be operated at an ambient temperature as close to the recommended minimum operating temperature as possible for optimum life, and must never exceed the recommended maximum (see appropriate product data sheet).

*SECONDARY SOURCES OF HEAT* are often encountered. These are usually external to the control system and not a result of its own power dissipation. These sources can be: other pieces of equipment raising the ambient air temperature after some period of operation such as power supplies, transformers, starters, etc., located near a control; heat conducted into the control through the mounting surface; or radiated heat where a control is exposed by line of sight to the sun or to extremely hot materials or flames. Special evaluations to determine the existence of these conditions must be made and the conditions corrected if found to be capable of increasing the semiconductor device temperature to excessive levels.

In instances where systems become large or ambient temperatures are unusually high, *SPECIAL COOLING METHODS* must be employed. Heat sinks should be positioned such that air may move vertically between cooling fins across the heat sink surface. This allows ease of air flow for convection cooling. In large systems, components carrying large currents should be evenly distributed throughout an enclosure to avoid localized hot areas. Fans on enclosures are effective, but precautions must be taken to avoid contamination by dust and especially conductive particles. Air flow should be directed if at all possible over heat sinks parallel to the cooling fin direction. Air filters should be employed with fan cooling since dust settling on heat sinks reduces their thermal efficiency. In extreme cases, heat exchangers or air conditioning of enclosures may be required. Often the above problems can be minimized by placing the entire control system in a separate room adjacent to the controlled machinery. One of the most effective means of maintaining low temperature and increasing operating life is to operate the controls well below their maximum load current ratings if possible.

Operation in extremely *COLD ENVIRONMENTS,* (below the recommended minimum temperature) should also be avoided since some semiconductor devices may temporarily cease to function properly while other circuit board components may be permanently damaged. The control manufacturer's recommendations should always be followed where exposure to very low temperature is anticipated.

**ENVIRONMENTAL EFFECTS** — Solid state controls are *SENSITIVE TO VARIOUS ENVIRONMENTAL FACTORS* but not the same ones as those which generally affect electromechanical devices. Solid state controls are generally less sensitive to shock and vibration since they contain no moving parts. At relatively high levels of shock and vibration, circuit boards may loosen, crack, or component leads may fail. Some electromechanical components are more susceptible to activation under shock and vibration and in this area, solid state controls may prove superior. Also mounting position is usually of little significance with the solid state control except in instances where air flow is required for cooling.

Since solid state controls usually consist of electronic devices mounted on printed circuit boards with relatively close spacing between conductors, *ATMOSPHERIC CONTAMINANTS* are capable of causing damage. These contaminants rarely affect the semiconductor devices since they are well packaged. Often the metalizations on printed circuit boards are coated but this coating may not be considered an effective moisture seal and can lead to problems. Humidity is a major atmospheric contaminant which can cause circuit failure. If moisture is allowed to condense on a printed circuit board, the board metalizations could "electroplate" across the conductor spacing when voltage is applied. In low impedance circuits, this conductive path would immediately burn open, then reform to be burned open again. This action could lead to noisy, erratic control operation. If impedances are relatively high, a short circuit may appear resulting in a permanent malfunction. The problem is most likely to be initiated during inoperative periods or during storage where moisture is allowed to condense on the boards or can be trapped under circuit board coatings. This situation should be avoided by proper humidity control during these periods. During operation, heat is generated and moisture seldom condenses on the boards. Product data sheets often specify a relative humidity exposure limit, but in any event, appropriate precautions must be taken. Failures due to moisture are often accelerated in the presence of corrosive gases or vapors. These merely increase the conductivity of a moisture layer allowing electromigration to occur more rapidly and at lower potentials. Effects of this type are not readily eliminated even by a high quality conformal coating since the board edge connectors, consisting of an extension of the metalizations, must be exposed. Excessively dry conditions should also be avoided since problems with static electricity may be encountered. Static electricity, for example, applied directly to module or circuit terminals, can cause erratic control operation and in some instances could produce voltage breakdown failures in semiconductor devices.

Due to the close spacing of metalizations on printed circuit boards, various *OTHER CONTAMINANTS* such as metal laden coolant oils and conductive dust or particles must be kept from reaching the boards. These

are capable of directly producing short circuit paths and resultant malfunctions where board metalizations are exposed. The power levels associated with the low level electronic circuitry are seldom capable of burning open conductive paths caused by these contaminants. Large accumulations of non-conductive dust and other contaminants can also be destructive by preventing adequate cooling of all components, and can be especially harmful on heat sinks where thermal conductivity to the surrounding air is lowered. Proper enclosures must be utilized, and when forced air cooling is employed, adequate air filters must be provided and cleaned periodically.

**NOISE CONSIDERATIONS** — *ELECTRICAL NOISE* is capable of causing various types of malfunctions of solid state equipment. This noise is defined as any unwanted electrical signal which enters the equipment through various means. It may cover the entire spectrum of frequencies and exhibit any waveshape. Solid state devices are especially sensitive to noise since they operate at low signal levels. Also, the speed of solid state components allows them to respond to relatively high frequencies.

Noise is not, however, present at all times. Certain sources of noise may exist only for short durations at widely spaced time intervals. Other sources are continuous. The latter is easily recognized and dealt with. Some noise is due to a combination of occurrences such as two or more machines performing a specific function at the same time. In many instances a noise source may appear at some time after a control is installed and functioning properly, as for example, more recent installations of equipment capable of inducing noise into the control. Thus, it is not sufficient to merely evaluate a control installation at the time of initial checkout. Some further searching for potential noise sources, and some anticipation is required. Periodic rechecks should also be made especially as other equipment is moved, modified or newly installed. When installing a solid state control, it is wise to assume that various noise sources exist and take special precautions to guard against possible interference. This practice minimizes most of the required anticipation of future problems and unexpected future incidents.

Electrical noise entering a solid state control is often incapable of damaging components directly unless extremely high energy and/or high voltage levels are encountered. Most of the *MALFUNCTIONS* due to noise are temporary "nuisance" type occurrences or operating errors, but could result in hazardous machine operations in certain applications. Noise entering Triac output circuits generally results in non-gate-controlled operation which can be of short duration (½ cycle or less) or long term (more than 1 cycle) depending on the nature of the noise signal. DC outputs may be turned on due to rectification in the output transistor. Input circuits may be susceptible to all forms of noise and their response may produce a turn-on signal to the Triac or output transistor control circuit. Larger systems containing complex logic circuitry may be expected to respond by turning on various outputs in a random fashion and occasionally tripping self-check circuits which result in nuisance shutdown of machinery.

*NOISE ENTERS SOLID STATE CONTROLS BY VARIOUS MEANS,* usually through input lines, output lines, and power supply lines. Noise may be coupled into the lines electrostatically through capacitance between these lines and lines carrying the noise signals. Here, a high potential is usually required, or long closely spaced conductors are necessary. Magnetic coupling is also quite common when control lines are closely spaced to lines carrying large currents. The signals in this case are coupled through the mutual inductances as in a transformer. Electrostatic and magnetic noise may also be directly coupled into the control logic circuitry. This generally appears in unenclosed, unshielded control electronics and requires a strong noise field. Finally, noise can occur in the form of electromagnetic radiation from remote sources. Close coupling is not required, and here the various lines entering the control act as receiving antennas. Occasionally, the control circuitry itself is sufficiently sensitive to detect a radiated signal and respond to it. This type of noise is troublesome when it is encountered since it is usually of high frequency and occasionally difficult to filter and shield against on a generalized basis. A particular installation may require special treatment, since the various coupling elements (control lines) exhibit unpredictable characteristics, some of which could render built-in filters ineffective. Metal enclosures are effective shields where adequate electrical bonding around doors and bolted surfaces are provided.

A great deal of effort has gone into the design of solid state controls to achieve a reasonable degree of *IMMUNITY TO NOISE* through incorporation of filters, shielding, and design of generally insensitive circuitry. It is, however, impossible to design a control which can handle every form of noise coupled into it especially through the external wiring. Noise must be minimized as much as possible from entering the control by employing the appropriate *INSTALLATION PRACTICES* especially when the anticipated noise signal has characteristics very similar to the desired control input signal.

Coupled electrical noise can be viewed as an unwanted signal originating in other wiring. To reduce the coupling, solid state control lines, especially TTL input lines, should be separated from noise sources by routing them through their own separate conduit. Thus, due to separation, there is little opportunity to couple from lines carrying 60Hz power and other lines carrying rapidly changing currents. Also, twisted, shielded pair wiring as shown in Figure 3 provides a very effective shield against electrostatic and magnetic coupling. The twisted wire should have approximately a 1-inch lay or 12 twists per foot. The magnetic field induced between 1-inch sections is alternately 180° out of phase providing effective cancellation of the coupling effect. Eddy currents induced in the shield produce a magnetic field opposing the original magnetic field. The shield is also effective in electrostatically decoupling since it places a conductive barrier between the signal lines and the noise source. The shield must be connected to control ground at only one point as shown in Figure 3, and shield continuity must be maintained over the entire length of the cable. Care must be taken to adequately insulate the shield over its entire length to maintain the "one point"

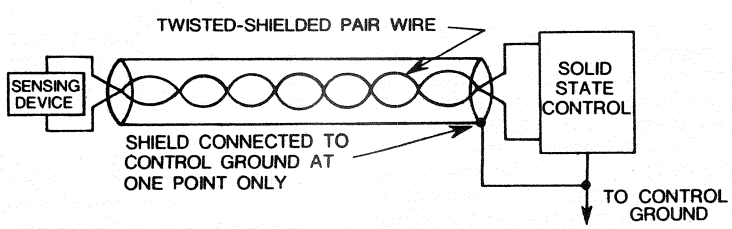



**Figure 3.** Use of twisted, shielded pair wiring.

connection. Cables should also be routed around rather than through high noise areas.

Where noise conducted into a control is encountered, appropriate filters should be employed. In the case of power lines where transients are anticipated or noted, commercially available line filters, isolation transformers, or voltage limiting varistors may be necessary. In larger systems, power supplies providing logic power are usually already protected but the raw AC used by Triacs to switch various line voltage operated loads may require additional protection. Conducted noise on input lines may also be dealt with by use of isolation transformers, or isolated power supplies in DC applications, and occasionally signal filters. Also, where "hard contact" input devices are employed, such sources of noise as contact bounce should not be overlooked.

In solid state control systems, the *GROUNDING PRACTICES* employed have a significant effect on noise immunity. Each ground should be connected to its respective reference point by no more than one wire (single point grounding). Under no circumstances should two or more systems share a common single ground wire, either equipment ground or control common. Since all wires are somewhat resistive and inductive, this would allow the system to share a common impedance. Variations in current flowing from one system would tend to modulate the zero reference level of the other and possibly result in erratic operation. Minimum wire sizes, color coding, safety practices, etc., should comply with the National Electrical Code and any local codes or laws. The recommendations found in control system product data sheets should always be followed since the manufacturer has determined by testing, the adequacy of the particular grounding arrangement in a typical industrial environment. For further information on grounding practices, see IEEE Standard 142-1972 "Recommended Practices for Grounding of Industrial and Commercial Power Systems".

*IMPEDANCE COUPLING,* as mentioned above where systems might share a common ground, is often a source of conducted noise and must be avoided. Noise coupling in this case is due to voltage drops appearing across any impedances which are common to several circuits. These impedances are usually the result of the inductances of common wires. Whenever possible, or when found to be necessary, individual signal return wires should be used as in Figure 4. Voltage drop across common wires may also be reduced by use of large conductor diameters where signal paths are shared. Often, this line takes the form of a heavy bus bar. In instances where several controls share a common source of power (60Hz line for AC controls, DC power supplies for DC controls), it must be determined whether the line impedance, or current capabilities of DC supplies, are adequate to maintain rated voltage under all loading conditions. Voltage drops across the internal power line impedance or de-regulation of a DC power supply results in interference between the systems similar to that experienced with an impedance coupling. The internal impedances of the power supplies here act as the common coupling element. Whenever possible, separate DC power supplies or separate AC branch circuits should be used for each control system.

Various *LOADS* especially inductive devices are capable of generating excessive noise which may affect other systems through coupling or radiation and may feed back unwanted signals to their own source of control. In these instances, some form of load suppression should be employed. The methods commonly used act to limit the transient voltage (and thus the noise current) across the load. Voltage limiters generally consist of RC "snubbers," varistors, and back-to-back zener diodes for AC applications, and in cases of less severe noise, resistors. DC loads are generally suppressed by reverse biased or reverse connected diodes. It should be noted, however, that use of these devices may reduce the speed of operation of electromechanical loads significantly. In addition, use of lightning arrestors from each power line to ground should not be overlooked.

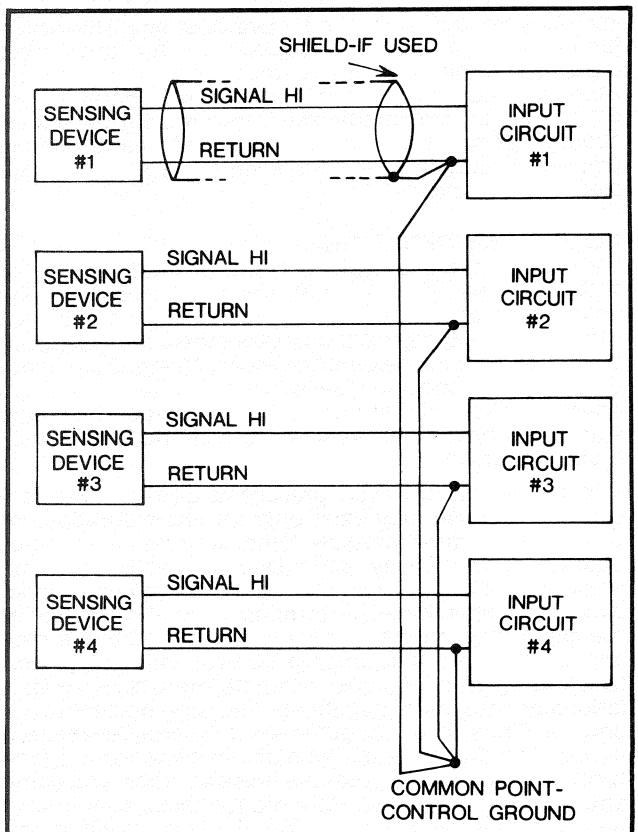



**Figure 4.** Recommended practice for use of return wires.

**SPECIAL APPLICATION CONSIDERATIONS** — Solid state components exhibit a high degree of *RELIABILITY* when operated within their ratings. For example, a Triac might have an average life of 450,000 hours or 50 years under typical operating conditions, but it fails at random even when operated well within its ratings. The lifetime above is an average. The time of failure of an individual device cannot be predicted by observation as in the case of a relay where patterns of wear might be watched. It is thus advisable to provide some sort of independent check on the operation of individual devices when they are controlling a critical or potentially hazardous operation. In addition, the predominant mode of failure of a solid state output is in the "on" or short circuit mode. This must also be considered in certain critical applications.

In relay systems, a relay having a mechanically linked normally open and normally closed contact can be wired so as to *CHECK ITSELF* for proper operation. This feature is sometimes used in certain safety circuits such as the anti-repeat circuit for a press control. Monitoring of a solid state component is not quite as simple. A dependable mutually exclusive NO-NC arrangement is not available. Thus, external circuitry must be employed in such applications which can sample the input signal and "contact" state and compare to determine whether the control is functioning properly. By proper design however, the critical machine operation can be shut down in the event of either a solid state control failure or a failure of the monitor circuit. Converting a ladder diagram originally designed for relay logic to one using solid state control must account for the differences between electromechanical and solid state devices. Simply replacing each contact in the ladder diagram with a corresponding solid state "contact" will not always produce the desired logic functions. Any safety previously provided by mechanically interlocked relay contacts will be lost.

In large solid state control systems containing many independent output stages, a need for built-in *DIAGNOSTIC CIRCUITRY* becomes apparent. Fault monitoring can be performed rather easily in system areas such as processors which are serial in operation. All information shares a common data bus and a diagnostic such as a parity check is quite effective along with a few circuits to exercise certain critical program functions. However, in other areas, especially input and output channels, effective monitoring can only be performed on an individual channel basis. This becomes extremely costly and if implemented, the additional part count would severely lower the overall system reliability resulting in many "nuisance" shutdowns. In practice, only a minimum amount of monitoring is provided for these circuits and in the event that a particular signal channel is responsible for control of a potentially hazardous machine operation, external monitoring or redundancy must be provided for that channel. Here, for example, an input channel might be reserved to receive a signal from the auxiliary contact of a starter to check on its operation. This input channel and the starter output channel can then be examined for occurrence of mutually exclusive events and shut down system power when a failed condition is noted. This method is often quite practical when only a few outputs are classified as critical.

For any size of solid state control capable of performing potentially hazardous machine operations, *EMERGENCY CIRCUITS* for stopping operation must be routed outside the controller. For example, devices such as end of travel limit switches or emergency stop pull cord switches should operate motor starters directly without being processed through controller logic. This forms a reliable means of control and should be implemented using a minimum number of simple, highly dependable components of an electromechanical nature if possible. Thus, in the event of a complete controller failure, an independent rapid shutdown means is available. A convenient means of disconnecting the critical or potentially hazardous portions of a machine from the controller should be provided for use during troubleshooting or set-up following maintenance.

*ADDITIONAL SAFETY PRECAUTIONS* should also be observed. In some solid state systems operating from a rectified AC supply, the "output contacts" may operate erratically for a short time period immediately after applying or removing power. A means to inhibit outputs until DC power supplies reach their specified voltage may be required. Also, an inhibit at power turn-off or power failure may be desirable for certain applications.

Consideration must be given to the restoration of power to a system after inadvertent loss of line voltage. If hazardous operation can result from unexpected restoration of power, the system should include a feature which requires an operator initiated action before power is reapplied to the system.

A low impedance tester should not be used for checking voltages in solid state systems. The low impedance of these devices can effectively change a voltage level from a logic "1" condition to a logic "0" condition when attempting to make a measurement. Hazardous machine motion can result if an output to a controlled device is energized as a result. High input impedance testers are required to safely check voltage levels associated with high impedance circuits. Unless otherwise specified by the manufacturer, a voltmeter with an input impedance of 10 megohms or greater is recommended.

# GENERAL GROUNDING AND FIELD WIRING PRACTICES FOR ALLEN-BRADLEY PROGRAMMABLE CONTROLLERS

## GENERAL GROUNDING INFORMATION

Grounding is an important safety measure in electrical installations. With solid state controls, grounding has an added value because it helps to reduce the effects of electromagnetic noise interference (EMI).

Allen-Bradley Programmable Controller components, and their enclosure must be properly grounded. All applicable Codes and Ordinances should be observed when wiring the Controller.

The grounding path for the Controller components, and their enclosure should be provided by a ground lug mounted on the enclosure or cabinet that is connected to a reliable earth ground. Earth ground is defined as the central ground for all electrical equipment and AC power within any facility. All earth ground connections must be permanent and continuous to provide a low-impedance path to earth ground for induced noise currents and/or fault currents.

An authoritative source for grounding requirements is the National Electrical Code published by the National Fire Protection Association of Boston, Massachusetts. Article 250 of the Code provides such data as the size and types of wire and conductors, and methods for safely grounding electrical equipment and components. Local Codes and Ordinances dictate which earth grounding method is permissible.

## PC COMPONENT GROUNDING REQUIREMENTS

The recommended configuration for grounding Allen-Bradley Programmable Controller components within an enclosure is illustrated in Figures 1 thru 5. To ensure that good electrical contact has been established between Controller components, the enclosure

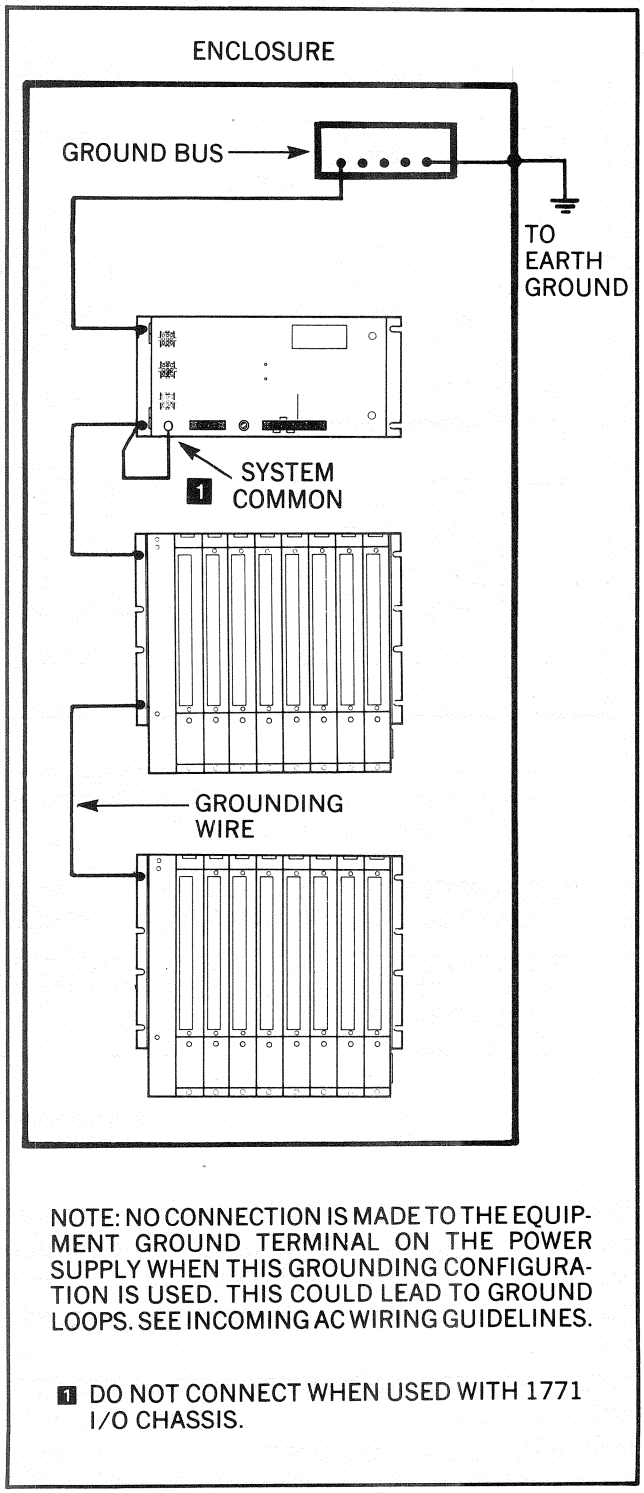



**FIGURE 1 — Typical Remotely Located PLC I/O Rack Grounding Configuration**

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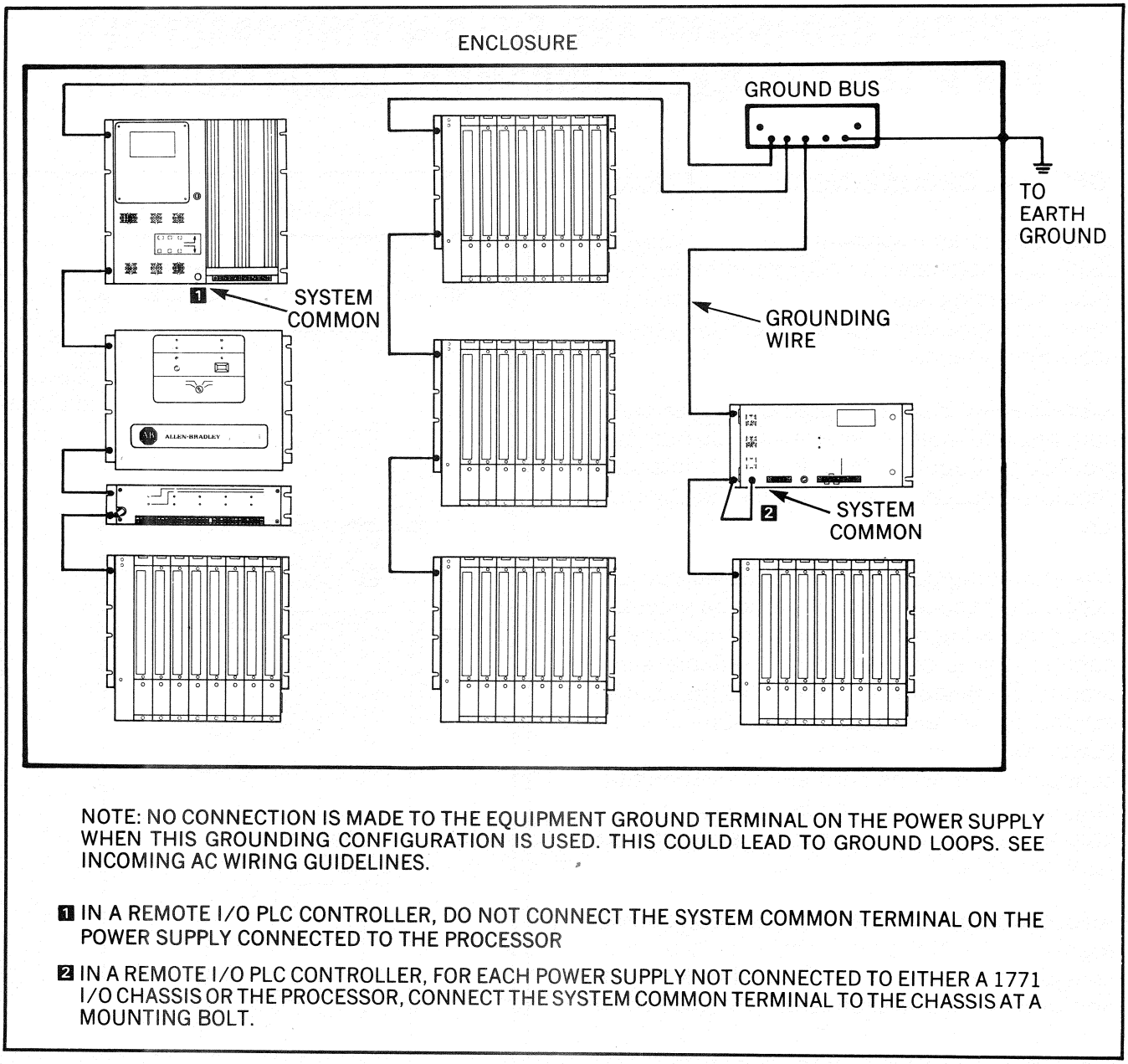



**FIGURE 2 — Typical Remote I/O PLC Controller Grounding Configuration**

back panel, and the enclosure, bare metal contact is required. Paint or other non-conductive finishes must be scraped from the back panel (and Controller components if necessary) where it comes in contact with the component mounting bolts, nuts, or welded studs. An 8-gauge or larger copper or equivalent wire should be used to connect each component in the enclosure. Connections should be made to the mounting bolts or studs on only one mounting bracket of the component's chassis (Figures 1 thru 5). Figures 6 and 7 illustrate several methods of mounting the component's chassis and grounding wire.

Each vertical group of components is connected together (Figures 1 thru 5) and these groups are connected to a ground bus mounted on the back panel of the enclosure (Figures 8 thru 10). The ground bus is connected to a ground lug that is mounted on the inside wall of the enclosure (Figure 11).

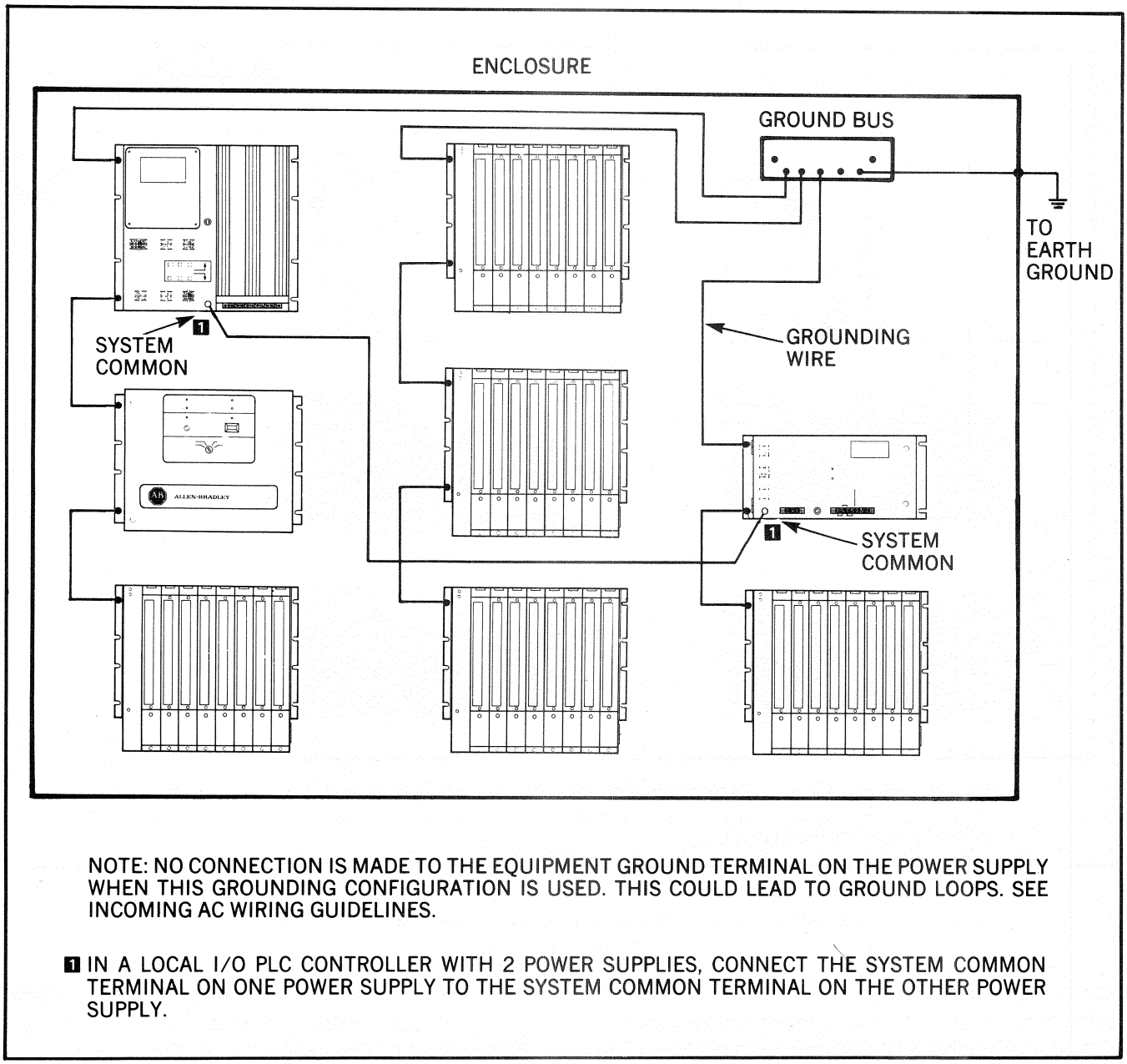



**FIGURE 3 — Typical Local I/O PLC Controller Grounding Configuration**

Avoid connecting more than two lugs to a single bolt because the connection can become loose due to the compression of the metal lugs.

## ENCLOSURE GROUNDING REQUIREMENTS

The enclosure that contains the Allen-Bradley Programmable Controller components must be connected to a reliable earth ground (Figure 11). Grounding paths to earth ground must be permanent and continuous, and must be able to safely conduct electromagnetic noise currents and possible ground fault currents to earth ground with minimum impedance.

## INCOMING AC WIRING GUIDELINES

When bringing AC power into the enclosure, the grounding wire (AC service ground) should be connected to the ground bus on the back panel (Figures 12 and 13). Generally the AC

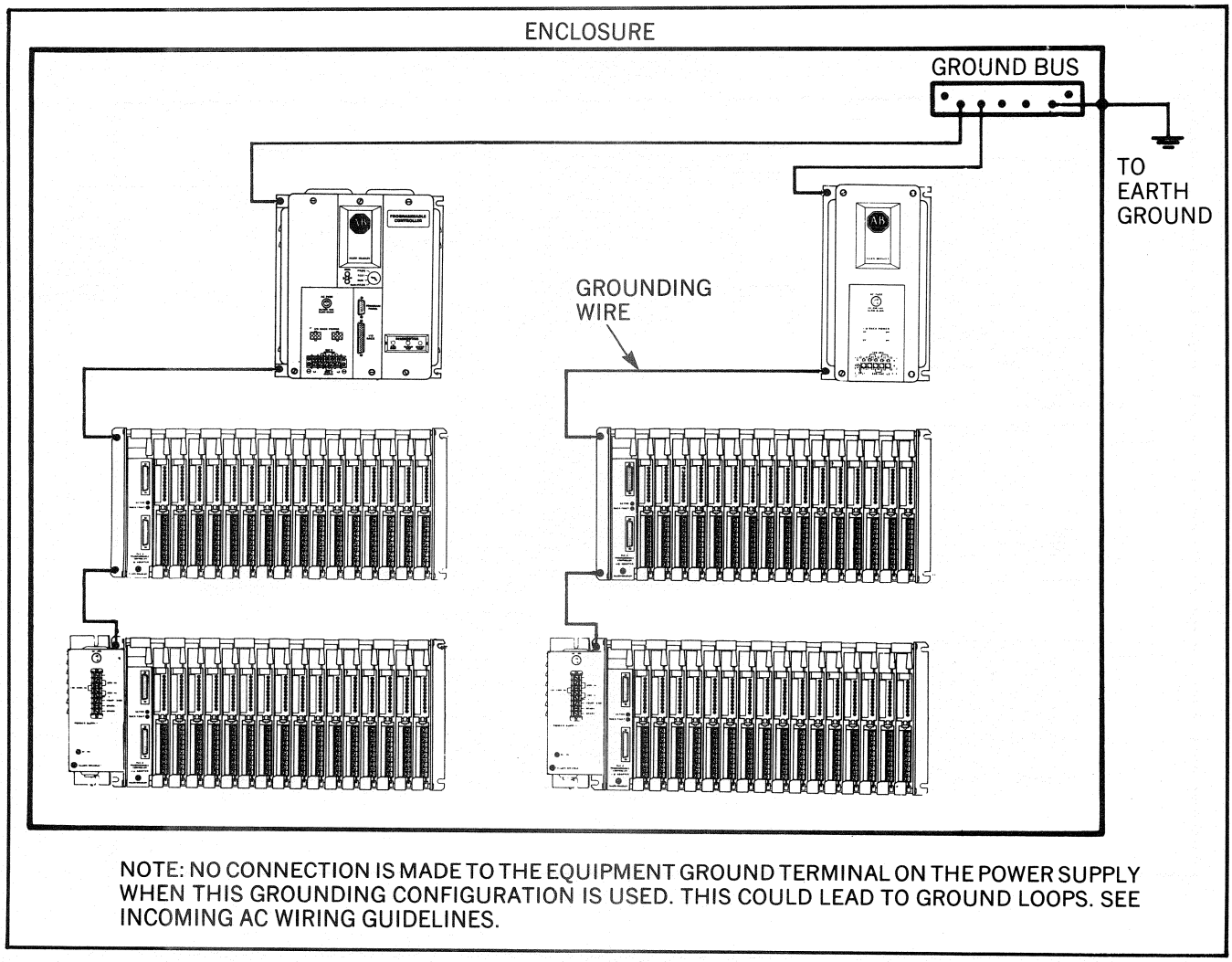



**FIGURE 4 — Typical PLC-2, PLC-2/20, or PLC-2/30 Controller Grounding Configuration**

service ground wire is connected to the enclosure ground bus. If this connection results in a ground loop which is suspected of introducing an objectionable ground current causing faulty operation of the Allen-Bradley Programmable Controller, refer to Article 250-21 of the National Electrical Code for recommended methods of reducing the objectionable ground current. A proper earth ground should be maintained for the enclosure as referenced under "PC Component and Enclosure Grounding Requirements" in this document. Local Codes and Ordinances dictate which earth grounding method is permissible.

In a grounded AC system, one side of the secondary of the step-down transformer must be connected to the ground bus (Figure 12).

In an ungrounded AC system, one side of the ground fault indicator test switch must be connected to the ground bus (Figure 13).

When the chassis of the Progammable Controller's Power Supply can not be directly connected to the enclosure or the enclosure ground bus, an AC grounding wire must be connected to the terminal labeled "Equipment Ground" on the Power Supply's terminal strip.

## FIELD WIRING CONSIDERATIONS

When planning duct layout, the following categories of wires and cables associated with an A-B Programmable Controller should be considered.

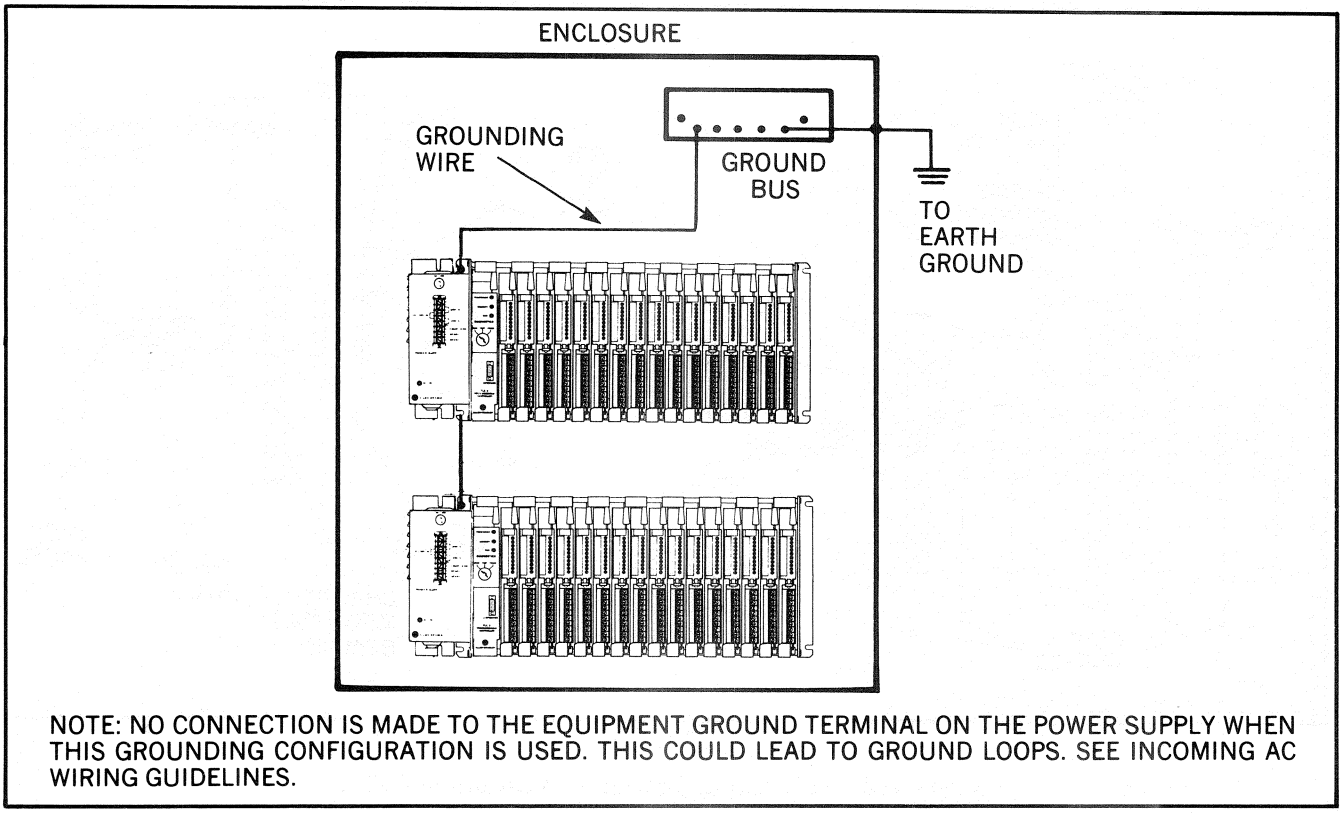



**FIGURE 5 — Typical Mini-PLC-2 or Mini-PLC-2/15 Controller Grounding Configuration**

I/O Power Cables carry regulated 5V and 15V power to I/O Racks.

I/O Interconnect Cables (for local I/O ) carry I/O status data transmissions between the Processor and the I/O Racks.

Serial Communication Cables, including Data Highway; Computer Interface; Data Handling; and I/O Interconnect Cables (for remote I/O ) carry data transmissions between Processors, I/O Racks, Computers, and/or Peripheral Printers.

Low Level DC I/O lines carry low voltage, low power signals and their input circuits have short time constant filters so that short pulses can be detected. Low Level DC I/O lines connect to TTL, Analog, Encoder/Counter, Pulse Output, Fast Response, Thermocouple and other Low Level DC I/O Modules.

AC I/O lines and High Level DC I/O lines have a greater degree of noise immunity than Low Level DC I/O lines. High Level DC I/O lines connect to all DC I/O Modules not defined as Low Level.

## FIELD WIRING GUIDELINES

The following are general wiring guidelines for A-B Programmable Controller components. These guidelines are applicable to typical installations for user wiring inside and outside of the enclosure:

All AC I/O lines and High Level DC I/O lines can be routed with machine power lines of up to 600V AC (feeding up to 100 horsepower devices), if this does not violate local codes. Article 300-3 of the National Electrical Code requires that all conductors (AC and/or DC) in the same duct must be insulated for the highest voltage carried by any one of the conductors in the duct.

All Low Level DC I/O lines must be properly shielded and run in a separate duct. Serial Communication Cables may also be run with these lines.

I/O Power Cables and I/O Interconnect Cables (for Local I/O) should remain external to all wiring ducts or in a duct not shared with other wiring within the enclosure.

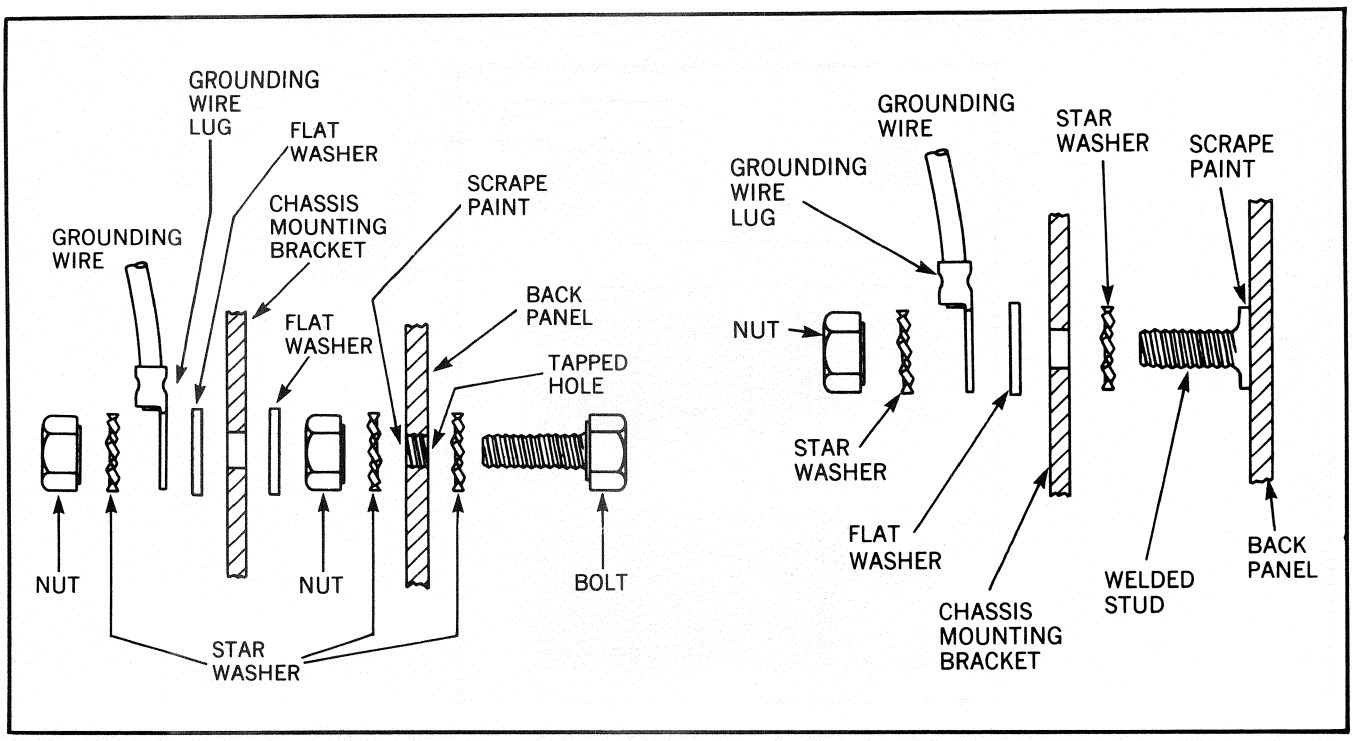



**FIGURE 6 — Mounting Chassis and Grounding Wire**

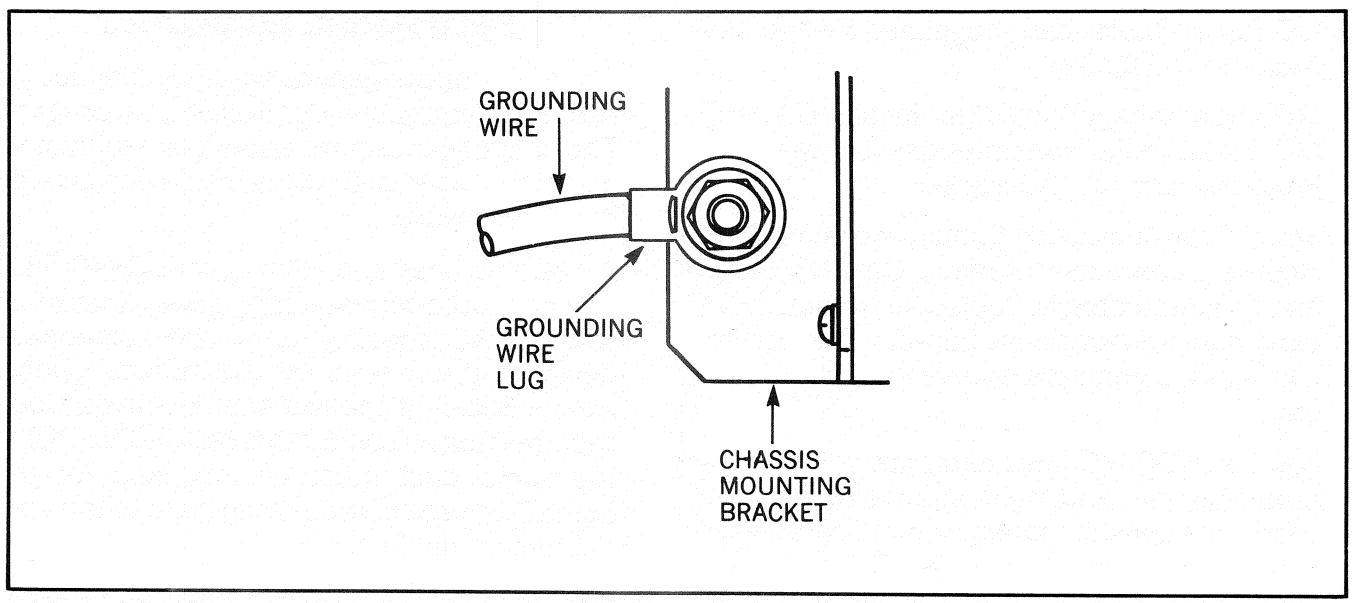



**FIGURE 7 — Mounted Ground Wire (Front View)**

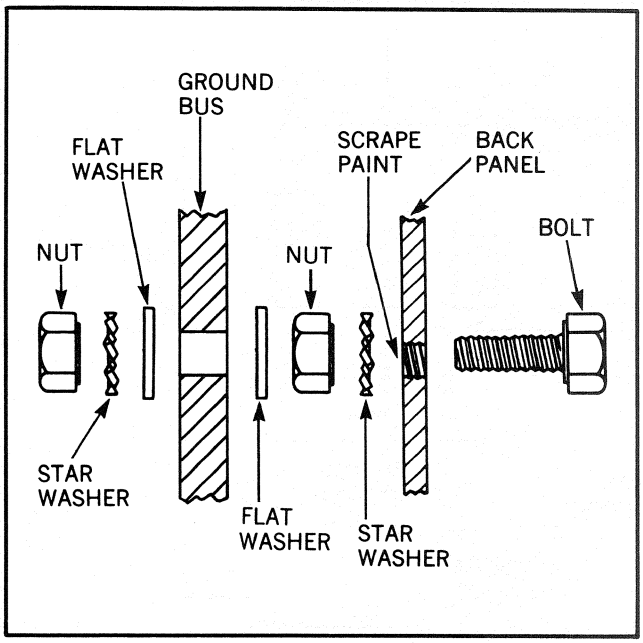



**FIGURE 8 — Mounting Ground Bus**

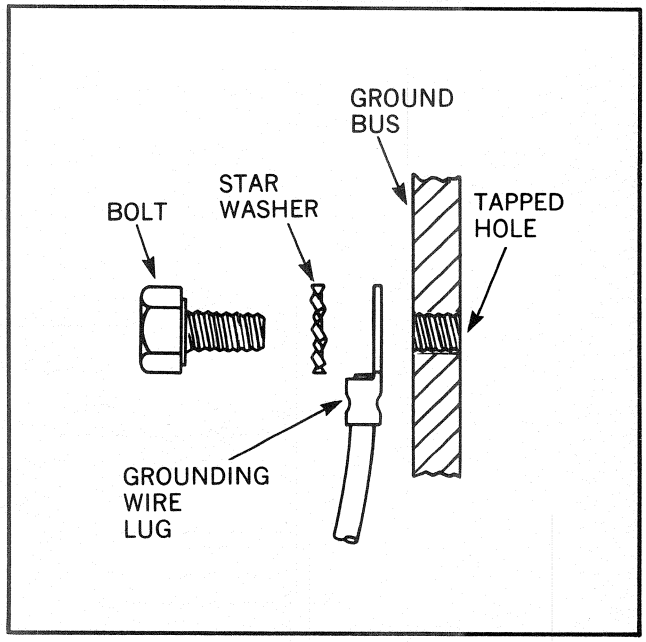



**FIGURE 9 — Connecting Grounding Wire to Ground Bus**

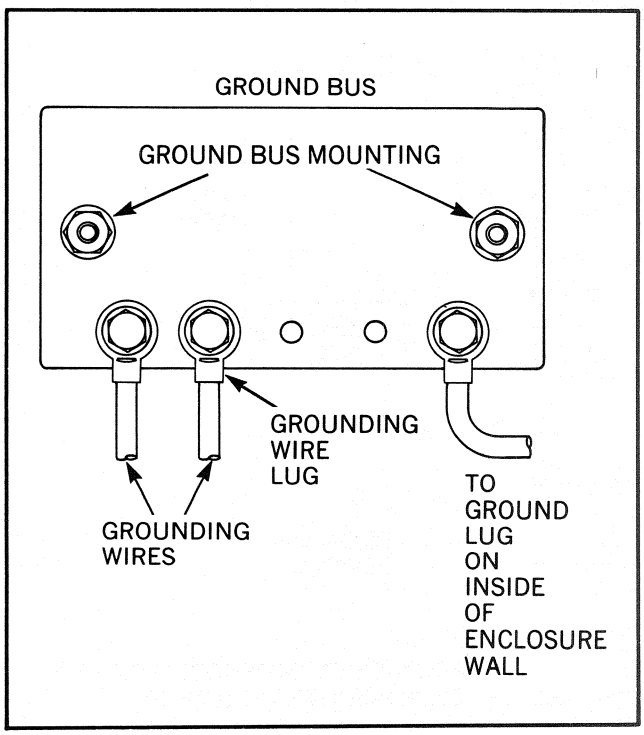



**FIGURE 10 — Wired Ground Bus**

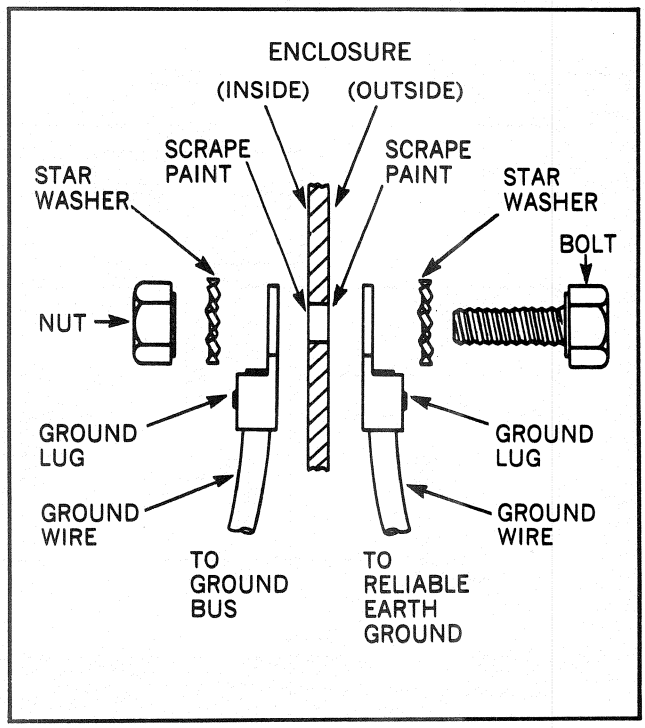
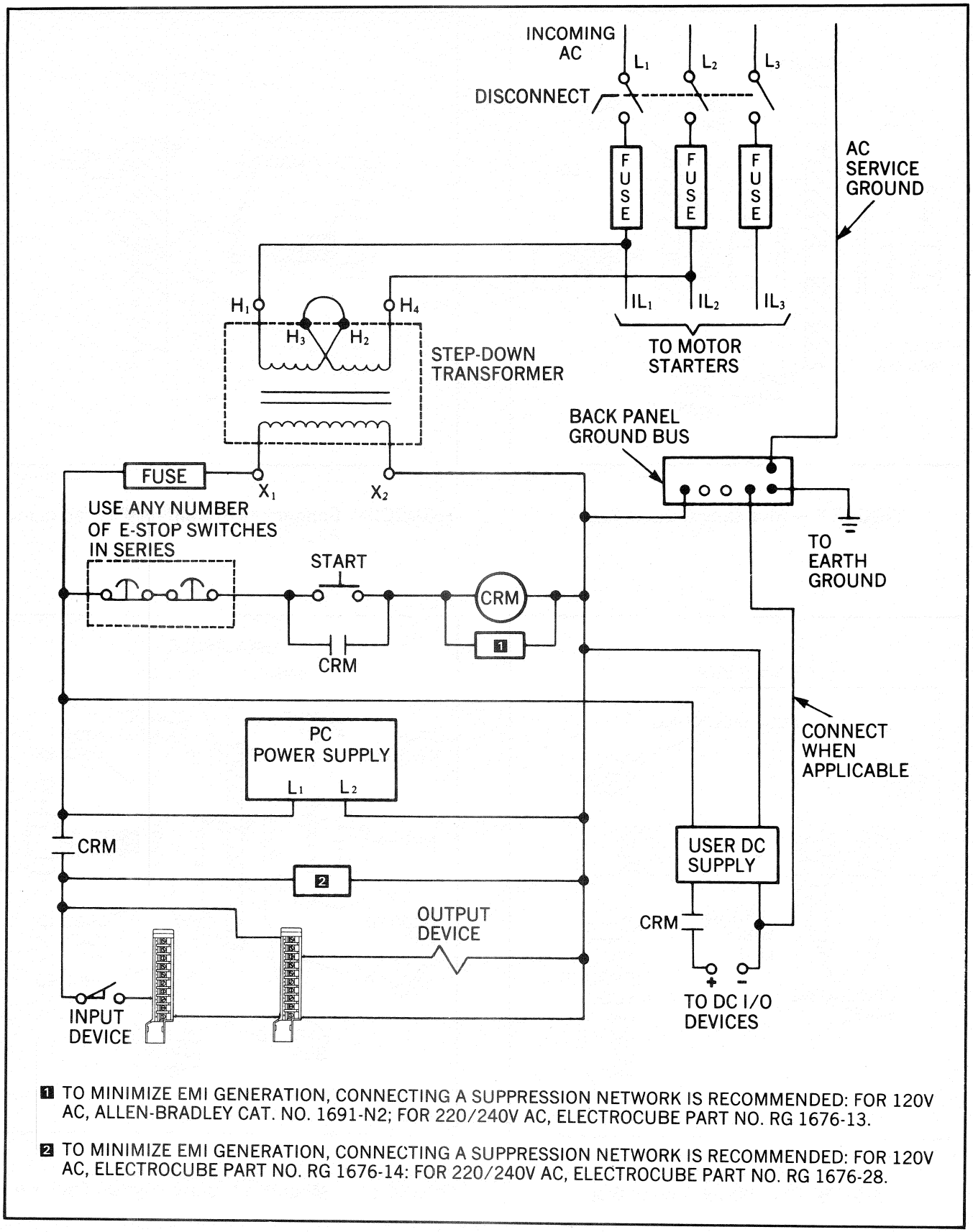


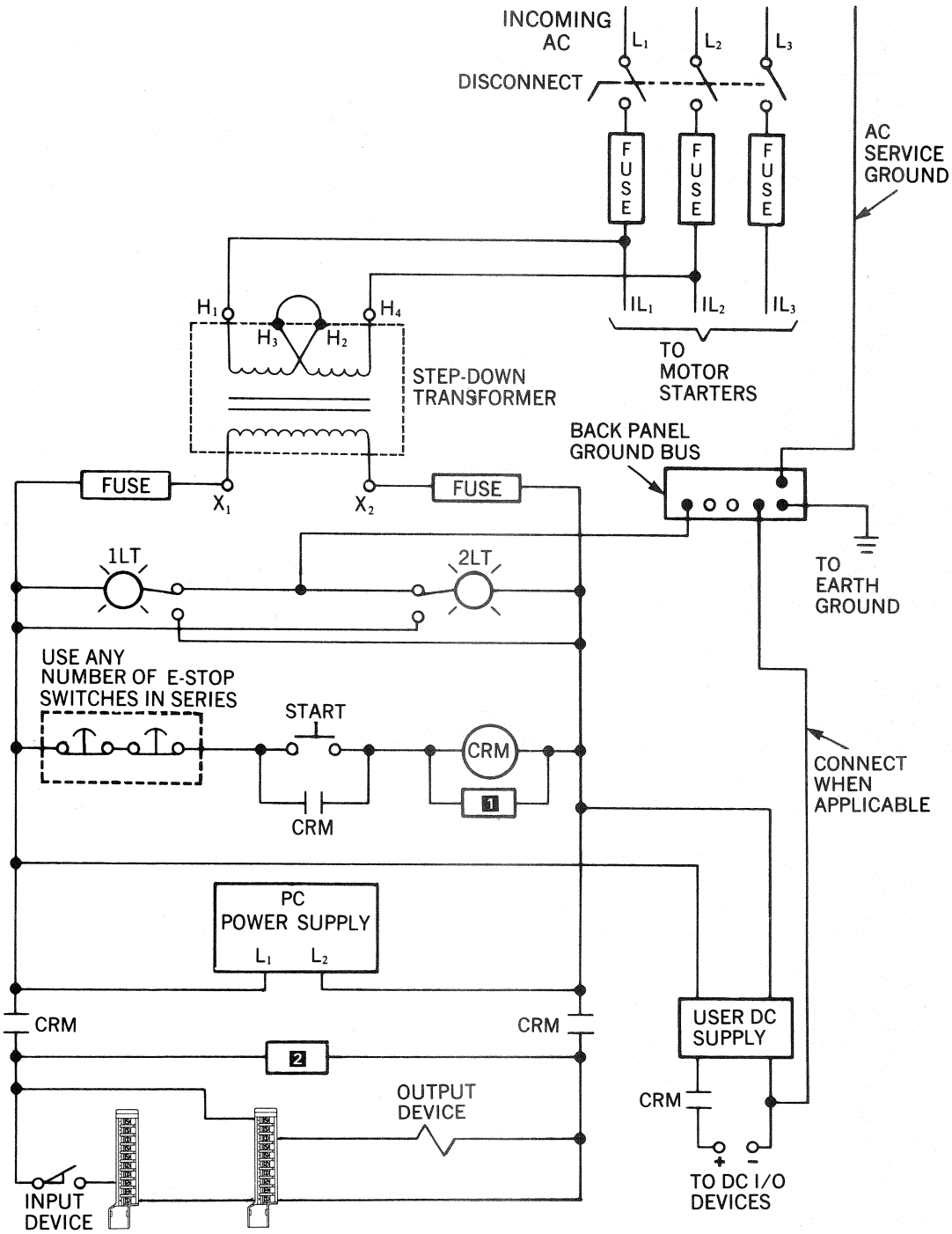

**FIGURE 11 — Mounting Ground Lugs on Enclosure**




1 TO MINIMIZE EMI GENERATION, CONNECTING A SUPPRESSION NETWORK IS RECOMMENDED: FOR 120V AC, ALLEN-BRADLEY CAT. NO. 1691-N2; FOR 220/240V AC, ELECTROCUBE PART NO. RG 1676-13.

2 TO MINIMIZE EMI GENERATION, CONNECTING A SUPPRESSION NETWORK IS RECOMMENDED: FOR 120V AC, ELECTROCUBE PART NO. RG 1676-14: FOR 220/240V AC, ELECTROCUBE PART NO. RG 1676-28.

**FIGURE 12 — Typical Power Distribution (with Master Control Relay) of a Grounded System**




1 TO MINIMIZE EMI GENERATION, CONNECTING A SUPPRESSION NETWORK IS RECOMMENDED: FOR 120V AC, ALLEN-BRADLEY CAT. NO. 1691-N2; FOR 220/240V AC, ELECTROCUBE PART NO. RG 1676-13.

2 TO MINIMIZE EMI GENERATION, CONNECTING A SUPPRESSION NETWORK IS RECOMMENDED: FOR 120V AC, ELECTROCUBE PART NO. RG 1676-14: FOR 220/240V AC, ELECTROCUBE PART NO. RG 1676-28.

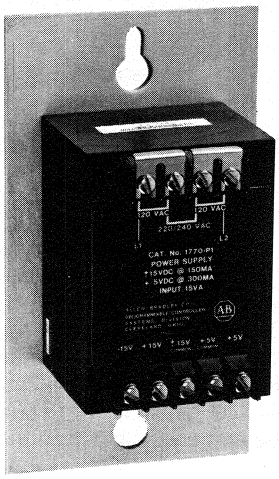
**FIGURE 13 — Typical Power Distribution (with Master Control Relay) of an Ungrounded System**

ALLEN-BRADLEY
Cleveland, Ohio 44143

## 4.1 POWER SUPPLIES

1770-905 Power Supply
1770-950 Allen-Bradley Lithium Battery Information
1771-908 System Power Supply
1771-909 Auxiliary Power Supply
1771-910 AC Line Voltage Stabilization with Constant Voltage Transformers
1772-902 Power Supplies
1772-904 AC Line Voltage Stabilization with Constant Voltage Transformers
1772-917 Allen-Bradley Power Supply Assembly

# POWER SUPPLY
## Cat. No. 1770-P1



### DESCRIPTION

The Power Supply (Cat. No. 1770-P1) provides well-regulated +5V and ±15V DC outputs. It can be used with Bulletin 1771 I/O Modules which require an external DC power source for operation, including the Analog Input Module Assemblies (Cat. No. 1771-IE, IF). It may also be used to power other devices connected to I/O modules, including thumbwheel switches and L.E.D. numeric displays.

The Power Supply provides sufficient output current for either of these configurations:

- 2 Analog Input Module (8 bit) Assemblies (Cat. No. 1771-IE)
- 2 Analog Input Module (12 bit) Assemblies (Cat. No. 1771-IF)

The Supply has built-in current-limiting circuitry to aid in protection from shorted outputs.

### WIRING

The Power Supply (Cat. No. 1770-P1) requires input from either 120V or 220/240V AC. It is factory-shipped for 120V AC operation, with two metal jumpers installed at the input terminals labeled 120V AC. (Refer to Figure 1.)

For 220/240V operation, **both** metal jumpers on the terminal strip must be removed from their original positions. **One** of these jumpers must then be re-installed at the input terminals labeled 220/240V AC. (Refer to Figure 2.)

The Supply has output COMMON terminals for both +5V DC COMMON and ±15V DC COMMON. When the Power Supply (Cat. No. 1770-P1) is used with the Cat. No. 1771-**IE** Analog Input Module, both COMMON terminals must be connected together. (This connection may be made at the Module or by wiring a jumper between the COMMON terminals.) When the Power Supply is used with the Cat. No. 1771-**IF** Analog Input Module, separate terminals are provided for both +5V DC COMMON and ±15V DC COMMON. To minimize ground loops when used with the Cat. No. 1771-IF module, do not connect commons together.

### SPECIFICATIONS

**Nominal Input Voltage**

120V AC
220/240V AC

**Input Voltage Range**

105-125V AC
205-250V AC

**Frequency Range**

50-440 Hz

**Output Voltages**

+5V DC
+15V DC
−15V DC

**Output Voltage Tolerance**

±1.0%

**Maximum Output Current**

+5V: 300mA
+15V: +150mA
−15V: −150mA

**Regulation**

Line: 0.02%
Load: 0.1% (at +5V output)
0.05% (at ±15V outputs)

**Output Voltage Ripple**

1.0 mV RMS (max.)

**Dimensions** (WHD)

3.5 x 6.5 x 2 inches
8.9 x 16.5 x 5.1 cm

**Weight**

2 lbs. (0.9 kg)

**Operating Temperature**

0°C to 60°C

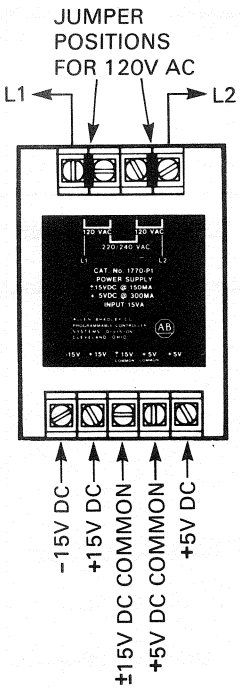



**Figure 1 — Supply Terminals**

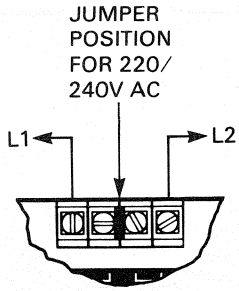



**Figure 2 — 220/240V Input Connections**

## MOUNTING

Sized for limited-space applications, the Power Supply can be installed on the back panel of the programmable controller enclosure. To minimize noise effects from other wiring within the enclosure, mount the Power Supply near the I/O Chassis and route Supply wiring away from high-voltage wiring within the enclosure.

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# ALLEN-BRADLEY LITHIUM BATTERY INFORMATION

## Cat. No. 1770-XO

Use of a Lithium Battery (Cat. No. 1770-XO) provides extended memory support for the following Allen-Bradley Programmable Controllers:

- Mini-PLC-2, Mini-PLC-2/15
- PLC-2, PLC-2/20, PLC-2/30
- PLC-3

Specific handling and disposal procedures peculiar to Lithium Batteries are described in this Publication. Also described are the installation procedures for Lithium Battery use with an Allen-Bradley Programmable Controller.

### HANDLING PROCEDURES

The following procedures must be followed to ensure proper Battery operation, Controller functions, and reduce personal hazards.

**WARNING:** Lithium Battery handling and disposal procedures outlined here must be followed. Failure to do so could result in damage to equipment and/or personal injury.

- **Do not** charge Battery.
- **Do not** puncture, crush, or incinerate.
- **Do not** inhale electrolyte vapors if Battery is crushed or punctured.
- **Do not** short Battery positive and negative terminals together.
- When used with **Mini-PLC-2** and **PLC-2** Controllers **replace after three years** with another Lithium Battery (one recently manufactured). When used with **PLC-3** Controllers **replace after one year**.
- Disposal of less than 220.46 pounds (100 kilograms) of Lithium Batteries may be handled in commercially available methods other than incinerating.
- Store in a cool dry environment, typically 20° to 25°C (68° to 77°F) temperature; 40% to 60% relative humidity.
- **Do not** ship by passenger aircraft.
- When Battery must be reshipped, as from Allen-Bradley Distributor, or OEM, to end user, ship each Lithium Battery in its original shipping container, packaging material, and vapor containment bag.

Lithium Battery can only be used with Allen-Bradley products listed in Table A.

### LITHIUM BATTERY INSTALLATION WITH MINI-PLC-2 AND PLC-2 PROGRAMMABLE CONTROLLERS

**CAUTION:** Memory contents are altered if Battery replacement occurs when the Allen-Bradley Power Supply (Cat. No. 1771-P1, 1772-P1) is "powered down" or OFF. Should data stored in memory be lost, the entire user program and all messages must be re-entered.

1. If memory contents are to remain unaltered, Battery installation must be performed while memory is receiving power from the Power Supply (Cat. No. 1771-P1, 1772-P1).
2. Turn the thumbscrew at the front of the Battery Pack counterclockwise until it turns freely and releases the Battery Housing from its mounting.
3. Disconnect the three-pin connector on the bottom of the Battery Housing.
4. Remove the Battery Housing.
5. If the Battery Housing has two D-size alkaline batteries presently installed, remove the two alkaline batteries. With the front of the Battery Housing on your left, locate the battery contacts at the positive end of each battery compartment (Figures 1 and 2). Remove both positive contacts and exchange their position within the Battery Housing.
6. Insert one Lithium Battery in the left battery compartment (the compartment **closest** to the front of the Battery Housing). Observe proper Battery polarity (Figure 2). If the Battery is installed with reverse polarity, the BATTERY LOW indicator flashes ON and OFF when the Supply is put into operation.
7. Place the Caution label on the top surface of the Battery Housing as shown in Figure 3. Write the date on both date labels. Place one date label on the Caution label and the other on the Lithium Battery (Figure 3).
8. Insert the Battery Housing into its mounting. Reconnect the three-pin connector to the connector at the bottom of the Battery Housing.
9. Tighten the Battery Housing mounting thumbscrew by turning it clockwise.

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Publication 1770-950 — May, 1981

**TABLE A — Lithium Battery Installation with Allen-Bradley Products**

| PROGRAMMABLE CONTROLLER FAMILY | LITHIUM BATTERY INSTALLED IN/ON |
|---|---|
| Mini-PLC-2 | System Power Supply, Series B or later (Cat. No. 1771-P1) |
| PLC-2 | Memory Module (Cat. No. 1772-ME) |
| PLC-3 | Error Correcting Memory Module (Cat. No. 1775-ME2, -ME4, -ME8) [1] |
| | CMOS RAM Memory Module (Cat. No. 1775-MR2, -MR4, -MR8) [1] |

[1] Each of these Memory Modules requires its own Lithium Battery. It is recommended that all Lithium Batteries supporting memory be replaced at the same time.

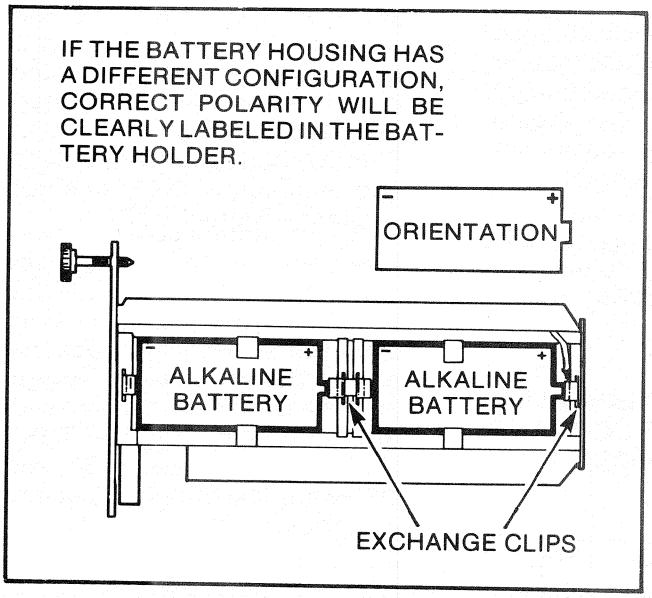



**FIGURE 1 — Battery Housing Cat. No. 1771-BH or 1772-B1 (Alkaline Batteries Installed)**

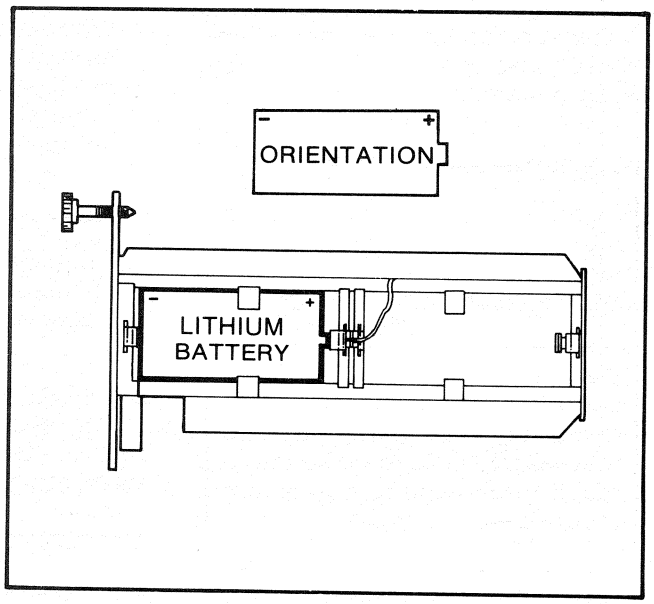



**FIGURE 2 — Battery Housing Cat. No. 1771-BH or 1772-B1 (Lithium Battery Properly Installed)**

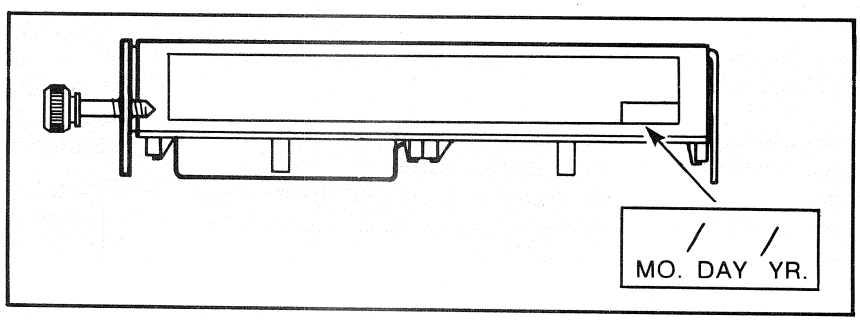



**FIGURE 3 — CAUTION Label Placement on Battery Housing**

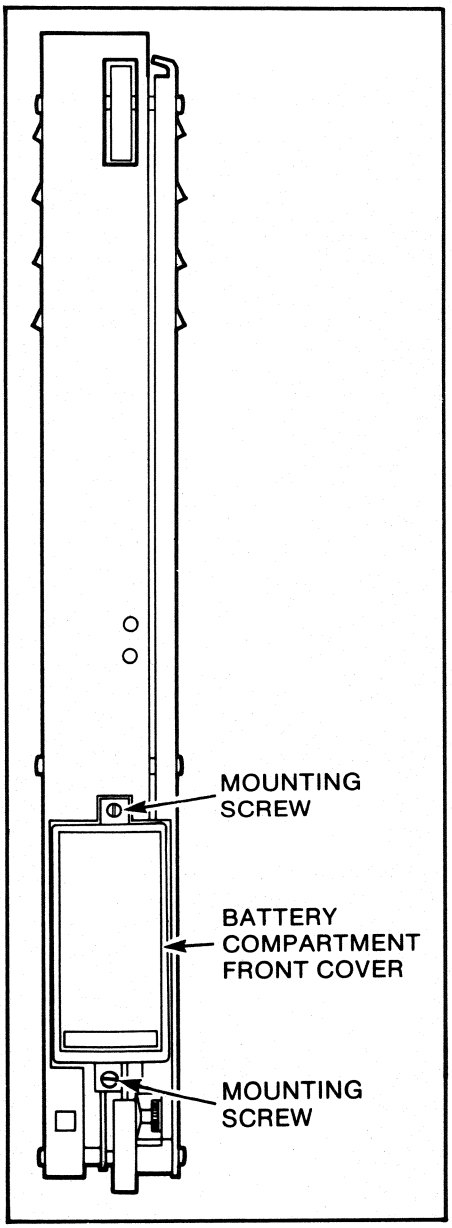



**FIGURE 4 — Battery Compartment On PLC-3 Controller Memory Module**

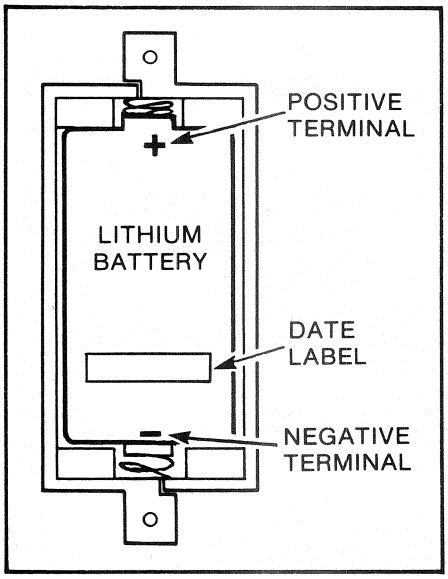



**FIGURE 5 — Lithium Battery Orientation with PLC-3 Controller**

## LITHIUM BATTERY INSTALLATION WITH PLC-3 PROGRAMMABLE CONTROLLER

**CAUTION:** Memory contents are altered if Battery replacement occurs when the Power Supply (Cat. No. 1775-P1) is "powered down" or OFF. Should data stored in one Memory Module be lost, the entire memory contents must be re-entered.

1. Locate the Memory Module into which the Lithium Battery will be installed. If memory contents are to remain unaltered, Battery installation must be performed while the Memory Module is receiving power from the Power Supply (Cat. No. 1775-P1).
2. Remove the two mounting screws on the battery compartment front cover (Figure 4). Remove the battery compartment front cover.
3. If an expended battery is installed, remove it.
4. Install a newly manufactured Lithium Battery in the battery compartment. Observe proper Battery orientation as shown in Figure 5. Should the Lithium Battery be installed incorrectly, or should it lack sufficient charge, the BATTERY LOW indicator illuminates.
5. Discard the Caution label which accompanied the Lithium Battery. Write the date on both date labels. Place one date label on the battery compartment front cover, and the other on the Lithium Battery.
6. Replace the battery compartment front cover and secure it to the battery compartment by turning the mounting screws clockwise.



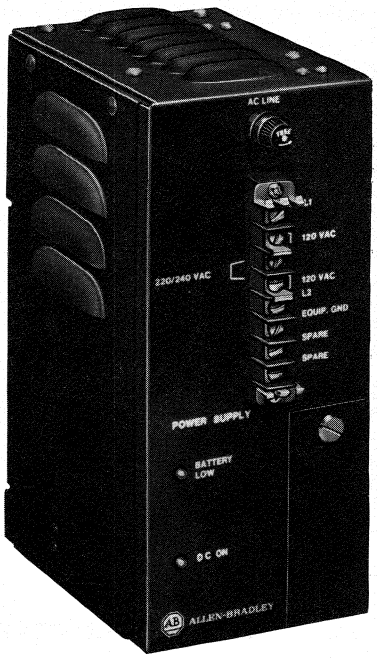
ALLEN-BRADLEY

Systems Division-PC Business
747 Alpha Drive, Cleveland, Ohio 44143

P/N 611045-60A

# SYSTEM POWER SUPPLY

## Cat. No. 1771-P1




### DESCRIPTION

**Introduction**— The System Power Supply (Cat. No. 1771-P1) is the required power source for the Bulletin 1772 Mini-PLC-2 programmable controller. Its output provides a regulated 5.1V DC for the logic circuitry of both the PLC-2 Mini-Processor Module and the interfacing I/O modules in the 32-, 64-, or 128-I/O Chassis. [1] In addition, the Supply provides 5V DC for the memory circuitry of the Mini-Processor Module. The Power Supply also has additional protective circuitry which monitors the outputs for proper operating levels.

The System Power Supply can be operated from 120V AC, 220/240V AC, or 24V DC.

The front face of the Power Supply provides a clearly marked terminal strip for user input connections, an easily accessible fuseholder for fuse replacement, and visual indicators of Supply and battery back-up status.

Standard with the System Power Supply is a Battery Pack (Cat. No. 1771-BB) which includes 2 alkaline batteries. The Battery Pack provides low-cost back-up power to maintain memory contents during AC power loss, removal or replacement of the Supply, or controller shut-down. The user installs the Battery Pack on the left side of the I/O Chassis; the Mounting Hardware Set (Cat. No. 1771-BX) is provided as standard with the Supply.

The Power Supply is mounted either on the left side-plate of the I/O Chassis or, optionally, up to 5 cable-feet from the I/O Chassis. Both mounting arrangements allow Mini-PLC-2 controller installation within an enclosure of 8-inch working depth.

[1] The Auxiliary Power Supply (Cat. No. 1771-P2), a slightly different version of the System Power Supply, is to be used in applications where Bulletin 1771 I/O Racks are interfaced with Remote I/O PLC and PLC-2 controllers. Refer to Publication 1771-909.

### SPECIFICATIONS

**Nominal Input Voltage**
120V AC
220/240V AC
24V DC [1]

**Input Voltage Range**
98-132V AC (for 120V operation)
196-250V AC (for 220/240V operation)

**Frequency Range**
60/50 Hz

**Output Voltage**
5.1V DC (logic circuitry)
5V DC (memory)

**Maximum Output Current**
6.5A

**Input Power**
75 VA (approx.)

**Power Capability**
1 PLC-2 Mini-Processor Module
and
1 Bulletin 1771 I/O Rack
(equivalent of 128 I/O)

**Location**
Side plate of Bulletin 1771 I/O Chassis
or
5 cable-feet from I/O Chassis

**Battery Type**
2 Alkaline D-size 1.5V
or
1 Lithium D-size 3.4V

**Ambient Temperature Rating**
0° to 60°C (operational)
-40° to 85°C (storage)
(without batteries)

**Humidity Rating**
5 to 95%
(without condensation)

**Weight**
13 lbs. (5.85 kg)

**Dimensions (W x H x D)**
4.56 x 11.25 x 7.16 inches
11.6 x 28.5 x 18.2 cm

**Fuse**
120V use: 1A, 3AG
(slow-blow)
220/240V use: 0.5A, 3AG
(slow-blow)

[1] Refer to Application Note 1.

**Publication 1771-908 — August, 1980**
Supersedes Publication 1771-908 — Dated November, 1978

When ordering the Cat. No. 1771-P1 Power Supply, the user must also specify and order the proper Power Cable for his mounting arrangement. These Cables are:

- Cat. No. 1771-CL Power Cable, for I/O Chassis mounting
- Cat. No. 1771-CM Power Cable, for mounting within 5 cable-feet of the Mini-Processor Module.

**Input Voltage** – The Power Supply requires input from an AC source. [1] Either 120V AC or 220/240V AC may be used. The Supply is factory-shipped for 120V AC operation. (Two metal jumpers are installed on the front terminal strip at the positions indicated 120V AC. Refer to Figure 1.) For 220/240V AC operation, **both** metal jumpers on the terminal strip must be removed from their original 120V positions. **One** of these jumpers must then be installed at the terminals labeled 220/240V AC.

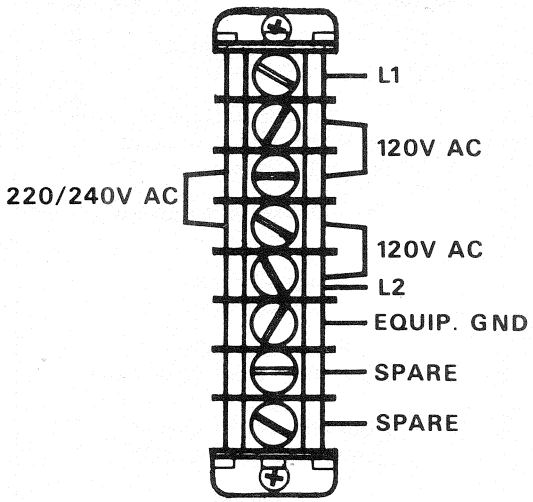



**Figure 1 – Power Supply Terminal Barrier**

**CAUTION:** The user must make certain that the Power Supply is correctly jumpered for **either** 120V **or** 220/240V AC. Incorrect jumpering on the terminal strip may cause improper operation or damage to the Supply.

AC input line connections for either 120 or 220/240V AC are made to the terminals marked L1 and L2. (L1 is the high side of the AC line; L2 the low side.) Ground is connected to the terminal labeled EQUIP. GND.

Input voltage is constantly monitored by the Supply for proper operating levels. The **normal** AC input range with 120V AC use is between 98 and 132V AC. When 220/240V AC is used, the normal range is between 196 and 250V AC.

The Power Supply allows some margin for variation from this normal voltage range. However, there is a **minimum** voltage of 92V for 120V AC operation or 184V for 220/240V AC operation. Should the AC line fall below this minimum voltage for more than one-half cycle, the Power Supply signals the Processor Module to stop communication with its I/O modules. This signal stops communication **before** loss of logic-level voltage to the Processor Module. This guards against the possible transmission of invalid I/O data.

With 24V DC operation the minimum voltage requirement is user-adjusted for 20V DC. (Refer to Application Note 1.)

If input line conditions have caused suspension of normal operation, line power need not be recycled to the Power Supply for a return to normal Processor operation. The Power Supply signals the Processor to restart automatically when the user's line is restored to the normal AC input range—that is, at 98V for 120V use, or 196V for 220/240V use. With 24V DC use, recovery to 20V DC is sufficient to restart the Processor.

In applications where the AC line is especially unstable and subject to unusual varlation, a constant voltage transformer can be used to stabilize the input voltage to the Power Supply as well as the input voltage to user devices. [2]

**Fuse Protection** – A slow-blow fuse protects the Power Supply from overcurrent at its inputs. The 1-ampere fuse installed in the Supply when shipped is appropriate for 120V operation. For 220/240V operation, this fuse must be replaced with a 0.5-ampere fuse. A separate 0.5 ampere fuse is included with the Supply for this purpose. For replacement, the fuseholder is easily accessed on the front cover of the Supply.

The user may order replacement fuses from Allen-Bradley. The optional Fuse Package (Cat. No. 1771-FP) contains both 1- and 0.5-ampere fuses. The user may also order the replacement fuses listed in Table B.

**Power Supply Outputs** – The maximum output current of the Cat. No. 1771-P1 Power Supply is 6.5 amperes. This is sufficient to supply the Mini-Processor Module and any size of Bulletin 1771 I/O Rack with up to 128 I/O, using the currently available I/O modules. The Power Supply current requirement for these modules is shown in Table A. [3]

**Table A**
**MODULE CURRENT REQUIREMENTS**

| MODULE | Cat. No. | MAXIMUM CURRENT |
|---|---|---|
| Mini-Processor | 1772-LN1<br>1772-LN2 | 1.5A<br>1.5A |
| DC (12-24V) Input<br>DC (48V) Input<br>DC (24-48V) Input<br>AC/DC (120V) Input<br>DC (12-24V) Output<br>DC (48V) Output<br>AC (120V) Output | 1771-IB<br>1771-IC<br>1771-IH<br>1771-IA<br>1771-OB<br>1771-OC<br>1771-OA | 74mA<br>74mA<br>74mA<br>74mA<br>165mA<br>165mA<br>210mA |

For protection of logic circuitry in the Mini-PLC-2 controller, Power Supply outputs have built-in monitoring circuitry. In a special power-up sequence, and also during normal operation, outputs are checked for possible overvoltage, undervoltage, and overcurrent conditions. Detection of any of these conditions shuts down the Supply. If shutdown is caused for these reasons, it is necessary to recycle AC power to the Supply. (This is accomplished by disconnecting, then reconnecting user line power, preferably from the user-supplied main disconnect switch, mounted near the Power Supply.)

---

[1] The System Power Supply can also be operated from a 24V DC source. (Refer to Application Note 1.)

[2] If a constant voltage transformer is used, it must have filtering to remove high harmonic content and provide a sinusoidal output. For the Cat. No. 1771-P1 Power Supply, a power rating of 250 VA is recommended. Refer to Publication 1771-910 for more information.

[3] Current requirements for subsequent I/O modules will be indicated in product literature for the modules.

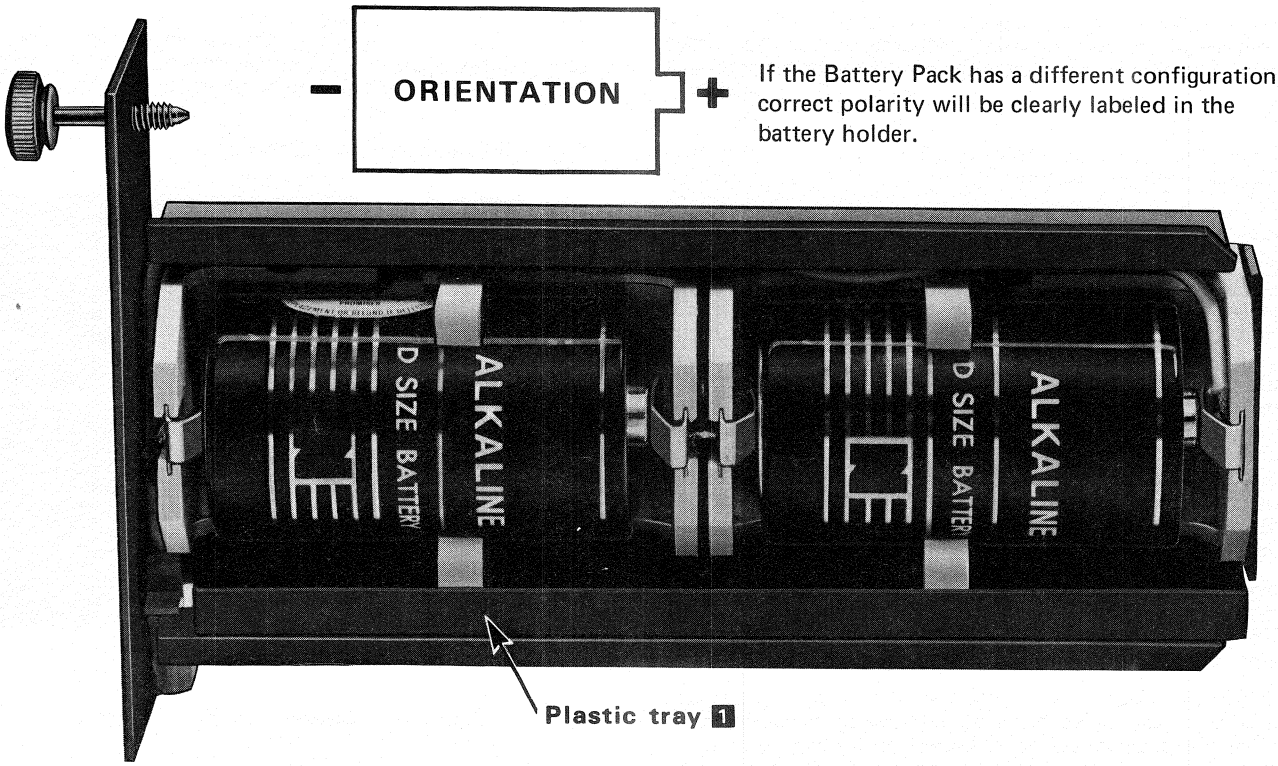



**Figure 2 — Battery Pack**

When the AC input voltage and DC output voltage and current are at proper levels the indicator on the front of the Supply, labeled DC ON, illuminates. This indicator remains illuminated during normal Power Supply operation.

**Battery Pack** — If the Power Supply shuts down due to loss of AC power on the user's line, or any other condition, batteries supply memory back-up power. The Battery Pack, mounted on the side of the Chassis, provides a compact housing for the batteries.

Examine the battery holder for a clear label which indicates proper battery polarity. If there is no such label, observe the polarity shown in Figure 2.

Note: A label in the Battery Pack may indicate polarity reversed from that shown in Figure 2. Because vendor specifications are subject to change, any clear labeling of battery polarity in the battery holder supersedes that shown in Figure 2. 1

If batteries are installed with incorrect polarity, the BATTERY LOW indicator will flash ON and OFF as soon as the Supply is put into operation. If this indicator begins to flash upon initial power-up, remove the 3-pin Power Cable connector from the Battery Pack, remove the Pack, and re-install batteries with reverse polarity.

A Mounting Hardware Set (Cat. No. 1771-BX), consisting of a mounting bracket and screws is provided as standard with the Power Supply. The mounting bracket is installed by the user onto the left-side-plate of the Chassis. The mounted bracket assembly is shown in Figure 3. Upper and lower tracks of the bracket guide the Battery Pack into position. A thumbscrew then holds the Battery Pack firmly in the bracket.

Alkaline D-size cells, shipped with the Power Supply, are the standard battery back-up. The "life" of the alkaline battery allows reliable, long-term memory back-up at low cost. Because the current requirement of the CMOS mem-

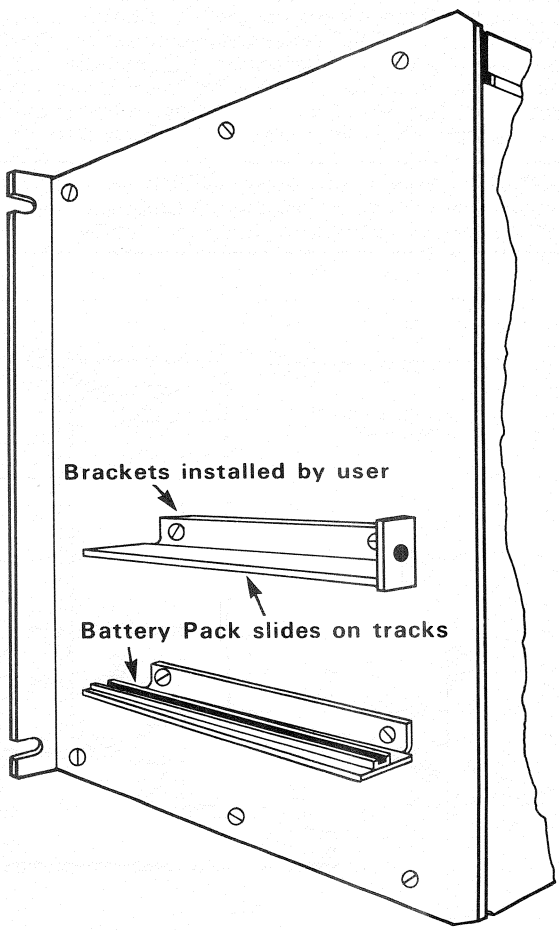



**Figure 3 — Battery Pack Mounting Bracket**

1 Refer to Application Note 7.

ory is relatively small, alkaline battery life is primarily a function of its own internal discharge, rather than usage drain. For this reason, batteries used to support memory circuitry of the Mini-Processor Module will last nearly as long as batteries in storage under similar conditions.

For applications where more back-up time is desired, the optional Lithium Battery (Cat. No. 1771-BL) may be used.

Protective circuitry monitors battery conditions to prevent overvoltage, charging, or shorting. In addition, Supply circuitry also checks for undervoltage. When battery voltage begins to drop toward levels which will not support the memory, a red indicator flashes on the System Power Supply's front panel. This BATTERY LOW indicator flashes continuously ON and OFF to alert the user that replacement batteries are needed. Note that this circuitry detects undervoltage **before** battery voltage becomes too low for memory back-up. This allows the user about one week to install fresh batteries.[1] As long as the Power Supply is operating, batteries may be replaced without loss of the Mini-Processor Module's memory contents.

**Power Supply Connections** – As stated in the Introduction, the user must specify either the Cat. No. 1771-CL or -CM Power Cables, depending on his mounting arrangement. These Cables differ only in length.

Each Power Cable has 3 connectors: two 9-pin plugs and one 3-pin plug. Cable plugs are configured for connection to the correct sockets only. Labels on each plug identify its proper connection. Once connection is made, convenient snap-locks hold Cable plugs securely in their sockets.

Connection to the Mini-PLC-2 programmable controller is made at the 9-pin socket on the I/O Chassis backplane. (Refer to Figure 4.) To make this connection, the Mini-Processor Module and left-most I/O module must be removed from the I/O Chassis. The Power Cable is run up through the bottom of the I/O Chassis, so that it does not interfere with insertion of the Mini-Processor Module.

**CAUTION:** Always turn power OFF before insertion or removal of **any** Module from the I/O Chassis. Damage may occur to logic circuitry if this rule is not followed.

Power Cable connection to the main body of the Power Supply is made to the 9-pin socket on its base. The 3-pin plug connects to the socket at the base of the Battery Pack. (The Battery Pack must be in its mounting bracket for this connection.)

Figure 5 illustrates Power Cable connections.

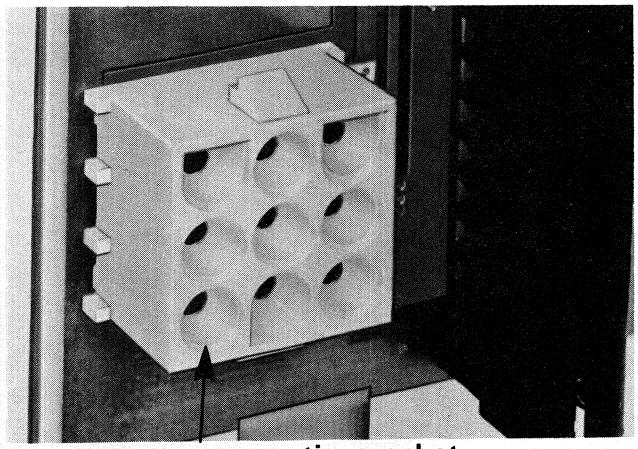



**Figure 4 – Chassis Backplane Socket**

## APPLICATION NOTES

1. The Cat. No. 1771-P1 Power Supply can be modified for operation from a 24V DC source. The DC source for the Supply must be able to provide 3 amperes at between 20 and 32V DC. Consult factory for modification procedures necessary for 24V DC operation.

2. When mounted separately, the Power Supply may be mounted above or next to the Chassis. It may **not** be mounted below, since it is necessary to allow convection cooling of both the Power Supply and the con-

[1] Refer to Application Notes 3 and 4.

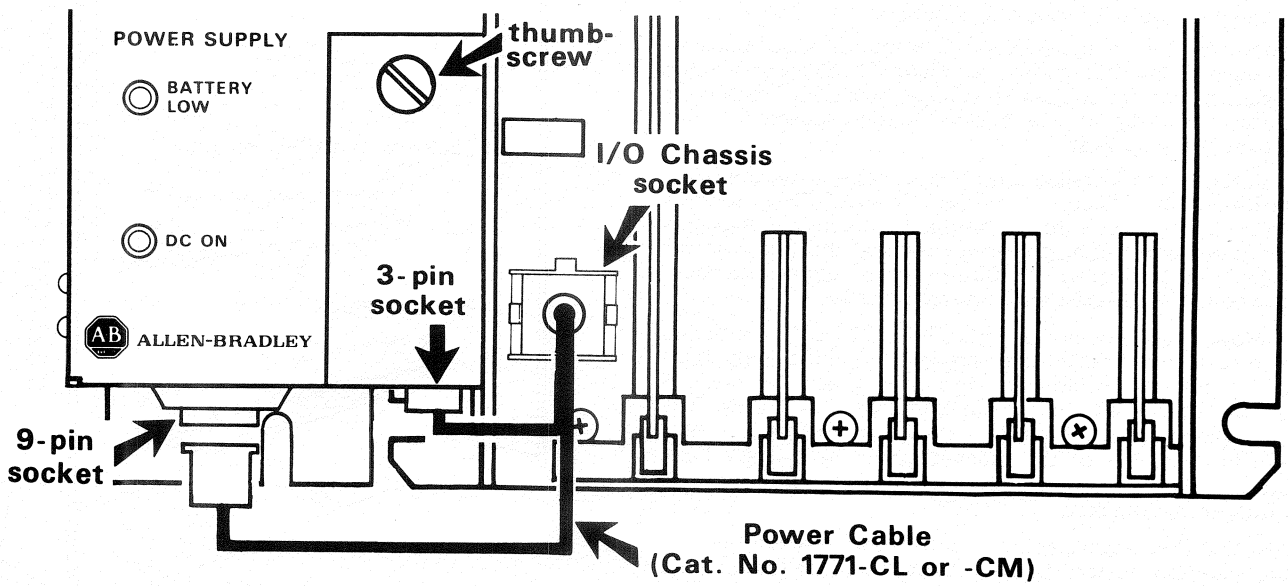



**Figure 5 – Power Cable Connections**

troller Chassis. A minimum vertical distance of 7 inches should be maintained.

3. Replacement alkaline batteries may be ordered using Cat. No. 1771-BA. It is strongly recommended that the user keep a fresh supply of these replacement batteries on hand. For storage of replacement cells, a cool, dry environment is most advantageous.

   In emergency situations, the user may **temporarily** substitute quality alkaline D-size batteries sold under these brand names:

   - National
   - Eveready
   - Ray-O-Vac

   The use of ordinary carbon-zinc D-size batteries is **not** recommended for this application.

4. The Power Supply signals a battery-low condition to the PLC-2 Mini-Processor Module. When this condition is detected, the Mini-Processor Module sets memory bit 02700 alternately ON and OFF. Bit 02700 may be examined by the user program, for example, and consequently a user-supplied warning light or annunciator may be energized to signal battery-low condition.

5. The Cat. No. 1771-P1 Power Supply can also be used to power one Bulletin 1771 I/O Rack when this Rack is used with Bulletin 1772 PLC-2 or Bulletin 1774 Remote I/O PLC programmable controllers. Thus, an additional Supply need not be purchased if expansion of the user's application requires use of the Remote I/O PLC or PLC-2 Processors. However, the primary unit recommended is the Cat. No. 1771-P2 Auxiliary Power Supply. Use of the Cat. No. 1771-P1 Supply for this application is acceptable only as an alternative.

6. Prior to June, 1979, Power Supplies had been shipped with a 2-ampere fuse for both 120V and 220/240V operation. Later Supplies are shipped with an installed 1-ampere fuse for 120V operation and a separate 0.5-ampere fuse for 220/240V operation.

   This change in fuse rating is due to a re-evaluation of the Supply current requirement under load. These revised fuse values do **not** imply that the user of an existing Supply must replace the 2-ampere fuse with either the 1- or 0.5-ampere fuse. The 2-ampere rating is suitable for the fuse function—protection of the Supply from input overcurrent.

   Replacement fuses of the 2-ampere rating are not available from Allen-Bradley. However, for replacement purposes, users of these earlier units may order the optional Fuse Package (Cat. No. 1771-FP). The 1- or 0.5-ampere fuses in this Fuse Package are suitable replacements for any System Power Supply (Cat. No. 1771-P1) or Auxiliary Power Supply (Cat. No. 1771-P2) labeled 2 AMP SLOW-BLOW at the fuseholder.

7. A plastic tray at the base of the Battery Pack helps to protect against possible alkaline cell leakage. It is recommended that the user align each battery within the Pack so that the seam of the battery case faces downwards, towards this protective tray.

8. For use of the optional Lithium Battery (Cat. No. 1771-BL), the System Power Supply must be Series B or later Series level. A label on the Supply sideplate identifies both Cat. No. and Series level for the Supply. If no Series level is listed, the Supply is Series A and thus **not** usable with the Lithium Battery.

   Consult factory for Lithium Battery availability.

**Table B**

**REPLACEMENT FUSE LIST**

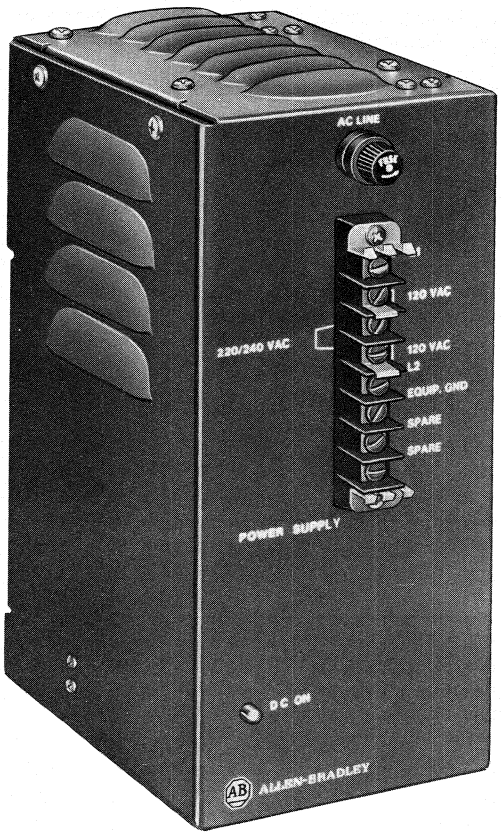
| INPUT VOLTAGE | FUSE | MANUFACTURER'S NO. |
|---|---|---|
| 120V AC | 3AG 1 amp | Bussman: 3AG MDL 1A<br>Littelfuse: 313001 |
| 220/240V AC | 3AG 0.5 amp | Bussman: 3AG MDL 0.5A<br>Littelfuse: 313.500 |

P/N 635229-60

ALLEN-BRADLEY
Cleveland, Ohio 44143

# AUXILIARY POWER SUPPLY

## Cat. No. 1771-P2




### SPECIFICATIONS

**Nominal Input Voltage**
120V AC
220/240V AC
24V DC [2]

**Input Voltage Range**
98-132V AC (for 120V operation)
196-250V AC (for 220/240V operation)
20-32V DC (for 24V DC operation)

**Frequency Range**
60/50 Hz

**Output Voltage**
5.1V DC

**Input Power**
75 VA (approx.)

**Power Capability**
1 Bulletin 1771 I/O Rack
(up to 128 I/O points)

**Location**
Side plate of Bulletin 1771 I/O Chassis
or
5 cable-feet from I/O Chassis

**Weight**
13 lbs. (5.85 kg)

**Dimensions (WHD)**
4.56 x 11.25 x 7.16 inches
11.6 x 28.5 x 18.2 cm

**Fuse**
120V use: 1A, 3AG
(slow-blow)
220/240V use: 0.5A, 3AG
(slow-blow)

**Maximum Output Current**
6.5A

**Ambient Temperature Rating**
0° to 60°C (operational)
-40° to 85°C (storage)

**Humidity Rating**
5 to 95%
(without condensation)

[2] Refer to Application Note 1.

### DESCRIPTION

**Introduction** – The Auxiliary Power Supply (Cat. No. 1771-P2) is the primary supply recommended to power one Bulletin 1771 I/O Rack when used with these programmable controllers:

- Bulletin 1774 Remote I/O PLC
- Bulletin 1772 PLC-2

Its output supplies 5.1V DC to the logic circuitry of any of the I/O Adapter Modules (Cat. No. 1771-AL, -AR, or -AE) and a full 32-, 64-, or 128-I/O Rack containing the currently available I/O modules. The Power Supply also has additional protective circuitry which monitors the outputs for proper operating levels. [1]

The Auxiliary Power Supply can be mounted either on the left-side plate of the I/O Chassis or, optionally, up to 5 cable-feet from the I/O Chassis. Both arrangements allow convenient mounting of the Bulletin 1771 I/O Rack in an enclosure of limited dimensions.

When ordering the Auxiliary Power Supply, the user must also specify and order separately the proper Power Cable, depending on his mounting arrangement. These Cables are:

- Cat. No. 1771-CE Power Cable, for Chassis mounting
- Cat. No. 1771-CD Power Cable, for mounting within 5 cable-feet of the Chassis.

The front face of the Power Supply provides a clearly marked terminal strip for user input connections, an easily

[1] The Cat. No. 1771-P1 System Power Supply is a slightly different version of this Supply for use with the Bulletin 1772 Mini-PLC-2 programmable controller. Refer to Publication 1771-908.

**Publication 1771-909 — August, 1980**
Supersedes Publication 1771-909 – Dated December, 1978

accessible fuseholder for fuse replacement, and a DC ON indicator to indicate proper operation status.

**Input Voltage** – The Power Supply requires input from an AC source.[1] Either 120V AC or 220/240V AC may be used. The Supply is factory-shipped for 120V AC operation. (Two metal jumpers are installed on the front terminal barrier at the positions indicated 120V AC. Refer to Figure 1.) For 220/240V AC operation, both metal jumpers on the terminal strip must be removed from their original positions. **One** of these jumpers must then be installed at the terminals labeled 220/240V AC.

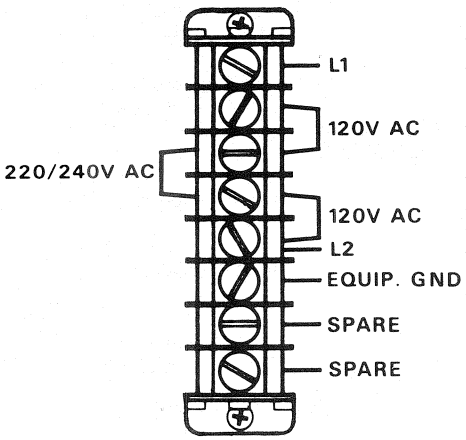



**Figure 1 – Power Supply Terminal Barrier**

**CAUTION:** The user must make certain that his Power Supply is correctly jumpered for **either** 120V **or** 220/240V AC. Incorrect jumpering on the terminal strip may cause improper operation or damage to the Supply.

AC input line connections for either 120 or 220/240V AC are made to the terminals marked L1 and L2. (L1 is the high side of the AC line; L2 the low side.) Ground is connected to the terminal labeled EQUIP. GND.

The **normal** AC input range with 120V AC use is between 98 and 132V AC. When 220/240V AC is used, the **normal** range is between 196 and 250V AC. With 24V DC use, this range is 20-32V DC.

The Auxiliary Power Supply monitors these input voltages for proper operating levels. The response of the Supply to a low-voltage condition on user lines depends on whether it is used with the **Remote** I/O PLC or **Local** I/O PLC-2 controllers.[2]

In applications where the AC line is especially unstable and subject to unusual variation, a constant voltage transformer can be used to stabilize the input voltage to the Power Supply as well as the input voltage to user devices.[3]

**Fuse Protection** – A slow-blow fuse protects the Power Supply from overcurrent at its inputs. The 1-ampere fuse installed in the Supply when shipped is appropriate for 120V operation. For 220/240V operation, this fuse must be replaced with a 0.5-ampere fuse. A separate 0.5 ampere fuse is included with the Supply for this purpose. For replacement, the fuseholder is easily accessed on the front cover of the Supply.

The user may order replacement fuses from Allen-Bradley. The optional Fuse Package (Cat. No. 1771-FP) contains both 1- and 0.5-ampere fuses. The user may also order the replacement fuses listed in Table B.

**Power Supply Outputs** – The Auxiliary Power Supply provides 5.1V DC with a maximum output current of 6.5 amperes. This output is sufficient for the largest Bulletin 1771 I/O Rack which uses one I/O Adapter Module (Cat. No. 1771-AL, -AR, or -AE) and as many as 16 of the I/O modules available presently. The current requirements for all these modules are listed in Table A.[4]

To protect the logic circuitry of these modules, the Power Supply continuously monitors its output. In a special power-up sequence, and also during normal operation, the Supply output is checked for possible overvoltage, undervoltage, and overcurrent conditions. Detection of any of these conditions shuts down the Supply.

If Supply shutdown is caused by an output condition, it is necessary to recycle AC power to the Supply for a return to normal operation. (This is accomplished by disconnecting, then reconnecting user line power, preferably from the user-supplied main disconnect switch, mounted near the Power Supply.)

When the DC output and current are at proper levels the indicator on the front of the Supply, labeled DC ON, illuminates. This indicator remains illuminated during normal Power Supply operation.

**Table A**

**MODULE CURRENT REQUIREMENTS**

| MODULE | Cat. No. | MAXIMUM CURRENT |
|---|---|---|
| PLC-2 I/O Adapter | 1771-AL | 700 mA [5] |
| Remote I/O Adapter | 1771-AR | 900 mA |
| | -AE | 900 mA |
| DC (12-24V) Input | 1771-IB | 74 mA |
| DC (48V) Input | 1771-IC | 74 mA |
| DC (24-48V) Input | 1771-IH | 74 mA |
| AC/DC (120V) Input | 1771-IA | 74 mA |
| DC (12-24V) Output | 1771-OB | 165 mA |
| DC (48V) Output | 1771-OC | 165 mA |
| AC (120V) Output | 1771-OA | 210 mA |

[5] Typical

**Power Supply Connections** – As stated in the Introduction, the user must specify either the Cat. No. 1771-CE or -CD Power Cable, depending on his mounting arrangement. These Cables differ only in length.

Each Power Cable has two 9-pin plugs. Cable plugs are configured for connection to the correct sockets only. A label on each plug identifies its connection. Once connection is made, convenient snap-locks hold the Cable plugs securely in place.

There is a 9-pin socket on the lower left of the I/O Chassis backplane. (Refer to Figure 2.) The Cable plug labeled I/O RACK connects to this socket. To make this connection, the adapter module and left-most I/O module must be removed from the I/O Chassis. The Power Cable is run up

[1] The Auxiliary Power Supply can also be operated from a 24V DC source. (Refer to Application Note 1.)

[2] For information pertinent to the Bulletin 1774 Remote I/O PLC controller, refer to Application Note 3. For the Bulletin 1772 PLC-2 controller, refer to Application Note 4.

[3] The constant voltage transformer used must have filtering to remove high harmonic content and provide a sinusoidal output. For the Cat. No. 1771-P2 Auxiliary Power Supply, a power rating of 250 VA is recommended. Refer to Publication 1771-910 for more information.

[4] Current requirements for newly developed I/O modules will be indicated in appropriate product literature.

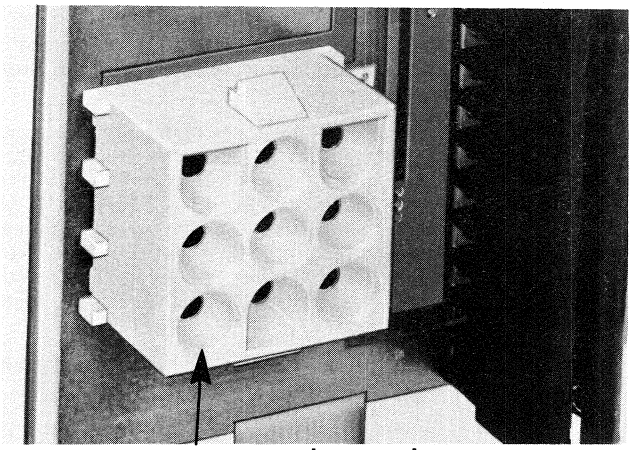



**Figure 2 — Chassis Backplane Socket**

through the bottom of the I/O Chassis so that it does not interfere with insertion of these modules.

The Cable plug labeled PWR SPLY connects to the 9-pin socket at the base of the supply. Figure 3 illustrates Power Cable connections.

**CAUTION:** Turn power OFF before insertion or removal of **any** module. Damage to module circuitry may occur if this rule is not followed.

## APPLICATION NOTES

1. The Cat. No. 1771-P2 Power Supply can be modified for operation from a 24V DC source. The DC source for the supply must be able to provide 3 amperes at between 20 and 32V DC. Consult factory for modification procedures necessary for 24V DC operation.

2. When mounted separately, the Auxiliary Power Supply may be mounted above or next to the Chassis, but **not** below it. This is necessary to allow convection cooling of the Supply and the I/O Rack. A minimum vertical distance of 7 inches should be maintained.

3. When used with the Bulletin 1774 Remote I/O PLC controller, the Auxiliary Power Supply, upon sensing a low-input-voltage condition, signals the Adapter Module (Cat. No. 1771-AR or -AE). This signal causes the Adapter Module to transmit one last full unit, or "byte," of data and then to stop transmission. The signal provides orderly I/O Rack shutdown, and aids in preventing invalid input data from being sent to the Processor.

   If jumpered for 120V AC operation, the Auxiliary Supply signals the Adapter Module if it detects line voltage below 92V for more than one half-cycle. This **minimum** rated voltage is 184V for 220/240V AC operation; for 24V DC use, this voltage is 20V.

   The PLC Processor interprets a termination of data transmission as a major fault at the I/O Rack. The response of the Remote I/O PLC controller to any major fault is determined by the type of Fault Zone programming which is used. Fault Zone programming reactions for Remote I/O PLC Processors are described in the Assembly and Installation manuals. These are Publication 1774-812 for Processors with Cat. No. 1774-RP3 and -RP4, or Publication 1774-803 for Processors with Cat. No. 1774-RP1 and -RP2.

   To restart communication between the I/O Rack and the Processor, the input voltage to the Auxiliary Supply must be restored to the **normal** range. The Supply will provide a reset signal to the Adapter Module once the normal voltage range is reached.

   No external reset of the I/O Rack is necessary if input line conditions caused a faulted I/O Rack condition.

4. When used with the Bulletin 1772 PLC-2 controller, the Auxiliary Power Supply maintains proper output voltage when input line voltage deviates slightly from the normal range.

   The System Power Supply Module (Cat. No. 1772-P1) monitors line voltage for the PLC-2 programmable controller. This Supply will stop the Processor from communication with its I/O Racks when line voltage drops below 92V. (Refer to User's Guide, PLC-2, Cat. No. 1772-UM.)

   If a faulted condition is caused by low input-line conditions, I/O Rack communication with the Processor

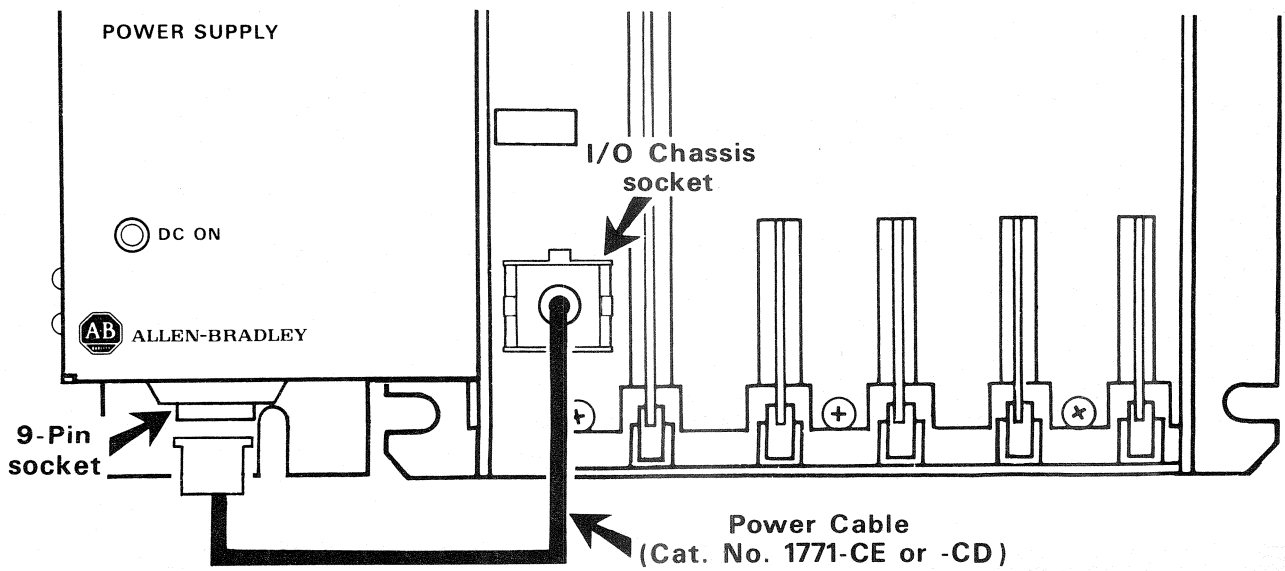



**Figure 3 — Power Cable Connections**

must be re-established once the Power Supply output returns to its normal level. To do this, the user must turn the Mode Select Switch on the Processor to the PROGRAM position, then back to RUN.

5. Several other power supplies can be used for the Bulletin 1771 I/O Rack, depending on the individual programmable controller. With the Bulletin 1772 PLC-2 controller, either the System Power Supply (Cat. No. 1772-P1) or the Auxiliary Power Supply (Cat. No. 1777-P2) can power Bulletin 1771 I/O Racks. These Power Supplies must be Series B or later. (Refer to Publication 1771-905.)

   With the Bulletin 1774 Remote I/O PLC controller, the Remote Power Supply (Cat. No. 1778-P2) can power Bulletin 1771 I/O Racks. A Local Power Supply (Cat. No. 1774-P1) can also be used for Bulletin 1771 I/O Racks. This Supply must be Series C or later. (Refer to Publication 1771-906.)

6. Prior to June, 1979, Power Supplies had been shipped with a 2-ampere fuse for both 120V and 220/240V operation. Later Supplies are shipped with an installed 1-ampere fuse for 120V operation and a separate 0.5-ampere fuse for 220/240V operation.

   This change in fuse rating is due to a re-evaluation of the Supply current requirement under load. These revised fuse values do **not** imply that the user of an existing Supply must replace the 2-ampere fuse with either the 1- or 0.5-ampere fuse. The 2-ampere rating is suitable for the fuse function—protection of the Supply from input overcurrent.

   Replacement fuses of the 2-ampere rating are not available from Allen-Bradley. However, for replacement purposes, users of these earlier units may order the optional Fuse Package (Cat. No. 1771-FP). The 1- or 0.5-ampere fuses in this Fuse Package are suitable replacements for any System Power Supply (Cat. No. 1771-P1) or Auxiliary Power Supply (Cat. No. 1771-P2) labeled 2 AMP SLOW-BLOW at the fuseholder.

   Use only the fuses in the Fuse Package with the proper rating for the input line voltage.

**Table B**
**REPLACEMENT FUSE LIST**

| INPUT VOLTAGE | FUSE | MANUFACTURER'S NO. |
|---|---|---|
| 120V AC | 3AG<br>1 amp | Bussmann: 3AG MDL 1A<br>Littelfuse: 313001 |
| 220/240V AC | 3AG<br>0.5 amp | Bussmann: 3AG MDL 0.5A<br>Littelfuse: 313.500 |

# AC LINE VOLTAGE STABILIZATION WITH CONSTANT VOLTAGE TRANSFORMERS

**1.0 General** – In some programmable controller installations, the input AC line may be especially "soft" or subject to unusual variation. To stabilize this input line voltage, a constant voltage transformer may be used. This Publication describes use of this type of transformer with Bulletin 1771 Power Supplies.

There are two Bulletin 1771 Power Supplies:

- System Power Supply (Cat. No. 1771-P1)
- Auxiliary Power Supply (Cat. No. 1771-P2)

The System Power Supply is the required power source for the Bulletin 1772 Mini-PLC-2 programmable controller. Its characteristics and use are described in Publication 1771-908.

The Auxiliary Power Supply is used to power a Bulletin 1771 I/O Rack. Thus, it is used in conjunction with either of these programmable controllers:

- Bulletin 1774 Remote I/O PLC
- Bulletin 1772 PLC-2

The Auxiliary Power Supply is described in Publication 1771-909.

Although these two Supplies differ in specific application, they are similar with respect to the AC input line power which they require. Thus, the recommendations of this Publication may be applied with using either Bulletin 1771 Power Supply with an Allen-Bradley programmable controller.

**2.0 Line Variation** – Downward line variation, as it concerns the programmable controller user, is a drop in AC line voltage below normal values. There may be several causes of line variation in an individual application. These causes include:

- Switching on of nearby heavy equipment, such as motors, pumps, welders, and air conditioning
- A "brown out" situation, in which line voltage is lowered by the power utility
- Accumulated line losses, due to distance from the generator source of power and poor contacts

The actual effect of line variation depends on the user's controlled process and equipment. In some applications, line voltage variations may cause inconvenient, time-consuming, and costly restart procedures. In other applications, line variation may have only a minimal effect on a controlled operation. Shutdown and restart of controlled equipment may cause little or no down-time in this instance.

The value of a constant voltage transformer, therefore, depends on the application. Its usefulness can be judged on these factors:

- Frequency of occurrence of line voltage variation
- Effect of line voltage variation upon the controlled process

**2.1 Power Supply Monitoring** – The Bulletin 1771 Power Supplies monitor AC line voltage for normal operating tolerances. The **normal** range of operation for 120V use is 98-132V AC. For 220/240V use, this range is 196-250V AC.

The Power Supply allows some margin for downward variation from the **normal** operating range. However, there is a **minimum** rated voltage of approximately 92V for 120V use, or approximately 184V for 220/240V use. When line voltage has dropped below normal range, to this minimum value, the Power Supplies signal this condition to the Mini-Processor (for the System Power Supply) or Adapter Module (for the Auxiliary Power Supply).

This signaling of input line variation is important to the controller for several reasons. A primary consideration is the validity of input device data. When the input AC line

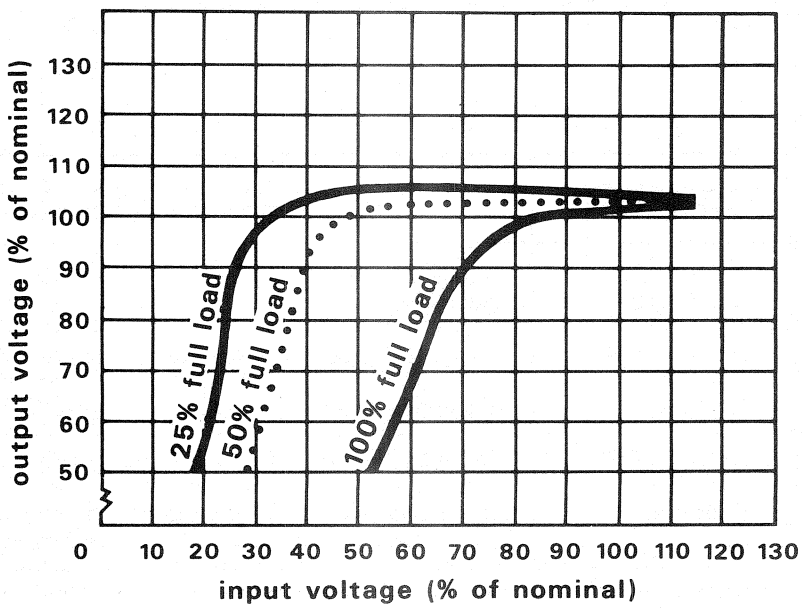



**Figure 1 – Sola CVS Output/Input Voltage Relationships (typical)**

voltage drops, the voltage at input module terminals may not reflect the true ON/OFF state of an input device. For example, closed limit switches fed from a "soft" AC line could appear to be open.

Downward variation of the input AC line also directly affects output device behavior. User-supplied power may not be sufficient to turn output devices ON from output modules. The controller memory, meanwhile, may represent these devices as being ON.

Because of these considerations, the programmable controller immediately suspends the operation of I/O modules when line loss is signaled. In doing this, the controller performs these functions:

- Stops writing input data into memory
- Turns off I/O Rack outputs

Because Bulletin 1771 Power Supplies are used with 3 different programmable controllers, the exact nature of line loss response varies between Processors. This response for each controller is listed in Table A.

For restart of I/O module operation, the user's input line must recover to the normal range: 98V for 120V AC use, 196V for 220/240V AC use.

**3.0 Constant Voltage Transformer** – A constant voltage transformer compensates, within specific limits, for voltage changes at its input, or primary, to maintain a steady voltage value at its output, or secondary. For example, when operated at less than rated load, the Sola CVS transformer can maintain approximately ±1% regulation when input voltages vary as much as ±15%. If the load on the transformer is very light, an exceptionally low input is sufficient to deliver full output voltages. A typical relationship of output to input voltage for a Sola CVS transformer under different loads is shown in Figure 1.

Note that the power supplied to a constant voltage transformer is the product of input current and voltage. Thus, as the input voltage to the transformer drops, the input current rises. Although the Sola CVS incorporates overload protection, it is not recommended practice to operate any transformer above its current rating for extended periods of time.

The response time of the constant voltage transformer is typically 25 msec. This means that substantial input (primary) changes are reflected at the output (secondary) approximately 1-1/2 cycles later. Thus, shutdown and restart, as signaled by the Power Supplies, will lag the actual AC line variation by this interval. However, this response time is a factor only on very poor feeder circuits. The problem should be corrected there.

**3.1 Connection** – When using a Sola CVS transformer, it is recommended that both the Bulletin 1771 Power Supply and all input devices be connected along the transformer secondary. (Refer to Figure 2.) This allows the input line monitoring of the Power Supplies to be used to the fullest advantage, as noted in Paragraph 2.1.

As Figure 2 shows, output devices are normally connected along the same AC line as the primary of the constant voltage transformer. If, in some cases, it is desirable to stabilize the voltage to one or more output devices, the devices may be connected through the transformer secondary. However, the transformer must have sufficient power rating for its load. (Refer to Paragraph 3.3.)

**3.2 Type** – The Sola CVS, Solatron series, or equivalent constant voltage transformers, are suitable for use with Bulletin 1771 Power Supplies.[1] These types of transformers incorporate line filtering which removes high harmonic content and provides a sinusoidal output. In addition, this filtering attenuates transients having a duration of 1 msec., or less.

However, other types of constant voltage transformers, such as the Sola CVN, are **not** recommended for this particular application. (Line filtering of high harmonics is not provided by transformers of this type.)

**3.3 Rating** – Constant voltage transformers are available with various power ratings in units of volt amperes (VA). When selecting a constant voltage transformer, the worst-case power requirement of the load must be considered. Depending on the type of load, this worst-case requirement may often exceed the nominal power rating of a given piece of electrical equipment.

Bulletin 1771 Power Supplies have an approximate power rating of 75 VA. To allow for the worst-case power requirement of these Supplies, it is recommended that the constant voltage transformer have at least **3 times** this rating. This allows ample power to be delivered to the Supply throughout the entire AC cycle. This also provides the necessary power for input devices. Thus, for most applications with Bulletin 1771 Power Supplies, a constant voltage transformer rated at 250 VA is sufficient.

However, where any **output** devices are connected through the transformer secondary, a higher rating may be needed. The user must determine the worst-case power requirement of these output devices and add this to the power rating required for the Supply.

Selected CVS transformers and their ratings are given in Table B.

---

[1] Sola Basic Industries
1717 Busse Road
Elk Grove Village, IL 60007

Table A

**CONTROLLER RESPONSE TO INPUT VOLTAGE DROP**

| POWER SUPPLY Cat. No. | PROGRAMMABLE CONTROLLER | CONTROLLER RESPONSE WHEN VOLTAGE DROP IS SIGNALED |
|---|---|---|
| 1771-P1 | Bulletin 1772 Mini-PLC-2 | Mini-Processor Module stops receiving input data and turns all outputs OFF. |
| 1771-P2 | Bulletin 1774 Remote I/O PLC | In the I/O Rack, the Remote I/O Adapter Module (Cat. No. 1771-AR) stops transmitting input data to the Processor. All outputs of the affected Remote I/O Rack are turned OFF. |
| | Bulletin 1772 PLC-2 (Local I/O) | In the I/O Rack, the PLC-2 I/O Adapter Module is not directly affected by voltage-drop detection. However, because this controller is a Local I/O system, the PLC-2 Processor itself stops communication with I/O modules upon low-voltage detection. |

Table B

**SELECTED SOLA CVS CONSTANT VOLTAGE TRANSFORMERS**

| SOLA Cat. No. | RATED LOAD (VA) |
|---|---|
| 23-22-125 | 250 |
| 23-22-150 | 500 |
| 23-25-175 | 750 |
| 23-25-210 | 1000 |
| 23-25-215 | 1500 |
| 23-25-220 | 2000 |

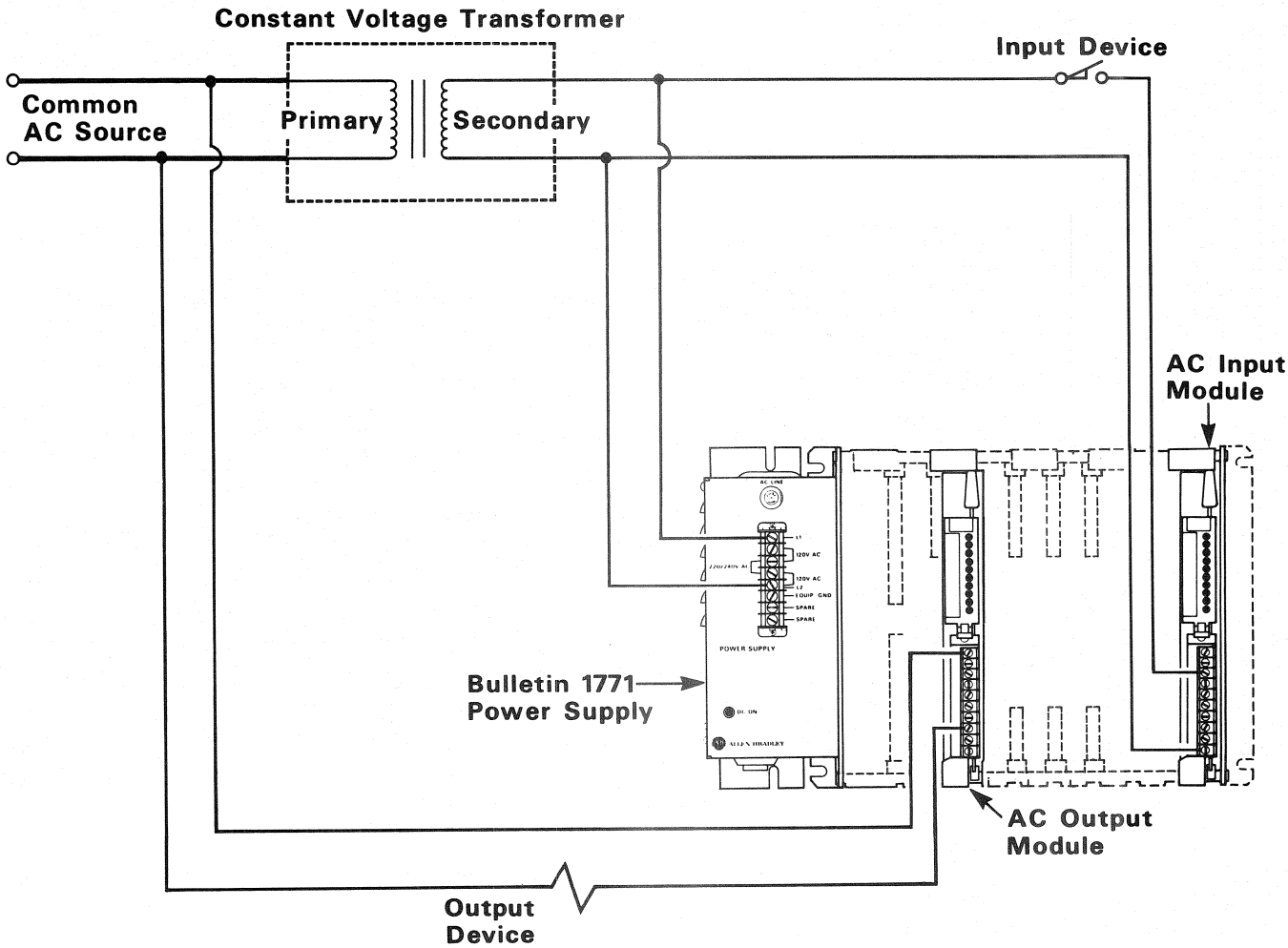
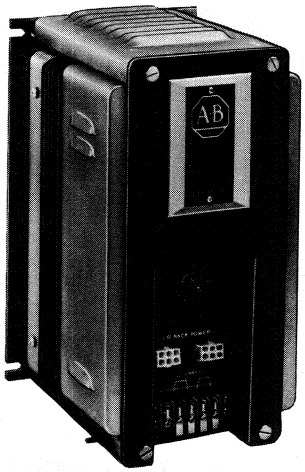



Figure 2 — Constant Voltage Transformer Connection (simplified)

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Cleveland, Ohio 44143

# POWER SUPPLIES
## Cat. No. 1772-P1 (Series B) and Cat. No. 1777-P2 (Series B)



**Auxiliary Power Supply**

**General** — The Series B System Power Supply Module (Cat. No. 1772-P1) is designed to provide all necessary DC voltages for proper controller operation. [1] It is capable of powering one PLC-2 Processor (Cat. No. 1772-LR, or -LP1) and Bulletin 1777 and/or Bulletin 1771 I/O Racks. Total I/O capacity, however, is limited both physically and electrically.

Physical limitation is provided by the two I/O power sockets; electrical limitation by circuitry capable of powering up to 128 I/O.

When connected to Bulletin 1777 I/O Racks, three **maximum** configurations are possible. These are:

- One Processor, two 32-I/O Racks
- One Processor, two 64-I/O Racks
- One Processor, one 32-I/O Rack, one 64-I/O Rack

When connected to Bulletin 1771 I/O Racks, four **maximum** configurations are possible. These are:

- One Processor, two 32-I/O Racks
- One Processor, two 64-I/O Racks
- One Processor, one 32-I/O Rack, one 64-I/O Rack
- One Processor, one 128-I/O Rack

Combinations of both Bulletin 1777 and 1771 I/O Racks are also possible, however, total I/O capacity can not exceed 128.

Installations in which the physical and/or electrical limitations of the System Power Supply Module have been exceeded require an additional power supply. The Auxiliary Power Supply (Cat. No. 1777-P2) is used in these installations. It contains the same circuitry as the System Power Supply Module, and is therefore capable of providing power to I/O Racks as outlined earlier. However, the Auxiliary Power Supply is entirely contained in its own enclosure and is not a module in the Processor Chassis as is the System Power Supply Module.

The System Power Supply Module differs from the Auxiliary Power Supply in several minor features. These differences are described in this Publication. Information common to both is discussed without distinction and referenced as "Power Supply."

### SPECIFICATIONS

**Input Voltage**
120V AC, 220/240V AC

**Input Voltage Range**
120V AC: 98 to 132V AC
220/240V AC: 196 to 250V AC

**Output Voltage**
+5.1, +12, -5.1V DC

**Input Power**
75VA

**System Power Supply Module Capability**
1 Processor and 2 I/O Racks

**Auxiliary Power Supply Capability**
2 I/O Racks

**Ambient Temperature Rating**
0° to 60°C (operational)
-40° to +85°C (storage)

**Humidity Rating**
5 to 95%
(without condensation)

**Location**
System Power Supply Module in Processor; Auxiliary Power Supply within 8 cable-feet max. of each I/O Rack.

**Dimensions (W x H x D)**
Auxiliary Power Supply
7.5 x 13.5 x 8.8 inch
19.1 x 34.3 x 22.4 cm.

**Weight**
System Power Supply Module
17 lbs. (7.7 kg.)
Auxiliary Power Supply
27.5 lbs. (12.5 kg.)

**Fuses**
2A/250V AC slow blow
0.5A in +12V DC circuit
0.25A in -5.1V DC circuit

**Input Voltage** — The Power Supply requires input from an AC source. Either 120V AC or 220V AC voltage is required. System operation from 120V AC continues uninterrupted when input voltage is within the range 98 to 132V AC. System operation based on 220V AC requires an input voltage between 196 and 250V AC.

In applications where the AC line is especially unstable and subject to unusual variations, a constant voltage transformer may be used to stabilize the input voltage to the Power Supply. A Sola CVS constant voltage transformer, or equivalent, can be used if unstable input voltage condi-

[1] Series B PLC-2 Power Supplies were introduced in April, 1979. Series B, and later, Power Supplies are modified for use with certain Bulletin 1771 I/O Modules.

**Publication 1772-902 — January, 1980**
Supersedes Publication 1772-902 — Dated September, 1977

tions exist. (Publication 1772-904, AC Line Voltage Stabilization, covers this topic in greater detail.)

The Power Supply monitors the input voltage for proper levels. Should the AC line voltage fall below the minimum rated voltage for more than one cycle, the DC output voltages to the PLC-2 Processor and the I/O Racks shut down. The Power Supply signals the Processor when AC line voltage drops to 92V. This allows the Processor to stop communication with the I/O Racks before signal levels are too low to transmit valid data. The Processor restarts when the correct AC level returns.

**AC Input Connections** – AC input connections are made to the terminals marked L1 and L2 on the Power Supply. L1 is the high side of the AC line; L2 the low side.

The Power Supply is factory jumpered for 120V AC operation. If 220V AC operation is desired, the user must connect the jumpers to terminals as shown in Figure 1.

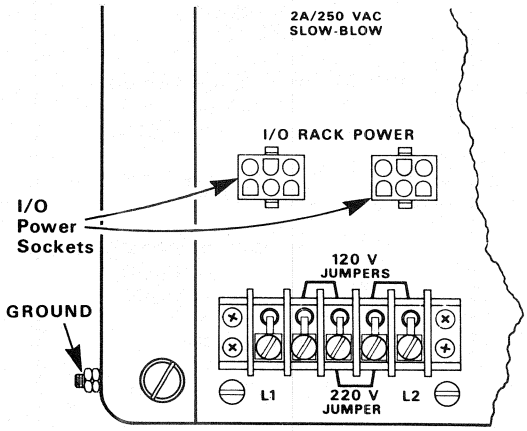



**Figure 1 – External Power Terminal Strip**

**Power Supply Outputs** – Output voltage and current from the Power Supply are monitored for overvoltage, undervoltage, and overcurrent conditions. An output power failure of the System Power Supply Module results in shutdown of the faulted circuit. This condition indicates a major fault and also shuts down the Processor. A major fault stops the Processor I/O scan and the execution of the program. An output power failure of the Auxiliary Power Supply generates a major I/O fault through the I/O Racks. Once the problem is corrected, the Auxiliary Power Supply resumes proper operation after the Mode Select Switch (Keylock) is turned to the PROGRAM position.

**Power Supply Connections** – Two sockets labeled I/O RACK POWER are provided on the face of the Power Supply for connection to I/O Racks. These sockets are keyed to guard against improper connection (Figure 1).

The 8-foot Power Cable (Cat. No. 1777-AC) or the 3-foot Power Cable (Cat. No. 1777-AD) connects each socket to another socket on the Bulletin 1777 I/O Racks. The Power Cable socket is located at the top left-hand side of these I/O Racks.

If the Power Supply is used to provide power to Bulletin 1771 I/O Racks, different cables are required. The 8-foot Power Cable (Cat. No. 1771-CJ) or the 3-foot Power Cable (Cat. No. 1771-CK) is used in this configuration.

An internal connection must be made between the System Power Supply Module and the PLC-2 Processor. A cable extends from the System Power Supply Module (Figure 2). Connect this cable to the socket provided on the Processor motherboard. The two sockets mate with the proper orientation.

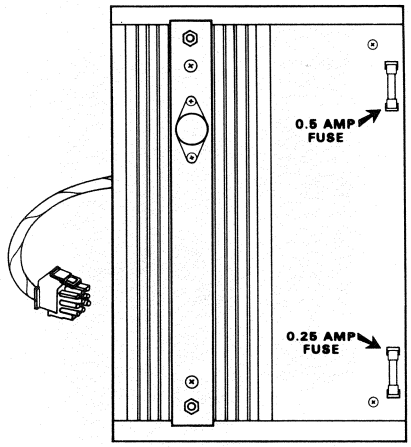



**Figure 2 – System Power Supply Module (Cat. No. 1772-P1) Fuse Locations**

**WARNING:** Input power must be removed from the System Power Supply Module before attempting to service or replace it. Failure to observe this warning may result in personal and/or property damage.

**Ground Terminal** – A lug is provided on the left side of the Power Supply for equipment grounding.

**Fuse Protection** – The input voltage to the Power Supply is fuse protected. This fuse is a 2 ampere slow-blow glass tube fuse, and is serviced at the Power Supply front panel. Fuse protection is also provided to protect against overcurrent conditions on both the +12V DC and -5.1V DC circuitry. These fuses are accessed by removing the fuse access cover. The fuse for the +12V circuit is a 0.5 ampere fuse located along the front of the circuit board near the top (Figure 2). The fuse for the -5.1V supply is a 0.25 ampere fuse located at the bottom of the circuit board near the front (Figure 2).

**CAUTION:** Do not connect I/O Racks to the System Power Supply or Auxiliary Power Supply if the sum total of their I/O capacity exceeds 128. Overcurrent conditions which might result present potential hazard to the Power Supply. Protective circuitry is designed to shut down the Supply when current ratings are exceeded.

Fuses are specified in Table A. Equivalent fuses may be used.

**Table A**

**PLC-2 POWER SUPPLY FUSES [1]**

| Fusing Current amperes | Bussmann [2] | Littelfuse [2] |
|---|---|---|
| 2.0 Slow Blow | 125V MDL | 313002 3AG 2 Amp |
| 0.5 | 250V AGC | 312.500 3AG 1/2 Amp |
| 0.25 | 250V AGC | 312.250 3AG 1/4 Amp |

[1] Replacement fuse packages are available from Allen-Bradley. See Price Sheet Publication 1772-47, or order Cat. No. 1772-FP.

[2] Or Equivalent.

# AC LINE VOLTAGE STABILIZATION WITH CONSTANT VOLTAGE TRANSFORMERS

In applications where the AC power line is especially "soft" and subject to unusual variations, a constant voltage transformer may be used to stabilize the AC power supplying the System Power Supply Module (Cat. No. 1772-P1) and the Auxiliary Power Supply (Cat. No. 1777-P2), if used, and the PLC-2 system's inputs.

The electronic circuitry of both the System Power Supply Module and the Auxiliary Power Supply is identical. Discussions common to both refer to the "Power Supply." When necessary the proper distinctions are made.

The PLC-2 Power Supply is designed to automatically shut down the Processor when the AC line voltage to it drops below approximately 98 volts or goes off completely. (The exact voltage depends, in part, on the Power Supply load.) This provides for an orderly shutdown of the PLC-2 system. It also provides that only valid data is entered into the PLC-2 memory during this unstable period. (Closed limit switches fed from a "soft" AC line could appear to be open. Thus input data would not necessarily reflect the actual status of these devices.)

The Power Supply automatically restarts the Processor when AC line voltage is approximately 98 volts. (Again, the exact voltage is dependent on Power Supply loading.)

The Sola CVS, "standard sinusoidal," the Solatron series, or equivalent constant voltage transformers are suitable for use with a PLC-2 system. (See Note 1.) However, constant voltage transformers such as the Sola CVN, "normal harmonic," transformers are not suitable because of the high harmonic content of their output waveform. The Sola CVS incorporates line filtering which attenuates transients having durations of 1 msec., or less. The Sola CVN has no filtering network.

When using a Sola CVS transformer (of sufficient rating), it is recommended that the transformer be connected on the AC line supplying the System Power Supply Module and the Auxiliary Power Supply, if used, and to all inputs on the I/O Racks. It is strongly recommended that PLC-2 controlled output devices draw power from the same AC line as the CVS transformer, but their connection on the line should be made before the transformer.

When the Sola CVS is operated at less than rated load, it is rated to maintain approximately ±1% regulation over a wide range of input line voltage variations. If the load is very light, an exceptionally low input voltage is sufficient to deliver the full output voltage. The operating ranges for a typical PLC-2 system consisting of two Power Supplies, one Processor and four 64-I/O Racks with a constant voltage transformer operated at approximately 35% of rated load are shown in Figure 1.

1 Sola Basic Industries 1717 Busse Road Elk Grove Village, IL 60007

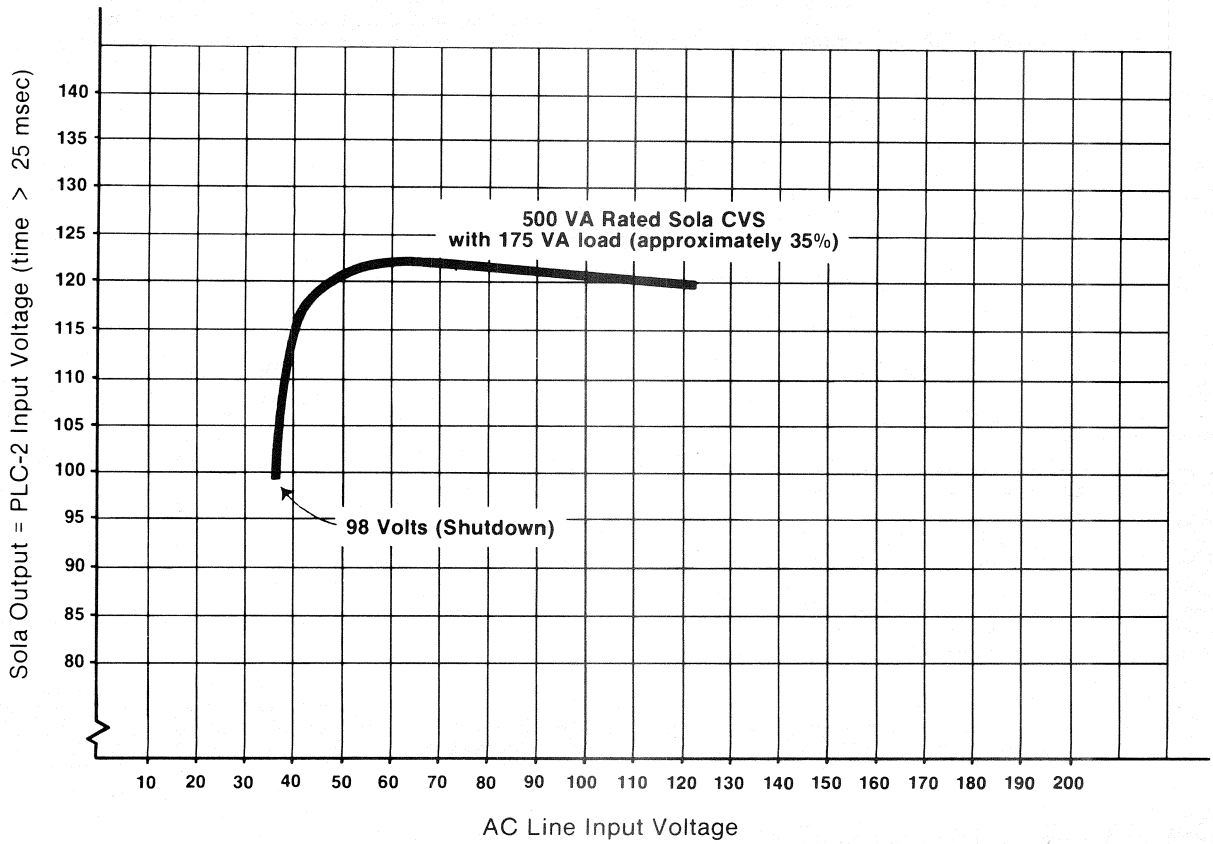



**Figure 1 — Reduced-Load Operating Range**

The relationship between the input and output voltages for a Sola CVS along with the lower limit of operation of a PLC-2 system are shown in Figure 2. Note that this constant voltage transformer, when operated at full load, permits the PLC-2 to operate normally even if line voltage drops to approximately 65% of its nominal value. A transformer operated at 50% of full load permits PLC-2 operation when the line voltage drops to 38% of its nominal value. A transformer operated at 25% of full load permits PLC-2 operation when the line voltage drops to 25% of its nominal value.

**CAUTION:** The power supplied to the PLC-2 system is the same, regardless of the input voltage to the transformer. As the input voltage to the transformer drops, the input current rises. Operating a constant voltage transformer for **extended** periods of time at low voltage will cause excessive heating and eventual destruction of the CV transformer.

Maximum power consumption for PLC-2 Power Supplies is shown in Table A. Actual power consumption may differ among systems. This difference depends on the magnitude of the load placed on each Power Supply by I/O Racks and the Processor. It is the user's responsibility to determine the power consumption of the inputs based on individual systems.

Exact power consumption values can be obtained from measurements on an operating PLC-2 system. Such measurements should be taken over the entire machine or process cycle to establish maximum values. After comparing these values to those in Table B, selection of an adequate transformer should be based on the desired regulation. The smaller the Power Supply's load (compared to the transformer nameplate rating) the better the regulation.

Ratings of selected Sola CVS constant voltage transformers are listed in Table B.

The 25 msec. response time for the constant voltage transformer limits its uses as a voltage regulator. If the output voltage of the transformer drops below approximately 98 volts for more than 12 msec., the Power Supply shuts down the Processor. The Power Supply restarts the Processor when the input voltage is approximately 98 volts. However, the Power Supply must go through its normal restart procedure.

The response time of the constant voltage transformer is a factor only on very poor feeder circuits. The problem should be corrected there.

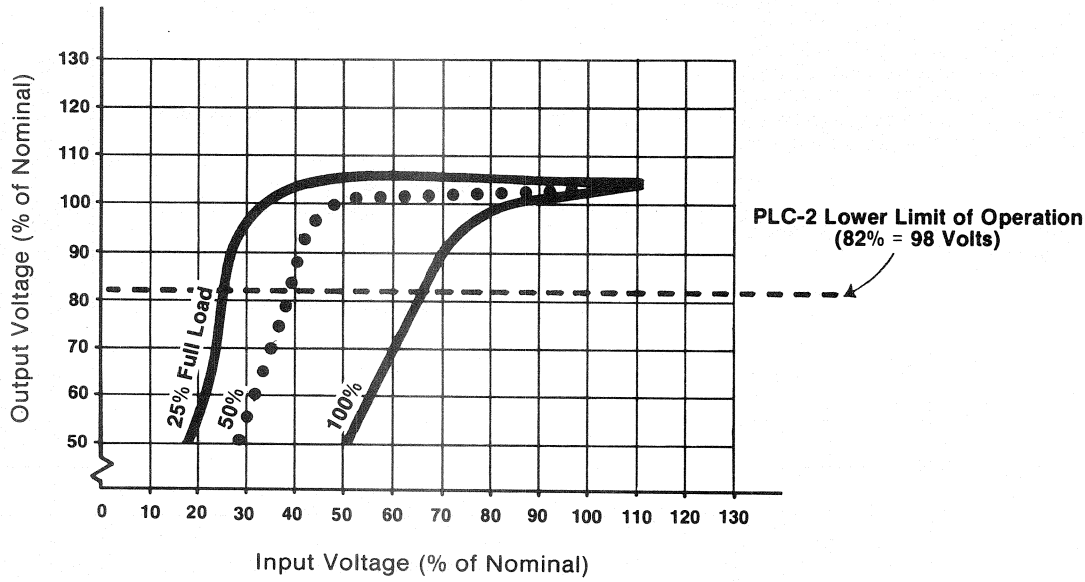



**Figure 2 — I/O Voltage Relationships with Sola CVS**

**TABLE A**
**Maximum Power Consumption for Power Supplies**

| Unit | VA* |
|---|---|
| System Power Supply Module | 85 |
| Auxiliary Power Supply** | 85 |

*Figures are approximate.

**When the Auxiliary Power Supply powers 2 I/O Racks, the maximum power consumption (85VA) is not reached, although it is available.

**TABLE B**
**Selected Sola CVS Constant Voltage Transformers**

| Sola Cat. No. | Rated Load (VA) |
|---|---|
| 23-22-125 | 250* |
| 23-22-150 | 500 |
| 23-22-175 | 750 |
| 23-22-210 | 1000 |
| 23-22-215 | 1500 |
| 23-22-220 | 2000 |

*Suitable for 1 System Power Supply Module and 1 Auxiliary Power Supply. This load draws less than 68% rated current.

A-B QUALITY
ALLEN-BRADLEY
Cleveland, Ohio 44143

# ALLEN-BRADLEY POWER SUPPLY ASSEMBLY

## Cat. No. 1772-PA and -PAA




### SPECIFICATIONS

**Nominal Input Voltage**
120V AC (1770-P3)
220/240V AC (1770-P3A)

**Input Voltage Range**
105 - 125V AC (120V)
205 - 250V AC (220V)

**Frequency Range**
50 - 400 Hz

**Output Voltage**
+25.5V DC (regulated)

**Output Voltage Tolerance**
±2.0%

**Output Current**
75 ma

**Dimensions (WHD) inches (cm)**
2.7 x 4.0 x 1.4
(6.9) x (10.2) x (3.7)

**Weight**
2 lbs. (0.9 kg)

**Programming Temperature**
20° to 30° C

### DESCRIPTION

The Power Supply Assembly (Cat. No. 1772-PA or -PAA) provides a regulated +25.5V DC output that is needed to power the optional on-board EPROM (Erasable Programmable Read Only Memory) programming function of the Mini-PLC-2/15 Processor (Cat. No. 1772-LV). The Power Supply Assembly provides sufficient output current to initiate and maintain the EPROM programming function.

The Cat. No. 1772-PA Power Supply Assembly consists of:

- One 25.5V DC Power Supply (Cat. No. 1770-P3) configured for 120V AC operation (Figure 1)
- One 6-foot Power Supply Cable (Cat. No. 1772-CA) (Figure 2)

The Cat. No. 1772-PAA Power Supply Assembly consists of:

- One 25.5V DC Power Supply (Cat. No. 1770-P3A) configured for 220V AC operation
- One 6-foot Power Supply Cable (Cat. No. 1772-CA)

### ASSEMBLY

Plug the Molex connector of the Power Supply Cable into the Molex connector on the 25.5V DC Power Supply (Figure 3). After this procedure has been completed, the Power Supply Assembly is ready to be used to program a blank EPROM installed in a Mini-PLC-2/15 Processor.

For detailed information on EPROM programming refer to "EPROM Programming With a Mini-PLC-2/15 Processor", Publication 1770-915, or the "Mini-PLC-2/15 Programmable Controller Programming and Operations Manual", Publication 1772-804.

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Publication 1772-917 — February, 1981

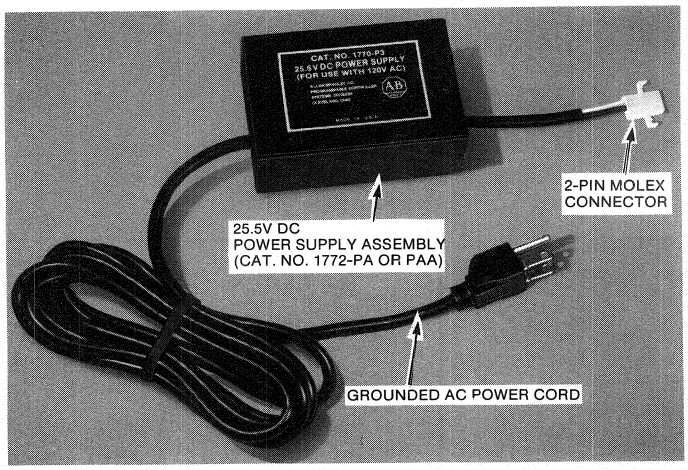



**FIGURE 1 — Power Supply**

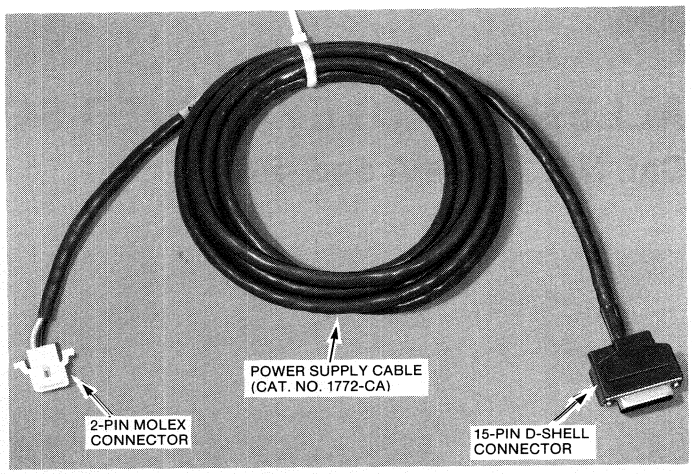



**FIGURE 2 — Power Cable**

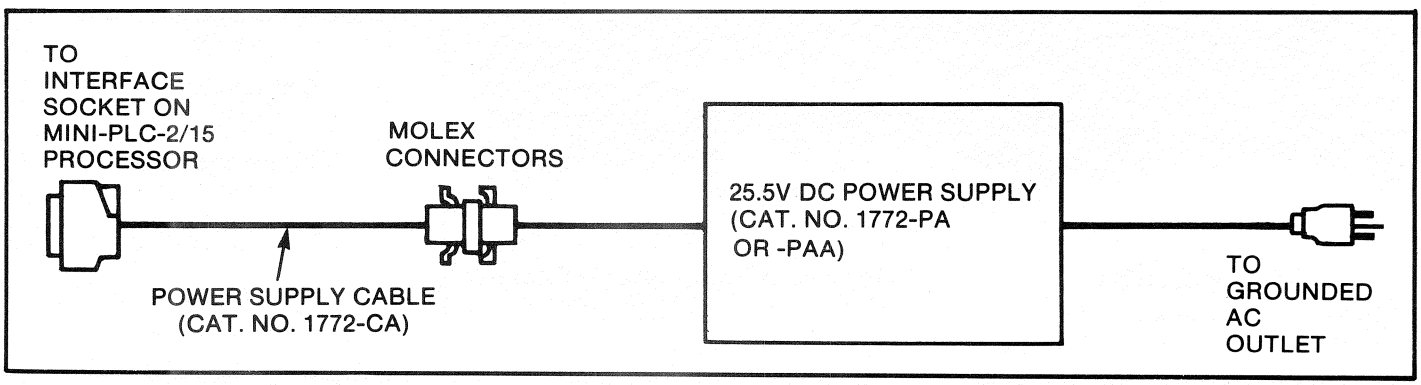



**FIGURE 3 — Power Supply Assembly**

ALLEN-BRADLEY

Systems Division-PC Business
747 Alpha Drive, Cleveland, Ohio 44143

P/N 955090-78

## 4.2 PROGRAMMING TERMINALS AND PERIPHERAL DEVICES

1770-900 Digital Cassette Recorder
1770-902 Silent 700 Data Terminals
1770-904 Industrial Terminal Systems

# DIGITAL CASSETTE RECORDER
## (Cat. No. 1770-SA)




### INTRODUCTION

The Digital Cassette Recorder (Cat. No. 1770-SA) is a portable, light-weight recording device which may be used to load user programs into, or to record the contents of, memories of Allen-Bradley control system products, including:

- Bulletin 1774, PLC
- Bulletin 1772, PLC-2
- Bulletin 1750, PMC
- Bulletin 1755, Mini-PMC

The Recorder is also capable of carrying on a verification process after the load or record operations. (Refer to Figure 1.)

The Digital Cassette Recorder, ordered under Cat. No. 1770-SA, consists of the following items:

- Recorder in carrying case
- 1 AC power cord
- 1 Cassette Tape (Cat. No. 1770-XA)
- User's Guide Digital Cassette Recorder (Publication 1770-800)

NOTE: There are three standard Interconnect Cables currently available for use with the Recorder. The user must specify and order one, as determined by the control system used in conjunction with the Recorder. (Refer to

[1] The Cat. No. 1770-SA was introduced in February, 1978, as a direct replacement for the Cat. No. 1774-T2 Digital Cassette Recorder System, which ceased to be manufactured. Note also that in March, 1978, the Cassette Tape Cat. No. was changed to 1770-XA from 1774-TP

### SPECIFICATIONS [2]

**Power Requirements**
120V AC (±10%)
60/50 Hz

**Baud Rate**
1200 Baud

**Data Format**
8-bit binary, serial
plus 1 start bit and 1 stop bit per character

**I/O Interface**
EIA RS-232-C

**Transmission Mode**
Full-Duplex, Asynchronous
Bit Serial

**Tape Bit Error Rate** [3]
Less than 1 "intermittent" error in $10^7$ bits
Less than 1 "unrecoverable" error in $10^8$ bits

**Tape Recording Density**
92,000 8-bit characters
on 1 track of 300-ft. tape

**Recording Heads**
Dual gap, single track,
Read/write with
separate erase head

**Cassette Type**
Cat. No. 1770-XA
or equivalent: standard
Philips-type digital cassette
with head pressure pad;
computer grade magnetic
tape certified at 1600 FCI
(flux changes per inch)

**Size**
6" x 14" x 18"
15.3 cm x 35.6 cm x 45.8 cm
(H x D x W)

**Weight**
19 lbs. (8.6 kg)

**Operating Temperature Range**
+10°C to +50°C

**Storage Temperature Range**
-40°C to +70°C

**Humidity Range**
5 to 95% R.H.
(without condensation)

**Fuse**
1A, slo blo 3AG
Bussmann MDL or equivalent

[2] Refers only to models made for Allen-Bradley.

[3] When used in Recorder.

Table A for proper Catalog Numbers. Also, additional Cassette Tapes, Cat. No. 1770-XA, may be ordered separately.)

**Table A** [1]
**AVAILABLE INTERCONNECT CABLES**

| TITLE | Cat. No. | PC SYSTEM |
|---|---|---|
| Cassette Recorder Interconnect Cable | 1774-TD | Bulletin 1774 PLC |
| Digital Cassette Recorder Cable | 1772-TH | Bulletin 1772 PLC-2 |
| Cassette Tape Cable | 1750-TD | Bulletin 1750 PMC<br>Bulletin 1755 MiniPMC |

[1] One must be ordered separately and specified by user when ordering Digital Cassette Recorder.

The Recorder is considered a bulk storage device which accesses the contents of a magnetic tape in a sequential manner. The speed of transmission is fixed at 1200 baud, or 120 "characters" per second. The effective speed of operation with a control system is 60 "words" per second. (Each "word" contains 2 "characters," and each character is composed of 1 start bit, 8 data bits, 1 stop bit.)

## DESCRIPTION

Push buttons on the Recorder control panel allow for manual activation of 4 functions. (Refer to Figure 1.) These are:

- RECORD ON TAPE
- REWIND
- STOP
- READ FROM TAPE

There is also a REMOTE CONTROL push button that is currently not used with control systems noted in the first paragraph of this Publication.

Individual status indicators provide visual confirmation that certain functions are active and the state of the record/read process. (Refer to Figure 1.) These are:

- POWER ON
- RECORD PROTECT
- RECORD ON TAPE
- RECORD FROM TAPE
- DATA IN
- DATA OUT
- REMOTE CONTROL

**Cassette Tape** – Allen-Bradley makes available a Cassette Tape (Cat. No. 1770-XA [2] ) which is certified for use in digital cassette recording applications. (Refer to Figure 2.) One track (side) of a Tape has the storage capacity of 92,000 8-bit characters, which is more than adequate for a 12K control program and Data Table.

Equivalent types are acceptable, providing they are certified for digital cassette recording applications.

**CAUTION:** Do not use tapes of less quality than that specified here. Improper data transfer may result.

**Purpose of Recording** – Recording is defined as producing a copy of the contents of a memory. The reasons for recording a user program are many:

- Provide a dependable back-up in case the program in memory is inadvertently cleared or altered, or in case a memory must be physically replaced.
- Allow for off-line storage of a number of different programs which may be loaded into the memory when production requirements demand quick change.

[2] This item was formerly given Cat. No. 1774-TP.

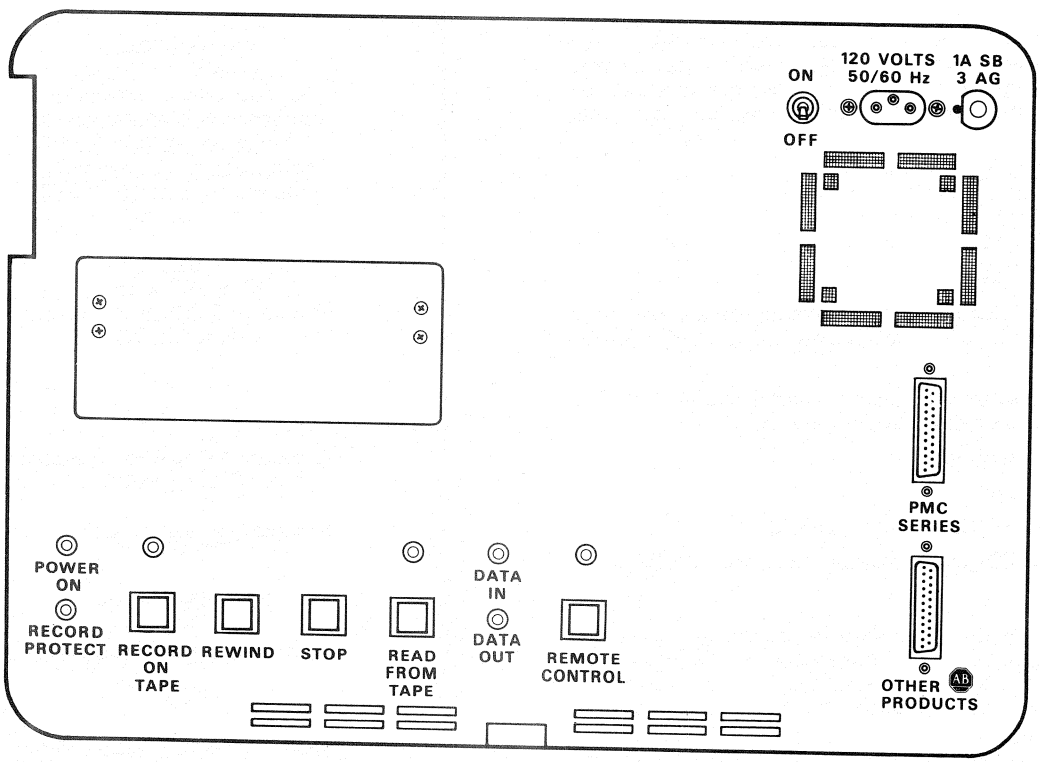



Figure 1 – Control Panel, Digital Cassette Recorder



**Figure 2 — Cassette Tape**

- Provide a "source," or valid record, when installation requirements necessitate temporary modifications to the basic program.
- Allow for transferring of a program to a user-supplied computer so that the program, in conjunction with a Translator Package (PLC, PLC-2 or PMC), may be generated in hardcopy ladder diagram format **with** user device designations immediately above the elements.
- Allow for storage of programs developed off-line on demonstration equipment.
- Allow for user-developed diagnostic programs to be available for immediate use.
- Allow for the free exchange of programs among installations which may be widely separated geographically, but where applications are identical.

**Purpose of Loading** — User programs and Data Tables may be loaded into a read/write memory of Allen-Bradley controller systems. With the Digital Cassette Recorder, this process may be done quickly any number of times. Identical programs may be loaded into any number of processors which control machines designed to operate in the same manner.

Also, as the result of the "verification" feature built into the controller systems, the contents of memory can be compared to the data on the tape in order to determine that variations exist. This information may be used as the basis of troubleshooting or debugging.

**Importance of Verification** — Emphasis is placed on the importance of verifying programs. This is a necessity, and it is the user's responsibility to carry out the process after recording **or** loading. Since data is transferred from one unit to another, incorrect transmissions may be created. Also, although the specified tape, used in conjunction with the Recorder, has an exceptionally low probability rate of error, the possibility must be anticipated.

**Additional Documentation** — The User's Guide, Digital Cassette Recorder (Publication 1770-800) is supplied as standard with each Recorder. Special operating procedures for each Allen-Bradley programmable controller are described in it. The Manual also contains a maintenance section.

## COMPATIBILITY

The Digital Cassette Tape Recorder (Cat. No. 1770-SA) is compatible with all Allen-Bradley controller systems, as specified in the first paragraph of this Publication. It is also functionally compatible with all Bulletin 1774 PLC Processors whatever Cat. No. and with Series 7300 and 7100 numerical controllers. It is also compatible with existing Program Panel Interface Modules having Cat. No. 1774-TB, -TB2, -TL. However, individual differences exist in areas controlled by the Modules. Thus certain procedures or displays may vary to a small degree. These are completely described in the User's Guide.

## APPLICATION NOTES

1. When the Digital Cassette Recorder is used with various control systems there may be a need for other optional equipment. For example, when the Recorder is used with the Bulletin 1774 PLC controller, it is necessary to have a Program Panel Interface Module (Cat. No. 1774-TB, -TB2 or -TL) in the Processor. With the Bulletin 1750 PMC and Bulletin 1755 Mini-PMC, it is necessary to also use a Program Loader (Cat. No. 1750-GA).
2. A user program should contain an END (of Program) statement after the last instruction. (Refer to the User's Guide for details.)
3. Users should verify all programs loaded into a memory or recorded from a memory.
4. To assure proper operation, always rewind the Cassette Tape after each operation.
5. The recommended Cassette Tape (Cat. No. 1770-XA) contains Recording Tabs which provide a "record protect" feature. When used, a tape may be protected from being accidentally over-written.
6. Equivalent digital tapes may be used. Specify a standard Philips type digital cassette with head pressure pad. It must be certified for digital cassette applications.
7. One track (side) is capable of storing 92,000 8-bit characters which is in excess of 36K words, and is thus large enough for the maximum user program and Data Table currently usable.
8. Users are encouraged to record the latest program considered acceptable or valid. Each time the memory is modified, a new record should be made. All previous recordings should be erased or over-written to avoid later confusion.
9. Cables from individual programmable controllers must be connected to proper sockets (ports) on the Digital Cassette Recorder. Follow Table B.

**Table B**
**CABLE-SOCKET RELATIONS**

| PROGRAMMABLE CONTROLLER | SOCKET/PORT |
|---|---|
| Bulletin 1774 PLC | OTHER A-B PRODUCTS |
| Bulletin 1772 PLC-2 | OTHER A-B PRODUCTS |
| Bulletin 1750 PMC | PMC SERIES |
| Bulletin 1755 MiniPMC | PMC SERIES |

## RECORD PROTECT FEATURE

The Cassette Tape (Cat. No. 1770-XA) offered by Allen-Bradley and manufactured by Information Terminals contains a "record protect feature." Each Cassette Tape contains two built-in Recording Tabs on the rear spine of the plastic case. (Refer to Figure 3.) Each lever has 2 positions:

- YES WRITE, which allows recording
- NO WRITE, which blocks recording

The positions are marked on the white name tag. However they may be also easily distinguished on the basis of being able to see a square hole in the lever bed. When the hole is covered, recording on the tape may be effected. When the hole is visible, data recording is not possible. Thus a program may be protected from inadvertent over-writing. Programs, however, may be read from the tape even in the NO WRITE position.

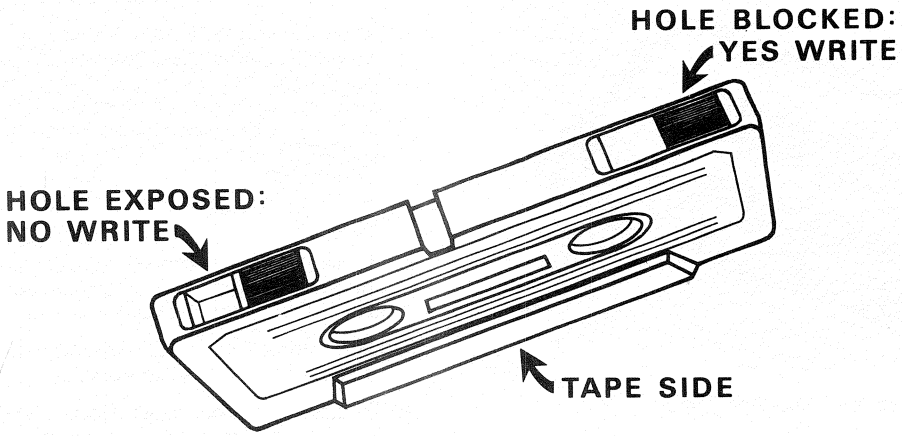



**Figure 3 — Recording Tabs**

The file protect feature is considered a valuable aid for dependable storage of user programs.

Two recording tracks are available on the face of the tape. A user can record on Track A, flip the cassette, and record on the Track B. One of the two Recording Tabs corresponds to one of the tracks. Thus one or both tracks may be protected on a given tape.

# SILENT 700 DATA TERMINALS



**General** – The Silent 700 Data Terminals, Model 743 KSR (Keyboard Send/Receive) and Model 745 can interface with Allen-Bradley programmable controllers, including:

- Bulletin 1774, PLC
- Bulletin 1772, PLC-2
- Bulletin 1772, Mini-PLC-2

The Silent 700 Data Terminals use ASCII code. The communications rate is switch-selectable for 110 or 300 baud (10 or 30 characters-per-second, respectively). Characters are printed by a thermal printhead on special heat-sensitive paper.

The Silent 700 Data Terminals are manufactured by Texas Instruments, Inc. [1] However, the Model 743 KSR data terminal may also be purchased through Allen-Bradley, Systems Division.

**Cat. No. 1770-HA** – The Model 743 KSR is available through Allen-Bradley, Systems Division, under Cat. No. 1770-HA. When this data terminal is shipped, the following items are included:

- 1 Model 743 KSR data terminal
- 1 cable for RS-232-C interface (Vendor P/N 983848)
- 1 roll of thermal paper
- 1 instruction manual
- 1 portable carrying case
- A 1-year maintenance service agreement by the manufacturer

Necessary maintenance and repair of the Model 743 KSR is handled through Texas Instruments, Inc. Information on local field service offices is included with the data terminal.

If repair of the Model 743 KSR becomes necessary, the 1-year maintenance agreement covers the cost of labor, material and serviceman's travel within 100 miles of a Texas Instruments Service Center.

## SPECIFICATIONS

**Function**
Produce hard-copy of user program
Produce hard-copy of application data

**Silent 700 Model**
Model 743 KSR or Model 745

**Interface**
E.I.A. RS-232-C

**Transmission Rate**
110 baud or 300 baud

**Code**
ASCII
11-unit code for 110 baud
10-unit code for 300 baud

**Parity**
Even (standard)

**Power Source**
120V AC

**Line Length**
80 characters

**Temperature**
Operating: 10°C to 40°C
Storage with Paper: -30°C to 40°C
Storage without Paper: -30°C to 70°C

**Dimensions**
4.25 x 14.6 x 15.25 inches (HWD)

**Weight**
11.2 pounds (with paper)

Additional thermal paper is **not** available through Allen-Bradley, Systems Division, but must be ordered from the manufacturer.

**Uses** – Silent 700 Models 743 and 745 can be used with PLC and PLC-2 programmable controllers to:

- Produce a printout of the user's PLC or PLC-2 program. This printout shows the program in ladder diagram form. (A hard-copy of the PLC program may aid the user in troubleshooting and program documentation.
- Produce a hard-copy of selected messages or information from the user's PLC program when using the optional Data Handling Module (Cat. No. 1774-DH2 or -DH). Silent 700 data terminals can be used to print production summaries, operation status reports, and messages for operator communication.

[1] Texas Instruments, Inc.
Digital Systems Division
Houston, TX 77001

**Publication 1770-902 – October, 1978**
Supersedes Publication 1770-902 – Dated May, 1978

**Interfacing** – Circuitry for the interfacing of the Silent 700 data terminals with the Bulletin 1774 PLC programmable controller is contained on the Program Panel Interface Module (Cat. No. 1774-TB2, -TB, or -TL). If the PLC Program Panel (Cat. No. 1774-TA) is connected to this Module, Silent 700 connection is made at the rear of the Program Panel. The 110-baud rate is used with this connection.

The Silent 700 data terminal can also be connected directly to the PLC Program Panel Interface Module with the Direct Data Terminal Cable (Cat. No. 1774-TG). Using this connection either the 110- or 300-baud rate can be used.

To interface with the Bulletin 1772 PLC-2 programmable controller, Silent 700 data terminal connection can be made either to the PLC-2 Program Panel or to the PLC-2 Program Panel Adapter. Either the 110- or 300-baud rate can be used.

In order to interface with either the PLC or PLC-2 controller, the Silent 700 data terminal must be equipped with an RS-232-C compatible interface. With Model 743, the user should specify the RS-232-C interface with Bell 103A cable (P/N 983848). This cable terminates in a 25-pin connector which provides proper connection for the PLC and PLC-2 controllers.

With the Model 745, the user must specify the Auxiliary EIA Interface Cable Kit (P/N 983856).

The modem is a standard feature of the Model 745. It is an option with the Model 743. Although the individual user may have many other applications for the modem, it is not required for interfacing with the PLC or PLC-2 controllers. [1]

**Documentation** – The following is a list of Publications which describe the use of the Silent 700 Data Terminals with the PLC and PLC-2 programmable controllers. Sections of the first two documents present generalized discussion of Silent 700 use. The other four documents refer to specific uses of these data terminals with PLC controllers.

- Publication 1774-809, Peripheral Data Terminals (for PLC only)
- Publication 1772-800, User's Manual, Bulletin 1772, PLC-2
- Publication 1774-816, User's Guide, Data Handling Module (Cat. No. 1774-DH2, Series B)
- Publication 1774-814, User's Guide, Protected Logic Module (Cat. No. 1774-DL2, Series B)
- Publication 1774-807, User's Manual, Data Handling Module (Cat. No. 1774-DH)
- Publication 1774-806, User's Manual, Protected Logic Module (Cat. No. 1774-DL)

## APPLICATION NOTES

1. The Direct Data Terminal Cable (Cat. No. 1774-TG) is factory-wired for a 110-baud rate. It can be modified for 300 baud, as described in Publication 1774-920.
2. The HIGH speed setting on the Silent 700 terminal refers to the 300-baud rate. The LO speed setting refers to the 110-baud rate. The Silent 700 data terminal will operate on-line only if the baud rate of the Direct Data Terminal Cable matches the rate selected on the data terminal.
3. Any Bulletin 1774 PLC program used with the Silent 700 data terminal should have an END (of program) statement.
4. To use the Silent 700 with the Bulletin 1774 PLC Data Handling Interconnect Cable (Cat. No. 1774-**DC**), some modification of the Cable may be necessary. In order to determine if an individual Cable is to be modified, the Series level is to be identified.

   The A-B part number 634757-01 is stamped on the side of the 41-pin connector of all Cables. If this number is followed by the letter B, **no** modification is necessary. However, to use the earlier version of this Cable with the Silent 700, pin No. 8 must be jumpered to pin No. 20 at the 25-pin connector of the Data Handling Cable. An earlier version may be identified since it has **no** alphabetical letter following the part number.

   Note that this jumper is **not** necessary when using the Cat. No. 1774-**DC2** Data Handling Interconnect Cable or Direct Data Terminal Cable (Cat. No. 1774-TG).
5. The user may make an optional cable to extend the distance between the PLC Processor and Silent 700 beyond the standard length of the Direct Data Terminal Cable or Data Handling Cable. Necessary wiring connections for this extension may be found in these Publications:

   - User's Guide, Data Handling Module (Cat. No. 1774-**DH2**, Series B), Publication 1774-816.
   - User's Guide, Data Handling Module (Cat. No. 1774-**DH**), Publication 1774-807, Figure 7.

   To use the Silent 700 Data Terminal with this extension, pin No. 8 must be jumpered to pin No. 20 in the user's cable.

   Fifty feet (including the 10-foot standard Cable) is the **maximum** distance this type of connection allows between the PLC programmable controller and the Silent 700 data terminal. For distances of up to 5000 feet, the optional Line Driver/Receiver System (Cat. No. 1774-D2) can be used.

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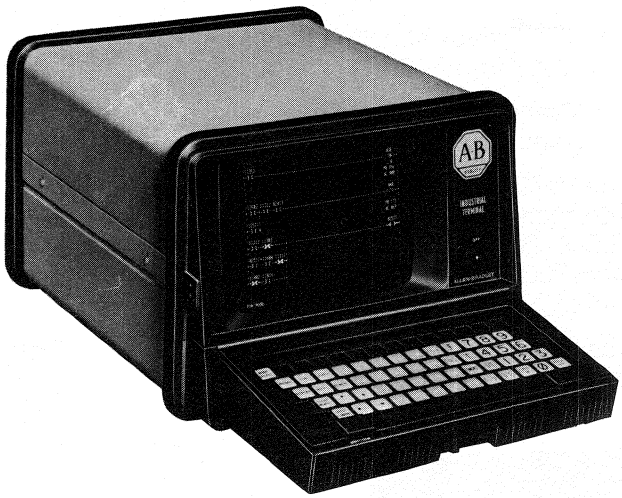
[1] A Model 743 with modem cannot be ordered through Allen-Bradley, Systems Division. If this option is needed, the data terminal should be ordered from the manufacturer.

A-B QUALITY
ALLEN-BRADLEY
Cleveland, Ohio 44143

PRINTED IN U.S.A.

# INDUSTRIAL TERMINAL SYSTEM

## Cat. No. 1770-T1 or 1770-T2



## INTRODUCTION

The Industrial Terminal System is a Cathode Ray Tube (CRT) programming terminal that will interface with the complete line of Allen-Bradley Programmable Controllers (PC), Series 7100 Computerized Numerical Control (CNC) and can also be used as a general purpose ASCII (alphanumeric) data terminal. The System can load, edit and monitor PLC, PLC-2, PLC-2/20 and Mini-PLC-2 Controller program instructions, as well as generate and display ASCII report messages. PC program instructions are entered through the detachable sealed touchpad keyboard and monitored on the screen. The symbols generated and displayed are similar to the familiar relay characters.

The Industrial Terminal System is lightweight (weighing less than 35 pounds), portable and easily carried yet rugged enough for most industrial environments (0°-55°C). The System can operate on line voltages of 120V AC or 220/240V AC at a line frequency of 50 Hz or 60 Hz. AC voltage selection can be made by repositioning a small printed circuit board within its housing. This circuit board is located on the rear panel next to the AC power cord connection (Figure 1). The line frequency can be selected by a dip switch located on the front of the Industrial Terminal's main logic board (Figure 10). Systems shipped are configured for 120V AC 60 Hz operations.

There is no need to de-energize the PC system or the Industrial Terminal System when connecting or disconnecting the Industrial Terminal.

There are two Industrial Terminal Systems to select from; a 1770-T1 INDUSTRIAL TERMINAL SYSTEM; or a 1770-T2 INDUSTRIAL TERMINAL SYSTEM.

## SPECIFICATIONS

**FUNCTIONS**

Load, Edit and Monitor PLC and PLC-2 Family Controller program instruction as well as Series 7100 CNC program instructions

Load and Monitor ASCII Report Generation Messages for PLC and PLC-2 Family of Controllers

General purpose RS-232-C Data Terminal with 9" CRT capable of displaying ASCII and graphic characters in an 80 x 24 format

**ELECTRICAL INTERFACE**

CHANNEL A — PLC-2, PLC-2/20 and Mini-PLC-2 Processors
Series 7100 CNC (Programmable Interface)

CHANNEL B — PLC Processor Data Terminal usage

CHANNEL C — RS-232-C interface for peripheral devices
(Cassette Recorder or Hard-Copy Printer)

VIDEO OUTPUT JACK — RS-170 (BNC) interface to User's CRT Monitor

**OPERATING LINE VOLTAGE**

120V AC or 220/240V AC (Selectable)

**OPERATING VOLTAGE RANGE**

98V — 132V AC (120V)
196 — 250V AC (220/240V)

**OPERATING LINE FREQUENCY**

50 Hz or 60 Hz (Selectable)

**COMMUNICATION RATE**

110 Baud, 300 Baud, 600 Baud, 1200 Baud, 2400 Baud, 4800 Baud, 9600 Baud
(Selectable from Dip Switches or Keyboard)

**DIMENSIONS**

14.5 x 10 x 23 (inches)
36.8 x 25.4 x 58.4 (centimeters)

9-inch (Diagonal) CRT
(22.9 centimeters)

**WEIGHT**

Less than 35 pounds (15.9 Kg)

**AMBIENT TEMPERATURE RATING**

0° to 55°C (operational)
—40° to 65°C (storage)

**HUMIDITY RATING**

5% to 95%
(without condensation)

**FUSE RATING**

1 amp at 120V AC
1/2 amp at 220/240V AC

**Publication 1770-904 — May, 1980**
Supersedes Publication 1770-904 — Dated January, 1980

The 1770-T1 INDUSTRIAL TERMINAL SYSTEM will interface with the Bulletin 1772 PLC-2, Bulletin 1772 PLC-2/20 or Bulletin 1772 Mini-PLC-2 Programmable Controller and also the Series 7100 CNC.

The Industrial Terminal System (Cat. No. 1770-T1) consists of the following:

- Industrial Terminal (Cat. No. 1770-TA)
- PLC-2 Keyboard (Cat. No. 1770-FCC)
- PLC-2 Keytop Overlay (Cat. No. 1770-KCA)
- Alphanumeric Keytop Overlay (Cat. No. 1770-KAA)
- PLC-2 Program Panel Interconnect Cable (Cat. No. 1772-TC)
- Keyboard Connector Cover (Cat. No. 1770-XB)
- CRT Troubleshooting Plug (Cat. No. 1774-TT)
- User's Manual (Pub. No. 1770-802)

The 1770-T2 INDUSTRIAL TERMINAL SYSTEM will interface with the Bulletin 1774 PLC, Bulletin 1772 PLC-2, Bulletin 1772 PLC-2/20 or Bulletin 1772 Mini-PLC-2 Programmable Controller and also the Series 7100 CNC.

The Industrial Terminal System (Cat. No. 1770-T2) consists of the following:

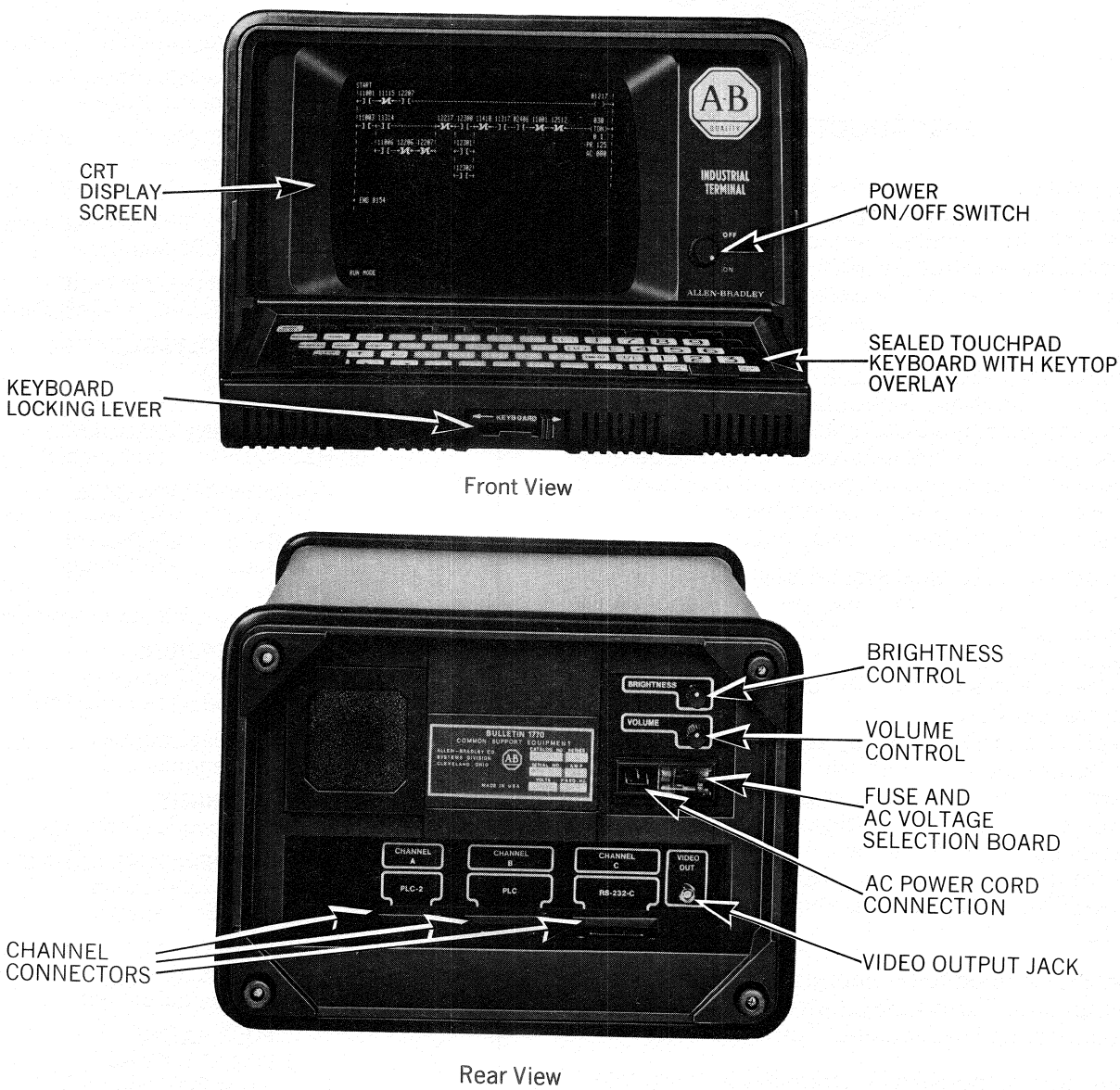



**FIGURE 1 — Controls and Channel Connectors**

- Industrial Terminal (Cat. No. 1770-TA)
- PLC/PLC-2 Keyboard (Cat. No. 1770-FAC)
- PLC Keytop Overlay (Cat. No. 1770-KBA)
- PLC-2 Keytop Overlay (Cat. No. 1770-KCA)
- Alphanumeric Keytop Overlay (Cat. No. 1770-KAA)
- PLC Program Panel Interconnect Cable (Cat. No. 1774-TC)
- PLC-2 Program Panel Interconnect Cable (Cat. No. 1772-TC)
- Keyboard Connector Cover (Cat. No. 1770-XB)
- CRT Troubleshooting Plug (Cat. No. 1774-TT)
- User's Manual (Pub. No. 1770-802)

If your present needs require only a 1770-T1 SYSTEM, it can be updated into a 1770-T2 SYSTEM without having to order a complete new SYSTEM.

NOTE: Unless otherwise specified, the information discussed in this document relates to BOTH SYSTEMS (1770-T1 and 1770-T2).

## CONTROLS AND HARDWARE

### CONTROLS

There are three controls on the Industrial Terminal:

- Power ON/OFF
- Brightness
- Volume

Power ON/OFF is located on the right side of the front panel (Figure 1). Brightness and Volume controls are located on the right side of the rear panel (Figure 1). Brightness controls the intensity of the screen and Volume controls the level of audio feedback (beep tone) that is generated when a valid key on the keyboard is pressed.

### CONNECTORS AND CABLES

A detachable AC power cord connects to the right side of the rear panel next to the voltage selection board (Figure 1). There are three channel connectors and a video output jack also located on the rear panel of the Industrial Terminal (Figure 1). Table A lists the function of each channel and the cables required.

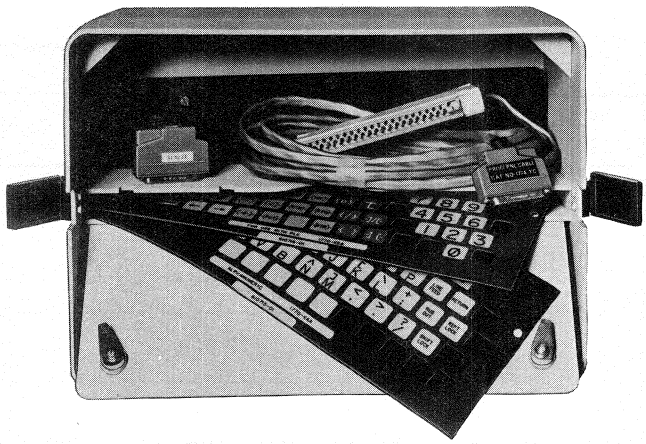


**FIGURE 2 — Protective Cover with Storage Area**

### PROTECTIVE COVER

A removable snap-on cover provides protection for the keyboard and display screen when the Industrial Terminal System is not being used. It also serves as a functional storage area for cables, power cord, troubleshooting plug, keyboard connector cover and keytop overlays (Figure 2).

## KEYBOARD

Detachable sealed touchpad keyboards with multiple keytop overlays are available for the Industrial Terminal System when ordered separately. To interface with a Bulletin 1772 PLC-2, Bulletin 1772 PLC-2/20 or Bulletin 1772 Mini-PLC-2 Controller, or a Series 7100 CNC; either a Cat. No. 1770-FAC or 1770-FCC keyboard can be used.

To interface with a Bulletin 1774 PLC, Bulletin 1772 PLC-2, Bulletin 1772 PLC-2/20 or Bulletin 1772 Mini-PLC-2 Controller or a Series 7100 CNC; a Cat. No. 1770-FAC keyboard is required.

Both keyboards are capable of generating ASCII (Alphanumeric) characters and 31 graphic (line drawing) characters.

Each keyboard houses PROM memory, a sealed touchpad and a keytop overlay. These keytop overlays are color-coded for easy reference (PLC = BLUE; PLC-2 Family = RED; ALPHANUMERIC = YELLOW).

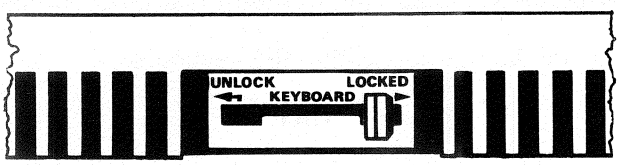



**FIGURE 3 — Keyboard Front Panel**

The keyboard is locked into place by the keyboard locking lever located on the front panel of the keyboard (Figure 3). Additionally, the power switch,

**TABLE A — Channel Connectors and Interconnection Cables**

| REAR PANEL CONNECTOR | FUNCTION | | | CABLES |
|---|---|---|---|---|
| CHANNEL A[1] PLC-2 (15 Pin) | Bulletin 1772 PLC-2 | | Processor Interface Module (Cat. No. 1772-LC) | Cat. No. 1772-TC [2] [3] |
| | Bulletin 1772 Mini-PLC-2 | | Mini-Processor Module (Cat. No. 1772-LN1 or -LN2) | |
| | Bulletin 1772 PLC-2/20 | | Processor Interface Module (Cat. No. 1772-LP1) | |
| | Series 7100 CNC | | Programmable Interface Module (Cat. No. 7100-GGA) | |
| CHANNEL B[1] PLC (25 Pin) (1770-T2 System) | Bulletin 1774 PLC with: | Cat. No. 1774-TB 1774-TB2 | Program Panel Interface Module | Cat. No. 1774-TC [3] |
| | | 1774-TL2 | On-Line Programming Module | |
| | Bulletin 1774 PLC with: | 1774-DH | Data Handling Module | Cat. No. 1770-CB [4] with Cat. No. 1774-DC [4] |
| | | 1774-DL | Protected Logic Module | |
| | | 1774-DH2 | Data Handling Module | Cat. No. 1770-CB [4] with Cat. No. 1774-DC2 [4] |
| | | 1774-DL2 | Protected Logic Module | |
| CHANNEL B | Data Terminal Use | | | Cat. No. 1770-CB [4] (Male Termination) or Cat. No. 1770-CC [4] (Female Termination) |
| CHANNEL C (25 Pin) | Interface with Peripheral Device (Cassette Recorder or Hard Copy Printer) | | | User Provided (RS-232-C) |
| VIDEO OUTPUT JACK (BNC) | To User's Cathode Ray Tube Monitor | | | User Provided (RS-170) |

[1] Only ONE of these channels may be connected to at any one time.
[2] Shipped with the Industrial Terminal System (Cat. No. 1770-T1).
[3] Shipped with the Industrial Terminal System (Cat. No. 1770-T2).
[4] Optional Cable. Must be ordered separately.

when in the ON position, serves as an interlock to guard against attaching or removing the keyboard while power is applied to the Industrial Terminal. This reduces the possibility of internal damage to the PROM memory within the keyboard.

## CRT

The Industrial Terminal has a large 9-inch (diagonal) Cathode Ray Tube (CRT) used as the display screen. When connected to a PLC Processor, a full screen will display 9 input instructions across by 5 rungs down. This is controlled by the Program Panel Interface Module or On-Line Programming Module in the PLC Processor. When connected to a PLC-2, PLC-2/20 or Mini-PLC-2 Processor, or a Series 7100 PI Module, the Industrial Terminal's full screen will display 11 input instructions across by 7 rungs down. This is controlled by firmware in the keyboard. When used as an ASCII (Alphanumeric) terminal, the full screen format is 80 characters across by 24 character lines down.

## DIAGNOSTICS

The Industrial Terminal performs self-diagnostics at power ON. If a problem is found, a FAULT diagnostic prompt (Table B) will appear (only at power ON) and a continuous beep tone will sound to alert the user that a problem has occurred. If at

power ON, the Industrial Terminal is not capable of displaying the FAULT prompt, a continuous beep tone will be generated to alert the user to an internal problem within the Industrial Terminal.

**TABLE B — Error Messages**

| |
|---|
| PROCESSOR COMMUNICATIONS FAULT |
| NO VALID PROCESSOR MEMORY |
| INVALID PROCESSOR OPERATIONS |
| UNKNOWN PROCESSOR FAULT |
| PROCESSOR MEMORY INVALID, HIT CANCEL COMMAND TO CLEAR AND CONTINUE |

If no problem is found, a "DIAGNOSTICS PASSED" message will be displayed in the upper left corner of the screen, along with the "MODE SELECTION" message for the SYSTEM keyboard attached.

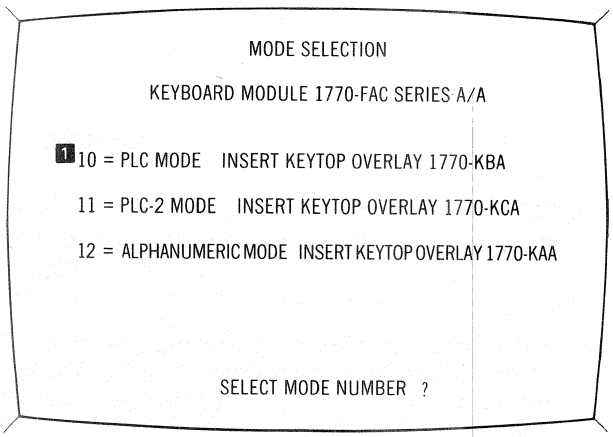
If a keyboard is not attached and after diaganostics have been performed successfully, a "MONITOR MODE FUNCTIONING" message will be displayed and the Industrial Terminal will automatically be placed into the Monitoring Mode of operation.

NOTE: Diagnostic prompts appear only at power ON.

## MODE SELECTION

At power ON after fault-free diagnostics have been performed or by pressing the Mode Select Key on the keyboard, a "MODE SELECTION" message will be displayed listing the modes of operation available for the keyboard attached (Figure 4).

To select the desired mode; install the proper overlay as listed for that mode over the sealed touchpad; then press the digits shown for that mode of operation. The Industrial Terminal will be placed into that mode of operation.




1 This line does not appear on the 1770-T1 System.

**FIGURE 4 — Mode Selection Display (1770-T2 System)**

### PLC-2 MODE

With the RED PLC-2 Keytop Overlay installed and the PLC-2 Mode selected, the Industrial Terminal will interface with the Bulletin 1772 PLC-2, Bulletin 1772 PLC-2/20 or Bulletin 1772 Mini-PLC-2 Programmable Controller, or the Series 7100 CNC. The keyboard and screen are used to load, edit and monitor PLC-2 Family program instructions. There are 53 keytops in 7 groupings on this keyboard (Figure 5). These groupings are:

- Control Functions - directs the operation of the Industrial Terminal and its communication with the PLC-2, PLC-2/20 and/or Mini-PLC-2 Processor or Series 7100 CNC PI Module.

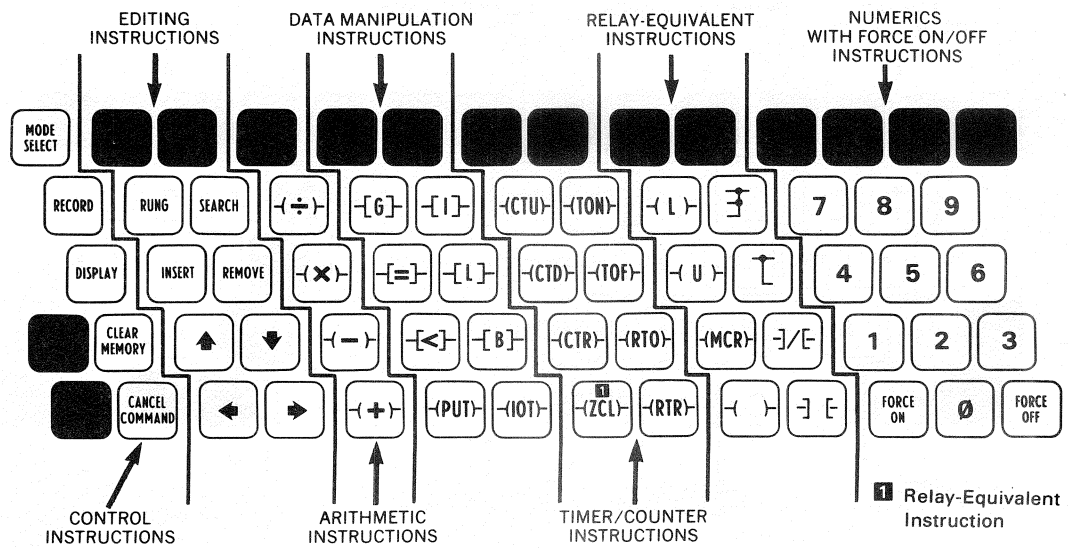



**FIGURE 5 — PLC-2 Keytop Overlay**

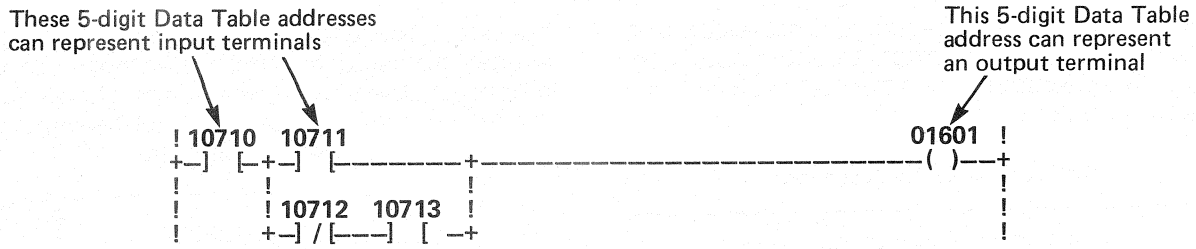



**FIGURE 6 — Typical Ladder Diagram**

- Editing Functions - can locate and display any instruction in the user's program. Also if the Processor is in the PROGRAM LOAD mode, any displayed rung or instruction may be altered.
- Arithmetic Functions - performs the four indicated arithmetic functions. NOTE: Multiplication and Divison are not presently available on the Mini-PLC-2 Processor or the Series 7100 CNC PI Module.
- Data Manipulation Instructions - used in the program to transfer and compare data in the form of BCD (Binary Coded Decimal) numbers which are stored in specified memory areas.
- Timer/Counter Instructions - allows the user to select various time-incremented and count-incremented functions to be used within the program.
- Relay-Equivalent Instructions - examines and controls the ON/OFF status of the individual bits (binary digits) in specified memory areas. These bits can, according to their addresses, represent inputs and outputs.
- Numerics - provides addresses for all ladder-diagram instructions as well as Control and Editing Instructions. Also provides FORCE ON/OFF Instructions.

### Display

The Industrial Terminal will display Input and Output Instructions that make up the ladder diagram. In this mode a full screen will display 11 input instructions across by 7 rungs down. A typical rung in the ladder diagram has only a few instructions (Figure 6). The Input and Output Instructions can be used to verify the proper functioning of individual inputs and outputs. Changes in the instruction's intensity can be logically related to the Controller's I/O Arm status indicators which turn on and off in conjunction with the input and output devices.

## PLC MODE (1770-T2 SYSTEM ONLY)

With the BLUE PLC Keytop Overlay installed and the PLC Mode selected, the Industrial Terminal will interface with the Bulletin 1774 PLC Progammable Controller. The keyboard and screen are used to load, edit and monitor PLC Controller program instructions. There are 47 keytops in 7 groupings on this keyboard (Figure 7). These groupings are:

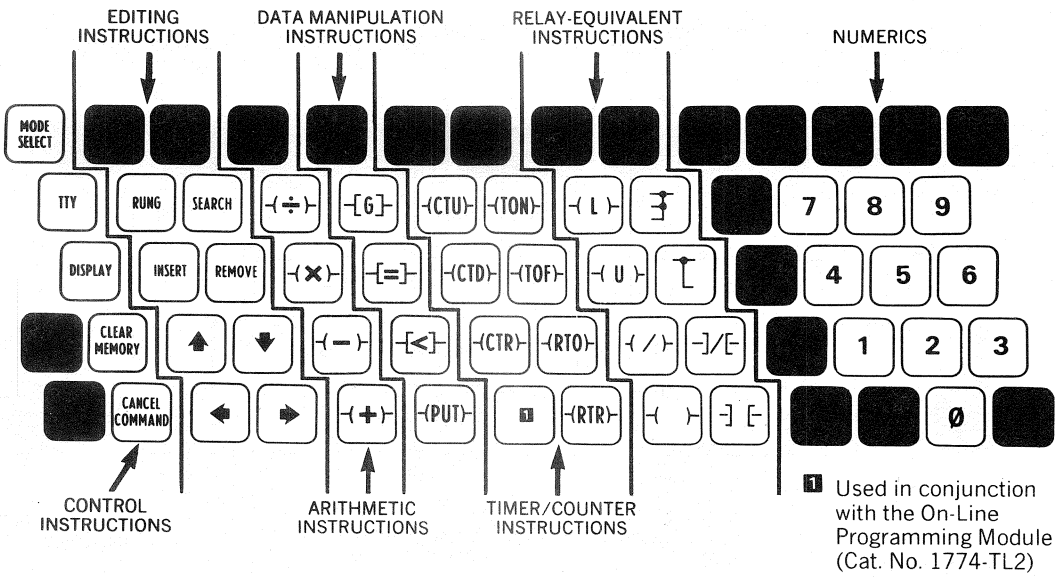
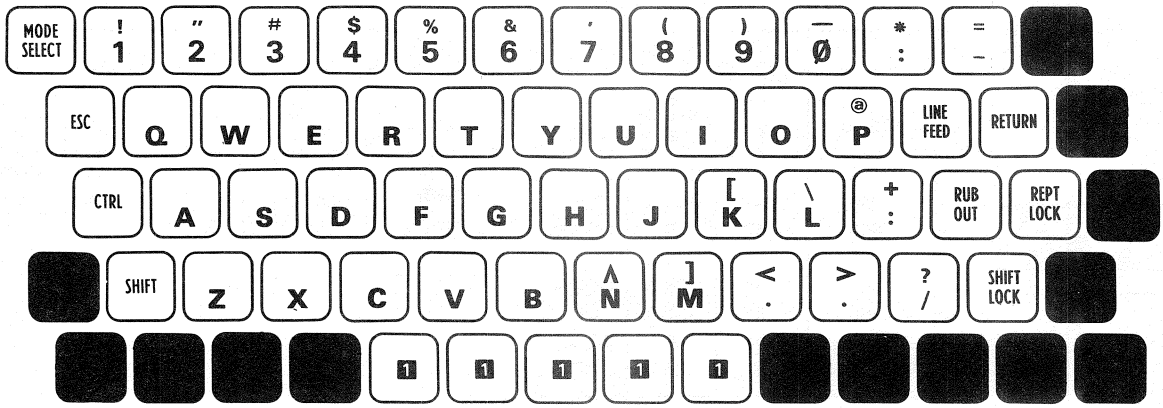



**FIGURE 7 — PLC Keytop Overlay**




1 Pressing any of these 5 keytops will cause a SPACE character to be generated.

**FIGURE 8 — Alphanumeric Keytop Overlay**

- Control Functions - directs the operation of the Industrial Terminal and its communication with the PLC Processor.
- Editing Functions - can locate and display any instruction in the user's program. Also if the Processor is in the PROGRAM LOAD or REMOTE PROGRAM LOAD mode, any displayed rung or instruction may be altered.
- Arithmetic Functions - performs the four indicated arithmetic functions only if the optional Arithmetic Module (Cat. No. 1774-LD2) is installed in the PLC Processor.
- Data Manipulation Instructions - used in the program to transfer and compare data in the form of BCD (Binary Coded Decimal) numbers which are stored in the specified memory areas.
- Timer/Counter Instructions - allows the user to select various time-incremented and count-incremented functions to be used within the program.
- Relay-Equivalent Instructions - examines and controls the ON/OFF status of the individual bits (binary digits) in specified memory areas. These bits can, according to their addresses, represent inputs and outputs.
- Numerics - provides addresses for all ladder-diagram instructions as well as Control and Editing Instructions.

### Display

The Industrial Terminal will display Input and Output Instructions that make up the ladder diagram. In this mode a full screen will display 9 input instructions across by 5 rungs down. A typical rung in the ladder diagram has only a few instructions (Figure 6). The Input and Output Instructions can be used to verify the proper functioning of individual inputs and outputs. Changes in the instruction's intensity can be logically related to the Controller's I/O Arm status indicators which turn on and off in conjunction with the input and output devices.

## ALPHANUMERIC MODE

With the YELLOW ALPHANUMERIC Keytop Overlay (Figure 8) installed and the ALPHANUMERIC Mode selected, the Industrial Terminal can be used as a general purpose Alphanumeric (ASCII) Data Terminal. When this mode is selected a "COMMUNICATION OPTIONS ALPHANUMERIC MODE" message will be displayed on the screen (Figure 9). There are seven options that can be set from the keyboard:

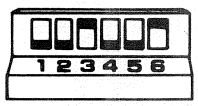
- BAUD RATE
- PARITY
- DUPLEX
- CHANNEL C
- CURSOR
- AUTO LINE FEED ON RETURN
- CONTROL CODE DISPLAY

COMMUNICATION OPTIONS ALPHANUMERIC MODE

| | |
|---|---|
| 1 = BAUD RATE | 300 |
| 2 = PARITY | NONE |
| 3 = DUPLEX | FULL |
| 4 = CHANNEL C | OFF |
| 5 = CURSOR | ON |
| 6 = AUTO LINE FEED ON RETURN | NO |
| 7 = CONTROL CODE DISPLAY | OFF |

ENTER NUMBER FOR OPTION TO BE CHANGED
OR
ENTER [RETURN] TO SELECT VALUES DISPLAYED

**FIGURE 9 — Alphanumeric Mode Message**




**BAUD RATE**

| SPEED | SWITCH 1 | 2 | 3 |
|---|---|---|---|
| 110 | DOWN | DOWN | DOWN |
| 300 | DOWN | DOWN | UP |
| 600 | DOWN | UP | DOWN |
| 1200 | DOWN | UP | UP |
| 2400 | UP | DOWN | DOWN |
| 4800 | UP | DOWN | UP |
| 9600 | UP | UP | DOWN |
| NOT USED | UP | UP | UP |

**PARITY**

| TYPE | SWITCH 4 | 5 |
|---|---|---|
| NONE | DOWN | DOWN |
| ODD | DOWN | UP |
| EVEN | UP | DOWN |
| NOT USED | UP | UP |

**LINE FREQ. (Hz)**

| Hz | SWITCH 6 |
|---|---|
| 50 | DOWN |
| 60 | UP |

**FIGURE 10 — Dip Switch and Settings**

In this mode there are also several control commands available to the user. These are:

- CURSOR MOVEMENT
- CURSOR ON or OFF
- CHANNEL C ON or OFF
- GRAPHICS ON or OFF
- ATTRIBUTES
    a. Normal
    b. Underline
    c. Intensified
    d. Blinking
    e. Reverse Video

### Display

The Industrial Terminal will display upper case ASCII characters as well as graphic (line drawing) characters. If lower case ASCII characters are received, their upper case equivalents will be displayed. Also, the Industrial Terminal will react to most ASCII control codes.

## MONITOR MODE

When the Industrial Terminal does not have a keyboard attached and power is applied, the Industrial Terminal will automatically be placed into the Monitor Mode. This means that it will act as a standard ASCII terminal capable of displaying received serial ASCII characters. Control commands that are mentioned under the Alphanumeric Mode section are also available in this mode. The only difference is that the ASCII terminal or the Processor, when used for report generation, connected to the Industrial Terminal will have to generate the control commands to the Industrial Terminal for them to be operational.

When used in the Monitor Mode, the BAUD RATE and PARITY are set using the dip switches located on the front of the Industrial Terminal's main logic board (Figure 10). These settings can be overridden by the use of the keyboard when attached. The Keyboard Connector Cover (Cat. No. 1770-XB) must be installed whenever the Industrial Terminal is being used without a keyboard attached.

## PERIPHERAL DEVICE

There is an alternate method for entering data into the Controller's memory. It is using Digital Cassette Recorder (Cat. No. 1770-SA).

Exact operating procedures for using this device with the Industrial Terminal System can be found in the INDUSTRIAL TERMINAL SYSTEMS USER'S MANUAL (Publication No. 1770-802).

Table C shows the relationship of the function to be performed and the position of the Processor's Mode Select Switch.

**TABLE C — Switch/Function Relations with Cassette Recorder**

| FUNCTION | MODE SELECT SWITCH POSITION |
|---|---|
| LOAD | Program, Run/Program Load [1] |
| VERIFY | Program, Test, Run, Run/Program Load |
| RECORD | Program, Test, Run, Run/Program Load |

[1] In this position, the user can enter commands thru the keyboard that will change the Processor's operating mode. This is not applicable on PLC-2 and Mini-PLC-2 Processors.



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## 4.3 I/O RACKS

1771-907 Mounting Dimensions - Bulletin 1771 I/O Chassis and Power Supplies
1771-912 Configurations for Bulletin 1771 I/O Equipment
1771-939 I/O Rack Use with PLC-2/20 Controller
1772-905 Mounting Dimensions - PLC-2 Programmable Controller
1772-910 Remote I/O Scanner/Distribution Panel

# MOUNTING DIMENSIONS BULLETIN 1771 I/O CHASSIS AND POWER SUPPLIES

The drawings in this Publication show the mounting dimensions for the various components of Bulletin 1771 I/O Chassis and Power Supplies.

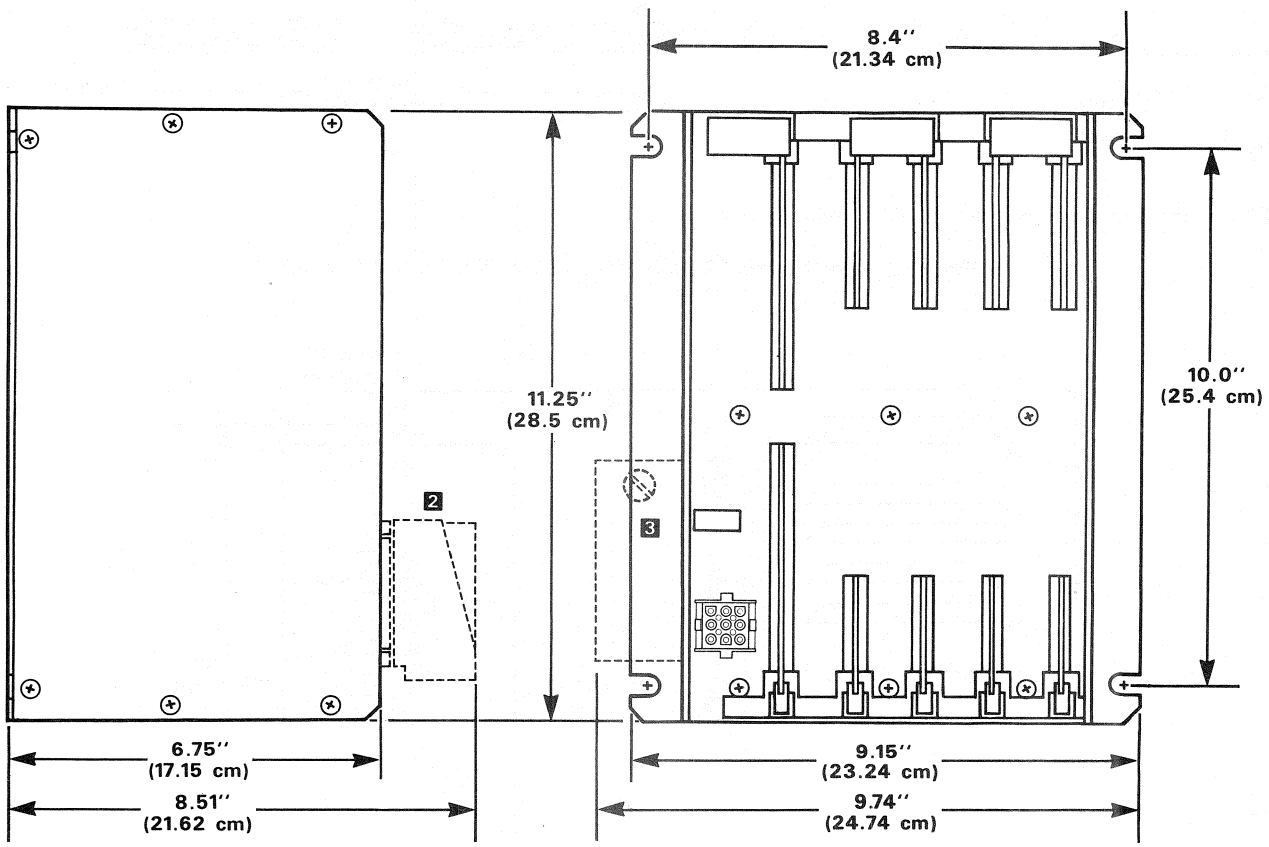
The Bulletin 1771 I/O Chassis fits within an enclosure with a **minimum** working depth of 8 inches. [1] This permits use of the I/O Chassis as a retrofit in many relay-type enclosures.

Bulletin 1771 Power Supplies may be mounted either on the left side-plate of the I/O Chassis, or up to 5 cable-feet away from the I/O Chassis. The Battery Pack, which is standard with the Cat. No. 1771-P1 Power Supply, mounts on the left side-plate of the I/O Chassis. (The Battery Pack is used **only** with the PLC-2 Mini-Processor.)

Mounting flanges on the I/O Chassis and Power Supplies are slotted for 1/4 - inch-diameter bolts.

At least 2 inches must be allowed between the base of each I/O Chassis and user wiring ducts mounted beneath on an enclosure back panel.

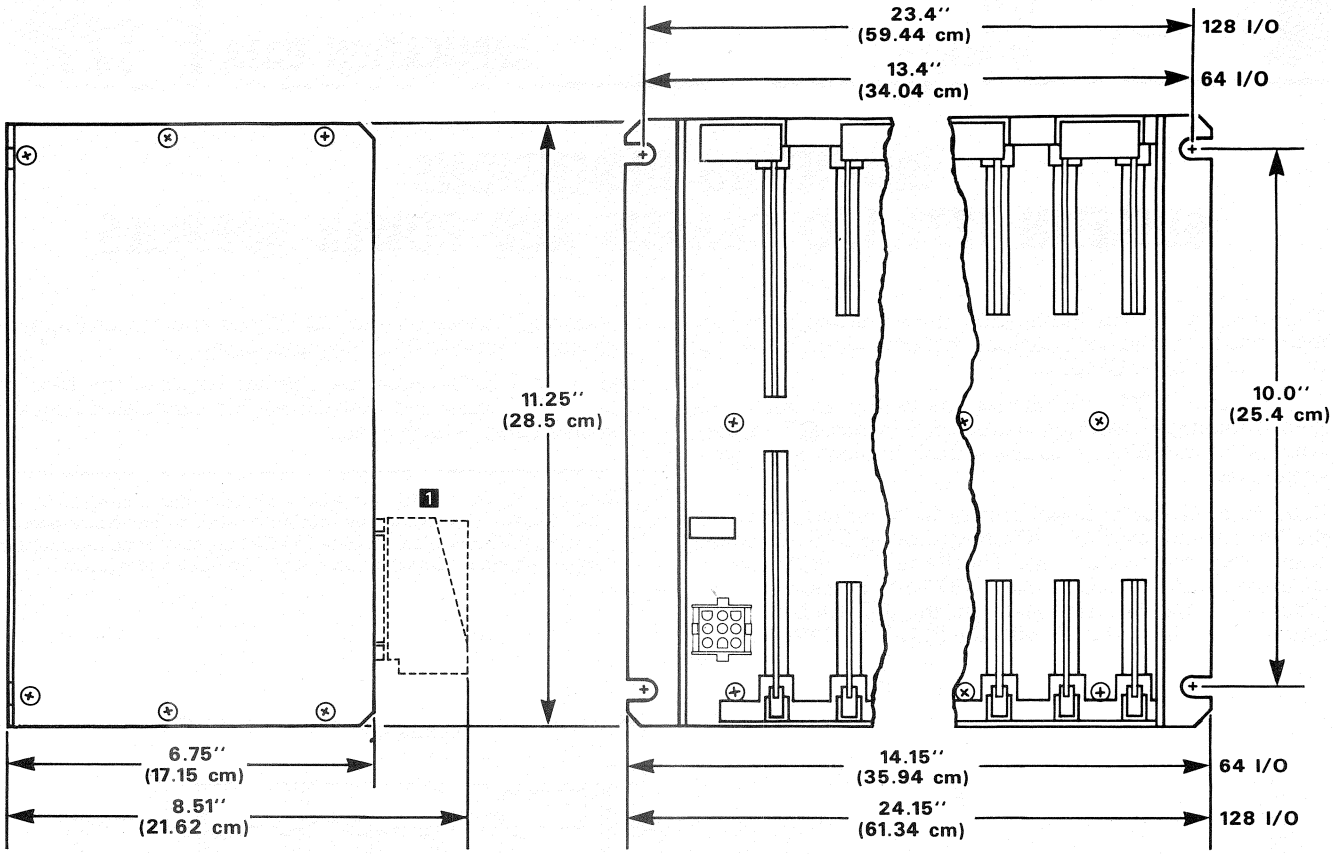
[1] As an I/O Rack with the PLC-2 programmable controller, the I/O Chassis fits within the minimum 10-inch enclosure needed for the PLC-2 Processor. (The I/O Chassis **cannot** be mounted in an 8-inch enclosure when used with the PLC-2 controller.)




[2] The plug shown is used with the PLC-2 I/O Adapter only.

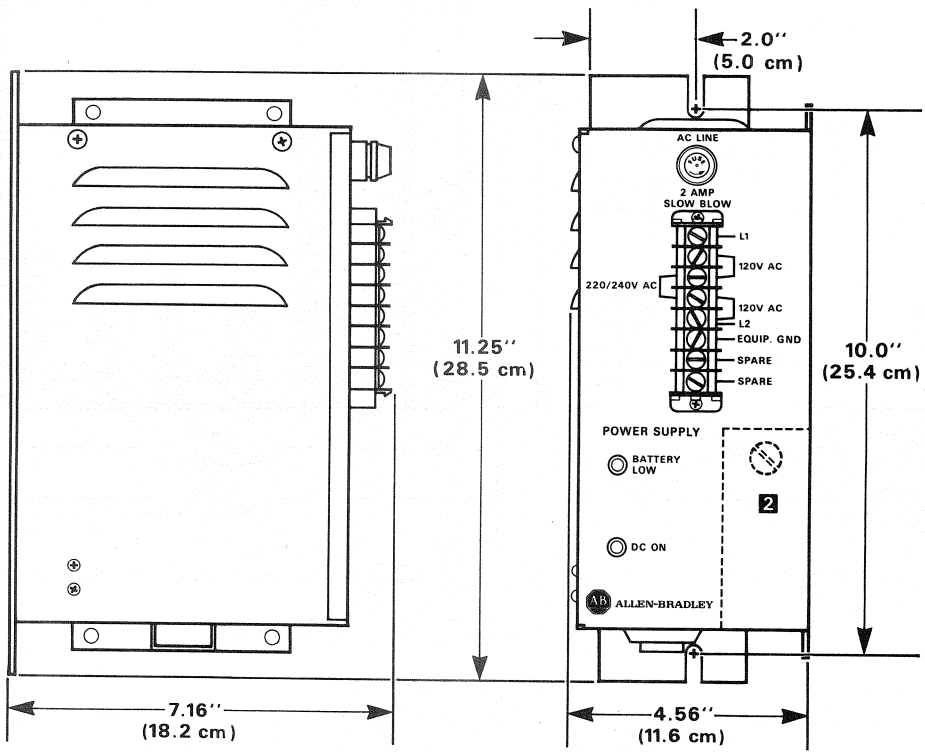
[3] The Battery Pack is used with the PLC-2 Mini-Processor only.

**Figure 1 — 32 I/O Chassis (Cat. No. 1771-A1)**



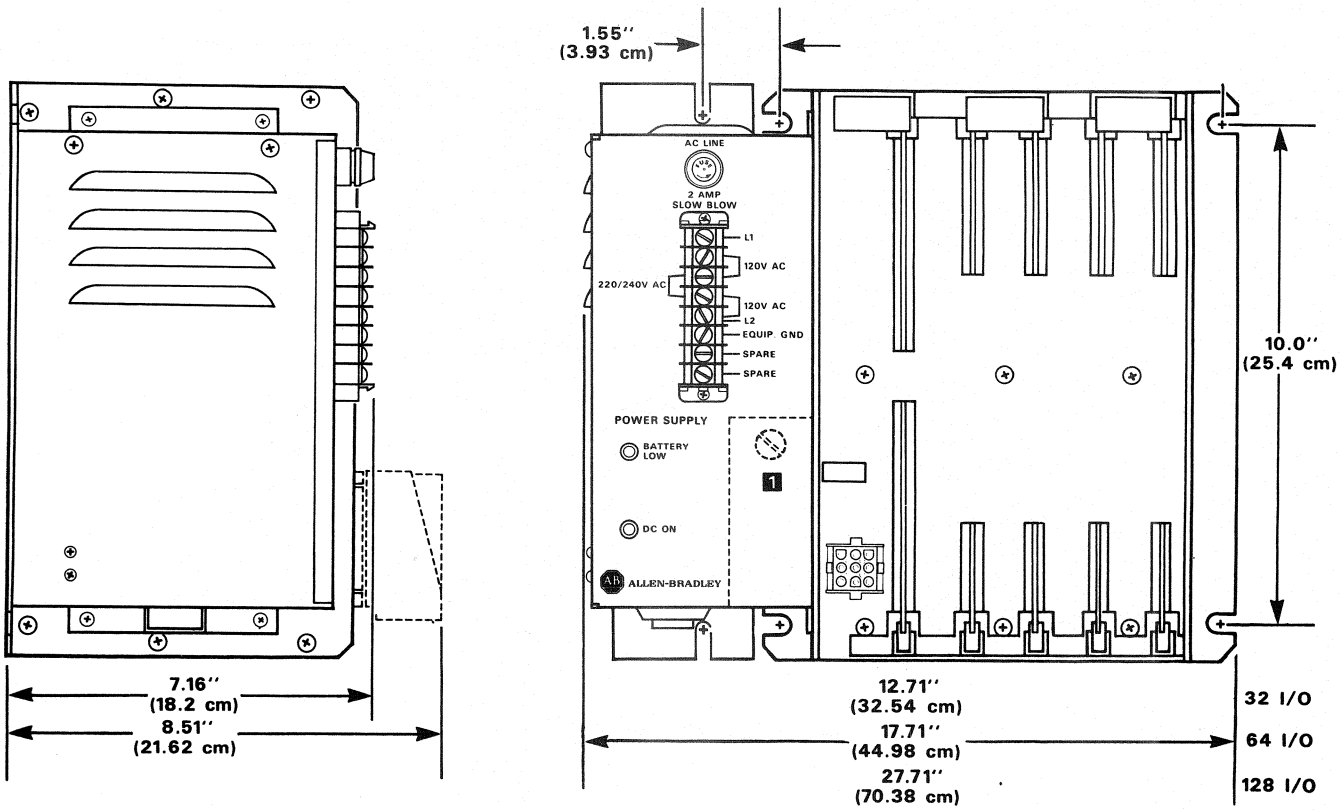

1 The plug shown is used with the PLC-2 I/O Adapter only.

**Figure 2 – 64 I/O and 128 I/O Chassis (Cat. No. 1771-A2 and -A4)**




2 Battery-Pack is used with the Cat. No. 1771-P1 only.

**Figure 3 – Power Supplies (Cat. No. 1771-P1 and -P2)**




Note: For ease of assembly, Power Supply and I/O Chassis should be assembled as a unit before mounting.

1 The Battery Pack is used with the PLC-2 Mini-Processor only.

**Figure 4 – I/O Chassis with Power Supply Mounted**

# CONFIGURATIONS FOR BULLETIN 1771 I/O EQUIPMENT

**Introduction** – Bulletin 1771 I/O equipment may be used with 3 Allen-Bradley programmable controllers:

- Bulletin 1772 Mini-PLC-2
- Bulletin 1772 PLC-2
- Bulletin 1774 Remote I/O PLC

This Publication may be used as a quick reference when applying Bulletin 1771 I/O equipment with each of these controllers. It shows the necessary Bulletin 1771 I/O components needed to interface each type of controller and the options currently available with these components. In addition, it lists Publications describing Bulletin 1771 I/O equipment.

An assembled Bulletin 1772 Mini-PLC-2 programmable controller is shown in Figure 1. Note that a single Chassis houses all logic and interfacing circuitry.

Because of the diversity of Bulletin 1771 equipment, the Mini-PLC-2 controller is not sold as an assembled unit. Instead, the required components are user-selected, and the basis of the selection is such factors as the size of the application, its electrical characteristics, and mounting arrangement. Thus, the controller may be tailored to the exact needs of the user's application.

The components required to form the Bulletin 1772 Mini-PLC-2 controller are listed in Figure 2.

The same component diversity exists when using Bulletin 1771 equipment to form an I/O Rack for use with either Bulletin 1772 **PLC-2** or Bulletin 1774 Remote I/O **PLC** controllers. Chassis and I/O module choices are identical to those offered with the Mini-PLC-2 controller, as shown in Figure 2. However, Adapter Modules and different Power Supply configurations are available for I/O Rack applications. Bulletin 1771 equipment used for I/O Rack configurations is shown in Figure 3.

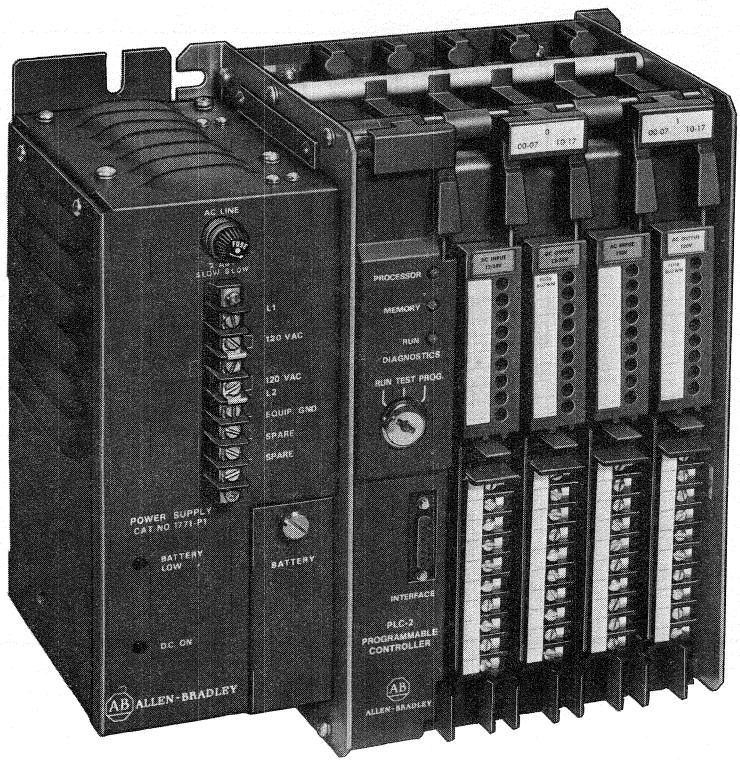
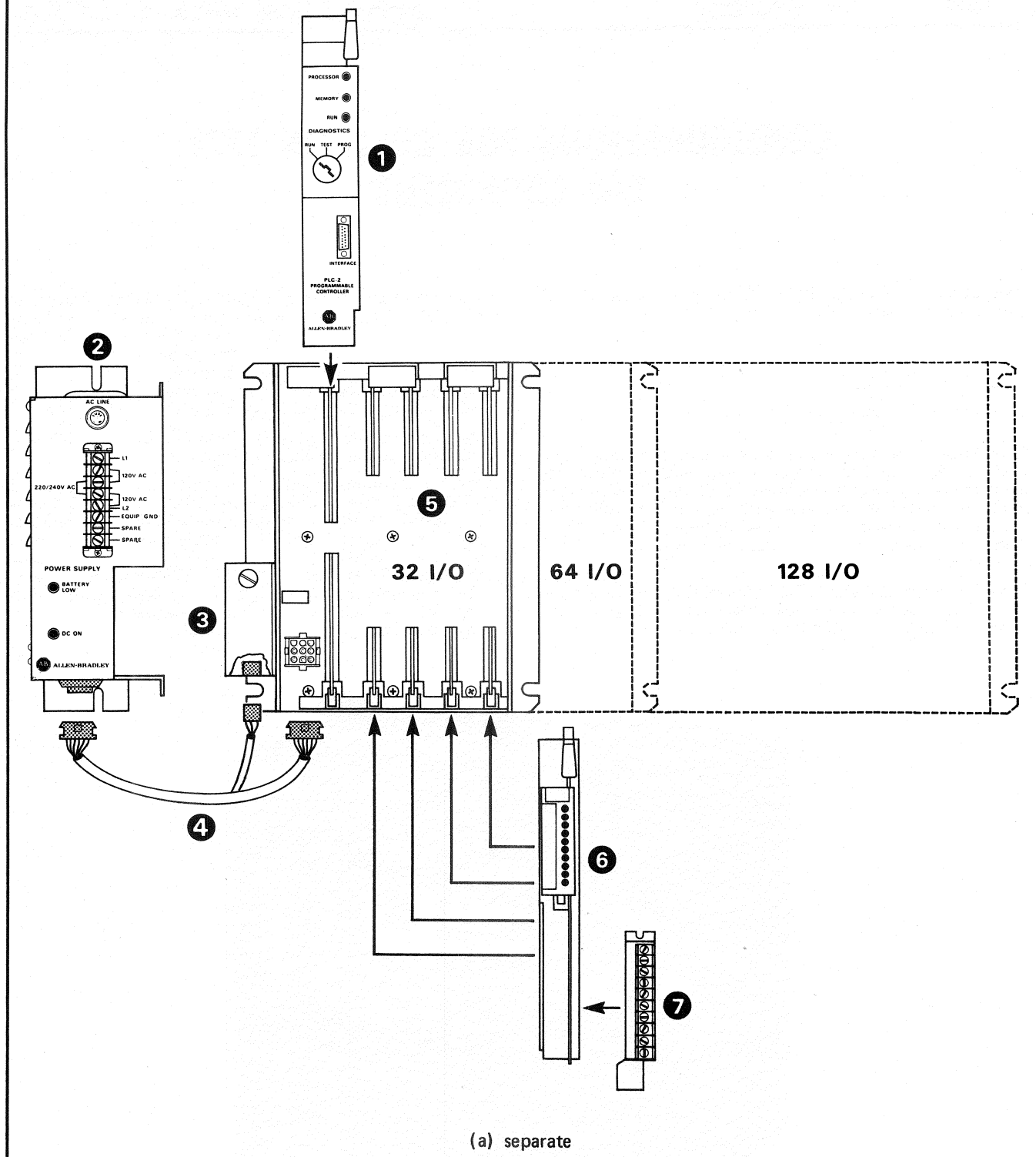
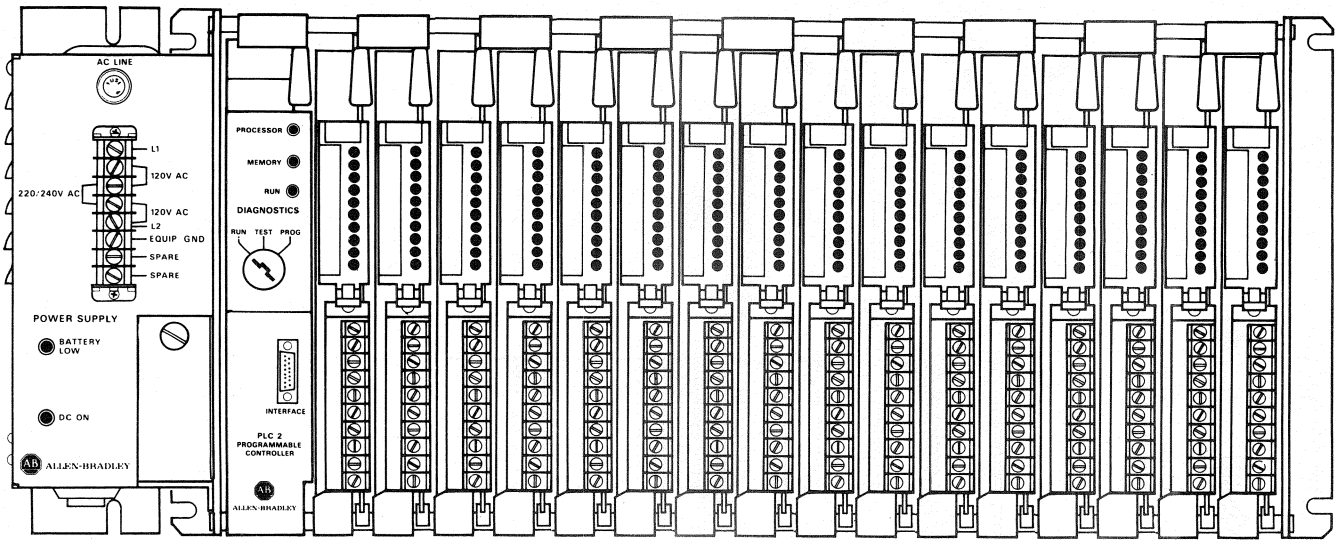



**Figure 1 – Mini-PLC-2 Programmable Controller**




(a) separate

**Figure 2 – Components of Mini-PLC-2 Controller**




(b) assembled

**1 Mini-Processor Module** (Cat. No. 1772-LN1, -LN2) – Acting as the control processing unit of the Mini-PLC-2 programmable controller, the Mini-Processor Module monitors and controls up to 128 I/O devices.

**2 System Power Supply** (Cat. No. 1771-P1) – Power for logic circuitry of the Mini-Processor and I/O modules is provided by the System Power Supply. Battery back-up for memory contents is standard with the Supply.

**3 Battery Pack** (Cat. No. 1771-BB) – This unit is mounted on the I/O Chassis by the user. Mounting hardware and 2 "D" size alkaline batteries are provided as standard.

**4 I/O Power Cable** – Depending on Power Supply mounting, one of two I/O Power Cables is used:

- Cat. No. 1771-CL I/O Power Cable, for mounting on the Chassis side-plate.
- Cat. No. 1771-CM I/O Power Cable, for mounting within 5 cable-feet of the Chassis.

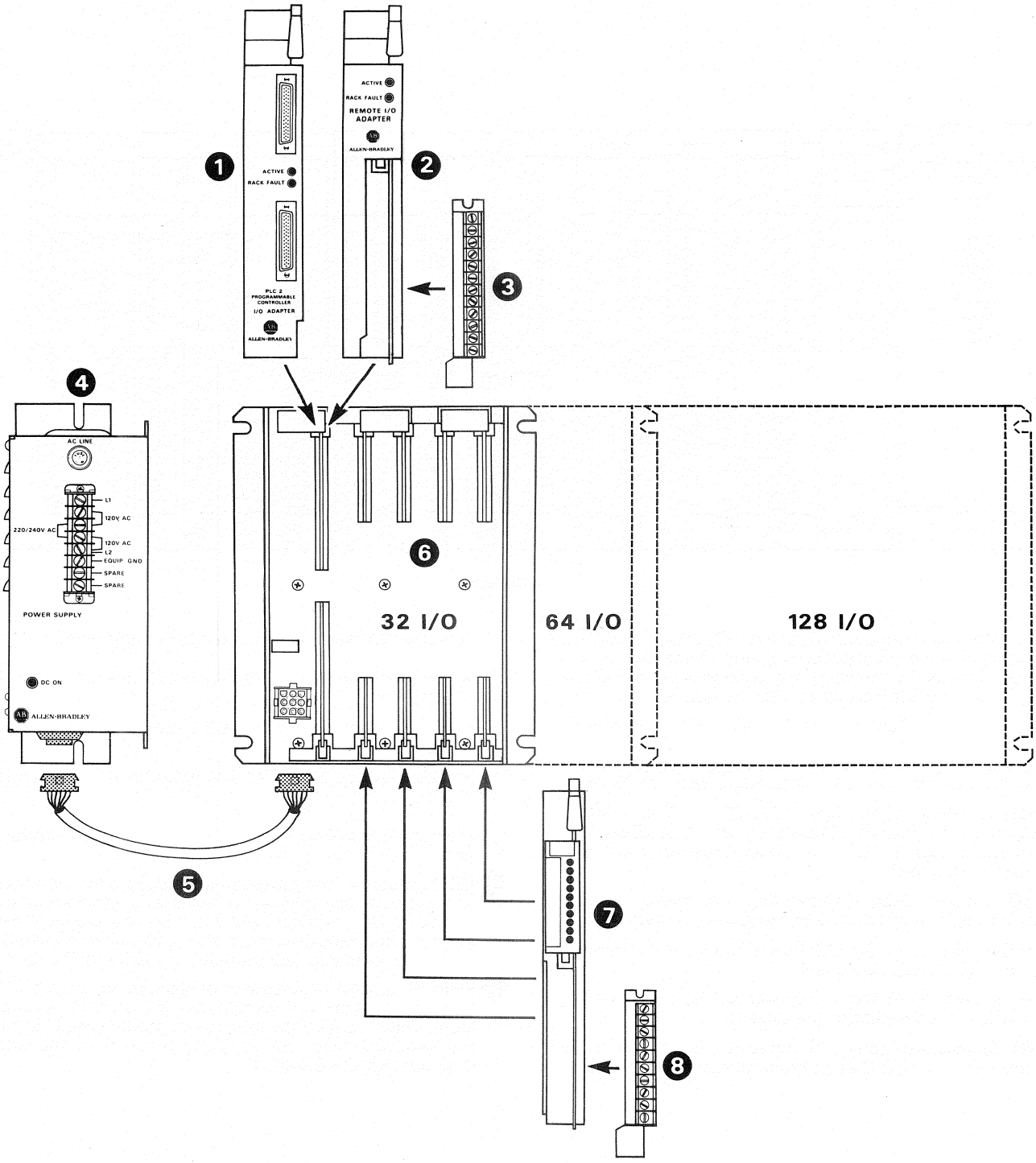
**5 I/O Chassis Assembly** – Suitable for 8-inch enclosure mounting, the I/O Chassis holds all controller modules. It is sized to meet varying interface requirements:

- 32 I/O (Cat. No. 1771-A1) provides 4 I/O module slots
- 64 I/O (Cat. No. 1771-A2) provides 8 I/O module slots
- 128 I/O (Cat. No. 1771-A4) provides 16 I/O module slots

A Field Wiring Arm is provided for each I/O module slot.

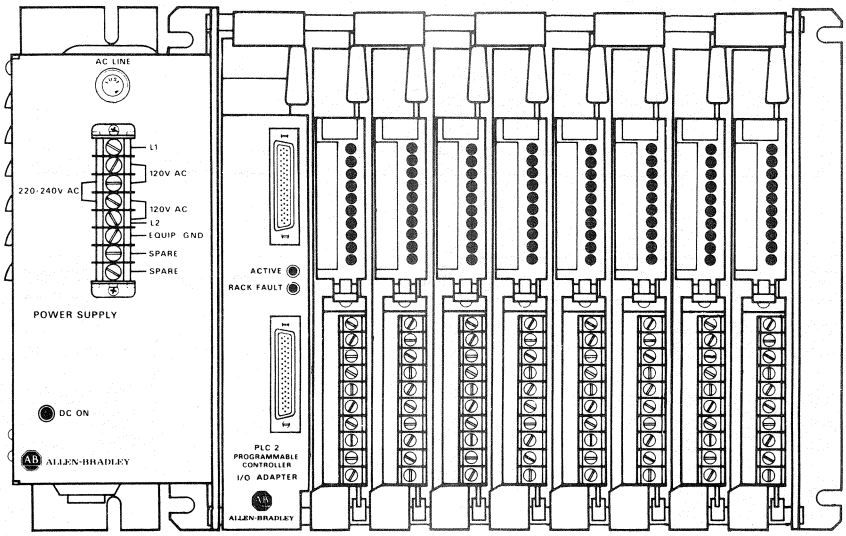
**6 I/O Modules** – The programmable controller monitors and controls the devices in the user's application by means of I/O modules. I/O modules are available for devices with various voltage levels and characteristics. Currently available I/O modules are listed in Table A.

**7 Field Wiring Arm** – Provided as standard with each I/O Chassis, the Arms are installed by the user. (The Catalog Number varies with the type of module used. Some I/O Modules may use an Arm other than the one shipped with the Chassis.)




(a) separate

**Figure 3 – Bulletin 1771 I/O Rack Components**




(b) assembled

1. **PLC-2 I/O Adapter Module** (Cat. No. 1771-AL) – For interfacing with the Bulletin 1772 PLC-2 Processor, the PLC-2 I/O Adapter Module is placed in the left-most Chassis slot.

2. **Remote I/O Adapter Module** (Cat. No. 1771-AR) – For interfacing with the Bulletin 1774 Remote I/O PLC Processor, the Remote I/O Adapter Modules allow Bulletin 1771 I/O Racks to be used in highly distributed arrangements. I/O Racks may be located as far as 5,000 cable-feet from the Processor.

3. **Field Wiring Arm** (Cat. No. 1771-WB) – Shipped standard with each Remote I/O Adapter Module. User places on I/O Chassis.

4. **Auxiliary Power Supply** (Cat. No. 1771-P2) – With either PLC-2 or Remote I/O PLC controllers, 1 Auxiliary Power Supply is used to power each Bulletin 1771 I/O Rack. (With these controller arrangements, Bulletin 1774 PLC and 1772 PLC-2 Supplies may also be used, along with special Bulletin 1771 Cables. Refer to applicable Publications listed in Figure 4.)

5. **I/O Power Cable** – Two Power Cables are available for use with the Auxiliary Power Supply:
   - Cat. No. 1771-CE I/O Power Cable, for Supply mounting on the Chassis side-plate.
   - Cat. No. 1771-CD I/O Power Cable, for Supply mounting within 5 cable-feet of the Chassis.

6. **I/O Chassis Assembly** – (See callout 5 in Figure 2.)

7. **I/O Modules** – (See callout 6 in Figure 2.)

8. **Field Wiring Arm** – (See callout 7 in Figure 2.)

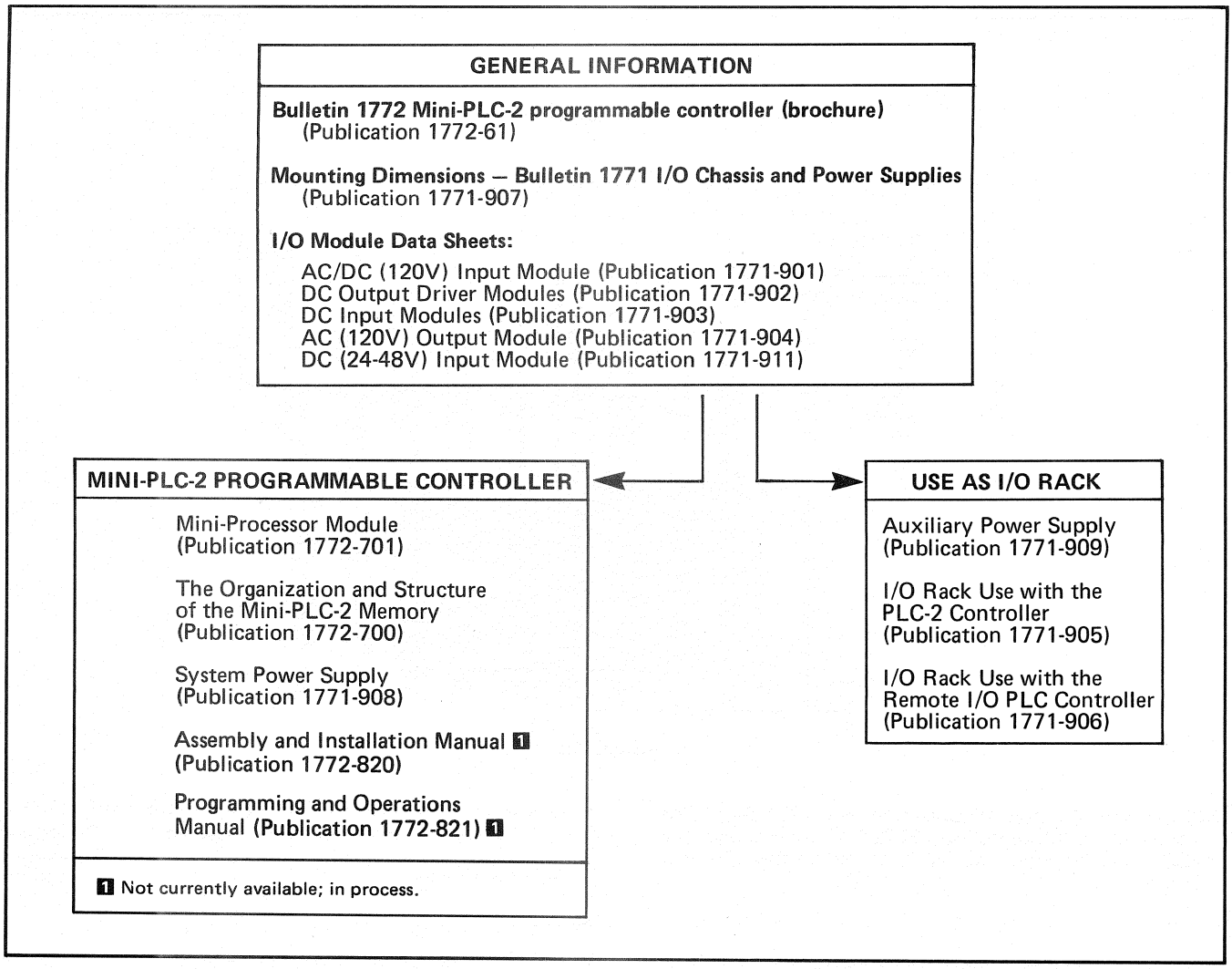



**Figure 4 — Related Publications**

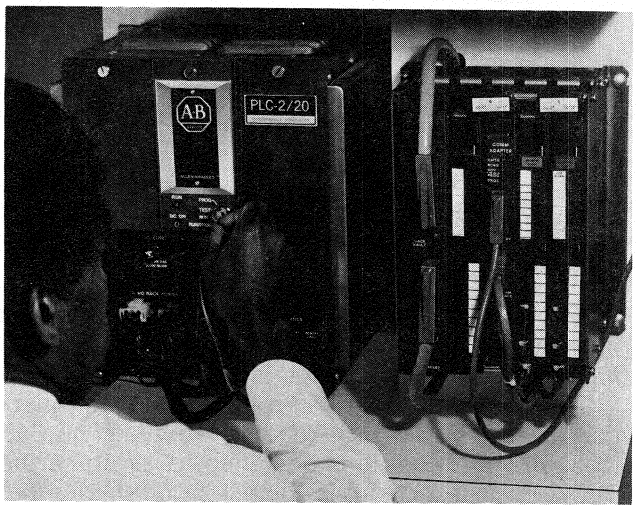
TABLE A

I/O MODULES

| MODULE | Cat. No. |
|---|---|
| DC (12-24V) Input<br>DC (48V) Input<br>DC (24-48V) Input<br>AC/DC (120V) Input | 1771-IB<br>1771-IC<br>1771-IH<br>1771-IA |
| DC (12-24V) Output<br>DC (48V) Output<br>AC (120V) Output | 1771-OB<br>1771-OC<br>1771-OA |

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# I/O RACK USE WITH PLC-2/20 CONTROLLER




## INTRODUCTION

Bulletin 1771 I/O Structure may be used with three Allen-Bradley Programmable Controllers:

- Bulletin 1772 PLC-2 (Cat. No. 1772-LR, -LP1)
- Bulletin 1772 Mini-PLC-2 (Cat. No. 1772-LN1, -LN2)
- Bulletin 1774 PLC (Cat. No. 1774-RP1, -RP2, -RP3)

Use of the Bulletin 1771 I/O Rack with the PLC-2/20 Programmable Controller is described in this Publication. [1]

An I/O Rack formed from Bulletin 1771 I/O Struc- can interface the PLC-2/20 Controller with input and output (I/O) devices in two ways:

- As the sole type of I/O interface
- As a supplement to an existing PLC-2/20 installation which currently uses one, or a maximum of two, Bulletin 1777 I/O Racks

When used as the sole type of I/O interface, four Bulletin 1771 I/O Racks allow control for an application with a maximum of 512 input and/or output devices. An Industrial Terminal (Cat. No. 1770-T1, -T2) must be used to program the Controller when the I/O configuration has three or four Bulletin 1771 I/O Racks.

A Bulletin 1771 I/O Rack can be added to a PLC-2/20 Programmable Controller which contains one, or a maximum of two, Bulletin 1777 I/O Racks. This configuration allows a maximum interfacing capability of 256 inputs and/or outputs.

### BULLETIN 1771 I/O RACK SPECIFICATIONS

**Interface**
PLC-2 I/O Adapter and I/O Modules contain circuitry to interface PLC-2 Processor (Cat. No. 1772-LR) or PLC-2/20 Processor (Cat. No. 1772-LP1) to user's inputs and outputs

**Current to module logic circuitry**
(+5.1V DC) Supplied by System Power Supply [1] (Cat. No. 1771-P1 or 1772-P1) Auxiliary Power Supply [1] (Cat. No. 1771-P2 or 1777-P2)

**Dimensions (W x H x D [2])**
Inches (Centimeters)

| | | | |
|---|---|---|---|
| 32 I/O Rack | 9.15 (23.24) | 11.25 (28.58) | 6.75 (17.15) |
| 64 I/O Rack | 14.15 (35.94) | 11.25 (28.58) | 6.75 (17.15) |
| 128 I/O Rack | 24.15 (61.34) | 11.25 (28.58) | 6.75 (17.15) |

**Ambient Temperature Rating**
0° to 60°C (operational)
−40° to 85°C (storage)

**Humidity Rating**
5 to 95%
(without condensation)

**Keying**
Keyed for seating both PLC-2 I/O Adapter and Bulletin 1771 I/O Modules

[1] Refer to Power Supplies paragraphs.
[2] Refer to I/O Cable Connection paragraphs.

If more than 256 I/O are required, all I/O Racks must be Bulletin 1771.

[1] This Application Data provides supplemental information to the PLC-2 User's Manual (Publication 1772-800).

Information contained in this Publication is presented in greater detail in the Bulletin 1772 PLC-2/20 Programmable Controller Assembly and Installation Manual (Publication 1772-801) and Programming and Operations Manual (Publication 1772-802).

For information on using Bulletin 1771 I/O Structure with Mini-PLC-2 and PLC Controllers, refer to Publications 1772-820, -821; and Publication 1771-906, respectively.

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Publication 1771-939 — December, 1980

Bulletin 1771 compatibility with Bulletin 1777 I/O Racks allows a wide variety of interfacing capabilities. The three maximum I/O configurations now possible with the PLC-2/20 Programmable Controller are:

- Two Bulletin 1777 Rack Address Groupings (the equivalent of four Bulletin 1777 I/O Racks)
- One Bulletin 1777 Rack Address Grouping and one Bulletin 1771 I/O Rack, for a total of 256 I/O
- Four Bulletin 1771 I/O Racks (Cat. No. 1771-A4)

A number of smaller configurations is also possible, depending on I/O requirements in the user's application. Each I/O system configuration is subject to electrical and physical limitations as described in Power Supplies paragraphs. These limitations must not be exceeded.

## DESCRIPTION

The Bulletin 1771 I/O Rack is formed from the following:

- One I/O Chassis (Cat. No. 1771-A1, -A2, or -A4)
- A number of I/O modules (See Table A)
- One PLC-2 I/O Adapter Module (Cat. No. 1771-AL)

**TABLE A — Bulletin 1771 I/O Modules**

| MODULE | CAT. NO. |
|---|---|
| AC/DC (120V) Input | 1771-IA |
| DC (12-24V) Input | 1771-IB |
| DC (48V) Input | 1771-IC |
| Isolated AC/DC (120V) Input | 1771-ID |
| Analog (8 bit) Input | 1771-IE |
| Analog (12 bit) Input | 1771-IF |
| TTL Input | 1771-IG |
| DC (24-48V) Input | 1771-IH |
| Encoder/Counter (5V) | 1771-IJ |
| Encoder/Counter (12-24V) | 1771-IK |
| AC/DC (220/240V) Input | 1771-IM |
| Fast Response DC (12-24V) Input | 1771-IT |
| DC (12-24V) Driver Logic Input | 1771-IV |
| Thermocouple Input | 1771-IX |
| Thermocouple Expander | 1771-IY |
| Absolute Encoder Input (8 bit) | 1771-DL |
| AC (120V) Output | 1771-OA |
| DC (12-24V) Output | 1771-OB |
| DC (48V) Output | 1771-OC |
| Isolated AC (120V) Output | 1771-OD |
| Analog (12 bit) Output | 1771-OF |
| TTL Output | 1771-OG |
| AC (220/240V) Output | 1771-OM |
| Contact Output | 1771-OY |

For ordering purposes, the user must specify each of the above units.

"I/O Chassis" identifies the metal shell into which the PLC-2 I/O Adapter and I/O Modules are inserted. Once these Modules are inserted into the I/O Chassis, the unit formed is called an "I/O Rack." In this Publication, the term I/O Rack is used for the functional unit formed from this combination.

### I/O CHASSIS

The I/O Chassis is a single compact enclosure for a PLC-2 I/O Adapter and I/O Modules. It is designed to fit within the same enclosure used for the PLC-2/20 Processor.

Slots in the I/O Chassis allow quick, easy insertion of modules. The left-most slot accepts an Adapter Module. When the Chassis is used with the PLC-2/20 Programmable Controller, this slot must contain the PLC-2 I/O Adapter Module. The Cat. No. 1771-AL Module is designed to interface the PLC-2 Processor with a local I/O configuration. This includes all PLC-2 and PLC-2/20 Programmable Controllers in use as of the date of this Publication.

Slots to the right of the I/O Adapter accept Bulletin 1771 I/O Modules.

A user specifies and orders an I/O Chassis in a size based on the application input/output requirements. There are three I/O Chassis sizes available, distinguished by I/O module capacity. Sizes are:

- 32 I/O — Cat. No. 1771-A1 contains 4 I/O module slots
- 64 I/O — Cat. No. 1771-A2 contains 8 I/O module slots
- 128 I/O — Cat. No. 1771-A4 contains 16 I/O module slots

An I/O Rack with 32-I/O Chassis is shown in Figure 1.

Included as standard with each I/O Chassis are a number of Field Wiring Arms (Cat. No. 1771-WA), one for each I/O module slot. Unused Field Wiring Arms must not be attached to the I/O Chassis. Unused Field Wiring Arms should be kept in the plastic bags in which they were shipped.

In addition, a package of keying bands is shipped with each I/O Chassis. Their use helps assure that only a designated module is placed in a particular slot.

Bulletin 1771 I/O Racks are designed for convenient system expansion. If a 32-I/O or 64-I/O Chassis is used, it may be replaced by a larger Chassis without the need for extensive rewiring.

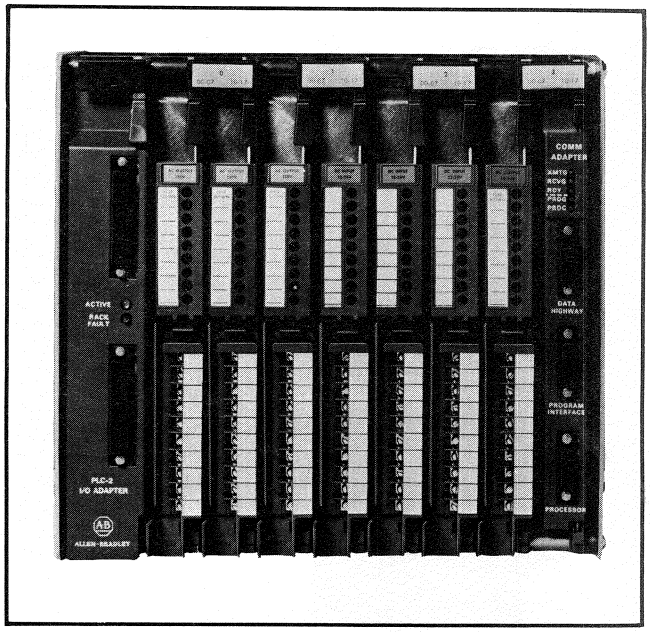



**FIGURE 1 — Bulletin 1771 I/O Rack with PLC-2 I/O Adapter Module**

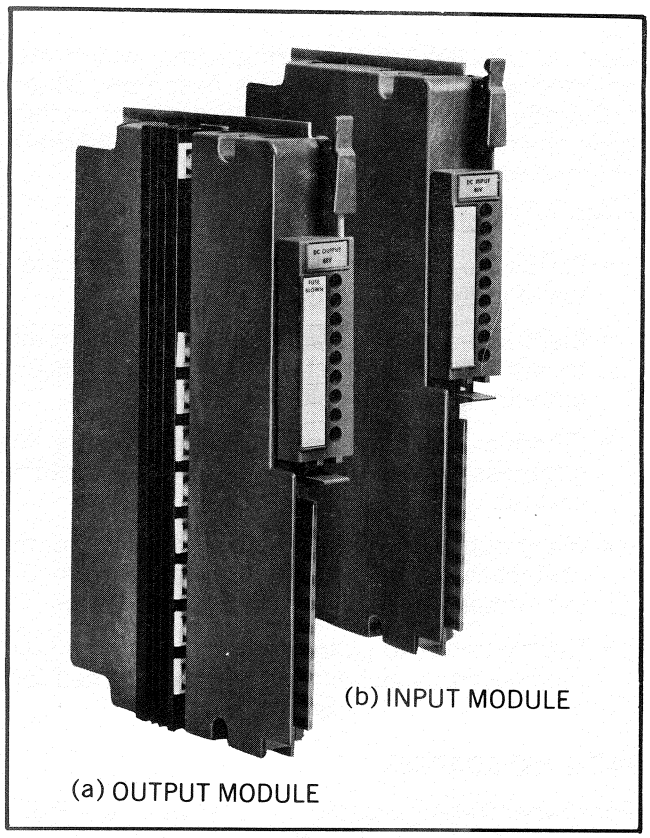



**FIGURE 2 — Typical Bulletin 1771 I/O Modules**

The Field Wiring Arms can be removed from the smaller Chassis and snapped onto corresponding positions on the larger Chassis with all wiring intact. Programming addresses of user I/O devices need not be changed with a larger I/O Chassis.

## I/O MODULES

Circuitry to interface various types of user's input and output devices with the PLC-2/20 Processor is provided by I/O modules. There are two general types of I/O modules:

- Input modules which monitor the ON/OFF status of user input devices connected to the I/O Rack (Figure 2b). Input signals generally originate from the closure of limit, selector, or float switches, push buttons, transducers, and many other sensing or switching devices.
- Output modules which control the ON/OFF status of user devices (Figure 2a). Such devices may include indicators, motor starters, and solenoids.

Specific I/O modules, both input and output, are available for various user input and output voltage levels. Currently available Bulletin 1771 I/O Modules are listed in Table A.

Connection of an I/O module to user devices is made at the Field Wiring Arm (Figure 3). The Field Wiring Arm terminal strip pivots to allow quick and easy insertion or removal of I/O modules during start-up and troubleshooting.

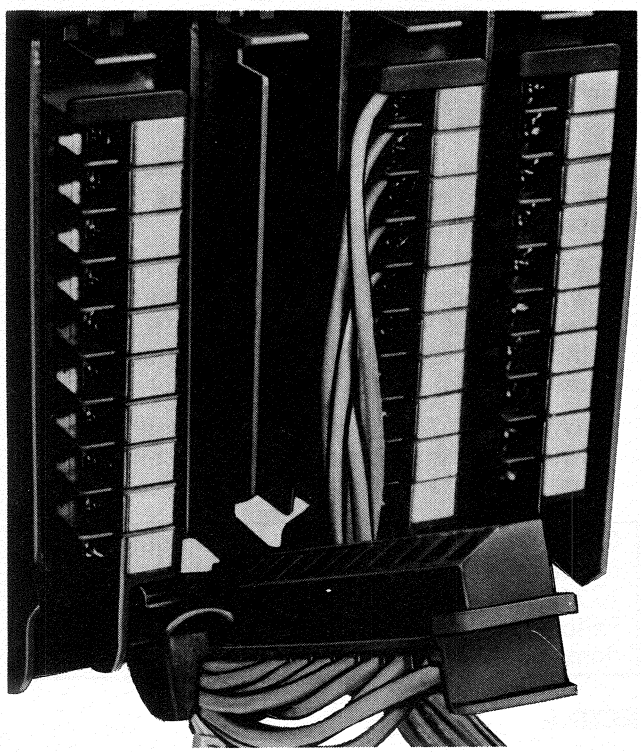


**FIGURE 3 — Field Wiring Arm**

Many of the I/O modules listed in Table A require Cat. No. 1771-WA Field Wiring Arms, which are shipped with each I/O Chassis Assembly. Other I/O modules require a different Wiring Arm. In this case, the necessary special-purpose Wiring Arm is shipped with the module.

Other I/O module design features include:

- Status indicators which show the ON/OFF status of individual inputs or outputs
- Electrical-optical isolation on each I/O circuit to aid in the protection of PLC-2/20 logic circuitry from high-voltage transients
- Filtering in input module logic circuitry to suppress voltage transients such as contact bounce
- Many output modules fused at each output to protect the user's power supply and I/O module circuitry against overcurrent conditions
- Keying bands to guard against seating an I/O module into a slot wired and programmed for an entirely different type of module

## PLC-2 I/O ADAPTER

For proper transmission of data between the PLC-2/20 Processor and Bulletin 1771 I/O Modules, the left-most slot in the Bulletin 1771 I/O Chassis must contain the PLC-2 I/O Adapter Module (Cat. No. 1771-AL). One PLC-2 I/O Adapter Module must be installed in each Bulletin 1771 I/O Rack used with the PLC-2/20 Controller.

I/O Adapter Module circuitry receives output data from the Processor and, in turn, transmits input module data to the Processor.

Diagnostic indicators on the cover of the PLC-2 I/O Adapter Module aid in troubleshooting (Figure 4). These indicators are labeled:

- ACTIVE — This green indicator illuminates when proper communication is established between the Processor and the I/O Rack. It also indicates that DC power is properly supplied to the I/O Rack. It is normally ON.
- RACK FAULT — This red indicator illuminates when I/O data transmission is absent or not in the proper form. It is normally OFF.

**CAUTION:** I/O Adapter and I/O Modules must not be removed from or inserted into the Bulletin 1771 I/O Chassis while system power is applied. Failure to follow this Caution may result in damage to Module circuitry.

## KEYING

Keying bands are shipped with each Chassis. These bands provide the user with an easy method

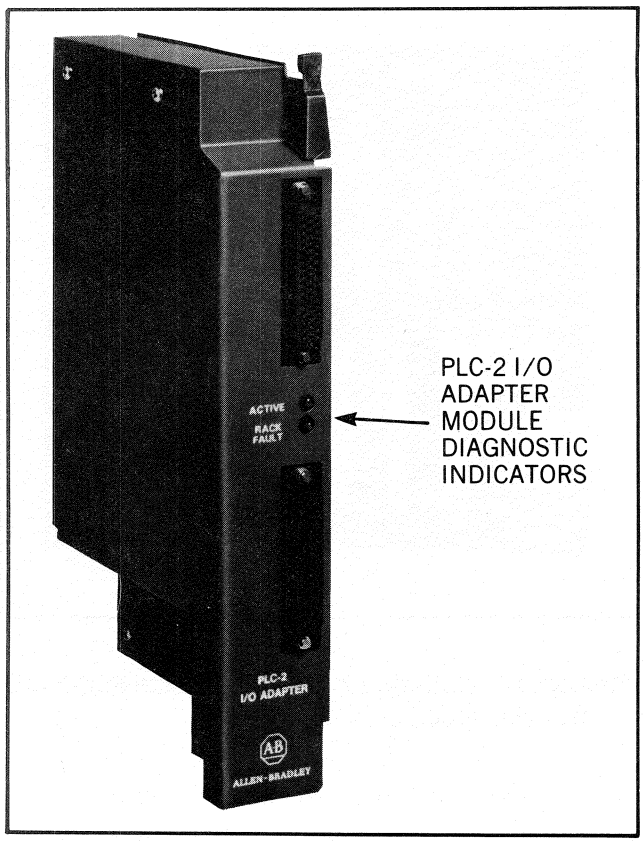



**FIGURE 4 — PLC-2 I/O Adapter Module Diagnostic Indicators**

for keying the left-most slot to accept only the PLC-2 I/O Adapter Module. Use of these keying bands is strongly recommended.

The PLC-2 I/O Adapter Module printed circuit board is slotted in two places at the rear edge. Positioning of keying bands on the backplane socket must correspond to these slots to allow Module insertion.

Needle-nose pliers may be used to insert keying bands into the upper, 56-terminal backplane socket. Bands are positioned between the numbers to the right of the socket (Figure 5). For the PLC-2 I/O Adapter Module, position bands:

- Between 38 and 40
- Between 54 and 56

Keying band positions may be changed by the user if subsequent change in type of Programmable Controller makes insertion of a different Adapter Module necessary.

## I/O ADDRESSING

Fundamental concepts that must be understood in order to program the PLC-2/20 Programmable

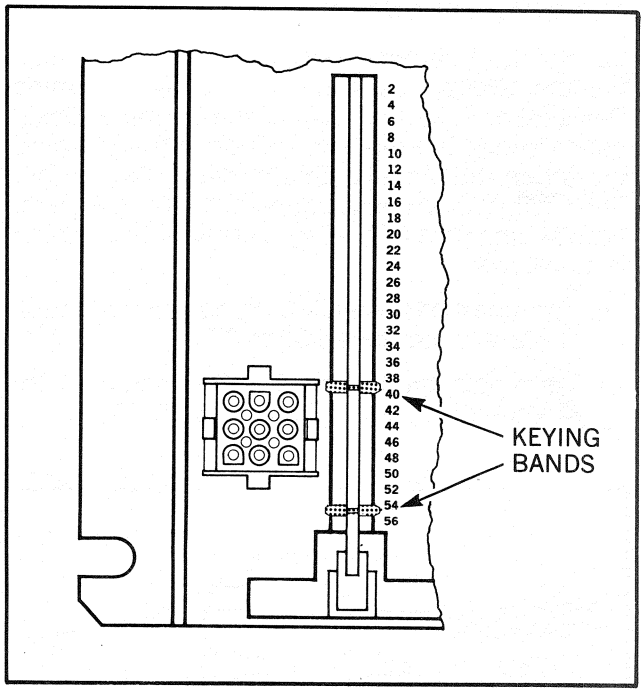



**FIGURE 5 — PLC-2 I/O Adapter Module Keying**

Controller when used with Bulletin 1771 I/O Racks include:

- Rack Number
- Module Group
- Terminal Designation

These concepts are cornerstones to understanding the 5-digit addressing scheme used by the program to identify individual input or output terminals.

## I/O RACK NUMBER

A maximum of four Bulletin 1771 I/O Racks, regardless of size, may be used with the current PLC-2/20 Controller (Cat. No. 1772-LP1). For addressing purposes, the user must designate I/O Racks as Rack 1, 2, 3, or 4.

I/O Rack Numbers are not arbitrary, and must be switch-selected by the user.

## MODULE GROUP

For addressing purposes, Bulletin 1771 I/O Modules in a given I/O Rack are organized into Module Groups. A Module Group is composed of a pair of adjacent Bulletin 1771 I/O Modules. Thus, the Module Group number of an individual I/O module depends only on the I/O slot the module occupies.

Module Groups are numbered from the left to right side of the Rack, beginning immediately to the right of the PLC-2 I/O Adapter Module. The first two I/O slots in any Bulletin 1771 I/O Rack form Module Group 0. The next two I/O slots form Module Group 1. In this manner, each additional pair of I/O slots forms a subsequent Module Group. Module Group capacity for all three I/O Rack sizes is shown in Figure 6.

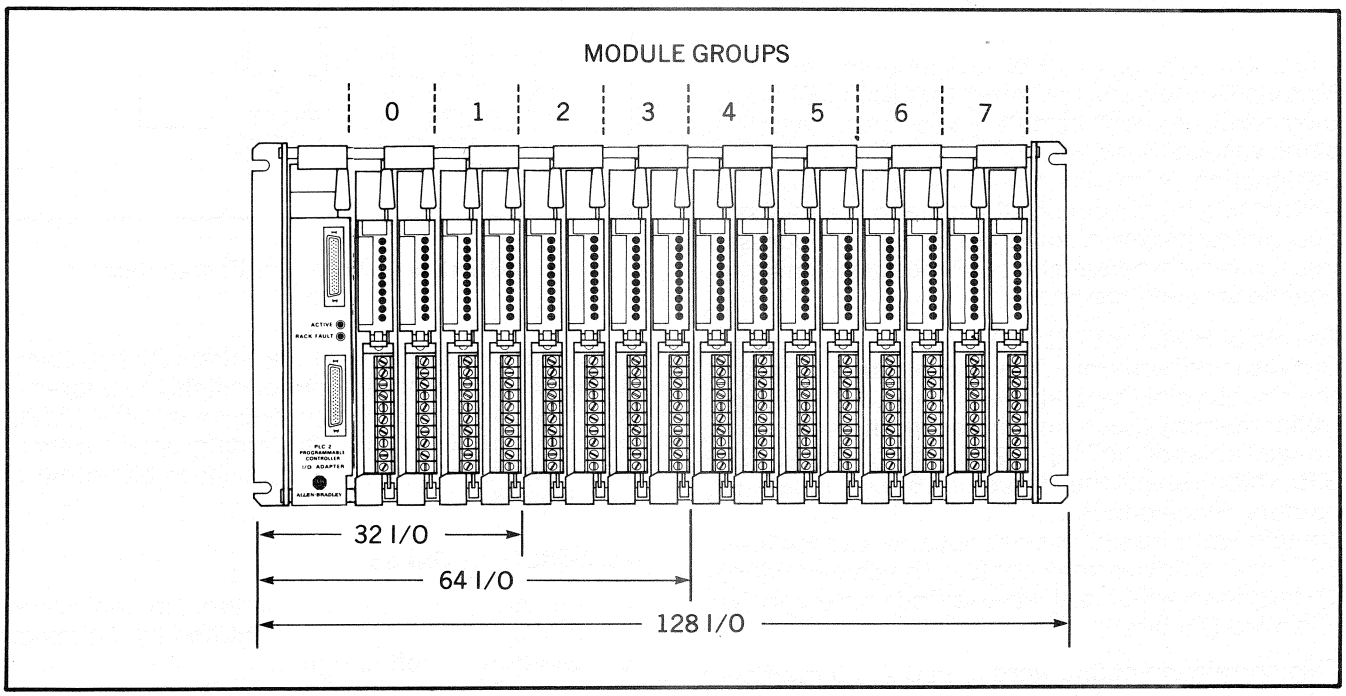



**FIGURE 6 — Module Groups**

The 128 I/O Rack, in maximum configuration, has eight Module Groups, numbered 0 to 7; 64 I/O and 32 I/O Racks have correspondingly fewer Module Groups (Figure 6).

It is important to note that the first Module Group in any Bulletin 1771 I/O Rack used with the PLC-2/20 Programmable Controller is **always** Module Group 0. (Numbering of Module Groups is **not** continued on from one I/O Rack to the next with this configuration.)

Module Groups can be easily identified by Module Group labels, affixed to latches on the top of the Bulletin 1771 I/O Chassis. Labels are shown in Figure 7.

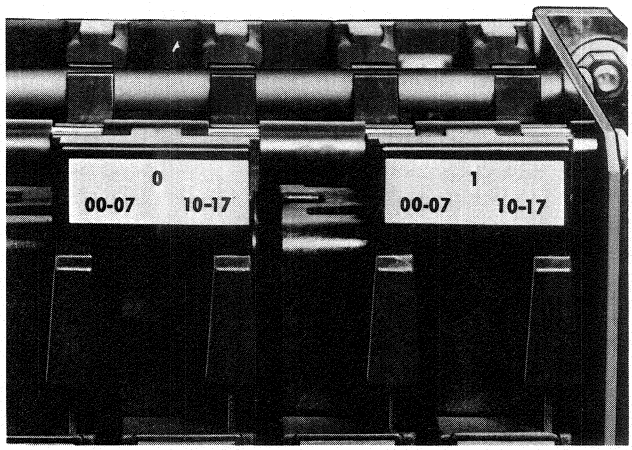



**FIGURE 7 — Module Group Labels**

Note: The arrangement of I/O modules within a Module Group does not imply that both I/O modules need be input or output modules, have the same voltage range, or be AC or DC. Module Group designation is required only for the purpose of addressing inputs or outputs in the user's application control program. However, for ease of addressing, it is recommended that I/O modules similar in type be grouped together.

Pairing of Bulletin 1771 I/O Modules into Module Groups is not arbitrary. This organization parallels the structure of the 16-bit word in PLC-2/20 Controller memory. Each word in the Input and Output Image Tables of the PLC-2/20 memory contains 16 bits which reflect the status of 16 user inputs or outputs. Since one Bulletin 1771 I/O Module may contain eight inputs or eight outputs, two Bulletin 1771 I/O Modules may contain the equivalent of 16 terminals which are represented in memory by one word (16 bits).

This correlation of one word of PLC-2/20 memory with two Bulletin 1771 I/O Modules forms the central basis for organization of the Module Group.

## TERMINAL DESIGNATION

Each of the 16 input or output terminals in a single Module Group has a distinct, 2-digit Terminal Designation. The first digit of the Terminal Designation shows the relative position of the I/O module within the Module Group; that is, left or right. The second digit corresponds to a terminal on the Field Wiring Arm (Figure 8). Terminal Designation is as follows:

- Terminals on the left I/O module in the Module Group are numbered 00 to 07.
- Terminals on the right I/O module in the Module Group are numbered 10 to 17.

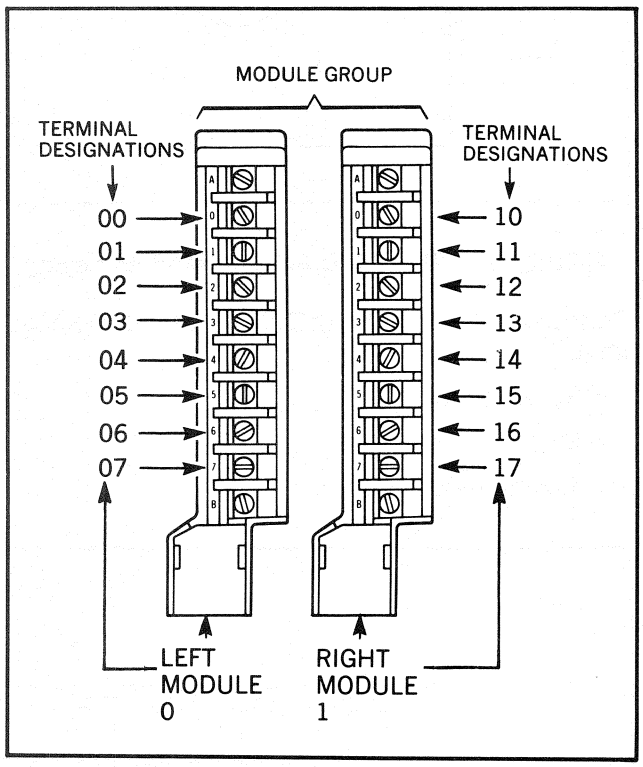



**FIGURE 8 — Terminal Designations**

Terminal Designation, with numbers 00 to 07 and 10 to 17 is not arbitrary, but parallels the addressing of each of the 16 bits in one word of PLC-2/20 memory. In PLC-2/20 programming, octal numbering is used to identify an individual bit within a 16-bit word.

## FIVE-DIGIT ADDRESS

In the user's PLC-2/20 program, an individual input or output terminal is identified by a distinct 5-digit address (left to right):

- First digit is either 0 or 1; 0 for output, 1 for input.

- Second digit is the I/O Rack Number (Rack Address Grouping) selected by the user. With the current PLC-2/20 Processor, the I/O Rack Number can be 1, 2, 3, or 4.
- Third digit refers to the Module Group Number within the I/O Rack (0 to 7).
- Fourth and fifth digits refer to the Terminal Designation within the Module Group (00 to 07, 10 to 17).

A representation of the 5-digit address is illustrated in Figure 9.

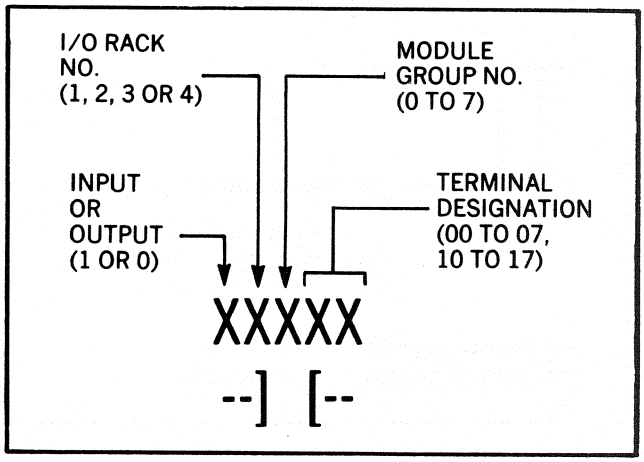



**FIGURE 9 — 5-Digit Address**

## BULLETIN 1777 I/O RACK COMPATIBILITY

A Bulletin 1771 I/O Rack may be added to an existing PLC-2/20 Programmable Controller, which currently uses one or a maximum of two Bulletin 1777 I/O Racks. If the I/O configuration requires more than one Bulletin 1771 I/O Rack, the resultant configuration must be entirely Bulletin 1771.

Bulletin 1777 I/O Racks are arranged in Rack Address Groupings. Briefly, a Rack Address Grouping is composed of up to two Bulletin 1777 I/O Racks, regardless of size. The maximum size Rack Address Grouping is two 64-I/O Racks, the equivalent of 128 I/O.

One Bulletin 1771 I/O Rack regardless of its size, is equivalent to one Bulletin 1777 I/O Rack Address Grouping. This equivalence is shown in Figure 10.

In order to use a Bulletin 1771 I/O Rack with two Bulletin 1777 I/O Racks, both Bulletin 1777 I/O Racks must be in the same user-selected Rack Address Grouping. When only one Bulletin 1777 I/O Rack is used, Bulletin 1777 and Bulletin 1771 I/O Racks must be in separate Rack Address Groupings. Two or more Bulletin 1771 I/O Racks can not be used in an I/O configuration which has one or more Bulletin 1777 I/O Rack.

If the Bulletin 1777 I/O Racks have been designated as Rack Address Grouping 1, the Bulletin

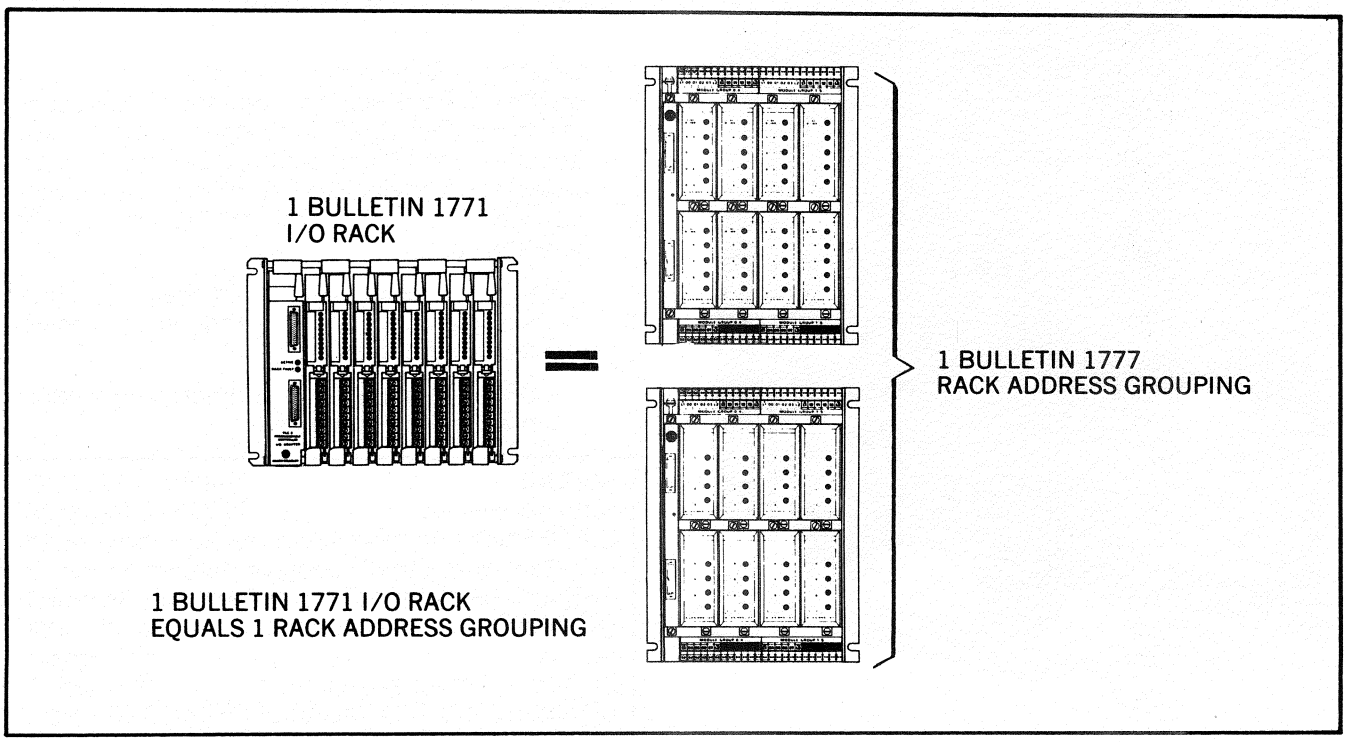



**FIGURE 10 — Equivalent I/O Structure**

1771 I/O Rack must be designated as Rack Number 2. Conversely, if the Bulletin 1777 Rack Address Grouping is Number 2, the Bulletin 1771 I/O Rack must be designated as Rack Number 1.

Switch positions for selecting the Bulletin 1771 I/O Rack Number are described in Rocker Switch Settings paragraphs.

## CONNECTIONS

The user must make certain switch settings and connections for proper I/O communication and supply of power to each Bulletin 1771 I/O Rack.

### ROCKER SWITCH SETTINGS

On the backplane of the I/O Chassis, near the leftmost slot, is a switch assembly containing eight rocker switches (Figure 11). These switches must be set by the user in proper combinations (Figure 12) to allow communication between Bulletin 1771 I/O Racks and the PLC-2/20 Processor. Rocker switches may be set ON or OFF with the tip of a ball-point pen. When the ON side of the switch is pressed, the switch is in the ON position; when depressed at the OFF side, the switch is OFF. (Graphically represented by shading on the side that is depressed.)

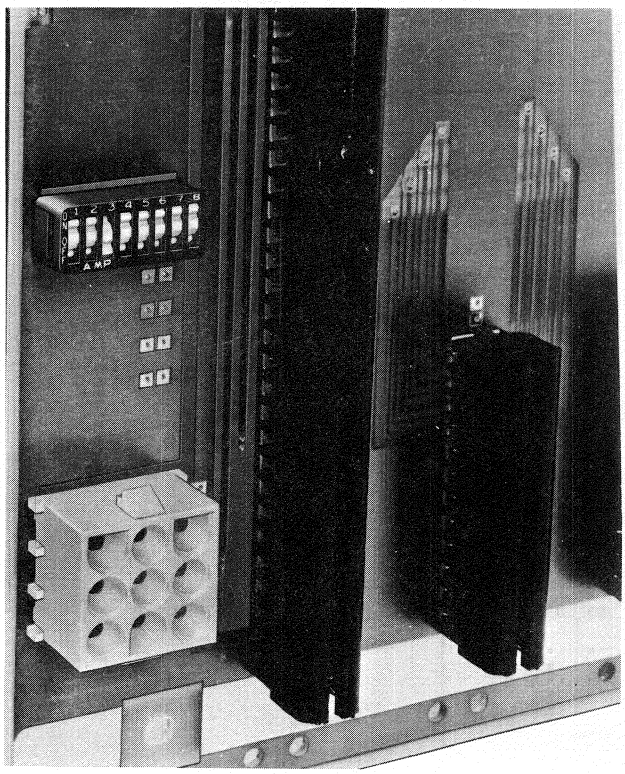


**FIGURE 11 — Switch Assembly on Bulletin 1771 I/O Chassis Backplane**

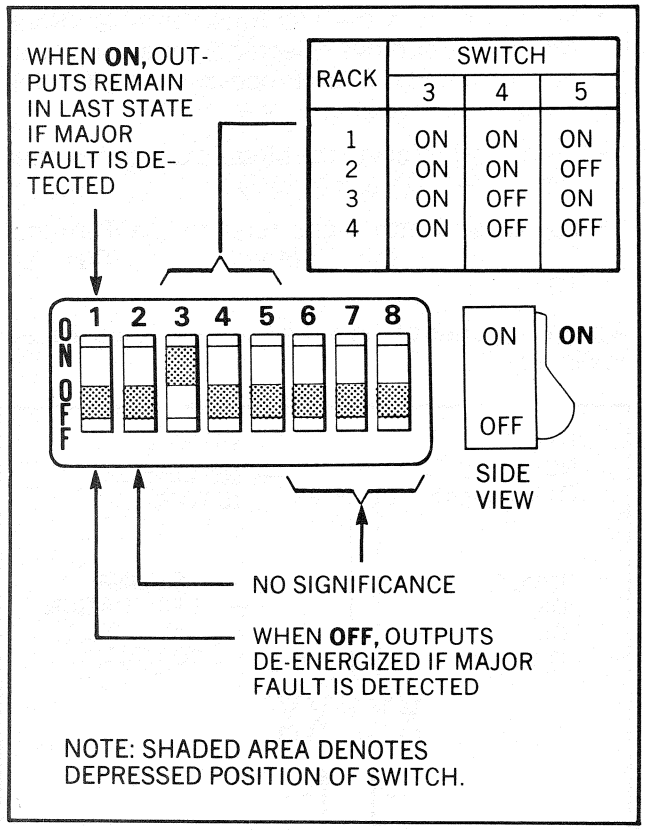



**FIGURE 12 — Switch Positions**

These positions are necessary when using the Bulletin 1771 I/O Rack with the current PLC-2/20 Programmable Controller:

- Switch 1 — Determines the status of all outputs on the I/O Rack when a major fault is detected. (With the PLC-2/20 Processor, a major fault occurs when I/O or memory parity errors are detected. A major fault stops communication between I/O Racks and the Processor.) The positions are:
  - ON — Outputs remain in their last state, energized or de-energized, when a major fault is detected.
  - OFF — Outputs are de-energized when a major fault is detected.

**WARNING:** Set Switch 1 for Bulletin 1771 I/O Racks or Switch 3 for Bulletin 1777 I/O Racks to the OFF position to de-energize outputs wired to this Rack when the Processor detects a fault. If Switch 1 (Bulletin 1771 I/O Racks) or Switch 3 (Bulletin 1777 I/O Racks) is set to the ON position, outputs connected to this Rack remain in their last state when a fault occurs. If Switch 1 (Bulletin 1771 I/O Racks) or Switch 3 (Bulletin 1777 I/O Racks) is ON, machine motion may continue after fault detection.

When outputs remaining in their last state is hazardous, it is desirable to have a fast means of de-energizing all outputs. With Switch 1 (for Bulletin 1771 I/O Racks) or Switch 3 (for Bulletin 1777 I/O Racks) in the ON position, outputs can be de-energized by removing external AC power supplied to input and output devices by means of Emergency Stop switches or the Controller enclosure power disconnect switch.

Outputs connected to either a Bulletin 1771 or Bulletin 1777 I/O Rack are de-energized when the Mode Select Switch is changed from a RUN mode (RUN or RUN/PROG Mode Select Switch position) to TEST or PROG position.

- Switch 2 — This switch currently has no significance.
- Switch 3, 4, 5 — Designate the I/O Rack Number for an individual Bulletin 1771 I/O Rack. Racks are numbered 1, 2, 3, or 4 by appropriate switch position (ON/OFF) selection.
- Switch 6, 7, 8 — Currently these switches have no significance with the PLC-2/20 Controller.

## I/O CABLE CONNECTION

With the PLC-2/20 Programmable Controller, I/O Racks must be connected in a serial chain for communication of I/O data. This I/O communication channel is connected using I/O Interconnect Cables (Cat. No. 1777-CA, -CB).

Each I/O Interconnect Cable connects with the upper socket on the PLC-2 I/O Adapter Module of the first Bulletin 1771 I/O Rack. At the Processor end, it connects with a socket marked I/O RACK.

If a second, third, or fourth Bulletin 1771 I/O Rack is used, one I/O Interconnect Cable is used for connection from the lower socket of the first, second, or third PLC-2 I/O Adapter Module to the upper socket on the next Adapter Module (Figure 13).

To enable proper I/O communication, an I/O Termination Plug (Cat. No. 1777-CP) must be placed on the bottom Adapter Module socket of the last I/O Rack used. If only one I/O Rack is used, the I/O Termination Plug must be placed on the bottom socket of the Adapter Module on that I/O Rack.

With the connection of the I/O Interconnect Cable, the working depth of the Bulletin 1771 I/O Rack becomes 8.51 inches. Thus, the I/O Rack mounts conveniently within an enclosure of 10-inch working depth. (Permits mounting the I/O Rack in the same enclosure which holds the PLC-2/20 Processor or Bulletin 1777 I/O Rack.)

### Bulletin 1771/1777 I/O Interconnection

Following paragraphs are intended for the user adding a Bulletin 1771 I/O Rack to an existing PLC-2/20 Programmable Controller which uses one or a maximum of two Bulletin 1777 I/O Racks.

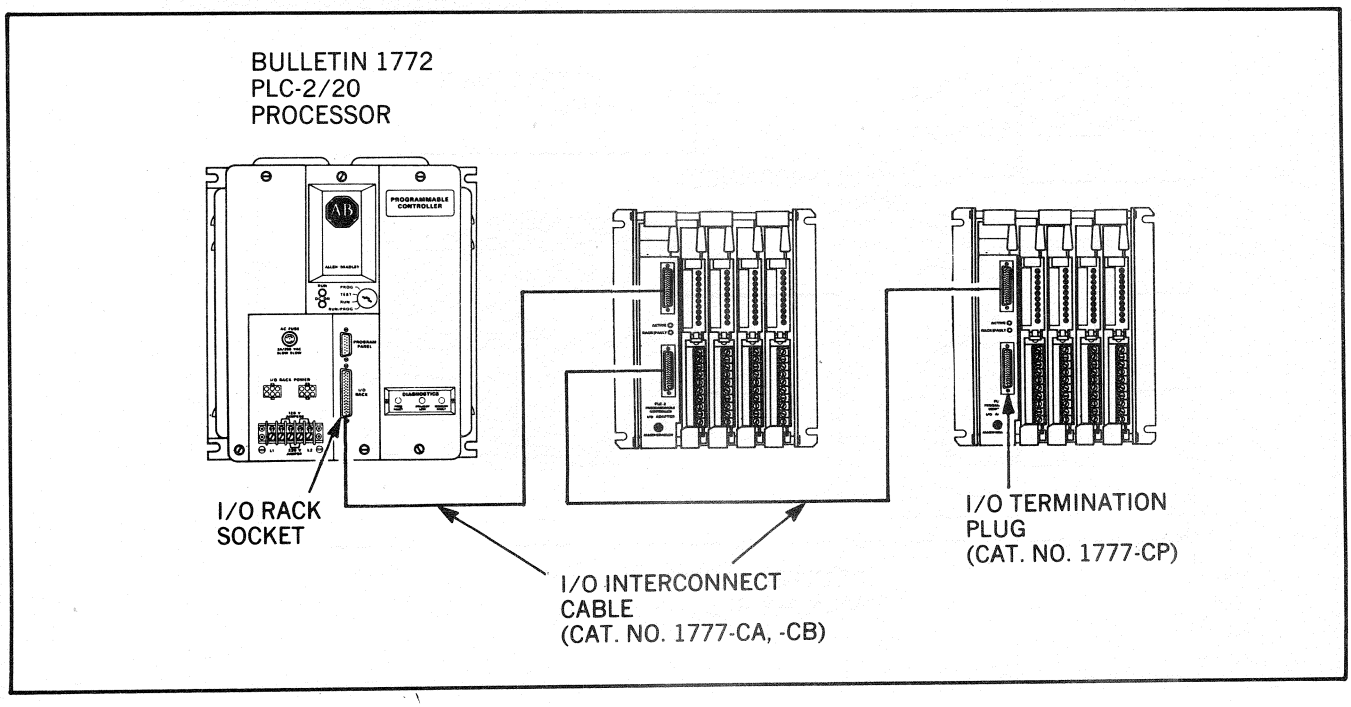



**FIGURE 13 — I/O Cable Connections**

I/O Interconnect Cables (Cat. No. 1777-CA, -CB) are used to establish the I/O communication channel when Bulletin 1771 and Bulletin 1777 I/O Racks are both used with the same PLC-2/20 Processor. Figure 14 shows one possible configuration for this combination of I/O Racks.

One I/O Interconnect Cable originates at the PLC-2/20 Processor socket labeled I/O RACK and terminates at the top socket of the I/O Adapter Module on the first Bulletin 1777 I/O Rack.

Another I/O Interconnect Cable originates at the lower socket of the Adapter Module on the first I/O Rack and terminates at the upper socket of the Adapter Module on the second I/O Rack. For connection of a third I/O Rack (in this case, a Bulletin 1771 I/O Rack), this same pattern is followed.

To complete I/O interconnections, an I/O Termination Plug must be placed on the bottom socket of the Adapter Module on the last I/O Rack in the chain.

When Bulletin 1771 and 1777 I/O Racks are used with the same PLC-2/20 Processor, I/O Racks may be connected in any order along the serial chain. However, Rack Address Grouping (Bulletin 1777) and Rack Number (Bulletin 1771) must be compatible.

## POWER CONNECTIONS

Power to PLC-2 I/O Adapter Modules and the logic side of Bulletin 1771 I/O Modules can be supplied by the following Power Supplies:

- Bulletin 1771 System Power Supply (Cat. No. 1771-P1)
- Bulletin 1771 Auxiliary Power Supply (Cat. No. 1771-P2)
- Bulletin 1772 System Power Supply (Cat. No. 1772-P1, Series B or later)
- Bulletin 1777 Auxiliary Power Supply (Cat. No. 1777-P2, Series B or later)

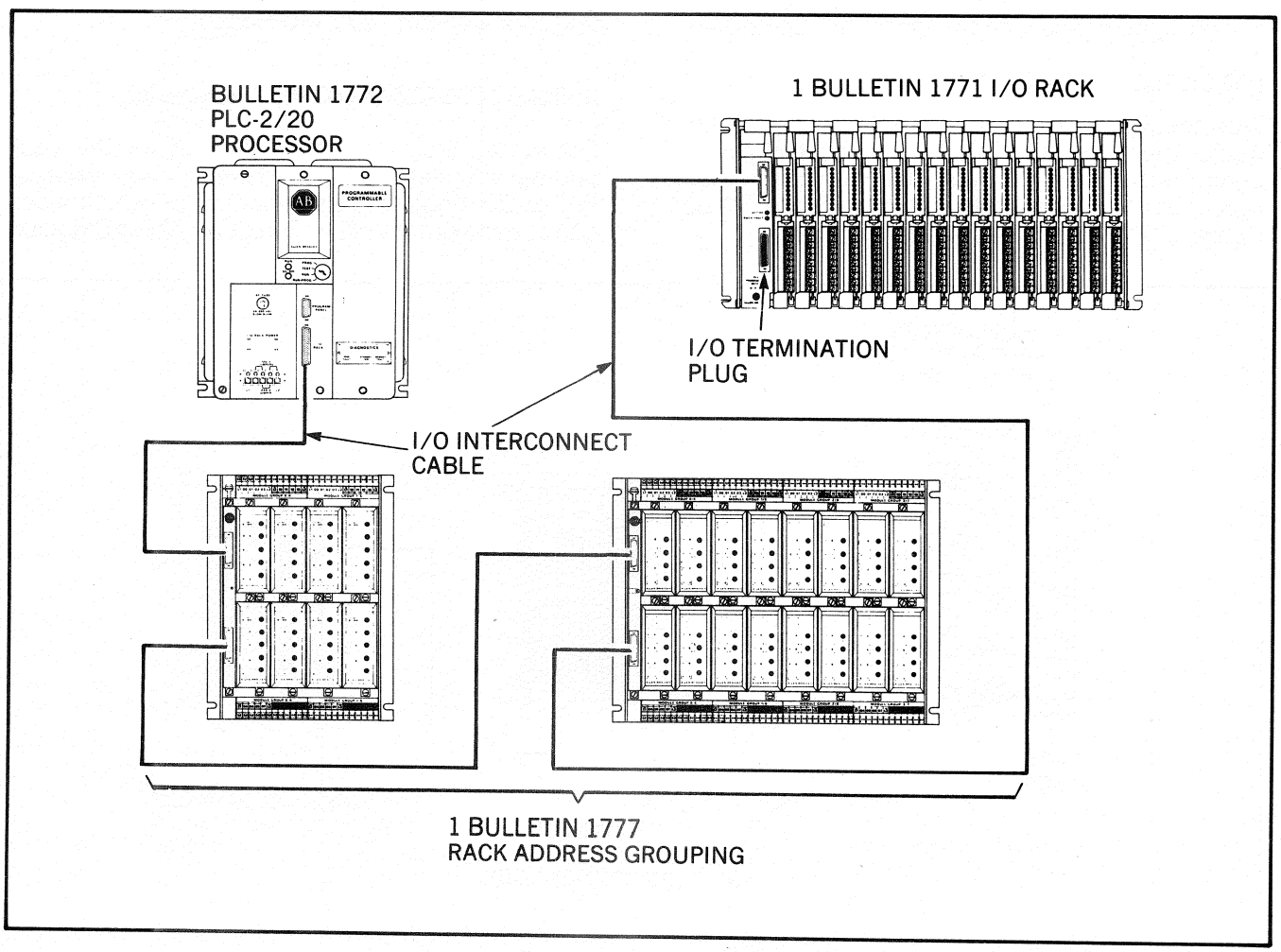



**FIGURE 14 — Bulletin 1771, 1777 I/O Rack Interconnections**

There are two cables which may be used to connect a Bulletin 1771 I/O Rack to either Bulletin 1771 Power Supply. These cables are:

- I/O Power Cable (Cat. No. 1771-CE), for I/O Chassis side plate mounting
- I/O Power Cable (Cat. No. 1771-CD), 5 feet

Power Cable connectors are labeled to aid with proper orientation. The connector labeled I/O RACK mates with the socket on the I/O Chassis backplane. The connector labeled PWR SPLY mates with the socket on the base of the Supply.

Figure 15 shows the Bulletin 1771 Auxiliary Power Supply connection to the I/O Chassis using the Cat. No. 1771-CE I/O Power Cable. (The Cat. No. 1771-CD connection differs by Cable length.)

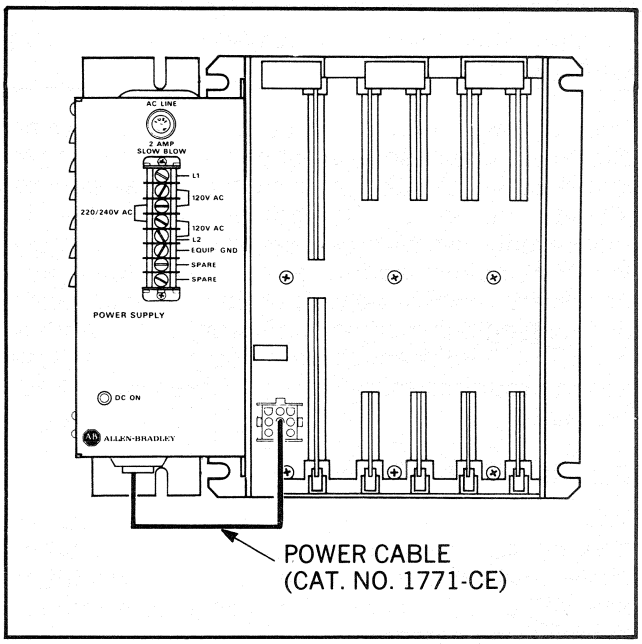



**FIGURE 15 — Auxiliary Power Supply Connections**

There are also two cables which may be used to connect a Bulletin 1771 I/O Rack to either Bulletin 1772 or 1777 Power Supply. These cables are:

- I/O Power Cable (Cat. No. 1771-CK), 3 feet
- I/O Power Cable (Cat. No. 1771-CJ), 8 feet

Each Cable connects from the 6-hole socket on the Bulletin 1772 or 1777 Power Supply front panel to the 9-hole socket on the Bulletin 1771 I/O Chassis backplane (Figure 11).

Connectors on both sets of Cables (Cat. No. 1771-CE, -CD and 1771-CK, -CJ) have snap-locks which firmly hold the connector in the socket once connection is made.

## POWER SUPPLIES

Bulletin 1771 System Power Supplies and Auxiliary Power Supplies, Bulletin 1772 System Power Supplies, and Bulletin 1777 Auxiliary Power Supplies are designed to operate with jumpers on terminals at the Supply front panel. A Bulletin 1771 and 1777 Auxiliary Power Supply is shown in Figure 16 and 17, respectively.

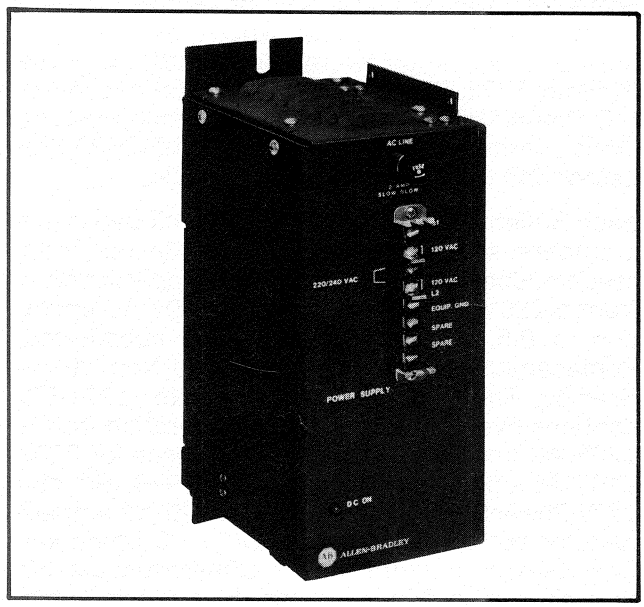



**FIGURE 16 — Bulletin 1771 Auxiliary Power Supply**

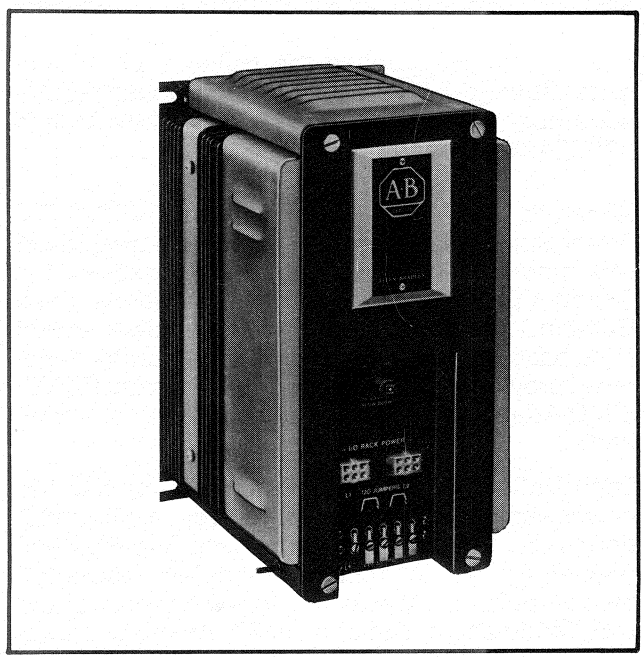



**FIGURE 17 — Bulletin 1777 Auxiliary Power Supply**

When factory-shipped, these Power Supplies have jumpers installed for 120V AC operation. For 220/240V AC operation, users must remove both jumpers and connect one of them to a different set of terminals. Jumper locations for 120V or 220/240V AC are indicated next to the terminals.

Bulletin 1771 and Bulletin 1772/1777 Supply circuitry monitors input and output voltage and current conditions to maintain proper operating levels for logic circuitry. This protective circuitry shuts down the Power Supply when these levels are not within specified tolerances. Shutdown of the Bulletin 1771 Power Supply or disconnection of I/O Power Cables causes a fault which, in turn, stops communication between the PLC-2/20 Processor and the Bulletin 1771 I/O Racks.

Each Bulletin 1771 Power Supply is shipped with a 1 ampere, slow-blow AC line fuse installed. The 1 ampere fuse is required when the Supply operates from a 120V AC source. For 220/240V AC operation, a 0.5 ampere fuse must be substituted. Replacement fuses may be ordered from Allen-Bradley. The Fuse Package (Cat. No. 1771-FP) contains five 1 ampere fuses for operation from a 120V AC line and five 0.5 ampere fuses for 220/240V AC operation. Prior to June, 1979, Bulletin 1771 Power Supplies were shipped with a 2 ampere fuse for both 120V and 220/240V AC operation. Changing to 1 ampere and 0.5 ampere fuses is due to a change in specifications. It is not required, however, that the 2 ampere fuse in existing Power Supplies be changed.

Like Bulletin 1771 Power Supplies, Bulletin 1772 System Power Supplies and Bulletin 1777 Auxiliary Power Supplies are fuse protected at the input circuit. However, unlike the Bulletin 1771 Supplies, Bulletin 1772/1777 Power Supplies require a 2 ampere, slow-blow fuse for both 120V AC and 220/240V AC operation.

Generally, both the Bulletin 1771 and 1772/1777 Power Supplies can provide power to a quantity of I/O modules, so configured not to exceed the Supply's physical and electrical limitations. Each Bulletin 1771 Power Supply has one power socket at its base (physical limitation) and circuitry capable of providing 6.5 amperes output current to PLC-2 I/O Adapter and I/O Modules (electrical limitation).

Each Bulletin 1772/1777 Power Supply has two power sockets at its front panel (physical limitation). A Bulletin 1772 System Power Supply, when providing power to Processor modules, has 3 amperes output current available to I/O Adapter(s) and I/O Modules; a Bulletin 1777 Auxiliary Power Supply has circuitry capable of providing 8 amperes output current to I/O Adapter(s) and I/O Modules (electrical limitation).

In any case, the exact number of I/O modules which can draw power from any one Supply must be determined by adding current requirements (from the Power Supply +5.1V DC circuit) for each module drawing power from this Supply. Use the figures listed in Table B. Be sure this total is less than the output current of the specific Power Supply being used (Table C).

Supply output current limitations are an important factor in installations in which several I/O modules having large current drain, such as Analog Input (8 bit) or Contact Output, draw power from the same Power Supply.

**CAUTION: Output current capacity of Bulletin 1771, Bulletin 1772, and Bulletin 1777 Power Supplies must not be exceeded. Overcurrent conditions can damage Power Supply circuitry. Protective circuitry is designed to shut down the Supply when current ratings (listed in Table C) are exceeded.**

Should Power Supply output current capacity be exceeded, one of several actions must be taken to guard against another occurrence. These actions include changing I/O module configuration to more evenly distribute current drawn from separate Power Supplies; adding another I/O Rack and necessary Power Supply, if possible; a combination of changing I/O module configuration and adding another I/O Rack and Power Supply. Each of these actions requires modification of present I/O addressing.

### Bulletin 1771 Power Supplies

Information on Bulletin 1771 Power Supply operation, limitations, and fusing was described previously. Supplemental information, as it relates to use with Bulletin 1771 I/O Racks, is presented in the following paragraphs.

Although the System Power Supply is designed to power a Mini-PLC-2 Programmable Controller, it may also be used to power a Bulletin 1771 I/O Rack which is used with the PLC-2/20 Programmable Controller. The Battery Pack, standard with this Supply, is not used in such an application. If the Battery Pack is left in its mounting bracket, remove batteries.

Because the Bulletin 1771 System Power Supply has circuitry for monitoring battery condition, the user may find it more economical to use a Bulletin 1771 Auxiliary Power Supply to power PLC-2 I/O Adapter and Bulletin 1771 I/O Module logic circuitry.

### Bulletin 1772/1777 Power Supplies

Information on Bulletin 1772 System Power Supply and Bulletin 1777 Auxiliary Power Supply opera-

**TABLE B — Module Current Requirements**

| MODULE | CAT. NO. | ALLEN-BRADLEY POWER SUPPLY +5.1V DC CURRENT REQUIRE-MENTS |
|---|---|---|
| **INPUT MODULES** | | |
| BULLETIN 1771 I/O | | |
| AC/DC (120V) | 1771-IA | 74 mA |
| DC (12-24V) | 1771-IB | 74 mA |
| DC (48V) | 1771-IC | 74 mA |
| Isolated AC/DC (120V) | 1771-ID | 50 mA |
| Analog (8 bit) | 1771-IE | 400 mA |
| TTL | 1771-IG | 122 mA |
| DC (24-48V) | 1771-IH | 74 mA |
| AC/DC (220/240V) | 1771-IM | 75 mA |
| BULLETIN 1777 I/O | | |
| AC/DC (120V) | 1777-IA | 60 mA |
| DC (12-48V) | 1777-IB | 60 mA |
| TTL | 1777-IG | 70 mA |
| AC/DC (220/240V) | 1777-IM | 60 mA |
| DC (12-24V) | 1777-IQ | 60 mA |
| DC (48V) | 1777-IR | 60 mA |
| Fast Response DC (12-24V) | 1777-IT | 60 mA |
| **OUTPUT MODULES** | | |
| BULLETIN 1771 I/O | | |
| AC (120V) | 1771-OA | 210 mA |
| DC (12-24V) | 1771-OB | 165 mA |
| DC (48V) | 1771-OC | 165 mA |
| Isolated AC (120V) | 1771-OD | 225 mA |
| TTL | 1771-OG | 168 mA |
| AC (220/240V) | 1771-OM | 225 mA |
| Contact | 1771-OY | 420 mA |
| BULLETIN 1777 I/O | | |
| AC (120V) | 1777-OA | 110 mA |
| DC (12-48V) | 1777-OB | 70 mA |
| TTL | 1777-OG | 120 mA |
| AC (220/240V) | 1777-OM | 110 mA |
| **MISCELLANEOUS** | | |
| Absolute Gray Encoder | 1771-DL | 250 mA |
| PLC-2 I/O Adapter | 1771-AL | 700 mA |
| I/O Adapter | 1777-AL | 700 mA |
| PLC-2/20 Processor | 1772-LP1 | 5 A |

**TABLE C — Power Supply (+5.1V DC) Output Capacities**

| POWER SUPPLY | +5.1V DC OUTPUT CIRCUIT CURRENT AVAILABLE TO I/O RACKS |
|---|---|
| System Power Supply (Cat. No. 1771-P1) | 6.5 A |
| Auxiliary Power Supply (Cat. No. 1771-P2) | 6.5 A |
| System Power Supply (Cat. No. 1772-P1) | 3 A [1] |
| Auxiliary Power Supply (Cat. No. 1777-P2) | 8 A |

[1] System Power Supply (Cat. No. 1772-P1) outputs 5 amperes to Processor modules leaving 3 amperes for logic circuitry of I/O Adapter and I/O Modules.

tion, limitations, and fusing was described previously. Supplemental information as it relates to use with Bulletin 1771 I/O Racks, is presented in the following paragraphs.

Bulletin 1772/1777 Power Supplies must be Series B, or later to be used with certain Bulletin 1771 I/O Modules. Should the user have a Bulletin 1772/1777 Power Supply which is not marked Series B, assume the Supply is Series A. Series A Bulletin 1772/1777 System and Auxiliary Power Supplies can be updated to the Series B level. Contact the factory for update information.

Because the Bulletin 1777 Auxiliary Power Supply output current available to I/O modules is larger than that of the Bulletin 1772 System Power Supply, an Auxiliary Supply can provide power to a greater number of I/O modules, or to I/O modules which have larger current requirements.

ALLEN-BRADLEY
Cleveland, Ohio 44143

P/N 955090-02

# MOUNTING DIMENSIONS • PLC-2 PROGRAMMABLE CONTROLLER

**Cabinet Mounting** — The drawings in this publication show the mounting dimensions for the various units used in Bulletin 1772-PLC-2 programmable controller.

Mounting flanges on all units are slotted for 1/4" diameter bolts at all mounting bolt locations.

The 64-I/O Rack (Cat. No. 1777-A1) can be mounted directly to a standard 19-inch rack mounting. However, the 32-I/O Rack (Cat. No. 1777-A2), the Processor and Power Supply (Cat. No. 1772-LR) and the Auxiliary Power Supply (Cat. No. 1777-P2) are **not** designed for 19-inch rack mounting. In applications using 19-inch rack mounts, it is suggested that the user fabricate a metal plate and bolt it to the mounts. The PLC-2 controller equipment can be attached to the place according to the dimensions given in this publication.

When mounting this equipment in an enclosure, the **minimum** acceptable cabinet "working depth" is 10 inches. Working depth is defined as the distance from the front surface of the mounting panel to the inside of the rear of the door.

Some panels may be fixed on, or very close to, the inside rear wall of the enclosure. Many others are mounted on standoffs which may use up valuable space. Thus, when specifying a NEMA Type 12 enclosure for the PLC-2, make sure to carefully examine the vendor's data sheets for standoff measurements; then calculate the "working depth" available.

Note that the PLC-2 Processor is 8.8 inches deep, but the key adds 0.75 inch; the I/O Interconnect Cable adds 0.13 inch. The other end of this cable adds 0.38 inch to the I/O Rack depth. Enclosures having a 10-inch "working depth" provide sufficient depth for the key and cable connector.

Also, note that some enclosures mount print pockets on the inside of the door. These, too, consume working depth.

Typical enclosures and panel layouts are illustrated here. One example of a minimum 32 I/O programmable controller system and two layout approaches for a maximum 256 I/O system are shown. Note that these are suggested layouts, but the particular size of enclosure and number of components allow for a number of other possibilities. Certain restrictions are noted, and these may be generally applied in all cases, whatever enclosure actually chosen.

**Minimum** — For a minimum PLC-2 controller consisting of 1 Processor, 1 32-I/O Rack, necessary wire channels, magnetics, transformers (if required), and disconnect switches a variety of sizes and types of enclosures are available. The Allen-Bradley Bulletin 1000 Enclosure, as specified here, is acceptable, although equivalents may be used. A user may find an even smaller enclosure to be acceptable, yet this illustration was designed to provide three distinct areas for devices which may be necessary in common applications. The user should plan his panel layout on the basis of his individual needs. (Refer to Figure 1 and to WARNING on Page 6.)

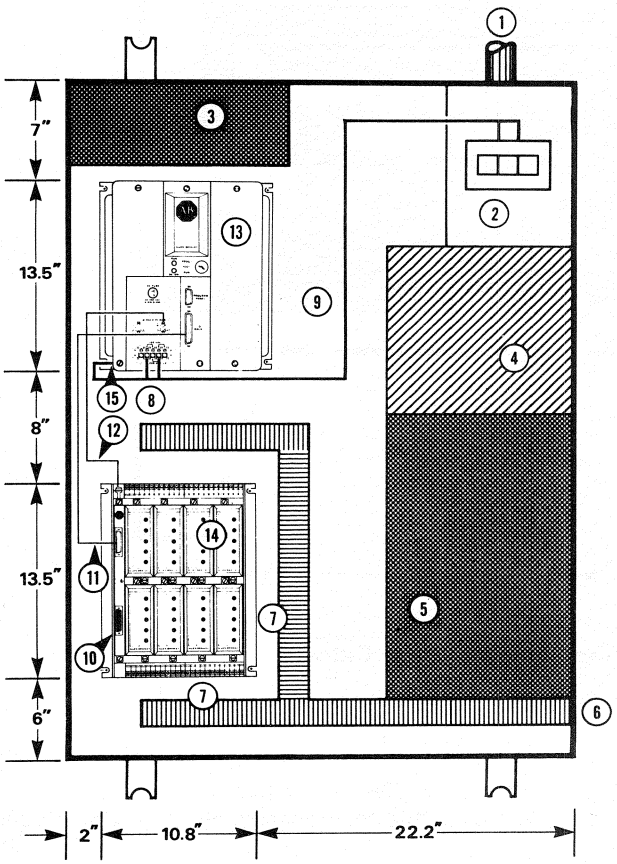



**Figure 1 — Typical Minimum Enclosure Layout**

Figure 1 Legend:

1. User-supplied 120/240V AC line. User must punch hole in cabinet.
2. This 9" x 12" area fixed for disconnect device.
3. Usable area (6" x 15"); if possible keep clear to aid heat dissipation. Do not clutter or mount heat sensitive devices.
4. Area (12" x 13") available for transformer. Maintain 2" channel/transformer distance if 220/240V AC is used.
5. Available area, note also a 64-I/O Rack will extend into this area (approx. 20" x 13").
6. User must punch hole in cabinet for I/O wiring. Location of this hole and cable channel highly dependent on application.
7. Distance between channel and device shown as 2". May be reduced to 1" in space limited applications.
8. Maintain 4" Processor/channel distance. When 120V AC is used this distance may be reduced to 2".
9. Minimum 2" required from Processor to AC line.
10. Termination Plug (Cat. No. 1777-CP)
11. I/O Interconnect Cable (Cat. No. 1777-CA, 3 feet)
12. I/O Power Cable (Cat. No. 1777-AD, 3 feet)
13. Basic Processor and Power Supply (Cat.No.1772-LR)
14. 32-I/O Rack Assembly (Cat. No. 1777-A2)
15. Ground terminal

Bulletin 1000 Enclosures with a working depth greater than 8 inches are stocked without disconnect slots. However, this mounting slot (for 30A to 200A disconnect or EF, FJ, and JL frame circuit breakers) can be cut at assembly. The disconnect and circuit breaker frame is purchased separately. It is illustrated in Figure 1 at the upper right, although its position may be changed.

This particular 35 x 48 inch (W x H) cabinet was chosen on the basis of the following features:

- Designed for wall mounting
- Overall size allows for comfortable layout of components
- Distance from panel surface to inside door surface met 8.8 inch working depth with margin for variation in standoffs

The particular Bulletin 1000 unit is Part No. EO354812W1J, which is 35 x 48 x 14-1/8 inches (W x H x D). This is a single-door, wall mounted enclosure that can be optionally floor mounted. (Refer to Product Data Sheet 1000-900.)

**Maximum** — In the case of maximum I/O capability for the PLC-2 system 1 Processor, 4 64-I/O Racks, 1 Auxiliary Power Supply, necessary wire channel

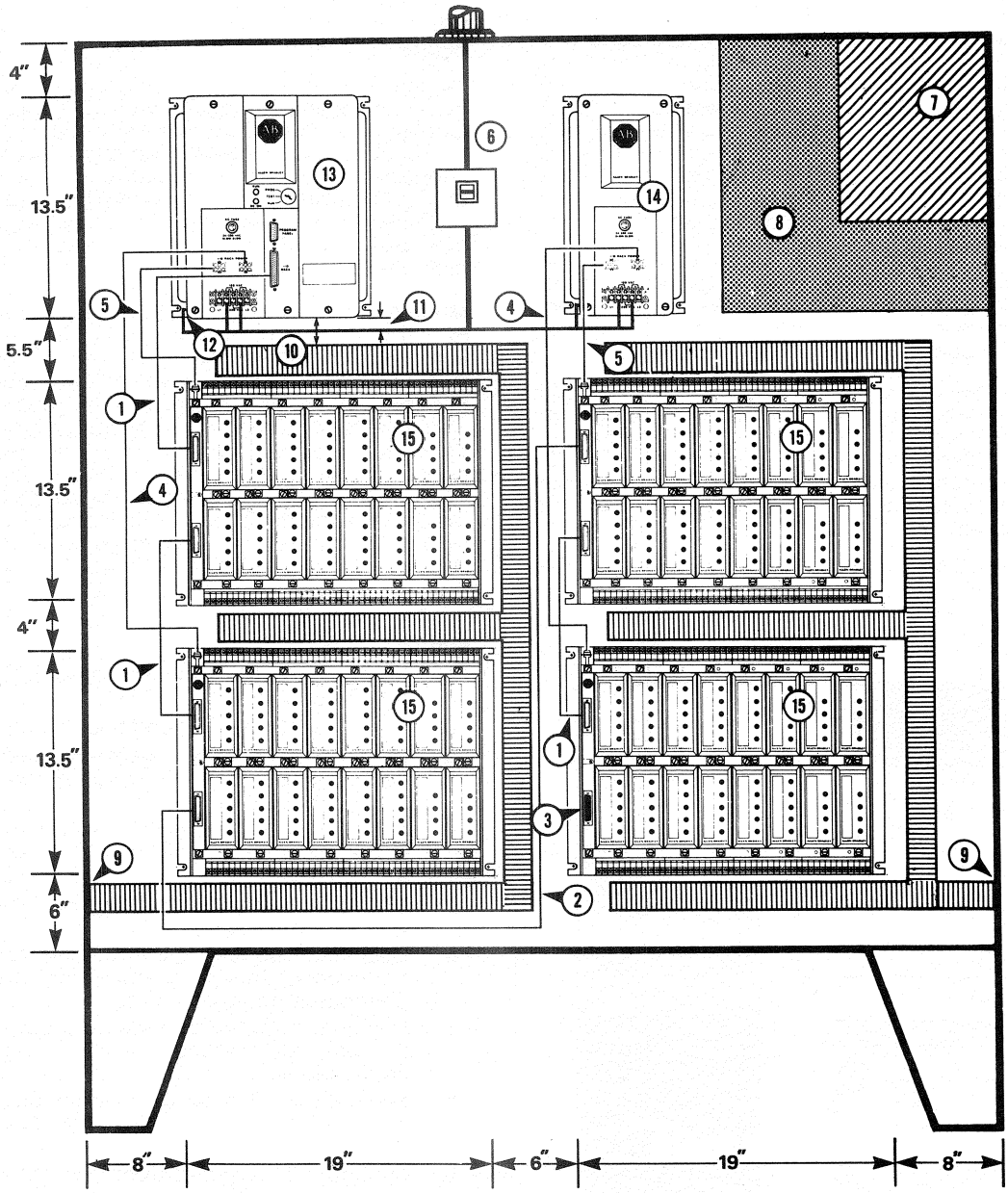



**Figure 2 — Typical Maximum Enclosure Layout; Multiple Cutouts**

Figure 2 and 3 Legend:

1. I/O Interconnect Cable (Cat. No. 1777-CA, 3 feet)
2. I/O Interconnect Cable (Cat. No. 1777-CB, 6 feet)
3. Termination Plug (Cat. No. 1777-CP)
4. I/O Power Cable (Cat. No. 1777-AC, 8 feet)
5. I/O Power Cable (Cat. No. 1777-AD, 3 feet)
6. User-supplied 120/240V AC line. User must punch hole in cabinet.
7. This 9" x 12" area is reserved for disconnecting means. (AB 30A - 600V nonfused)
8. Area available for transformer, magnetics, fuses; do not come closer than 2" to channel if using 220/240V AC.

magnetics, transformers, and disconnect means are often required. A typical Allen-Bradley Bulletin 1000 Enclosure, Part No. ED606012L2J, was chosen although equivalents may be used. This enclosure provides adequate component spacing for the Processor, I/O Racks, Auxiliary Power Supply, and system wiring. A larger enclosure may be required for applications using several electro-mechanical devices, such as motor starters, contactors, or relays. The user should plan the panel layout on the basis of his individual needs.

Two possible layouts are presented. Figure 2 provides individual cutouts for input power, input lines from field wired devices, and output lines to field devices. Figure 3 layout provides a single cutout for all incoming and outgoing signals. This may not be acceptable in all installations, especially those using 220/240V AC. (The legend is common for both Figures.)

These two maximum configurations are designed around a 60 x 60 x 13-13/16 inches (W x H x D) enclosure. It was found to:

- Meet requirements (min.) for component spacing
- Provide an area (min) for required magnetics
- Easily meet the working depth requirement for the PLC-2 system (9.55 inches with key)

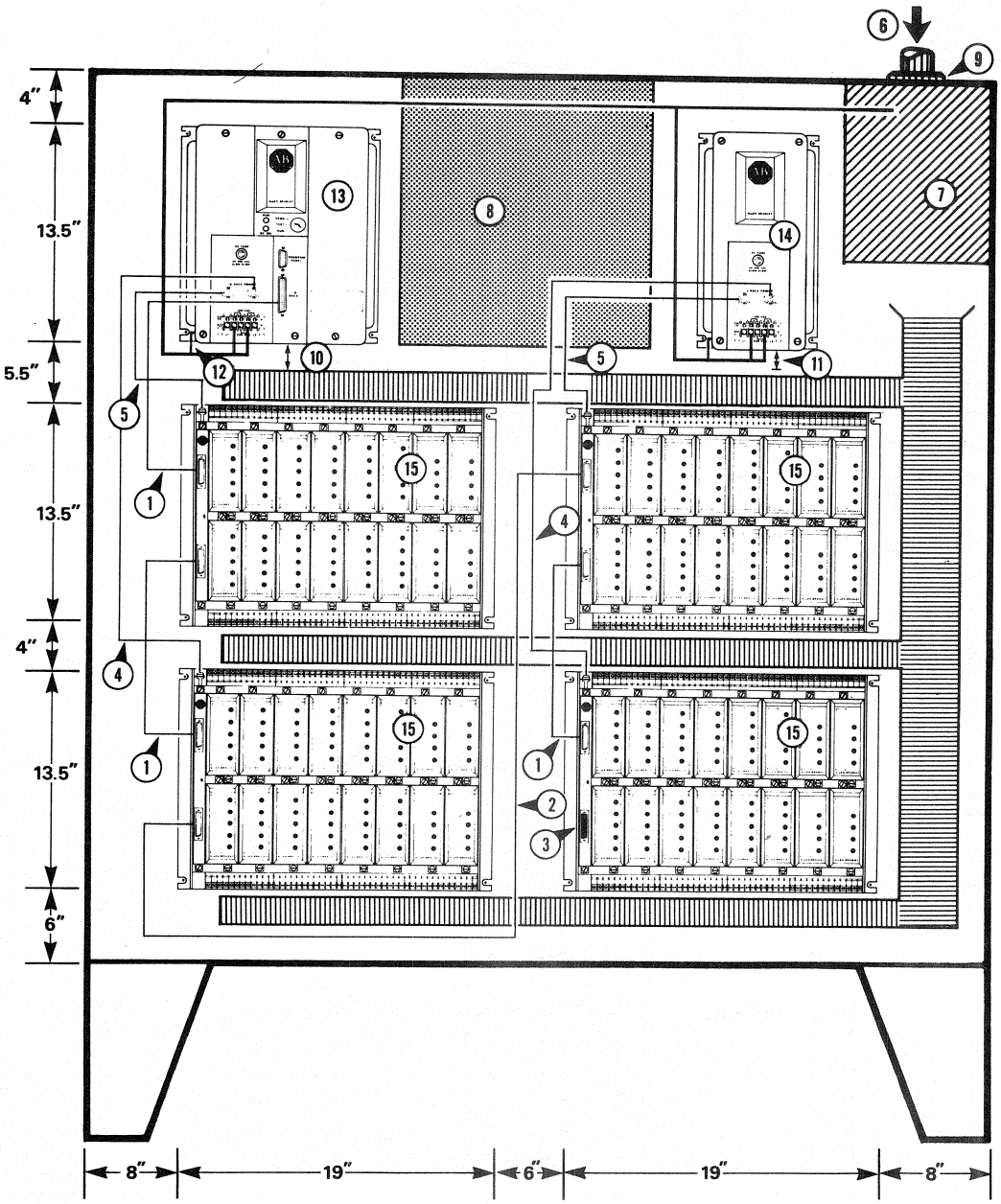



**Figure 3 — Typical Maximum Enclosure Layout; Single Cutout**

9. User must punch hole in cabinet.
10. Processor/channel separation of 4" for 220/240V AC; reduce to 2" for 120V AC.
11. Maintain 2" Processor/supply line distance when 220/240V AC is used.
12. Ground terminal.
13. Basic Processor and Power Supply (Cat. No. 1772-LR)
14. Auxiliary Power Supply (Cat. No. 1777-P2)
15. 64-I/O Rack Assembly (Cat. No. 1777-A1)

This 2-door enclosure, as specified, comes with floor mounting hardware. Additional information on Bulletin 1000 Enclosures is presented in Product Data Sheet 1000-900.

The mounting dimensions for the PLC-2 Processor are shown in Figure 4. Dimensions for the 64-I/O Rack are shown in Figure 5. The 32-I/O Rack is shown in Figure 6. Finally, the Auxiliary Power Supply is shown in Figure 7.

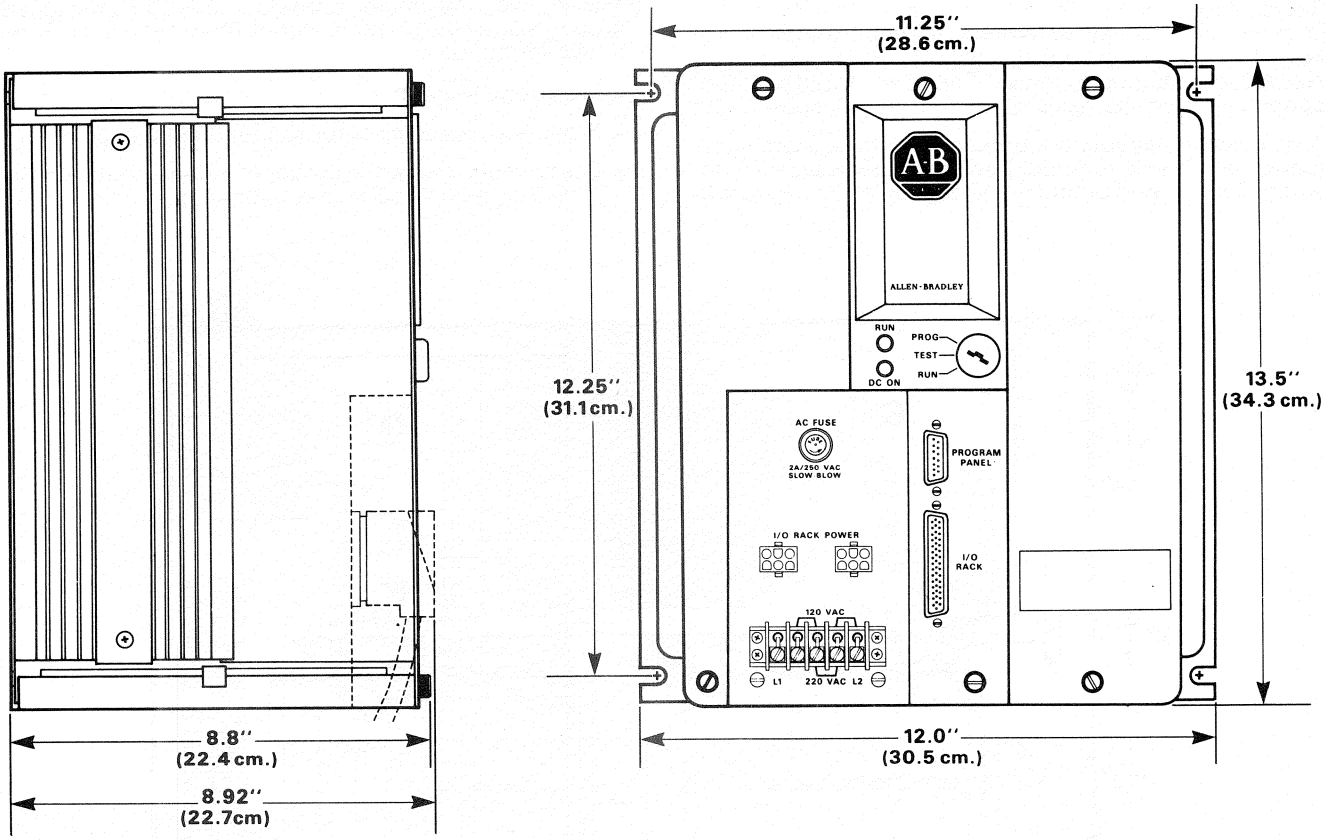



**Figure 4 — Processor and Power Supply (Cat. No. 1772-LR)**

**NOTE:** Inserting the key adds approximately 3/4" (1.90 cm.) to the depth of the Processor. Connecting the I/O Interconnect Cable to its socket adds approximately 1/8" (0.32 cm.) to the depth of the Processor.

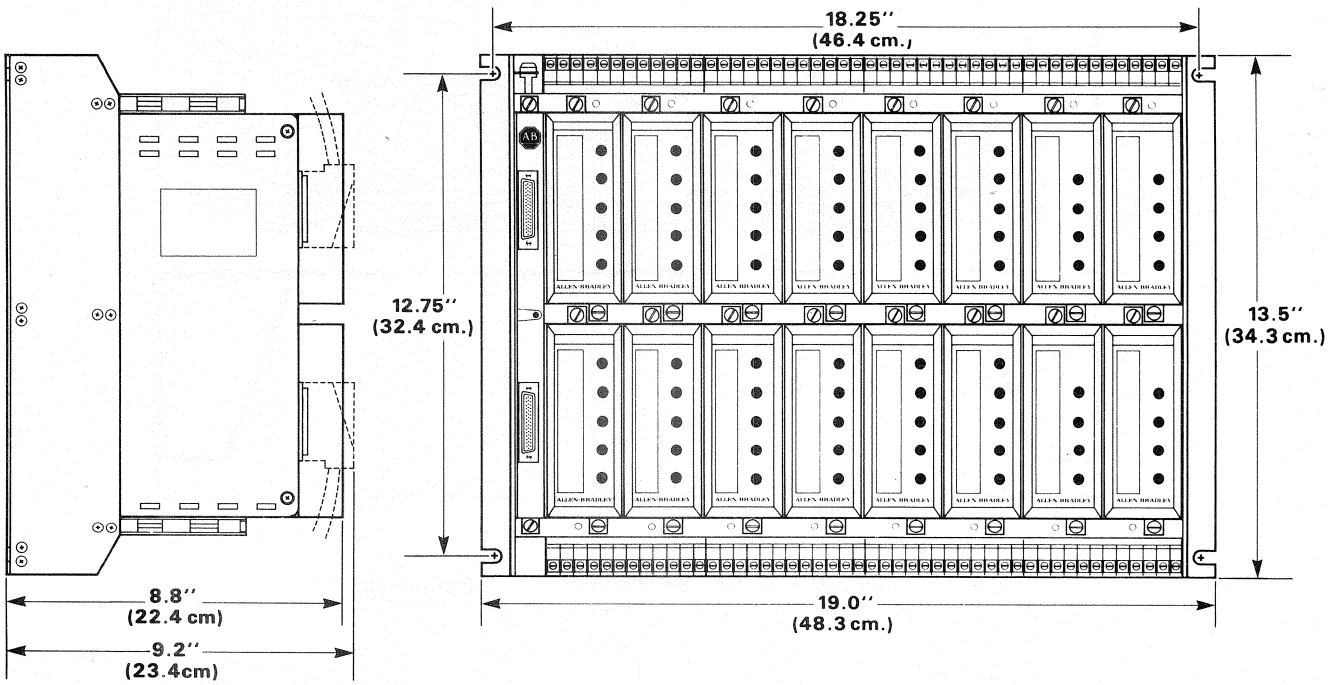



**Figure 5 — 64-I/O Rack (Cat. No. 1777-A1)**

**NOTE:** Depth given is for an I/O Rack containing I/O Modules. Depth without Modules is 3.0" (7.62 cm.). I/O Termination Plug and I/O Interconnect Cable connector extend approximately 3/8" (0.95 cm.) beyond I/O Modules when fixed for operation.

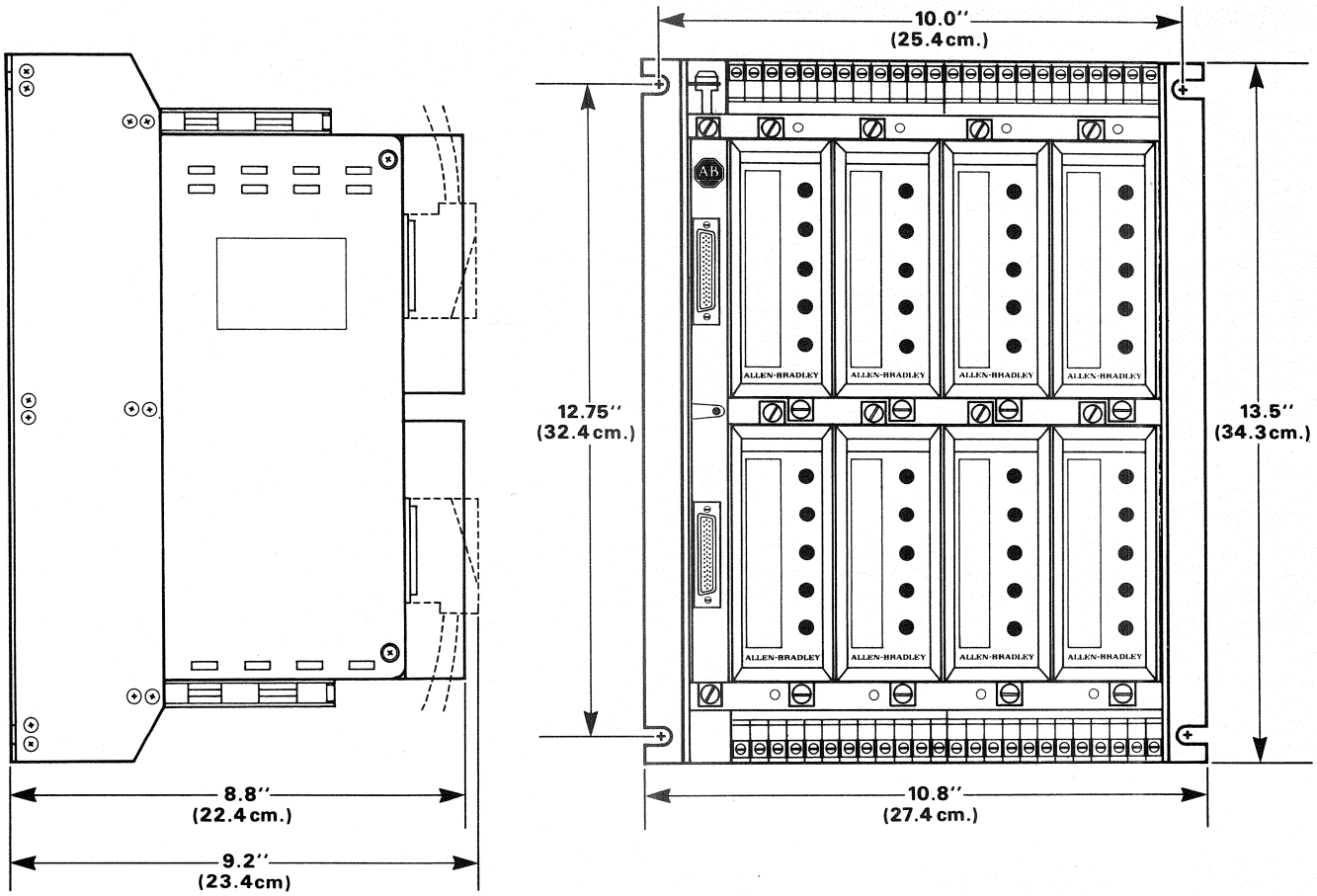



**Figure 6 — 32-I/O Rack (Cat. No. 1777-A2)**

**NOTE:** Depth given is for an I/O Rack containing I/O Modules. Depth without Modules is 3.0" (7.62 cm.). I/O Termination Plug and I/O Interconnect Cable connector extend approximately 3/8" (0.95 cm.) beyond I/O Modules when fixed for operation.

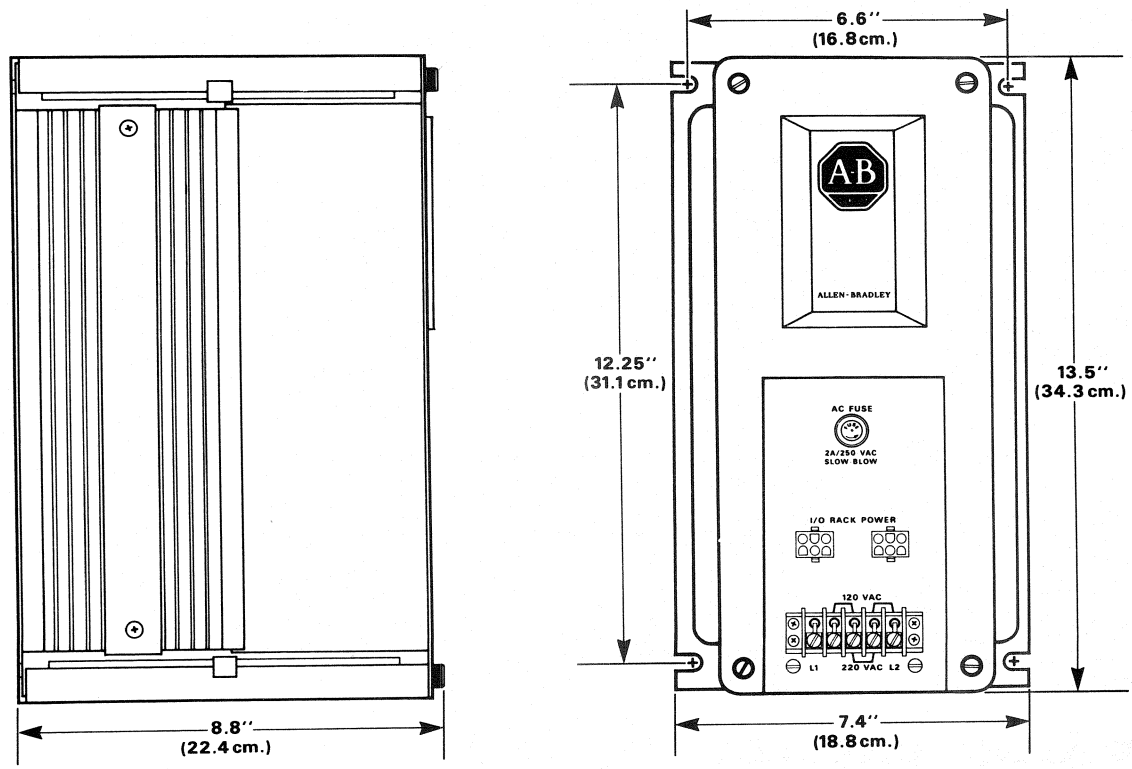



**Figure 7 — Auxiliary Power Supply (Cat. No. 1777-P2)**

**WARNING:** When installing the PLC-2 Processor in an enclosure with a sealing capability (such as NEMA Type 4 or Type 12) and with an internal volume of less than 12 cu. ft., care must be taken to provide adequate ventilation. During charging periods there is a possibility that the Memory Battery (Cat. No. 1772-BG) may generate hydrogen and oxygen gasses which could accumulate in the enclosure. This could be a potentially hazardous situation if ignition sources are also present in small enclosures.

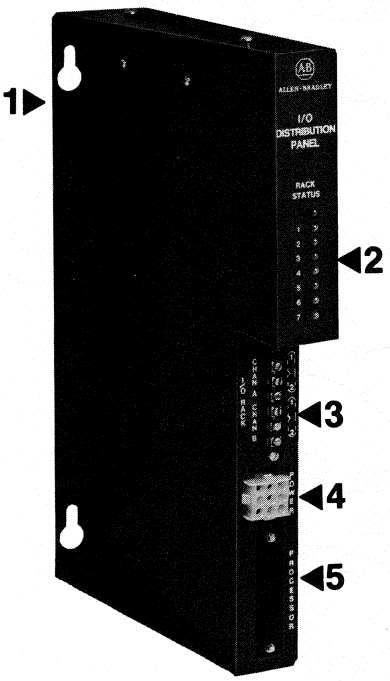
In order to dissipate these gasses in installations having less than 12 cu. ft. internal volume, additional ventilation must be provided in one of 3 ways. First: By locating an unobstructed hole 0.31 inch in diameter anywhere in the surface of the enclosure. Second: By the inclusion of a gap of 0.6 sq. in. (min.) in the lower door lip of the enclosure. Third: By assuring that these gasses are able to escape **into** long runs of conduit.

**CAUTION:** Care must be taken to maintain proper "sealing" of the enclosure against industrial environments.

If the required ventilation cannot be provided, specify Memory Module (Cat. No. 1772 MN) which includes a NiCad Memory Battery (Cat. No. 1772-BN) at the time of system order.

A-B QUALITY
ALLEN-BRADLEY
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# ALLEN-BRADLEY
# REMOTE I/O SCANNER/DISTRIBUTION PANEL
## Cat. No. 1772-SD




1. Mode Select Switches Cover Plate
2. RACK STATUS Indicators
3. I/O RACK Terminal Strip
4. POWER Connection Socket
5. PROCESSOR Connection Socket

### SPECIFICATIONS

**Function**
Distribute output status data to outputs
Gather input status data from inputs

**Max. No. of I/O Points**
896

**Current Requirement**
(from System Power Supply)
2 amperes max.

**Ambient Temperature Rating**
0° to 60° c (operational)
-40° to 85° c (storage)

**Relative Humidity Rating**
5% to 95%
(without condensation)

**Dimensions**
W x H x D
2.5 x 13.75 x 8.63 inches
6.35 x 34.9 x 21.9 cm

### INTRODUCTION

The Remote I/O Scanner/Distribution Panel (Cat. No. 1772-SD) is a compact, single board, stand-alone unit. It enables the Allen-Bradley PLC-2, PLC-2/20 and PLC-2/30 Processors to communicate with up to 896 Input/Output (I/O) points, as indicated in Table A.

**TABLE A — Maximum I/O**

| PROCESSOR | MAXIMUM I/O* |
|---|---|
| PLC-2 (1772-LR) | 256 |
| PLC-2/20 (1772-LP1 | 512 |
| PLC-2/20 (1772-LP2) | 896 |
| PLC-2/30 (1772-LP3) | 896 |

* I/O maximum is 256 regardless of processor type if system includes any 1777 I/O.

Bulletin 1771 I/O Racks may be placed up to 10,000 feet away from the Scanner/Distribution Panel.

Interconnection between the Scanner/Distribution Panel and the Remote I/O Adapter Module (Cat. No. 1771-AS) is via Cat. No. 1770-CD twinax cable (Figures 1 and 2).

NOTE: The cable limitation is 10,000 ft. for each channel (20,000 ft. total) at low Baud rates, or 5000 ft. for each channel (10,000 ft. total) at high Baud rates.

The functions of the Remote I/O Scanner/Distribution Panel are:

- Gather input data from Remote I/O Adapter Modules (1771-AS) and send this data to the PLC-2, PLC-2/20 and PLC-2/30 Processor which uses it to update the Input Image Table.
- Receive Output data from the Output Image Table of the PLC-2, PLC-2/20 and PLC-2/30 Processor and distribute this data to Remote I/O Adapter Modules (1771-AS), thereby updating the status of the output signals.

The Scanner/Distribution Panel may be connected directly for all **remote** I/O, or up to 2 **local** I/O racks may be connected between it and the PLC-2. Remote I/O consists of Racks of up to 128 I/O, made up of 1 to 4 1771 I/O Chassis. (Refer to Pub. No. 1771-938, Remote I/O Adapter Module Assembly.)

Figures 1 and 2 outline I/O configuration examples and Figure 3 illustrates I/O addressing.

#### Status Indicators

The front of the Scanner/Distribution Panel has eight bicolor red/green LED indicators. If the I/O Rack is declared used and serial communication is valid, that Rack status LED will be green. If not used, the LED will be off. For any I/O Rack fault condition, the corresponding Rack Status LED will be red.

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Publication 1772-910 — October, 1981

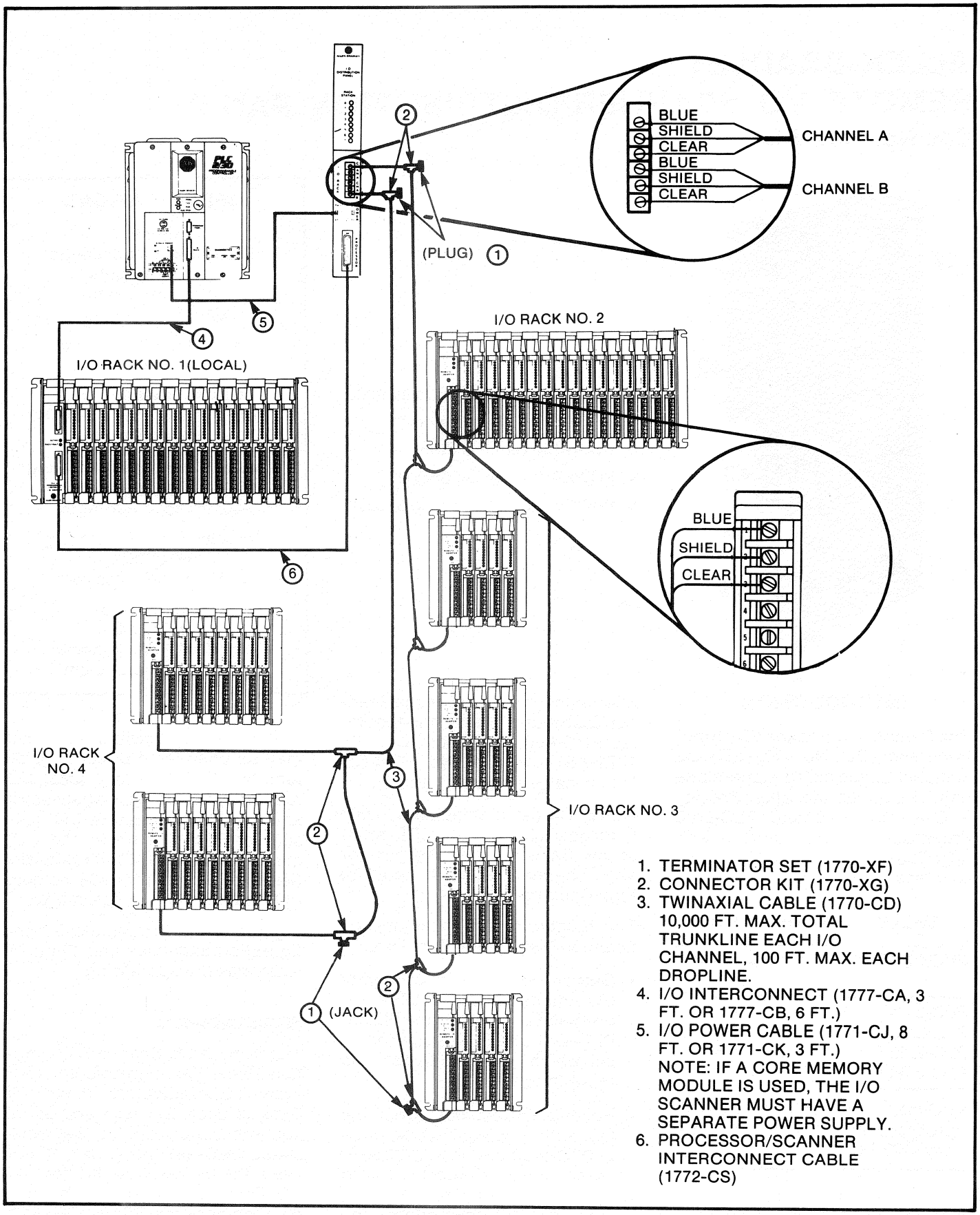



**FIGURE 1 — I/O Trunkline/Dropline Configuration Example**

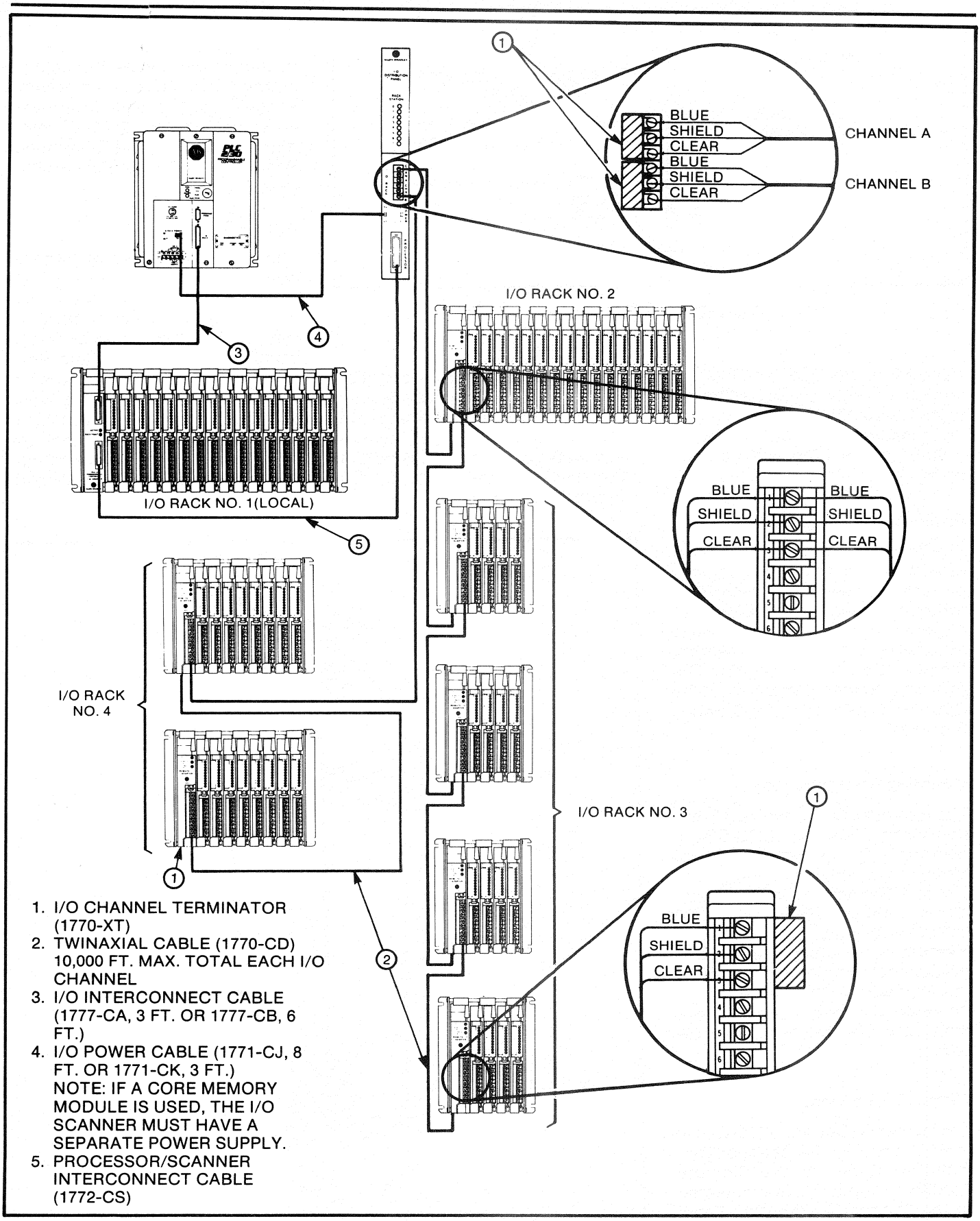



**FIGURE 2 — Daisy Chain Configuration Example**

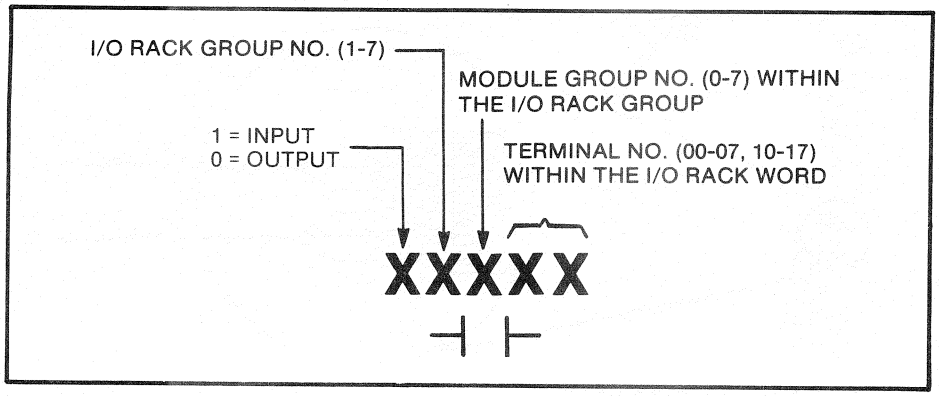



**FIGURE 3 — I/O Addressing**

At power up the Scanner/Distribution Panel PROM memory is checked to verify its integrity. Any diagnostic error results in the Scanner/Distribution Panel halting, with all LEDs being red.

### Power Supply Requirements

The Power Supply in the Processor or an Auxiliary Power Supply may be used to power the Scanner/Distribution Panel. The Auxiliary Supply must be used if the Controller is equipped with a core Memory Module (Cat. No. 1772-M8). The Auxiliary Power Supply must be Cat. No. 1772-P1 or 1777-P2, Series B or later.

### Mounting Configuration

The Remote I/O Scanner/Distribution Panel (Cat. No. 1772-SD) is designed for panel mounting. Mounting dimensions are shown in Figure 4. Recommended mounting is to the right of the PLC-2, PLC-2/20 or PLC-2/30 Processor. Maintain at least six inches clearance between the Scanner/Distribution Panel and the Processor. Do not mount the Scanner/Distribution Panel more than 10 cable feet from the Processor.

### Wiring Connections

Twinax cable (Cat. No. 1770-CD) is used to connect the Scanner/Distribution Panel to the Remote Adapters. The cable is connected to the Scanner/Distribution Panel at the terminal strip on the front of the module.

The Remote Adapters are connected to the remote I/O channel using Cat. No. 1770-XG Connector Kit. The remote I/O channel must be terminated at both ends using Cat. No. 1770-XF terminators (See Figure 1).

The Remote Adapters may be connected to the remote I/O channel directly in a daisy chain fashion. The remote I/O channel is terminated using Cat. No. 1770-XT terminators at the Scanner/Distribution Panel and the last Remote Adapter (See Figure 2).

### Switch Settings

There are three sets of switches beneath the cover plate of the Scanner/Distribution Panel. To select a particular configuration, remove the two slotted screws which secure the cover plate. Refer to Figure 5. Set the switches to your requirements using a blunt-pointed instrument, such as the tip of a ball-point pen. Do not use anything that might break off and jam the switch. Replace cover plate and secure screws.

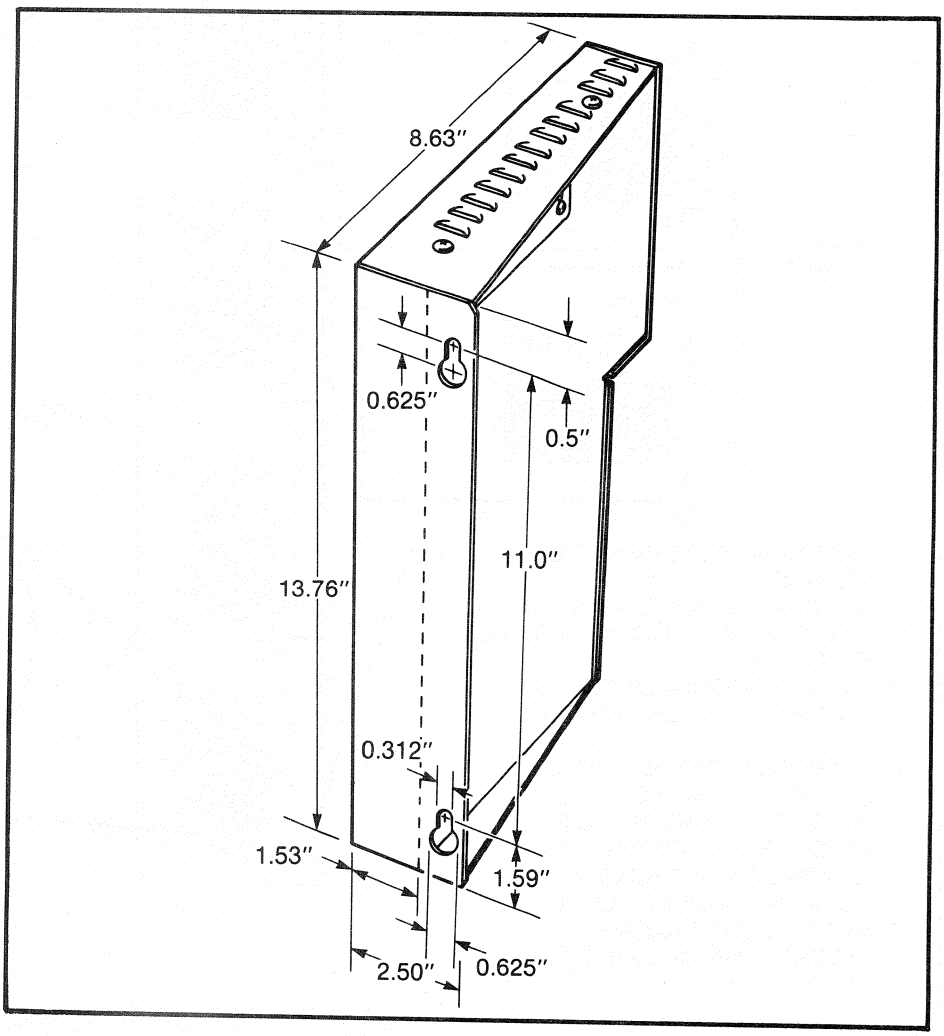
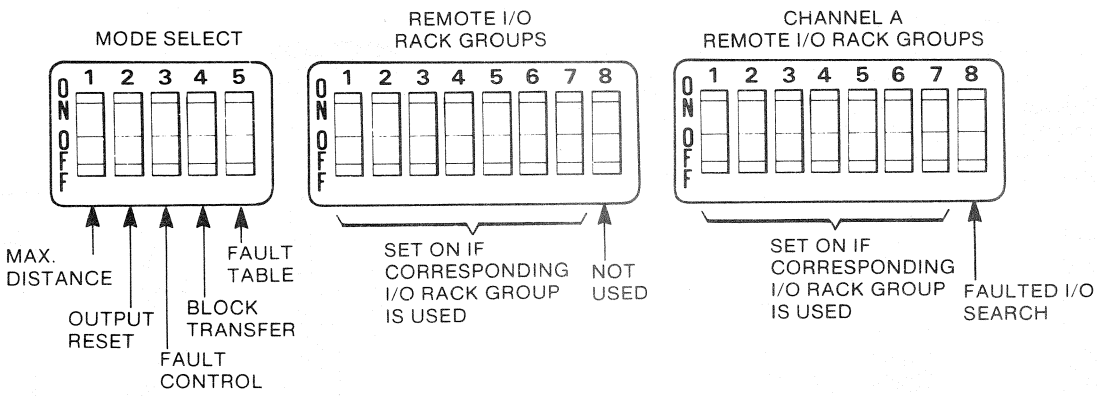



**FIGURE 4 — Mounting Dimensions**




**Mode Select**

1. Maximum distance

ON: 10,000' maximum cable length each channel (57.6K baud)
OFF: 5,000' maximum cable length each channel (115.2K baud)

2. Output Reset*

ON: All non-faulted outputs are reset by taking the processor out of the RUN mode.
OFF: Non-faulted outputs are not reset by taking the processor out of the RUN mode.

* PLC-2 (1772-LR) will behave as though Fault Reset were at OFF regardless of actual switch position.

3. Fault Control

ON: Independent — A remote I/O fault will cause only the faulted Rack to respond according to its last state switch setting. (See faulted I/O search).

OFF: Dependent — A remote I/O fault will cause all Racks to respond according to their last state switch setting.

NOTE: When a fault occurs other than in a remote I/O Rack, all Racks will respond according to their last state switch setting regardless of whether Independent or Dependent Fault Control has been selected.

4. Block Transfer

ON: Enable Block Transfers
OFF: Disable Block Transfers

5. Fault Table

OFF: Word addresses 125 and 126 are reserved for remote I/O Fault Table (See Table B). Remote I/O Rack 2 must be declared used (must be physically present if dependent fault control selected.)
ON: No Fault Table generated.

**Remote I/O Racks**

1 thru 7

ON: Corresonding I/O Rack is used.
OFF: Corresonding I/O Rack is not used.

8 — Not used.

**Channel A Remote I/O Racks**

1 thru 7

ON: Corresponding I/O Rack is used on Channel A.
OFF: Corresponding I/O Rack not used on channel A.

8 — Faulted I/O Search

ON: Enable Search. Used only when any I/O Rack consists of more than one I/O Chassis. Valid I/O data will continue for all non-faulted I/O Chassis within a Rack. Independent Fault Control is by I/O Chassis.
OFF: Disable Search. Independent Fault Control is by I/O Rack.

**FIGURE 5 — Switch Settings**

**Scan Times**

Each of the two remote I/O channels has an independent I/O scan which is not synchronous to either the program scan or the I/O scan of the other channel. The I/O scan time fluctuates according to the amount of I/O data change taking place at the moment; however, the I/O scan time without Block Transfer can be calculated by adding up the following times for each I/O Chassis in the channel:

| | 5000' MAX (115.2K BAUD) | 10,000' MAX (57.6K BAUD) |
|---|---|---|
| Nominal | 7 msec | 8.5 msec |
| Worst Case | 8 msec | 10 msec |

If faulted I/O Search is enabled, the per Chassis I/O scan times can increase to as much as seven times the above nominal and worst case values.

Block Transfer modules are handled fastest by placing one, or an equal amount, in each Rack used. It should be noted that Block Transfer modules increase I/O scan times significantly, due to the large amounts of data that must be transferred. Therefore, they should be placed in local I/O Racks, if possible.

**TABLE B — Fault Table**

| RACK | MODULE GROUPS | FAULT STATUS BIT |
|---|---|---|
| 1 | 0-1<br>2-3<br>4-5<br>6-7 | 12507<br>12506<br>12505<br>12504 |
| 2 | 0-1<br>2-3<br>4-5<br>6-7 | 12503<br>12502<br>12501<br>12500 |
| 3 | 0-1<br>2-3<br>4-5<br>6-7 | 12517<br>12516<br>12515<br>12514 |
| 4 | 0-1<br>2-3<br>4-5<br>6-7 | 12513<br>12512<br>12511<br>12510 |
| 5 | 0-1<br>2-3<br>4-5<br>6-7 | 12607<br>12606<br>12605<br>12604 |
| 6 | 0-1<br>2-3<br>4-5<br>6-7 | 12603<br>12602<br>12601<br>12600 |
| 7 | 0-1<br>2-3<br>4-5<br>6-7 | 12617<br>12616<br>12615<br>12614 |

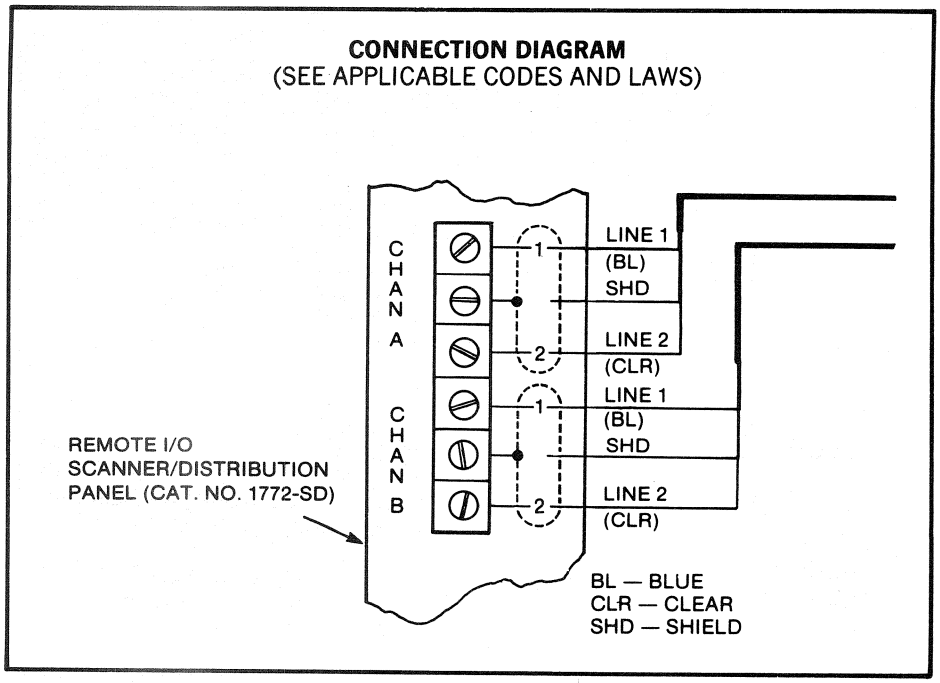



**FIGURE 6 — Connection Diagram**




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Systems Division-PC Business
747 Alpha Drive, Cleveland, Ohio 44143

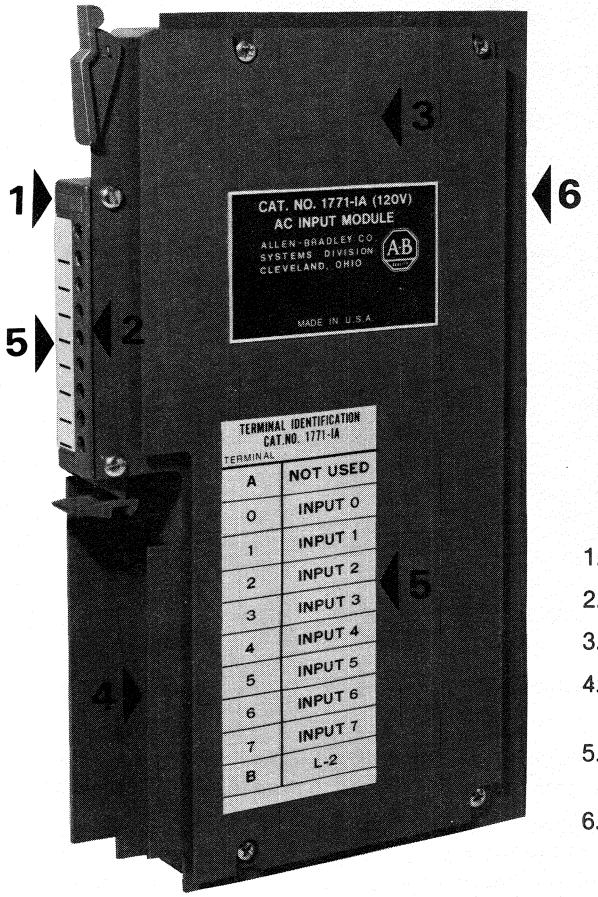
P/N 955091-18A

## 4.4 I/O MODULES

1771-901 AC/DC (120V) Input Module
1771-902 DC Output Driver Modules
1771-903 DC Input Modules
1771-904 AC(120V) Output Module
1771-911 DC Input Module
1771-913 TTL Input Module Assembly
1771-914 TTL Output Module Assembly
1771-915 Analog Input Module (8 Bit) Assembly
1771-916 Isolated AC (120V) Output Module Assembly
1771-917 Analog Input Module (12 Bit) Assembly
1771-918 Analog Output Module (12 Bit) Assembly
1771-919 Contact Output Module Assembly
1771-920 Single-Channel Programming for the Analog Input Module (8 Bit)
1771-922 Communication Adapter Module
1771-923 Communication Controller Module
1771-925 AC (220/240V) Output Module
1771-926 Isolated AC/DC (120V) Input Module Assembly
1771-927 AC/DC (220/240V) Input Module
1771-928 Encoder/Counter Module Assembly
1771-929 Fast Response DC Input Module
1771-931 DC (5-30V) Selectable Input Module Assembly
1771-932 DC (12-24V) Driver Logic Input Module
1771-933 Thermocouple Input Module Assembly
1771-934 Thermocouple Input Expander Module Assembly
1771-938 Remote I/O Adapter Module Assembly
1771-941 Absolute Gray Encoder Module Assembly

# AC/DC (120V) INPUT MODULE

## Cat. No. 1771-IA




1. Red identification label
2. Status indicators
3. Protective covers
4. Field Wiring Arm connects here
5. Labels identify user inputs
6. Slotted for I/O slot insertion only

**SPECIFICATIONS**

**Inputs per Module**
8

**Module Location**
I/O Rack

**Nominal Input Voltage**
AC: 120V (50/60 Hz)
DC: 125V

**Input Logic Voltage Range**
AC/DC
MIN MAX
92V – 138V

**Nominal Input Current**
DC: 4.5 mA
AC: 8 mA

**Input Filter Time Constant**
20 msec (± 6 msec)

**Ambient Temperature Rating**
0° to 60°C (operational)
-40° to 85°C (storage)

**Humidity Rating**
5 to 95%
(without condensation)

**Electrical-Optical Isolation**
2500V
Isolation is between the input voltages and control logic

**Keying**
Modules are keyed for insertion into I/O slots only

**Wiring**
14 ga. stranded (max.)
3/64" insulation (max.)

**Power Supply Current Requirement**
74 mA per Module

### DESCRIPTION

The AC/DC (120V) Input Module (Cat. No. 1771-IA) provides interfacing between ON/OFF voltage levels of the user's 120V AC/DC inputs and logic levels required with the Bulletin 1771 I/O Rack or Bulletin 1772 PLC-2 Mini-Processor. User's input signals commonly originate in switch closures such as limit, selector, and float switches and push buttons.

Connection to user devices is made at the Field Wiring Arm (Cat. No. 1771-WA) which is a removable part of the Bulletin 1771 I/O Rack. The Field Wiring Arm then pivots up in order to connect quickly and conveniently with terminals on the front of the I/O Module. (Refer to Figure 1.) The Field Wiring Arm allows easy removal of an I/O Module without removing wiring connections.

Module logic circuitry is protected from possible damage by transients from user inputs by 2500V optical isolation.

In addition to this protection, Module circuitry provides filtering to limit the effects of voltage transients. (Such transients, occurring in a noise-polluted industrial environment, could introduce mislogic to the Input Module if filtering were not used.) Delay resulting from this type of filtering is typically 20 ms (± 6 ms).

There are eight status indicators on the front face of the Module to represent the status of each input. The status indicator for an input illuminates when the input is ON. (Refer to Figure 2.)

**CAUTION:** The Module must **not** be removed from or inserted into the Bulletin 1771 I/O Chassis while system power is ON. Failure to observe this rule may result in damage to Module circuitry.

A package of keying bands is shipped with each Module. (Refer to Application Note 5.)

### APPLICATION NOTES

1. The status of an individual input is examined by these Instructions in the user's program:
   - ⊣ ⊢ Examine input for an energized (ON) state
   - ⊣/⊢ Examine input for a de-energized (OFF) state
2. The user must supply 120V AC (L1)or 125V DC to his input devices and L2 or common to the "B" terminal on the Field Wiring Arm.

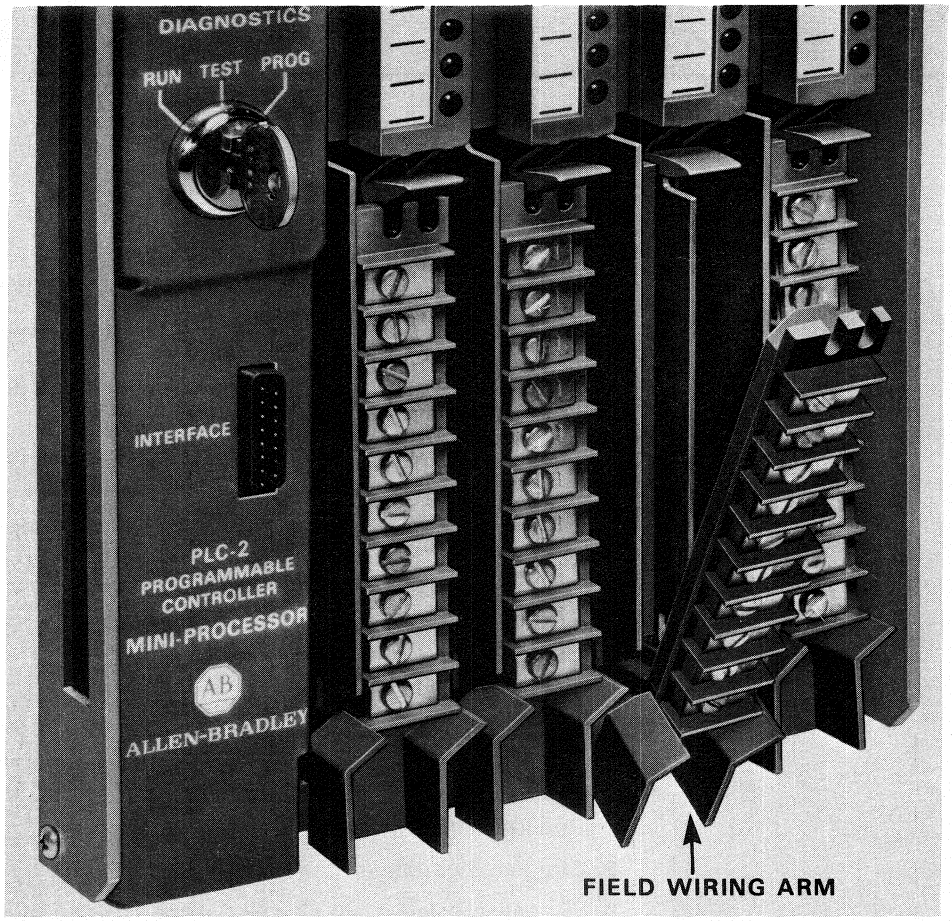



**Figure 1 — Field Wiring Arm Connection**

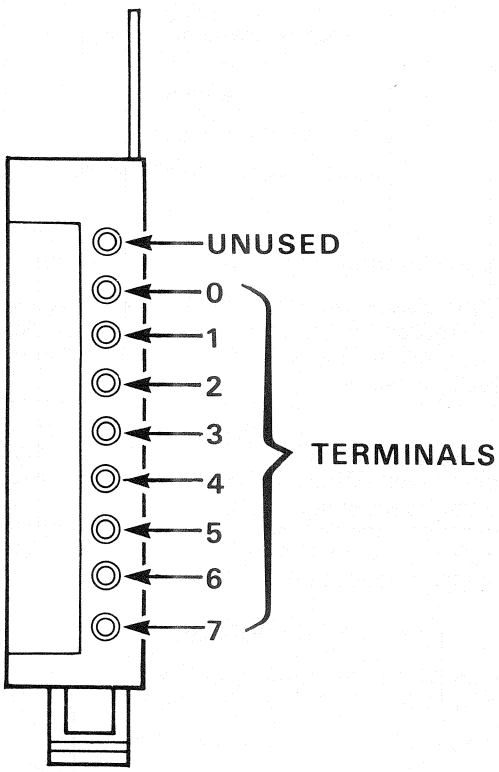



**Figure 2 — Status Indicators**

3. Labels are provided on the Module for the user to designate inputs connected to the Field Wiring Arm.

4. Terminals on the AC (120V) Output Module (Cat. No. 1771-OA) may be used as inputs to the AC/DC (120V) Input Module (Cat. No. 1771-IA). However, an external resistor must be added between the output terminal and L2 (common). Typically, this is a 2.5K ohm, 10 watt resistor. (Refer to Figure 3.) The same AC power source should power both Modules to assure proper phasing.

5. In initial design stages, the AC/DC (120V) Input Module may be inserted into any of the I/O Rack slots. However, once specific slots have been designated for this Module, care should be taken so that other types of Modules will not be mistakenly placed into these slots.

   It is **strongly** recommended that the keying bands provided with the Module be used to permit only insertion of the correct Input Modules into the proper slots. Any I/O Rack connector may be keyed solely to receive the AC/DC (120V) Input Module. (Refer to Figure 4.)

## KEYING

Plastic keys, shipped with each I/O Module, provide an easy method for the user to allow insertion of only one type of I/O Module into a specific I/O slot. Needle-nosed pliers may be used to insert keys onto the up-

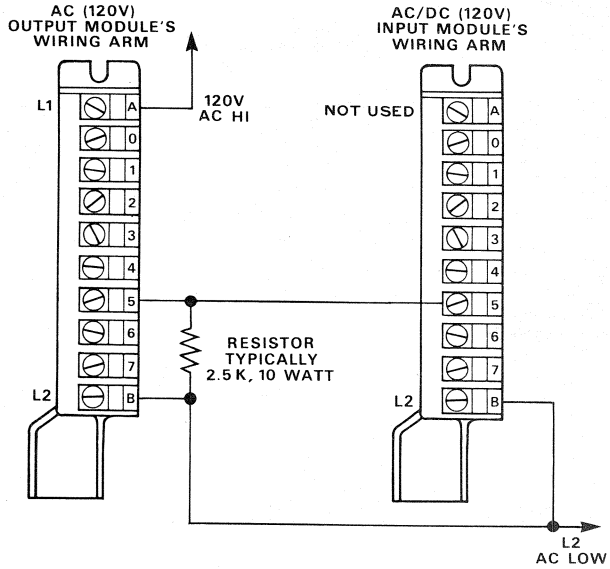
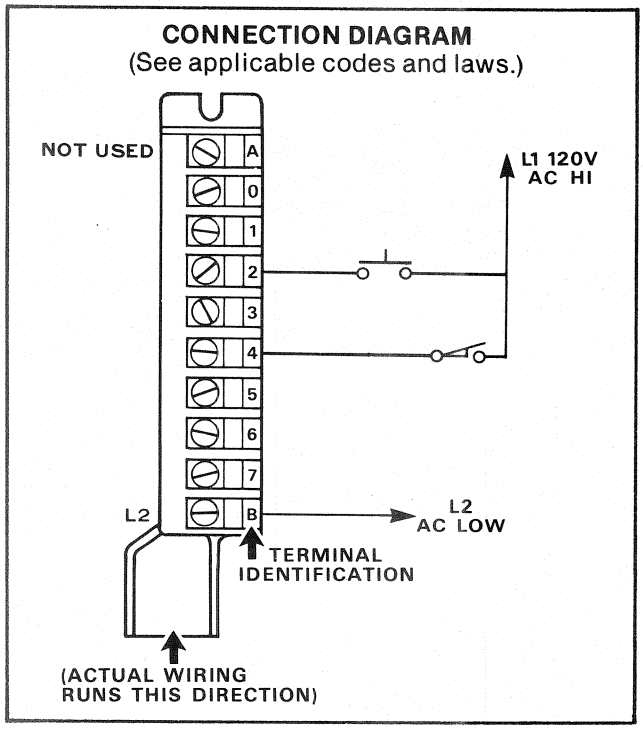



**Figure 3 — Driving an Input with an Output**




per, 36-terminal, backplane connector.

Each type of I/O Module is slotted in two places at the rear edge. Positioning of keys on the backplane connector must correspond to these slots to allow insertion of the I/O Module. Keys are placed on the backplane connector in the area **between** numbers on the backplane.

In any slot designated for the AC/DC (120V) Input Module, position keys at these two locations on the upper backplane connector:

- Between 4 and 6
- Between 10 and 12

The position of these keys may be changed by the user if subsequent system design and rewiring makes insertion of a different Module necessary.

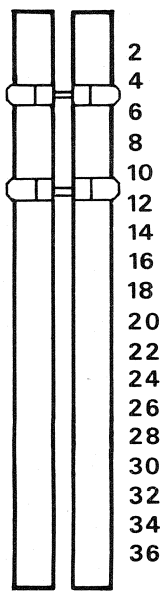
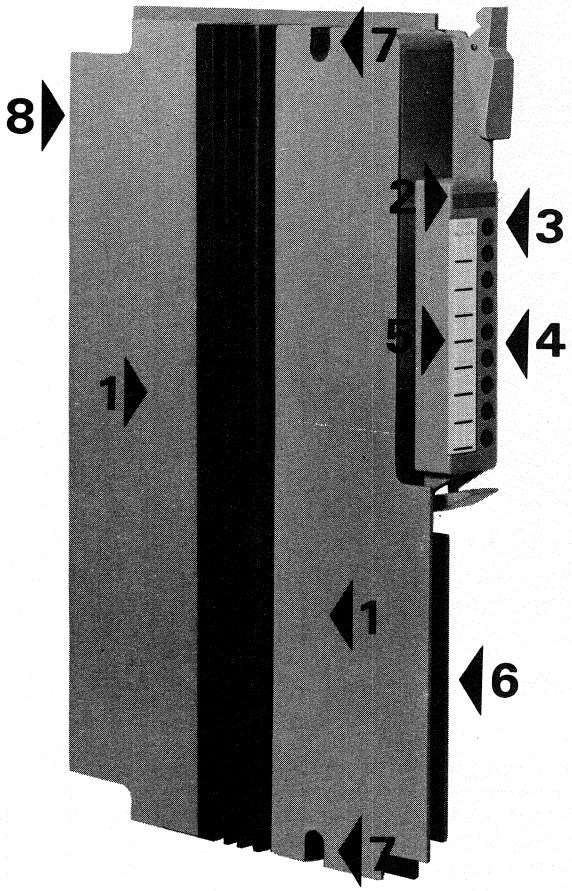



**Figure 4 — Keying Diagram**

ALLEN-BRADLEY
Cleveland, Ohio 44143

# DC OUTPUT DRIVER MODULES

## Cat. No. 1771-OB, -OC




1. Protective covers
2. Green identification label
3. Blown fuse indicator
4. Status indicators
5. Label identifies user outputs
6. Field Wiring Arm connects here
7. Fuse cover removed with two screws
8. Slotted for I/O slot insertion only

**SPECIFICATIONS**

**Outputs per Module**
8

**Module Location**
I/O Rack

**Nominal Output Voltage**
Cat. No. 1771-OB: 12-24V DC
Cat. No. 1771-OC: 48V DC

**Allowable Output Voltage Range**

| | Min | Max |
|---|---|---|
| Cat. No. 1771-OB | 10V | 27V |
| Cat. No. 1771-OC | 42V | 56V |

**Output Current Rating**
1.5A (max.) per output
(not to exceed 8A per Module)

**Surge Current (max.)**
4A for 10 ms.
Repeatable every 1 second
(fuse-limited)

**ON State Voltage Drop (max.)**
2V DC

**OFF State Leakage Current**
1 mA per output (max.)

**Power Supply Current Requirement**
165 mA per Module

**Electrical-Optical Isolation**
1500V
Isolation is between power output and control logic

**Ambient Temperature Rating**
0° to 60°C (operational)
-40° to 85°C (storage)

**Humidity Rating**
5 to 95%
(without condensation)

**Wire Size**
14 ga. stranded (max.)
3/64" insulation (max.)

**Keying**
Modules are slotted for placement in I/O slots only

**Fuses**
2 Amp 8AG "Normal-Blo"

### DESCRIPTION

The DC Output Driver Modules contain the output circuitry necessary to control the ON/OFF status of eight user devices. Output devices which can be controlled with this Module may include DC motor starters, indicators, or solenoids.

There are two Bulletin 1771 DC Driver Output Modules:

- DC (12-24V) Output Module (Cat. No. 1771-OB)
- DC (48V) Output Module (Cat. No. 1771-OC)

Connection to user devices is made at the Field Wiring Arm (Cat. No. 1771-WA) which is a removable part of the Bulletin 1771 I/O Rack. The Field Wiring Arm then pivots up in order to connect quickly and conveniently with terminals on the front of the I/O Module. (Refer to Figure 1.) The Field Wiring Arm allows easy removal of an I/O Module without removing wiring connections.

Each of eight status indicators on the front of the Module shows the ON/OFF condition of an individual output. When the output is ON (energized) the indicator illuminates. An additional indicator, normally OFF, illuminates when any fuse in the Module has blown. (Refer to Figure 2.)

Each of the eight outputs on the Module is fused to protect Module circuitry and the user's power supply. Fuses are easily accessed by removal of the front component-side cover of the Output Module.

Module logic circuitry is protected from possible damage by transients from power outputs by 1500V optical isolation.

**CAUTION:** The Module must **not** be removed from or inserted into the Bulletin 1771 I/O Chassis while system power is ON. Failure to observe this rule may result in damage to Module circuitry.

A package of keying bands is shipped with each Module. (Refer to Application Note 7.)




**Figure 1 — Field Wiring Arm Connections**

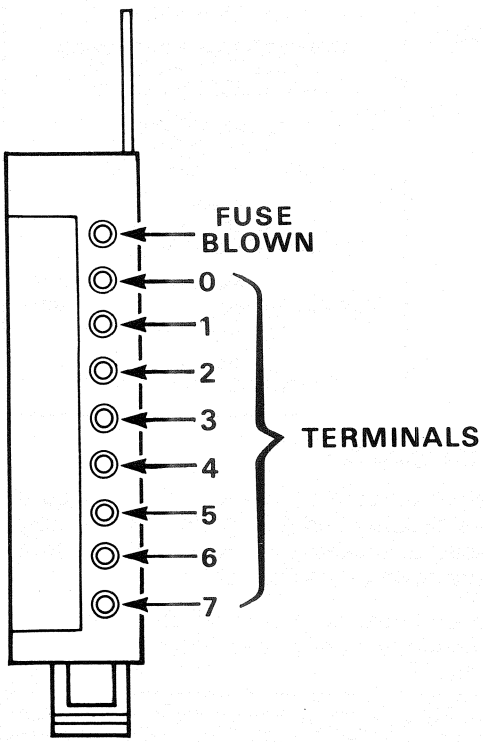



**Figure 2 — Status Indicators**

## APPLICATION NOTES

**CAUTION:** Proper polarity, as indicated in the Connection Diagram, must be observed with DC power connections. Reverse polarity, or incorrect application of 120V AC, may cause damage to the Module. (Any damage would affect user side of Module only.)

1. The status of an individual output device is controlled by one of these Instructions in the user's program:

   Energize output device at addressed terminal

   Latch output device ON at addressed terminal

   Unlatch output device at addressed terminal

   PUT — Transfers a 16-bit memory word from one address to another. (This Instruction may control outputs when data is transferred to the Output Image Table of memory. [1])

2. The user must supply DC voltage to the "A" terminal on the Field Wiring Arm. He must also supply DC common to output devices and to the "B" terminal of the Field Wiring Arm. (Refer to the Connection Diagram.)

3. Labels on the Module identify individual outputs connected to the Field Wiring Arm.

[1] For a description of PLC and PLC-2 memory structure, refer to Publication 1774-921 or -934.

4. Terminals on the DC (12-24V) Input Module (Cat. No. 1771-IB) may be directly driven from terminals on the DC (12-24V) Output Module (Cat. No. 1771-OB). It is recommended that the same DC supply power both Modules to assure that ground is at the same potential.

5. Terminals on the DC (48V) Input Module (Cat. No. 1771-IC) may be directly driven from terminals on the DC (48V) Output Module (Cat. No. 1771-OC). It is recommended that the same DC supply power both Modules to assure that ground is at the same potential.

6. The maximum continuous output current per terminal is 1.5 amperes. However, maximum continuous output current per Module should not exceed 8 amperes.

7. In initial design stages, either the 12-24V or 48V DC Output Module may be inserted into any of the I/O Chassis slots. However, once specific slots have been designated for a Module, care should be taken so that other types of Modules will not be mistakenly placed into these slots.

   It is **strongly** recommended that the keying bands provided with the Module be used to permit only insertion of the correct DC Output Modules into the proper slots. Any I/O Rack connector may be keyed solely to receive either the 12-24V or 48V DC Output Module. (Refer to Figure 3.)

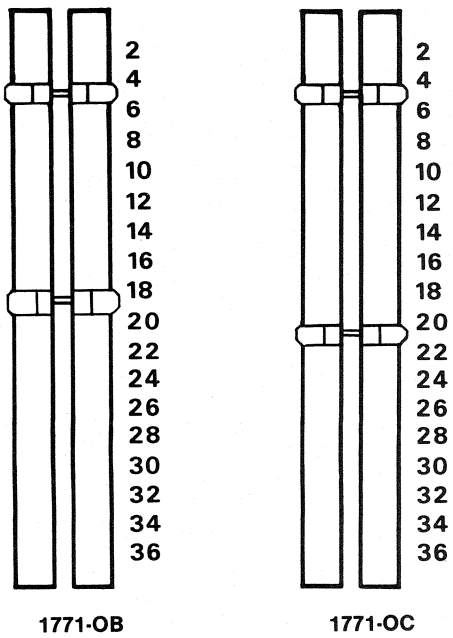



**Figure 3 — Keying Diagram**

## KEYING

Plastic keys, shipped with each I/O Module, provide an easy method for the user to allow insertion of only one type of I/O Module into a specific I/O slot. Needle-nosed pliers may be used to insert keys onto the upper, 36-terminal, backplane connector.

Each type of I/O Module is slotted in two places at the rear edge. Positioning of keys on the backplane connector must correspond to these slots to allow insertion of the I/O Module. Keys are placed on the backplane connector in the area **between** numbers on the backplane.

For the DC (12-24V) Output Module, position keys at these two locations on the upper backplane connector:

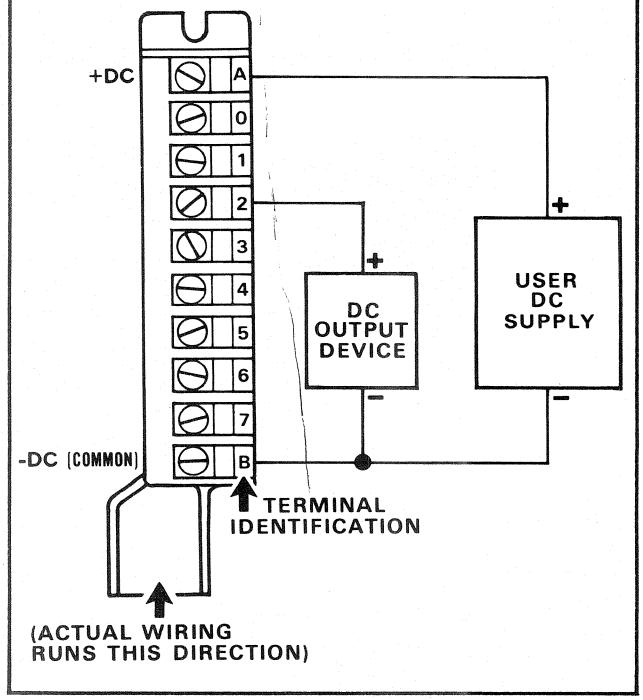
- Between 4 and 6
- Between 18 and 20

For the DC (48V) Output Module, position keys at these two locations on the upper backplane connector:

- Between 4 and 6
- Between 20 and 22

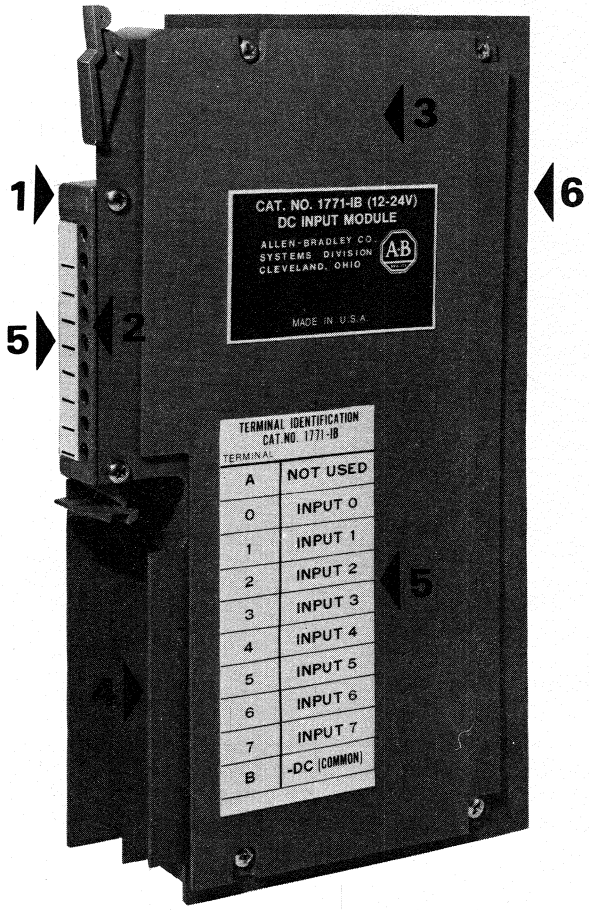
The position of these keys may be changed by the user if subsequent system design and rewiring makes insertion of a different Module necessary.

**CONNECTION DIAGRAM**
(See applicable codes and laws.)




ALLEN-BRADLEY
Cleveland, Ohio 44143

# DC INPUT MODULES
## Cat. No. 1771-IB, -IC




1. Blue identification label
2. Status indicators
3. Protective covers
4. Field Wiring Arm connects here
5. Labels identify user inputs
6. Slotted for I/O slot insertion only

### SPECIFICATIONS

**Inputs per Module**
8

**Module Location**
I/O Rack

**Nominal Input Voltage Rating**
Cat. No. 1771-IB: 12-24V DC
Cat. No. 1771-IC: 48V DC

**Allowable Input Logic Voltage Range**

| | MIN | MAX |
|---|---|---|
| Cat. No. 1771-IB: | 10V | 27V |
| Cat. No. 1771-IC: | 42V | 56V |

**Nominal Input Current**
12V DC: 8 mA
24V DC: 24 mA
48V DC: 9 mA

**Input Impedance**

| | ON | OFF |
|---|---|---|
| Cat. No. 1771-IB | 1K-2KΩ | 2K-3KΩ |
| Cat. No. 1771-IC | 2.5K-3.5KΩ | 5K-6KΩ |

**Input Filter Time Constant**
15 ms (± 7 ms)

**Power Supply Current Requirement**
74 mA per Module

**Electrical-Optical Isolation**
1500V
Isolation is between the input circuitry and control logic circuitry

**Ambient Temperature Rating**
0° to 60°C (operational)
– 40° to 85°C (storage)

**Humidity Rating**
5 to 95%
(without condensation)

**Wire Size**
14 ga. stranded (max.)
3/64″ insulation (max.)

**Keying**
Modules are slotted for insertion into I/O slots only

### DESCRIPTION

The DC Input Modules provide interfacing between ON/OFF voltage levels of the user's DC inputs and logic levels required with the Bulletin 1771 I/O Rack or Bulletin 1772 PLC-2 Mini-Processor. User's DC input signals commonly originate in switch closures such as limit, selector, and proximity switches and push buttons. There are two versions of DC Input Modules:

- Cat. No. 1771-IB Input Module for 12-24V DC inputs
- Cat. No. 1771-IC Input Module for 48V DC inputs

Connection to user devices is made at the Field Wiring Arm (Cat. No. 1771-WA) which is a removable part of the Bulletin 1771 I/O Rack. The Field Wiring Arm then pivots up in order to connect quickly and conveniently with terminals on the front of the I/O Module. (Refer to Figure 1.) The Field Wiring Arm allows easy removal of an I/O Module without removing wiring connections.

Module logic circuitry is protected from possible damage by transients from user inputs by 1500V optical isolation.

In addition to this protection, Module circuitry provides filtering to limit the effects of voltage transients. (Such transients, occurring in a noise-polluted industrial environment, could introduce mislogic to the Input Module if filtering were not used.) Delay resulting from this type of filtering is typically 15 ms (± 7 ms).

There are eight status indicators on the front face of the Module to represent the status of each input. The status indicator for an input illuminates when the input is ON. (Refer to Figure 2.)




**Figure 1 — Field Wiring Arm Connection**

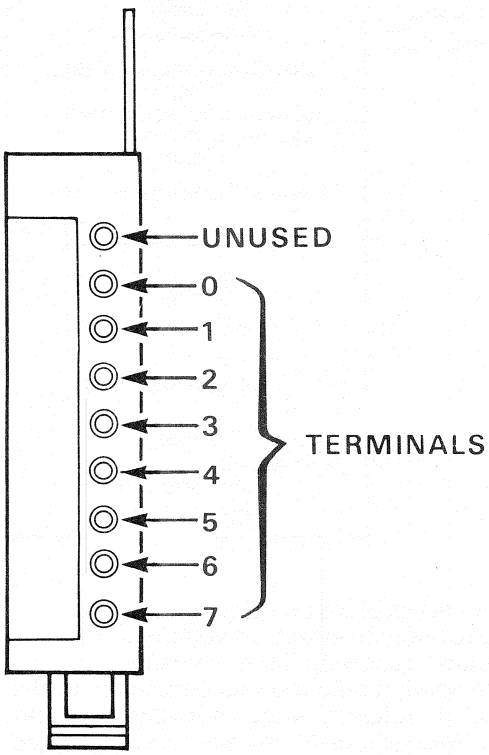



**Figure 2 — Status Indicators**

**CAUTION:** The Module must **not** be removed from or inserted into the Bulletin 1771 I/O Chassis while system power is ON. Failure to observe this rule may result in damage to Module circuitry.

A package of keying bands is shipped with each Module. (Refer to Application Note 6.)

## APPLICATION NOTES

**CAUTION:** Proper polarity, as indicated in the Connection Diagram, must be observed with DC power connections. Reverse polarity, or incorrect application of 120V AC, may cause damage to the Module. (Any damage would affect user side of Module only.)

1. The status of an individual input is examined by these Instructions in the user's program:

   ⊣ ⊢ Examine input for an energized (ON) state

   ⊣/⊢ Examine input for a de-energized (OFF) state

2. The user must supply DC voltage to his input devices. DC common must be connected to the "B" terminal on the Field Wiring Arm. (Refer to the Connection Diagram.) Note that the "A" terminal on the Field Wiring Arm is not used with DC Input Modules.

3. Labels are provided on the Module for the user to designate the inputs connected to the Field Wiring Arm.

4. Terminals on the DC (12-24V) Input Module (Cat. No. 1771-IB) may be directly driven from terminals on the DC (12-24V) Output Module (Cat. No. 1771-OB). It is recommended that the same DC supply power both Modules to assure that ground is at the same potential.

5. Terminals on the DC (48V) Input Module (Cat. No. 1771-IC) may be directly driven from terminals on the DC (48V) Output Module (Cat. No. 1771-OC). It is recommended that the same DC supply power both Modules to assure that ground is at the same potential.

6. In initial design stages, either the 12-24V or 48V DC Input Module may be inserted into any of the I/O Chassis slots. However, once specific slots have been designated for a Module, care should be taken so that other types of Modules will not be mistakenly placed into these slots.

   It is **strongly** recommended that the keying bands provided with the Module be used to permit insertion of the correct DC Input Modules only into the proper slots. Any I/O Rack connector may be keyed solely to receive either the 12-24V or 48V DC Input Module. (Refer to Figure 3.)

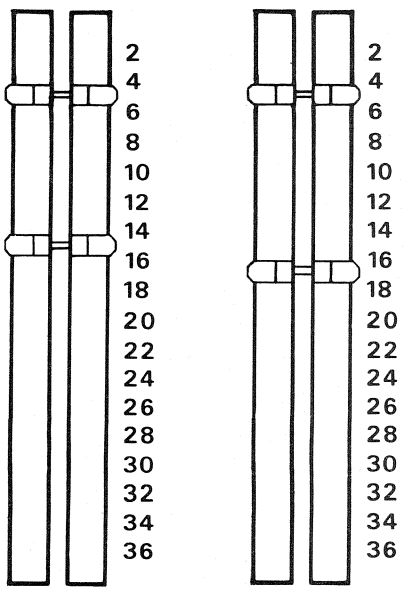



**Figure 3 — Keying Diagram**

## KEYING

Plastic keys, shipped with each I/O Module, provide an easy method for the user to allow insertion of only one type of I/O Module into a specific I/O slot. Needle-nosed pliers may be used to insert keys onto the upper, 36-terminal, backplane connector.

Each type of I/O Module is slotted in two places at the rear edge. Positioning of keys on the backplane connector must correspond to these slots to allow insertion of the I/O Module. Keys are placed on the backplane connector in the area **between** numbers on the backplane.

For the DC (12-24V) Input Module, position keys at these two locations on the upper backplane connector:

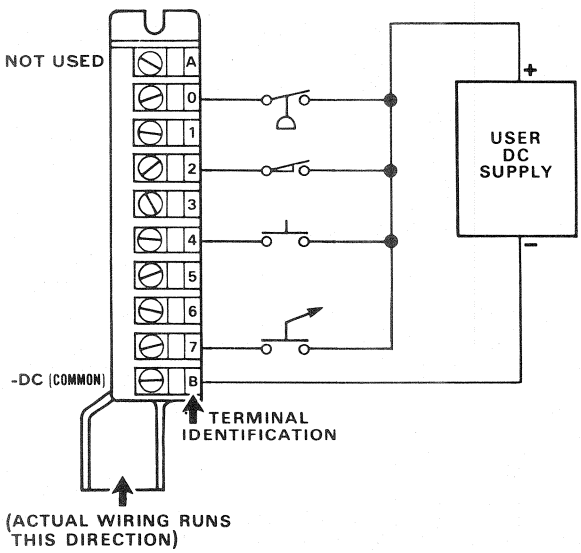
- Between 4 and 6
- Between 14 and 16

For the DC (48V) Input Module, position keys at these two locations on the upper backplane connector:

- Between 4 and 6
- Between 16 and 18

The position of these keys may be changed by the user if subsequent system design and rewiring makes insertion of a different type of Module necessary.

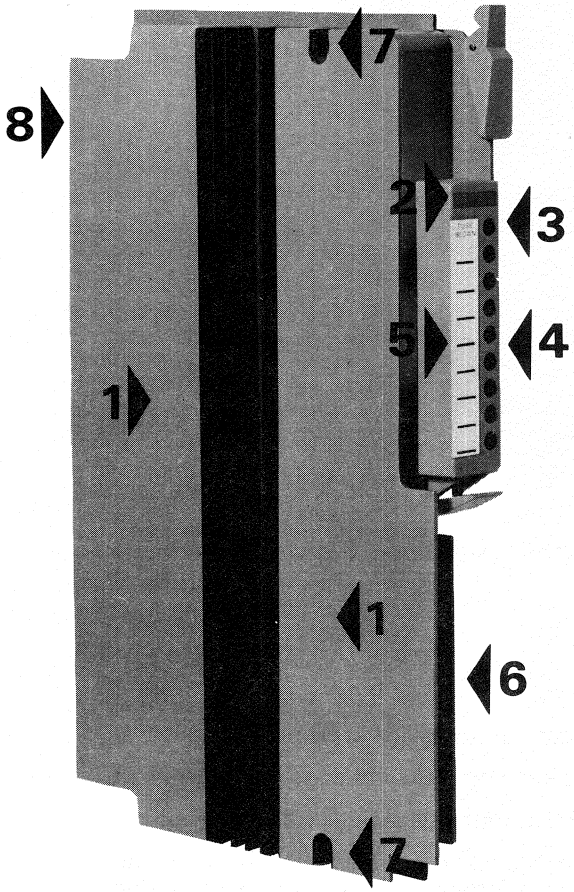
**CONNECTION DIAGRAM**
(See applicable codes and laws.)




ALLEN-BRADLEY
Cleveland, Ohio 44143

# AC (120V) OUTPUT MODULE

## Cat. No. 1771-OA




1. Protective covers
2. Orange identification label
3. Blown fuse indicator
4. Status indicators
5. Label identifies user outputs
6. Field Wiring Arm connects here
7. Fuse cover removed with two screws
8. Slotted for I/O slot insertion only

### SPECIFICATIONS

**Outputs per Module**
8

**Module Location**
I/O Rack

**Nominal Output Voltage**
120V AC, 50/60 Hz

**Output Voltage Range**
92-138V AC

**Output Current Rating**
1.5A (max.) per output
(not to exceed 6A per Module)

**Surge Current (Max.)**
4A for 8.3 ms. (1/2 cycle)
Repeatable every 1 second
(fuse-limited)

**Minimum Load Current**
50 mA

**ON State Voltage Drop**
2V @ 100 mA

**OFF State Leakage Current**
5 mA per output (max.)

**Power Supply Current Requirement**
210 mA per Module

**Electrical-Optical Isolation**
2500V
Isolation is between power output and control logic

**Ambient Temperature Rating**
0° to 60°C (operational)
−40° to 85°C (storage)

**Humidity Rating**
5 to 95%
(without condensation)

**Wire Size**
14 ga. stranded (max.)
3/64″ insulation (max.)

**Keying**
Modules are slotted for placement in I/O slots only

**Fuses**
2 Amp 8AG "Normal-Blo"

### DESCRIPTION

The AC (120V) Output Module (Cat. No. 1771-OA) contains the output circuitry necessary to control the ON/OFF status of eight user devices. Output devices which can be controlled with this Module may include AC motor starters, indicators, or solenoids.

Connection to user devices is made at the Field Wiring Arm (Cat. No. 1771-WA) which is a removable part of the Bulletin 1771 I/O Rack. The Field Wiring Arm then pivots up in order to connect quickly and conveniently with terminals on the front of the I/O Module. (Refer to Figure 1.) The Field Wiring Arm allows easy removal of an I/O Module without removing wiring connections.

Each of eight status indicators on the front of the Module shows the ON/OFF condition of an individual output. When the output is ON (energized) the indicator illuminates. An additional indicator, normally OFF, illuminates when any fuse in the Module has blown. (Refer to Figure 2.)

Each of the eight outputs on the Module is fused to protect Module circuitry and the user's power supply. Fuses are easily accessed by removal of the front component-side cover of the Output Module.

Module logic circuitry is protected from possible damage by transients from power outputs by 2500V optical isolation.

**CAUTION:** The Module must **not** be removed from or inserted into the Bulletin 1771 I/O Chassis while system power is ON. Failure to observe this rule may result in damage to Module circuitry.

A package of keying bands is shipped with each Module. (Refer to Application Note 6.)

### APPLICATION NOTES

1. The status of an individual output device is controlled by one of these Instructions in the




**Figure 1 — Field Wiring Arm Connection**

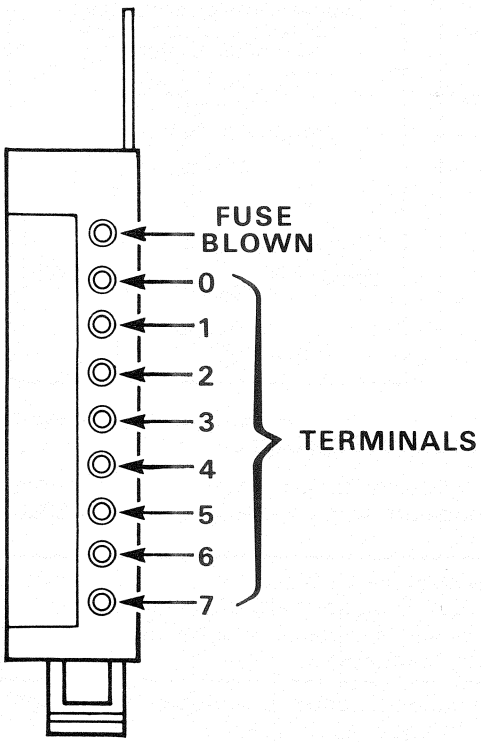



**Figure 2 — Status Indicators**

user's program:

- Energize output device at addressed terminal
- Latch output device ON at addressed terminal
- Unlatch output device at addressed terminal
- PUT — Transfers a 16-bit memory word from one address to another. (This Instruction may control outputs when data is transferred to the Output Image Table of memory. [1])

2. The user must supply 120V AC (L1) to the "A" terminal and AC low (L2) to the "B" terminal on the Field Wiring Arm. User output devices must also be connected to L2. (Refer to the Connection Diagram.)
3. Labels on the Module identify individual outputs connected to the Field Wiring Arm.
4. The maximum continuous output current per terminal is 1.5 amperes. However, maximum continuous output current per Module should not exceed 6 amperes.
5. Terminals on the AC (120V) Output Module (Cat. No. 1771-OA) may be used as inputs to the AC/DC (120V) Input Module (Cat. No. 1771-IA). However, an external resistor must be added between the output terminal and L2 (common). Typically, this

[1] For a description of PLC and PLC-2 memory structure, refer to Publication 1774-921 or -934.

is a 2.5K ohm, 10 watt resistor. (Refer to Figure 3.) The same AC power source should power both Modules to assure proper phasing.

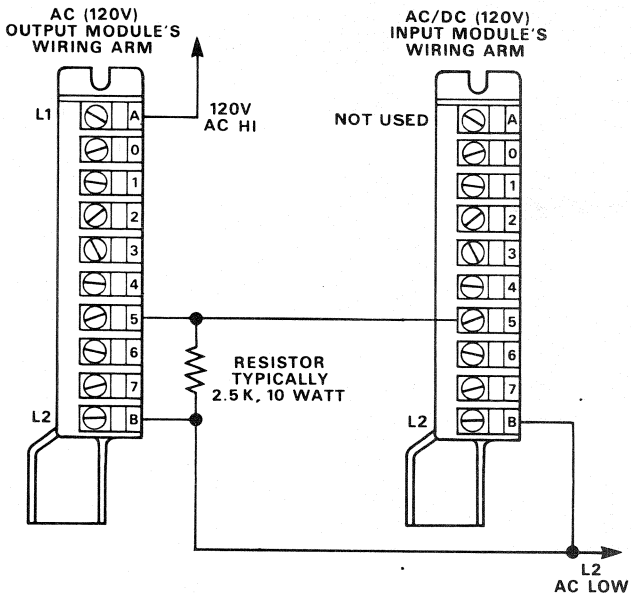



**Figure 3 — Driving an Input with an Output**

6. In initial design stages, the AC (120V) Output Module may be inserted into any of the I/O Chassis slots. However, once specific slots have been designated for this Module, care should be taken so that other types of Modules will not be mistakenly placed into these slots.

   It is **strongly** recommended that the keying bands provided with the Module be used to permit only insertion of the correct Output Modules into the proper slots. Any I/O Rack connector may be keyed solely to receive the AC (120V) Output Module. (Refer to Figure 4.)

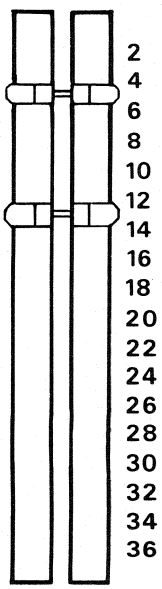



**Figure 4 — Keying Diagram**

## KEYING

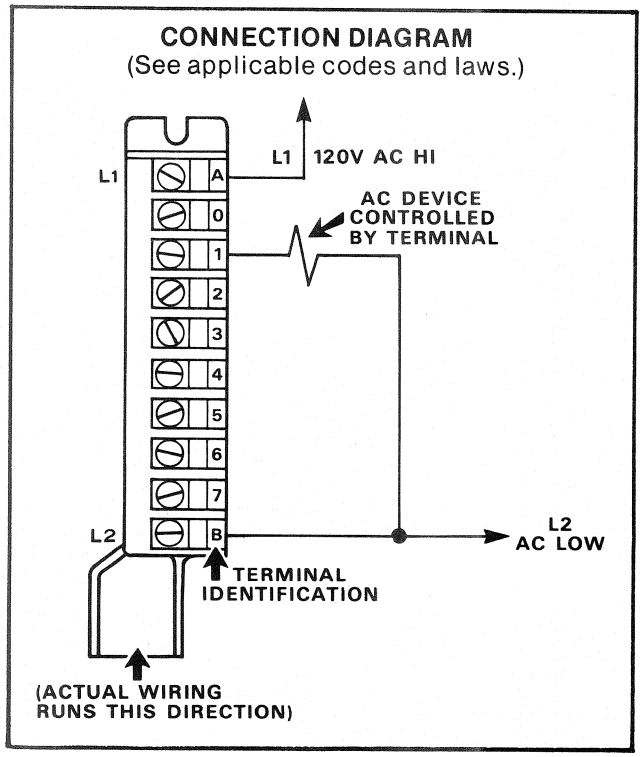
Plastic keys, shipped with each I/O Module, provide an easy method for the user to allow insertion of only one type of I/O Module into a specific I/O slot. Needle-nosed pliers may be used to insert keys onto the upper, 36-terminal, backplane connector.

Each type of I/O Module is slotted in two places at the rear edge. Positioning of keys on the backplane connector must correspond to these slots to allow insertion of the I/O Module. Keys are placed on the backplane connector in the area **between** numbers on the backplane.

In any slot designated for the AC (120V) Output Module, position keys at these two locations on the upper backplane connector:

- Between 4 and 6
- Between 12 and 14

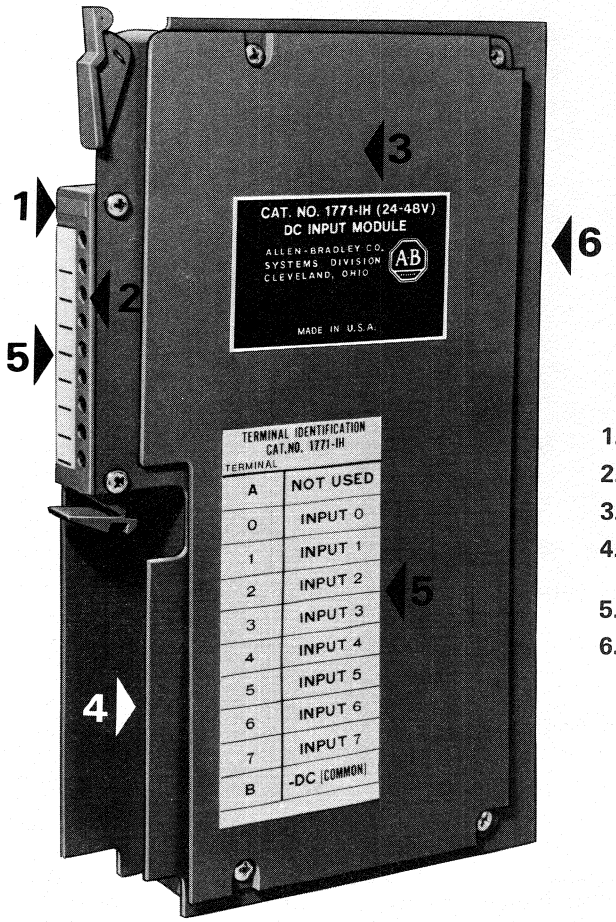
The position of these keys may be changed by the user if subsequent system design and rewiring makes insertion of a different Module necessary.




ALLEN-BRADLEY
Cleveland, Ohio 44143

# DC INPUT MODULE

## Cat. No. 1771-IH




1. Blue identification label
2. Status indicators
3. Protective covers
4. Field Wiring Arm connects here
5. Labels identify user inputs
6. Slotted for I/O slot insertion only

### SPECIFICATIONS

**Inputs per Module:** 8

**Module Location**
I/O Rack

**Nominal Input Voltage Rating**
24-48V DC

**Allowable Input Logic Voltage Range**
24-50V DC

**Nominal Input Current**
24V DC: 8.4 mA
48V DC: 20 mA

**Input Impedance**

| ON | OFF |
|---|---|
| 2.5-3KΩ | 5-6KΩ |

**Input Filter Time Constant**
15 ms (±7 ms)

**Power Supply Current Requirement**
74 mA per Module

**Electrical-Optical Isolation**
1500V
Isolation is between the input circuitry and control logic circuitry

**Ambient Temperature Rating**
0° to 60°C (operational)
-40° to 85°C (storage)

**Humidity Rating**
5 to 95%
(without condensation)

**Wire Size**
14 ga. stranded (max.)
3/64" insulation (max.)

**Keying**
Modules are slotted for insertion into I/O slots only

### DESCRIPTION

The DC (24-48V) Input Module (Cat. No. 1771-IH) provides interfacing between ON/OFF voltage levels of the user's 24-48V DC inputs and logic levels required with the Bulletin 1771 I/O Rack or Bulletin 1772 PLC-2 Mini-Processor. User's input signals commonly originate in switch closures such as limit, selector, and float switches and push buttons.

Connection to user devices is made at the Field Wiring Arm (Cat. No. 1771-WA) which is a removable part of the Bulletin 1771 I/O Rack. The Field Wiring Arm then pivots up in order to connect quickly and conveniently with terminals on the front of the I/O Module. (Refer to Figure 1.) The Field Wiring Arm allows easy removal of an I/O Module without removing wiring connections.

Module logic circuitry is protected from possible damage by transients from user inputs by 1500V optical isolation.

In addition to this protection, Module circuitry provides filtering for contact-bounce suppression and to limit the effects of voltage transients. (Such transients, occurring in a noise-polluted industrial environment, could introduce mislogic to the Input Module if filtering were not used.) Delay resulting from this type of filtering is typically 15 ms (±7 ms).

There are eight status indicators on the front face of the Module to represent the status of each input. The status indicator for an input illuminates when the input is ON. (Refer to Figure 2.)

**CAUTION:** The Module must **not** be removed from or inserted into the Bulletin 1771 I/O Chassis while system power is ON. Failure to observe this rule may result in damage to Module circuitry.

A package of keying bands is shipped with each Chassis. (Refer to Application Note 5.)




**Figure 1 — Field Wiring Arm Connection**

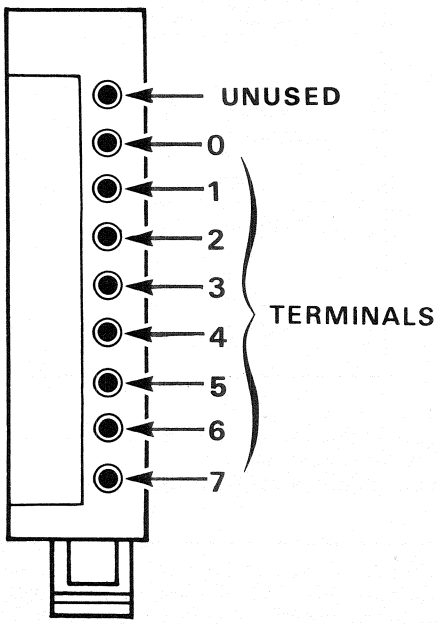



**Figure 2 — Status Indicators**

## APPLICATION NOTES

**CAUTION:** Proper polarity, as indicated in the Connection Diagram, must be observed with DC power connections. Reverse polarity, or incorrect application of 120V AC, may cause damage to the Module. (Any damage would affect user side of Module only.)

1. The status of an individual input is examined by these Instructions in the user's program:

   ⊣⊢ Examine input for an energized (ON) state

   ⊣/⊢ Examine input for a de-energized (OFF) state

2. The user must supply DC voltage to his input devices. DC common must be connected to the "B" terminal on the Field Wiring Arm. (Refer to the Connection Diagram.) Note that the "A" terminal on the Field Wiring Arm is not used with DC Input Modules.
3. Labels are provided on the Module for the user to designate the inputs connected to the Field Wiring Arm.
4. Terminals on the DC (24-48V) Input Module (Cat. No. 1771-IH) may be directly driven from terminals on the DC (12-24V) Output Module (Cat. No. 1771-OB) or the DC (48V) Output Module (Cat. No. 1771-OC). It is recommended that the same DC supply power both Modules to assure that ground is at the same potential.

5. In initial design stages, the DC (24-48V) Input Module may be inserted into any of the I/O Chassis slots. However, once specific slots have been designated for a Module, care should be taken so that other types of Modules will not be mistakenly placed into these slots.

   It is **strongly** recommended that the keying bands, provided with the Chassis, be used to permit insertion of the correct DC Input Modules only into the proper slots. Any I/O Rack connector may be keyed solely to receive the DC (24-48V) Input Module. (Refer to Figure 3.)

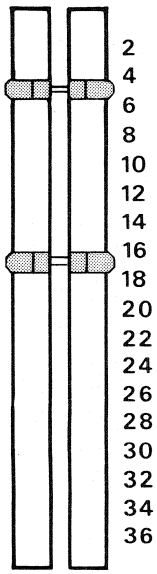



**Figure 3 — Keying Diagram**

## KEYING

Plastic keying bands, shipped with each I/O Chassis, provide an easy method for the user to allow insertion of only one type of I/O Module into a specific I/O slot. Needle-nosed pliers may be used to insert the bands onto the upper, 36-terminal, backplane connector.

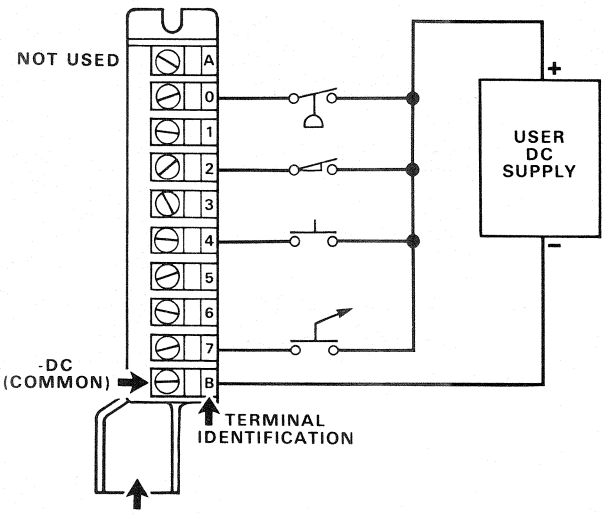
Each type of I/O Module is slotted in two places at the rear edge. Positioning of keying bands on the backplane connector must correspond to these slots to allow insertion of the I/O Module. Bands are placed on the backplane connector in the area **between** numbers on the backplane.

For the DC (24-48V) Input Module, position keys at these two locations on the upper backplane connector:

- Between 4 and 6
- Between 16 and 18

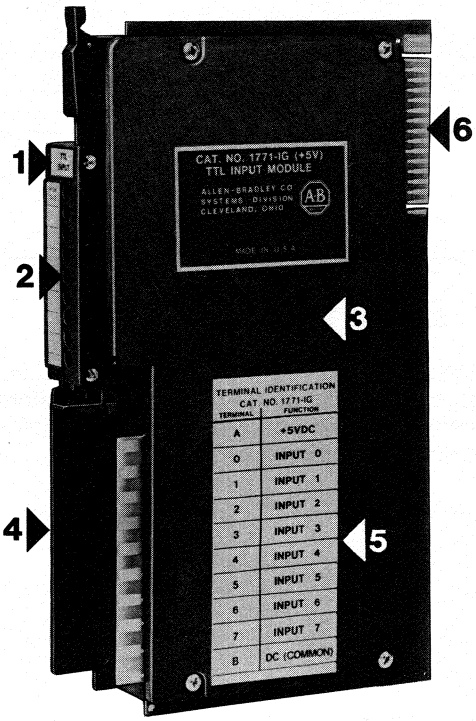
The position of these keying bands may be changed by the user if subsequent system design and rewiring makes insertion of a different type of Module necessary.

**CONNECTION DIAGRAMS**
(See applicable codes and laws.)



# TTL INPUT MODULE ASSEMBLY

## Cat. No. 1771-IG




1. Pink identification label
2. Status indicators
3. Protective covers
4. Field Wiring Arm connects here
5. Label identifies terminal connections
6. Slotted for I/O slot insertion only

### DESCRIPTION

The TTL Input Module Assembly (Cat. No. 1771-IG) monitors the status of transistor-transistor logic (TTL) compatible devices and provides this status information to the programmable controller. With this Module, the controller can interface with many TTL-compatible devices, including solid-state controls and sensing instruments. In addition, the TTL Input Module can be used for interfacing with some 5V DC level control devices and many types of photoelectric sensors.

The TTL Input Module Assembly (Cat. No. 1771-IG) consists of the following items:

- TTL Input Module (Cat. No. 1771-IGC)
- Field Wiring Arm (Cat. No. 1771-WC)

User wiring connections are made to the Field Wiring Arm. The Wiring Arm, acting as a terminal strip, pivots on the I/O Chassis to connect with terminals on the front of the Module. The Wiring Arm allows the Module to be removed from the Chassis without the need to disconnect terminal wiring.

To increase noise immunity, a signal input delay of approximately 1 millisecond is provided. Module logic circuitry is provided 1500V opto-electrical isolation from Module TTL input circuitry.

### SPECIFICATIONS

**TTL Compatible Inputs per Module**
8

**Input Voltage Rating**
HIGH=TRUE (Switch No. 1 ON) [1]

| | MIN | MAX |
|---|---|---|
| ON | 2.4V DC | 5.25V DC |
| OFF | -0.2V DC | +0.4V DC |

LOW=TRUE (Switch No. 1 OFF) [1]

| | MIN | MAX |
|---|---|---|
| ON | -0.2V DC | +0.4V DC |
| OFF | 2.4V DC | 5.25V DC |

**Customer Supply Voltage**
5V DC (±0.25V)
50 mV p-p ripple (max.)

**Customer Current Sink Requirements**
7 mA (sink per input)

**Customer Supply Current per Module**
200 mA (typical)
500 mA (max.)

**Power Supply 5V Current Requirements [2]**
76 mA (typical)
122 mA (max.)

**Opto-Electrical Isolation**
1500V
Isolation between input and control circuits

**Input Delay**
1 ms (max.)

**Cable**
Belden 8761
or equivalent

**Ambient Temperature Rating**
0°to 60°C (operational)
-40°to 85°C (storage)

**Humidity Rating**
5% to 95%
(without condensation)

**Module Location**
I/O Rack

**Keying**
Modules are slotted for placement in I/O slots only

[1] Refer to Figure 2.
[2] Refer to POWER SUPPLY REQUIREMENTS.

## LOGIC LEVELS

TTL-compatible devices have only one of 2 well-defined voltage levels at a given instant. Each voltage level corresponds to a distinct binary logic state: 1 or 0. A logic "1" voltage level may be termed TRUE or ON. A logic "0" voltage level may be termed FALSE or OFF. The TTL Input Module allows the user to select the logic state which is represented by a high or low voltage level. The user makes a switch selection for one of 2 logic levels:

- HIGH = TRUE logic
- LOW = TRUE logic

The input voltage range for each logic selection is listed in Table A.

**TABLE A**
**Bit, Device Status for HIGH and LOW=TRUE Logic [1]**

| MEMORY BIT STATUS | DEVICE STATUS | |
|---|---|---|
| | HIGH=TRUE | LOW=TRUE |
| "1" | ON State Considered: | |
| | 2.4V to 5.25V DC | -0.2V to +0.4V DC |
| "0" | OFF State Considered: | |
| | -0.2V to +0.4V DC | 2.4V to 5.25V DC |

[1] Refer to Figure 2.

## PROGRAMMING

An input may be examined for status by the following instructions:

Examine input for energized (ON) state

Examine input for de-energized (OFF) state

When an input terminal is in the ON or logic "1" state, the memory bit which represents the terminal in the Input Image Table is set to 1.

When an input terminal is in the OFF or logic "0" state, the memory bit which represents the terminal in the Input Image Table is reset to 0.

Memory bit status for each switch selection is shown in Table A. For a complete description of the programmable controller memory, refer to the Publications listed in Table B.

With Bulletin 1772 PLC-2 and Mini-PLC-2 controllers, Immediate Input instructions can be used to reduce the time required by the controller to respond to an input device status (ON/OFF) change. Using this instruction, along with the necessary programming technique, the input data from the Module can be updated before the I/O scan.

**TABLE B - Publications on Memory Structure**

| PROCESSOR | CAT. NO. | PUBLICATION |
|---|---|---|
| PLC Processor | 1774-RP3, -RP4<br>1774-RP1, -RP2 | 1774-934<br>1774-921 |
| PLC-2 Processor | 1772-LP1, Series A<br>1772-LR, Series B<br>1772-LR, Series A | 1772-909<br>1772-907<br>1774-921 |
| PLC-2 Mini-Processor Module | 1772-LN1, -LN2 | 1772-700 |

## STATUS INDICATORS

There are 9 status indicators on the front of the Module. (Refer to Figure 1.) Each of the lower 8 indicators illuminates when its corresponding input terminal senses TTL voltage in the TRUE or logic "1" state.

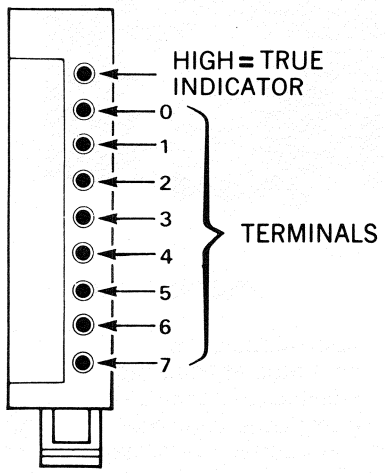



**FIGURE 1 - Status Indicators**

The status indicator for each input terminal is useful for diagnostic purposes. Based on the user Logic State Switch selection, this indicator illuminates when its corresponding input is ON, TRUE, or at a logic "1". As Table A indicates, this voltage must be between 2.4V and 5.25V DC when HIGH = TRUE logic has been selected. This voltage is between -0.2V and +0.4V DC when LOW = TRUE logic is selected.

Terminal status indicators may appear dim during rapid pulsing of the input signal.

The top indicator is labeled HIGH=TRUE. This indicator is ON when HIGH=TRUE logic is selected and Switch No. 2 on the Switch Assembly is ON. Should it be necessary, this indicator may be disabled by turning Switch No. 2 to the OFF position. (No separate logic indicator is provided for LOW = TRUE operation.)

## SWITCH SELECTION

The user logic selection is made on the TTL Logic Level Switch Assembly. Figure 2 shows the settings of this switch assembly. These switches are to be set by the user prior to installation of the Module in the Chassis.

The TTL Logic Level Switch Assembly is located on the component side of the Module circuit board. The Module cover must be removed to expose the Switch Assembly. Four screws hold this plastic cover to the Module at its corners.

## POWER SUPPLY REQUIREMENTS

**CAUTION:** Do not apply AC or reverse DC voltage to Module terminals. Circuitry at the input of the Module may be damaged.

A customer-supplied 5V DC power source is connected to the Wiring Arm of the Module. This source must be capable of providing 500 mA to each TTL Input Module. (This source is required to provide electrical isolation between Module logic circuitry and the user's input devices.)

The **logic** circuitry of the TTL Input Module is powered by the PLC, PLC-2, or Bulletin 1771 Power Supply which connects to the I/O Chassis. The typical 5V DC current drain from this Supply is 76 mA. Maximum current drain is 122 mA.

## CONNECTIONS

**CAUTION:** Power must be removed from the Module before it is placed into, or removed from, the I/O Chassis. This means that **both** power from the Power Supply connected to the I/O Chassis and power from the user-supplied 5V DC source must be turned OFF. Failure to observe this caution can result in damage to the Module.

The connection of user TTL input devices to the Module's Field Wiring Arm is made using Belden No. 8761 or equivalent cable. Follow the Connection Diagram in this Publication.

This cable has a foil shield with a bare stranded drain wire. These are to be grounded at one end of the cable **only**. The best ground for this connection is usually the enclosure ground at an I/O Chassis mounting bolt or stud. At the end of the cable which connects to the user device, the shield is cut short and taped back to prevent it from making any electrical contact.

To ground the shield at the I/O Chassis end, carefully remove a length of cable jacket and pull back the foil shield from the insulated wires. Twist this shield and bare stranded drain wire together to form a single strand. Clip the insulated wires to extend no more than 2 inches beyond the cable jacket and make connection to the appropriate Wiring Arm terminals. Then, fold the shield back and route it to the Chassis ground. (Refer to Figure 3.)

The single ground at the Chassis is the only electrical contact of the shield. Where necessary, use electrical tape to insulate the shield from any other contact.

The recommended maximum cable length is 50 feet.

The insulated signal ground return wire of each transmission cable must be connected to the user power supply DC common at both transmitting and receiving ends. (Do not confuse this connection with the practices for shield grounding, as described here.)

The user driving gate, whether it is a discrete or integrated circuit component, should drive **only** the Cat. No. 1771-IG TTL input and **not** other gates. The user device must be capable of sinking 7 mA in the low voltage range, -0.2V to +0.4V DC. Typically, a TTL device will have an open collector output with a pull-up resistor, typically 1K ohm.

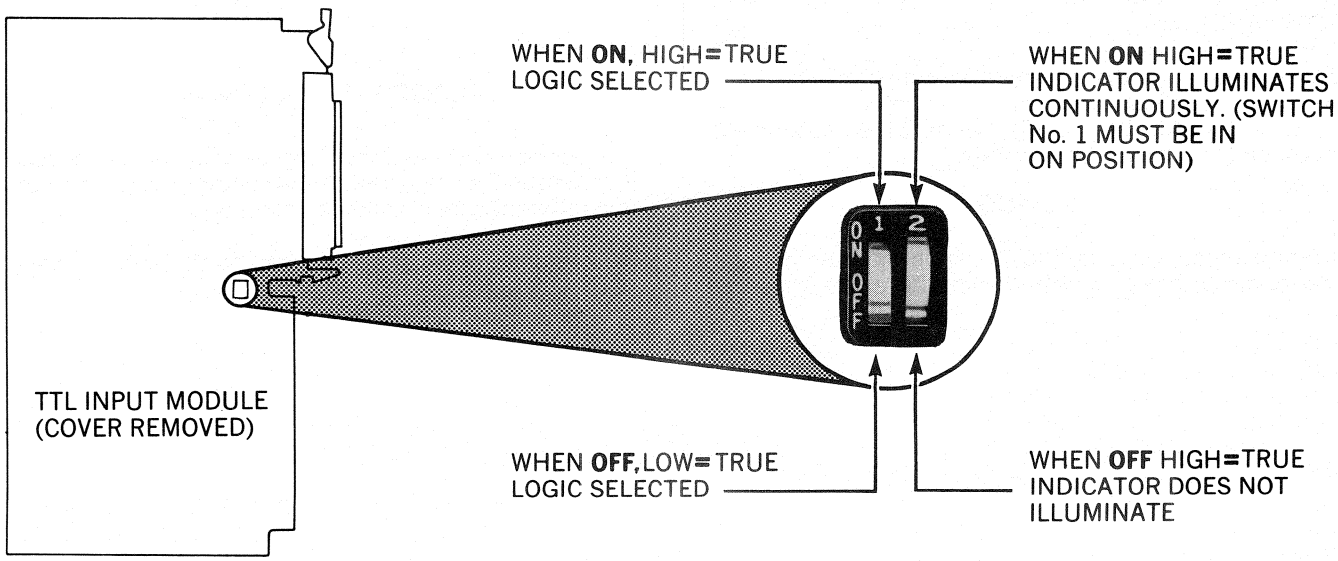
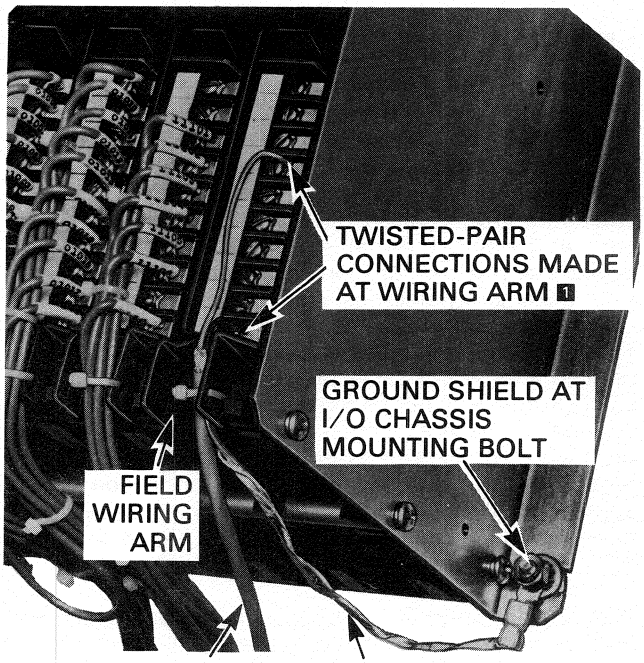



**FIGURE 2 - TTL Logic Level Switch Assembly**




1 Refer to individual I/O Module Data Sheets for exact twisted-pair terminal connections.

**FIGURE 3 - Cable Shield Grounding**

Unused or accidentally disconnected inputs on the TTL Input Module will float HIGH. Thus, when HIGH = TRUE switch selection is made, an unconnected input is seen by the Module as a logic "1". When LOW = TRUE switch selection is made, an unconnected input is seen by the Module as a logic "0".

Unused inputs may be jumpered to the DC common terminal if necessary. The state of any such input would then be logic "0" with HIGH = TRUE logic, logic "1" with LOW = TRUE logic.

Input terminals of the TTL Input Module (Cat. No. 1771-IGC) may be directly driven by outputs of the TTL Output Module (Cat. No. 1771-OGC). Connect the cable shield between Modules at one end **only**.

## KEYING

In initial design stages, the TTL Input Module may be inserted into any I/O module slot of the I/O Chassis. However, once specific slots have been designated for a module, care should be taken so that other types of modules will not be mistakenly placed into these slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for the user to key an I/O slot to accept only one type of I/O module. Use of these keying bands is strongly recommended.

Each type of I/O module is slotted in two places at its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed solely to receive the TTL Input Module (Cat. No. 1771-IG).

For the TTL Input Module, position keying bands on the upper backplane connector between these numbers printed on the backplane:

- Between 4 and 6
- Between 34 and 36

Refer to Figure 4.

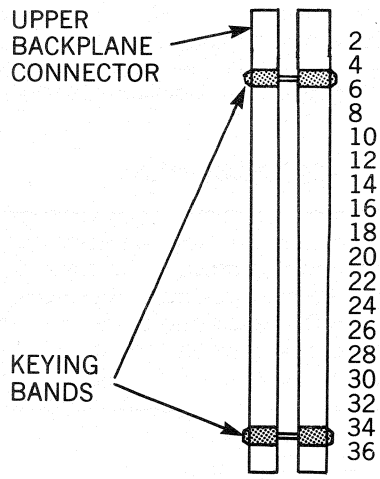
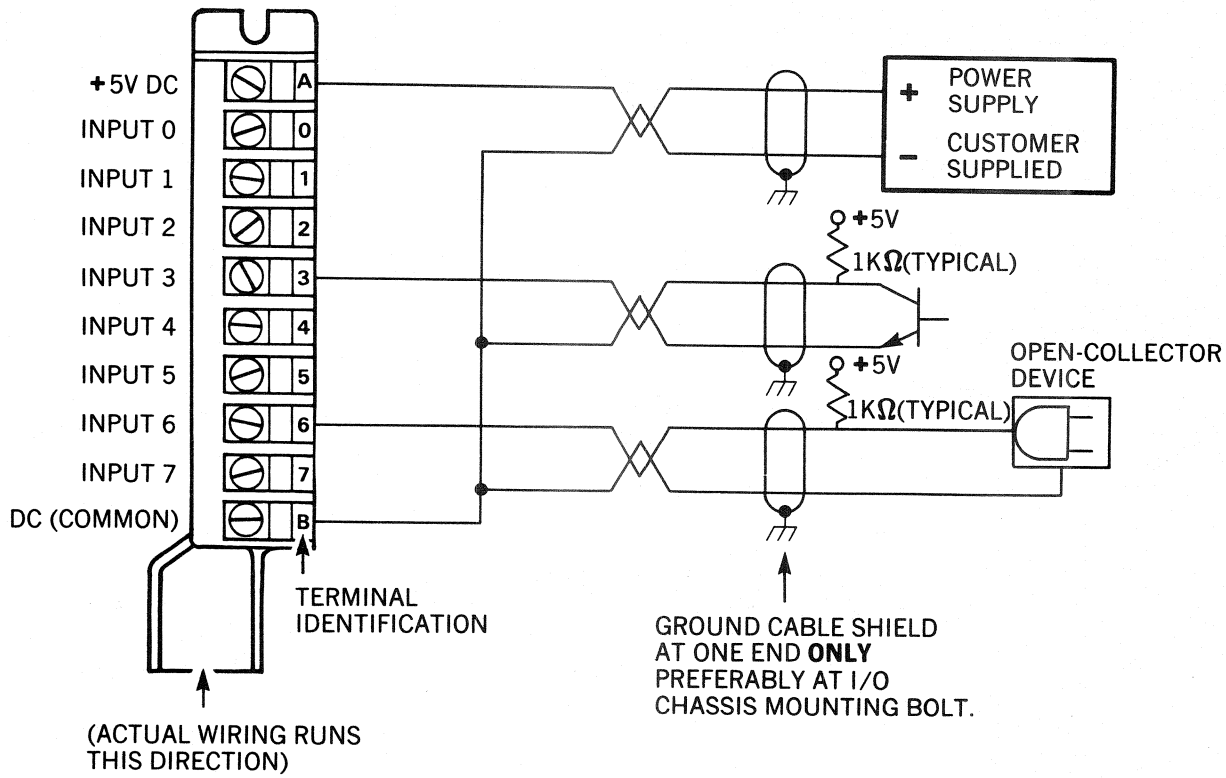



**FIGURE 4 - Keying Diagram**

The position of these bands may be changed by the user if subsequent system design and rewiring make insertion of a different type of module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

**CONNECTION DIAGRAM**
**(See applicable codes and laws)**

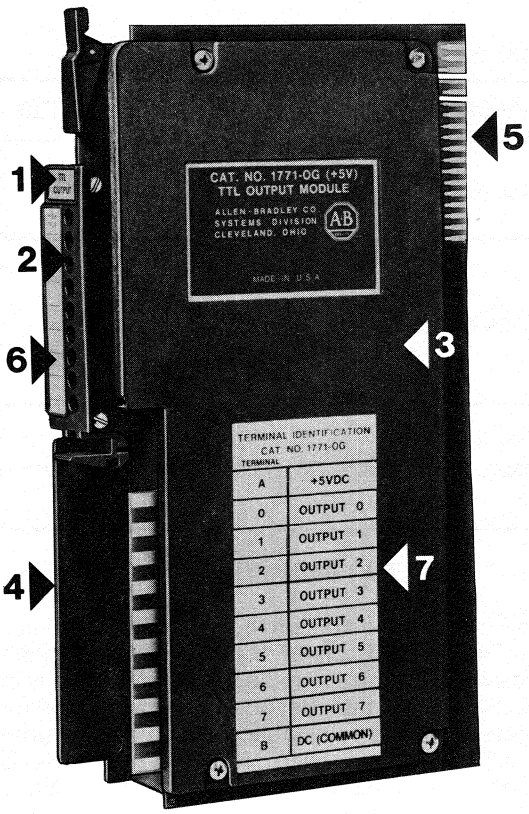


ALLEN-BRADLEY
Cleveland, Ohio 44143

P/N 636027-50

PRINTED IN U.S.A.

# TTL OUTPUT MODULE ASSEMBLY
## Cat. No. 1771-OG




1. Gray identification label
2. Status indicators
3. Protective covers
4. Field Wiring Arm connects here
5. Slotted for I/O insertion only
6. Space for user output labeling
7. Label identifies terminal connections

### DESCRIPTION

The TTL Output Module Assembly (Cat. No. 1771-OG) provides 8 transistor-transistor logic (TTL) compatible outputs for interfacing with discrete or integrated circuit TTL devices, LED displays, and various other 5V DC devices.

The TTL Output Module Assembly (Cat. No. 1771-OG) includes the following items:

- TTL Output Module (Cat. No. 1771-OGC)
- Field Wiring Arm (Cat. No. 1771-WC)

User wiring connections are made to the Field Wiring Arm. The Wiring Arm, acting as a terminal strip, pivots on the I/O Chassis to connect with terminals on the front of the Module. The Wiring Arm allows the Module to be removed from the Chassis without the need to disconnect terminal wiring.

Module logic circuitry is provided 1500V opto-electrical isolation from Module TTL output circuitry.

### SPECIFICATIONS

**TTL Compatible Outputs per Module**
8

**Output Voltage Rating**
HIGH = TRUE (Switch No. 1 ON) [1]

| | MIN | MAX |
|---|---|---|
| ON | 2.4V DC | 5.25V DC |
| OFF | -0.2V DC | +0.4V DC |

LOW = TRUE (Switch No. 1 OFF) [1]

| | MIN | MAX |
|---|---|---|
| ON | -0.2V DC | +0.4V DC |
| OFF | 2.4V DC | 5.25V DC |

**Output Current Rating**
20 mA (max.) sink current
1 mA (max.) source current

**Customer Supply Voltage**
5V DC (±0.25V)
50 mV p-p ripple (max.)

**Customer Current Required**
250 mA per Module

**Slew Rate** [2]
1 - 4 volts/$\mu$sec
at 5V DC levels

**Power Supply 5V Current Requirements**
131 mA (typical)
168 mA (max.) [3]

**Opto-Electrical Isolation**
1500V
Isolation between input and control circuits

**Cable**
Belden 8761
or equivalent

**Ambient Temperature Rating**
0° to 60° C (operational)
-40° to 85° C (storage)

**Humidity Rating**
5% to 95%
(without condensation)

**Module Location**
I/O Rack

**Keying**
Modules are slotted for placement in I/O slots only

[1] Refer to LOGIC LEVELS.
[2] Exact value depends on customer circuitry.
[3] Refer to POWER SUPPLY REQUIREMENTS.

## LOGIC LEVELS

TTL-compatible devices have only one of 2 well-defined voltage levels at a given instant. Each voltage level corresponds to a distinct binary logic state: 1 or 0. A logic "1" voltage may also be termed TRUE or ON. A logic "0" voltage may also be termed FALSE or OFF.

The TTL Output Module allows switch-selection of one of 2 levels:

- HIGH = TRUE logic
- LOW = TRUE logic

The output voltage range for each logic selection is listed in Table A.

**TABLE A**

**Bit, Device Status for HIGH and LOW = TRUE Logic [1]**

| MEMORY BIT STATUS | DEVICE STATUS | |
|---|---|---|
| | HIGH = TRUE | LOW = TRUE |
| "1" | ON State Considered: | |
| | 2.4V to 5.25V DC | -0.2V to +0.4V DC |
| "0" | OFF State Considered: | |
| | -0.2V to +0.4V DC | 2.4V to 5.25V DC |

[1] Refer to Figure 2.

## PROGRAMMING

Each output may be controlled by the following Instructions:

- Energize output device at addressed terminal (non-retentive)
- Latch output device ON at addressed terminal (retentive)
- Unlatch output device at addressed terminal (retentive)
- PUT — Transfer status of 16 bits (1 word) to a location in memory specified (retentive)

In the Output Image Table of controller memory, a single bit controls each TTL Output Module output terminal. As the controller Processor executes the user program, it sets or resets the logic state of this bit. This logic state, as a "1" or "0", is transmitted to the output terminal of the TTL Output Module.

The **voltage** which appears at the module terminal depends on **both** the "1" or "0" state of the memory bit **and** the user switch selection. Table A shows the voltage range for each user selection. For HIGH = TRUE logic, the voltage range for an ON or logical "1" state is 2.4V to 5.25V DC. The voltage range for an OFF or logical "0" state is -0.2V to +0.4V DC.

When LOW=TRUE logic is selected, the voltage range for an ON or logical "1" state is -0.2V to +0.4V DC. The voltage range for an OFF or logical "0" state is 2.4V to 5.25V DC.

For a complete description of the programmable controller memory, refer to the Publications listed in Table B.

**TABLE B - Publications on Memory Structure**

| PROCESSOR | CAT. NO. | PUBLICATION |
|---|---|---|
| PLC Processor | 1774-RP3, -RP4<br>1774-RP1, -RP2 | 1774-934<br>1774-921 |
| PLC-2 Processor | 1772-LP1, Series A<br>1772-LR, Series B<br>1772-LR, Series A | 1772-909<br>1772-907<br>1774-921 |
| PLC-2 Mini-Processor Module | 1772-LN1, -LN2 | 1772-700 |

## STATUS INDICATORS

There are 9 status indicators on the front of the Module. (Refer to Figure 1.) Each of the lower 8 indicators illuminates when its corresponding output terminal is in the TRUE or logic "1" state. Because the voltage level for a logic state is switch-selectable, the indicator illuminates at a high voltage when HIGH = TRUE logic is selected, at a low voltage when LOW = TRUE logic is selected.

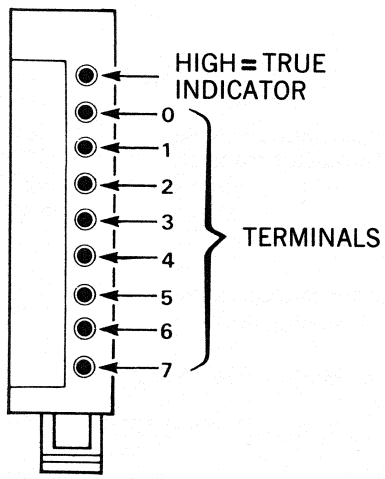



**FIGURE 1 - Status Indicators**

These status indicators are useful for diagnostic purposes. Based on the user Logic State Switch selection, each indicator illuminates when its corresponding output

terminal is ON, TRUE, or at a logic "1". As Table A indicates, this voltage must be between 2.4V and 5.25V DC when HIGH = TRUE logic has been selected. This voltage is between-0.2V and+0.4V DC when LOW=TRUE logic is selected.

Status indicators may appear dim during rapid pulsing of the output signal.

The top indicator is labeled HIGH=TRUE. This indicator is ON when HIGH=TRUE logic is selected and Switch No. 2 on the Switch Assembly is ON. Should it be necessary, this indicator may be disabled by turning Switch No. 2 on the Switch Assembly to the OFF position. (No separate logic indicator is provided for LOW=TRUE operation.)

## SWITCH SELECTION

Figure 2 shows the settings of the TTL Logic Level Switch Assembly on the Module. These rocker switches are to be set by the user prior to installation of the Module in the Chassis.

The TTL Logic Level Switch Assembly is located on the component side of the Module circuit board, near the output terminals. The Module cover must be removed to expose the Switch Assembly. Four screws hold this plastic cover to the Module at its corners.

## POWER SUPPLY REQUIREMENTS

**CAUTION:** Misapplication of AC voltage or application of reverse DC voltage can cause a failure or damage the output circuitry of the Module.

For the TTL **output** circuitry of the Module, a customer-supplied 5V DC power source is connected to the Wiring Arm of the Module. This source must be capable of providing 250 mA to each TTL Output Module. (The use of this separate source is required to provide electrical isolation between Module logic circuitry and the user's TTL devices.)

The **logic** circuitry of the TTL Output Module is powered by the PLC, PLC-2, or Bulletin 1771 Power Supply which connects to the I/O Chassis. The +5V DC current drawn from this Supply by the TTL Output Module depends on the number of outputs that are ON at a specific time. The term "ON" means that the output is considered at a TRUE state for the type of logic selected. (Note that this refers not only to the high or low voltage level at the output, but also to the logic level switch selection made by the user.)

## CONNECTIONS

**CAUTION:** Power must be removed from the Module before it is placed into, or removed from, the I/O Chassis. This means that **both** power from the Power Supply connected to the I/O Chassis and power from the user-supplied 5V DC source must be turned OFF. Failure to observe this caution can result in damage to the module.

Connection of user TTL output devices to the Module's Field Wiring Arm is made using Belden No. 8761 or equivalent cable. Follow the Connection Diagram in this Publication.

This cable has a foil shield with a bare stranded drain wire. These are to be grounded at one end of the cable only. The best ground for this connection is usually the enclosure ground at an I/O Chassis mounting bolt or stud. At the other end of the cable, which connects to the user device, the shield is cut short and taped back to prevent it from making electrical contact.

To ground the shield at the I/O Chassis end, carefully remove a length of cable jacket and pull back the foil shield from the insulated wires. Twist this shield and bare stranded drain wire together to form a single strand. Clip the insulated wires to extend no more than 2 inches beyond the cable jacket and make connection to the appropriate Wiring Arm terminals. Then, fold the shield back and route it to the Chassis ground. (Refer to Figure 3.)

The single ground at the Chassis is the only electrical contact of the shield. Where necessary, use electrical tape to insulate the shield from any other contact.

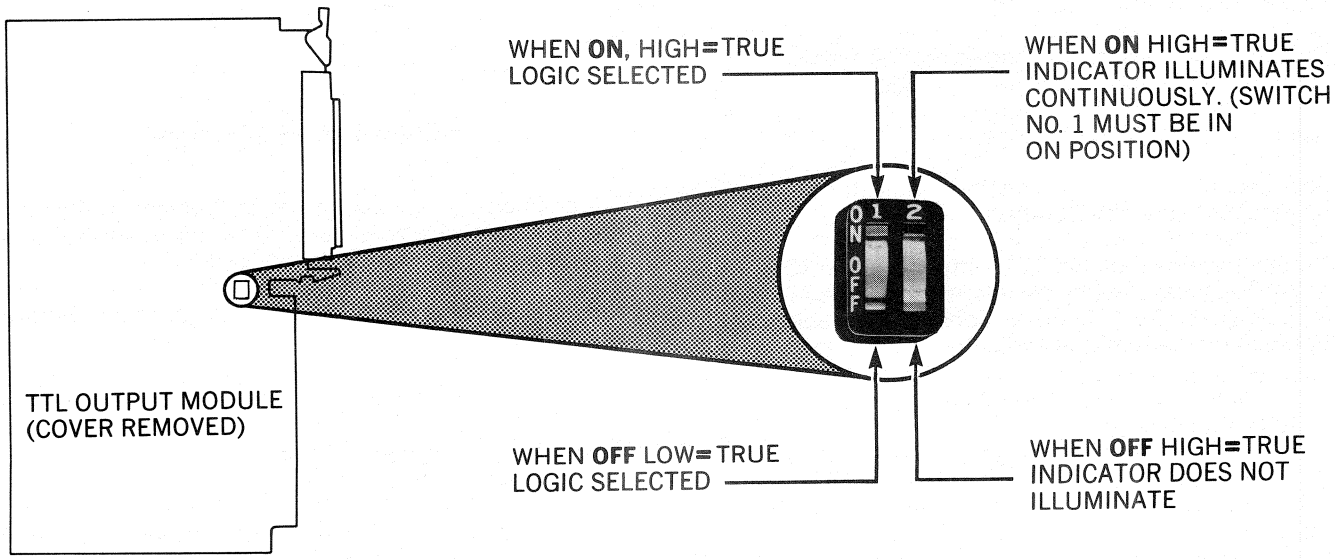
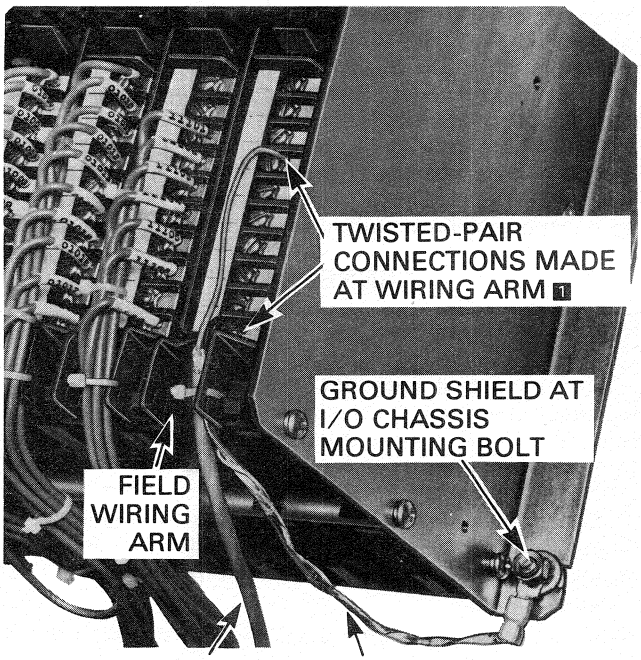



**FIGURE 2 - TTL Logic Level Switch Assembly**




1 Refer to individual I/O Module Data Sheets for exact twisted-pair terminal connections.

**FIGURE 3 - Cable Shield Grounding**

The recommended maximum cable length is 50 feet.

The signal ground return wire of each transmission cable must be connected to the user power supply DC common at **both** transmitting and receiving ends. (Do not confuse this connection with the practices for shield grounding, as outlined here. Refer to the Connection Diagram.)

A reverse-biased Schottky diode can be used to limit negative overshoot at the receiving end. A Schmitt trigger input may be used to increase noise immunity when located near user TTL circuitry.

Customer-supplied gates used as receivers should have all inputs tied to the signal line. A single gate should be used as the termination of a signal line. Avoid using other logic inputs to the receiving gate.

Source current is provided on the Module through a pull-up resistor to the +5V DC line.

Output terminals of the TTL Output Module (Cat. No. 1771-OGC) may directly drive terminals of the TTL Input Module (Cat. No. 1771-IGC). Connect the cable shield between modules at one end only.

## KEYING

In initial design stages, the TTL Output Module may be inserted into any I/O module slot of the I/O Chassis. However, once specific slots have been designated for a module, care should be taken so that other types of modules will not be mistakenly placed into these slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for the user to key an I/O slot to accept only one type of I/O module. Use of these keying bands is strongly recommended.

Each type of I/O module is slotted in two places at its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed solely to receive the TTL Output Module (Cat. No. 1771-OG).

For the TTL Output Module, position keying bands on the upper backplane connector between these numbers printed on the backplane:

- Between 6 and 8
- Between 10 and 12

Refer to Figure 4.

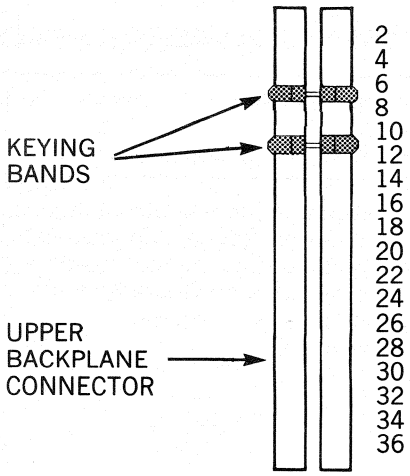
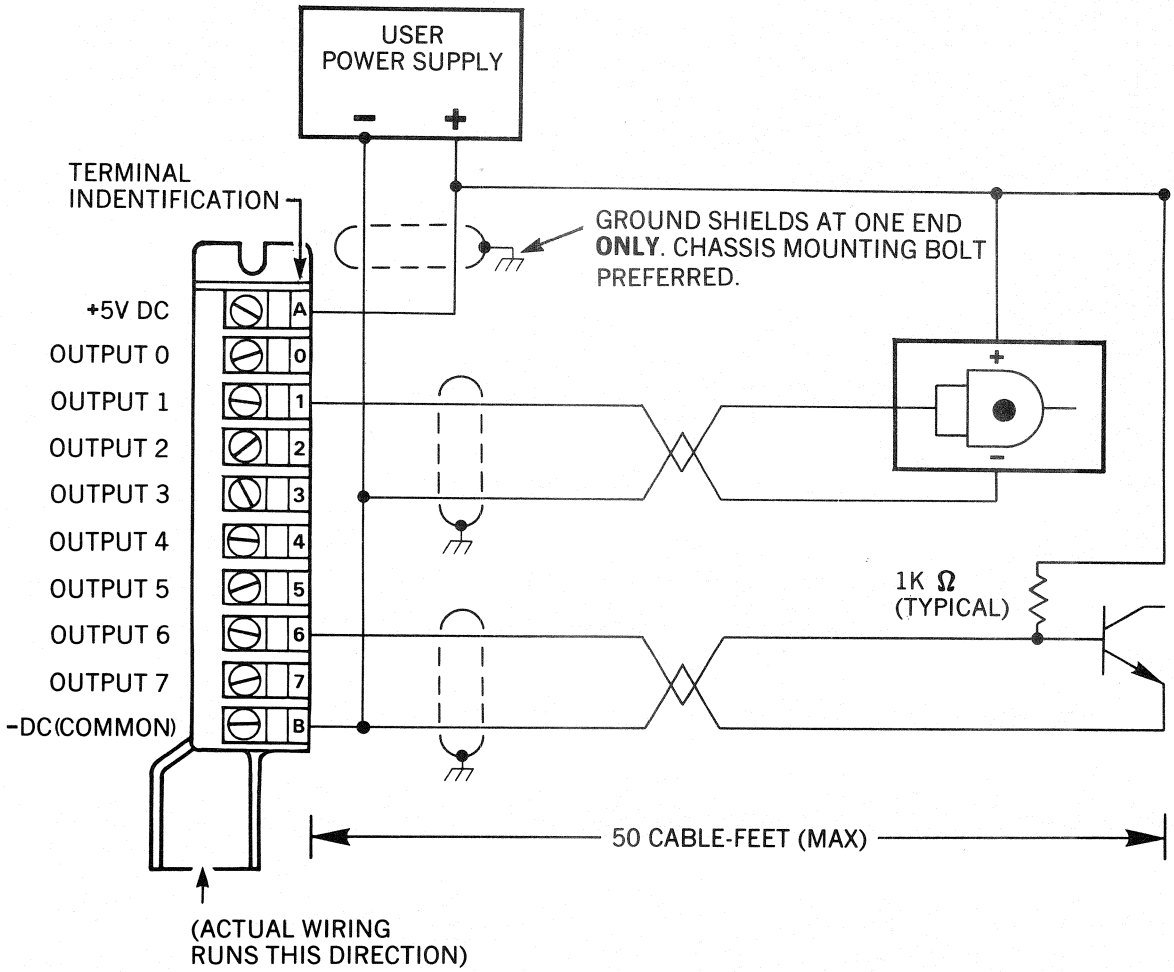



**FIGURE 4 - Keying Diagram**

The position of these bands may be changed by the user if subsequent system design and rewiring make insertion of a different type of module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

**CONNECTION DIAGRAM**
**(See applicable codes and laws)**

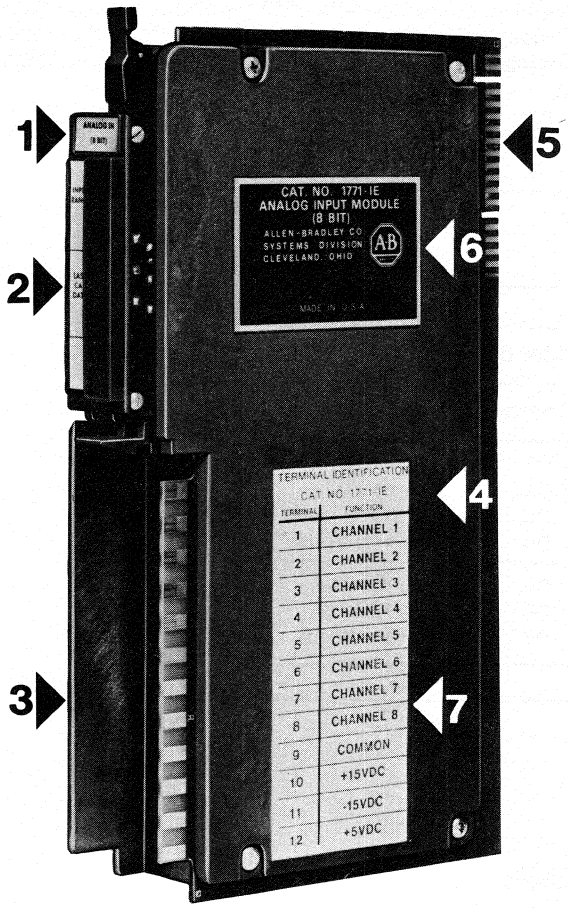


ALLEN-BRADLEY
Cleveland, Ohio 44143

P/N 636028-50

# ANALOG INPUT MODULE (8 BIT) ASSEMBLY

## Cat No. 1771-IE




1. Pink identification label
2. Range/Calibration date label
3. Field Wiring Arm Connects here
4. Protective covers
5. Slotted for I/O insertion only
6. Labels identify Module type/series
7. Label specifies terminal connections

### SPECIFICATIONS

**Inputs per Module**
8 single-ended

**Module Location**
I/O Rack

**Input Voltage Ranges (Nominal)**
+1 to +5V
0 to +5V
0 to +10V
-10 to +10V

**Input Current Ranges (Nominal)**
0 to +20 mA
+4 to +20 mA
-20 to +20 mA

**Digital Resolution**
1 part in 256

**Input Overvoltage Protection**
±35V DC
25V RMS (sinusoidal)

**Cable Type**
Belden 8761, or equivalent

**Input Impedance**
$\geq 10^{10}$ Ohms for voltage ranges
250 Ohms (±0.1%) for current ranges

**5V Current Requirement**
(from System Power Supply or Supply to I/O Rack)
400 mA

**External Power Supply Requirements**
(See Table D)

**Ambient Temperature Rating**
0° to 60°C (operational)
-40° to 85°C (storage)

**Humidity Rating**
5% to 95%
(without condensation)

**Electrical - Optical Isolation**
1500V
Isolation is between the input circuit and the control logic

**Keying**
Modules are slotted for insertion into Chassis I/O Module slots only

### DESCRIPTION

The Analog Input Module (8 bit) Assembly (Cat. No. 1771-IE) senses analog signals at its inputs and converts these to a proportional 3-digit BCD value for use by the programmable controller Processor. The Analog Input Module accepts analog signals in one of several user-specified voltage or current ranges. Thus, it allows interface between a programmable controller and several types of analog devices, sensing such variables as temperature, pressure, R.P.M., light intensity, and position.

The Analog Input Module (8 bit) Assembly includes the following units:

- Analog Input Module (8 bit) (Cat. No. 1771-IEC).
- Field Wiring Arm (Cat. No. 1771-WD).

User wiring connections are made to the Field Wiring Arm. (Refer to the Connection Diagram.) The Wiring Arm, acting as a terminal strip, pivots on the I/O Chassis to connect with terminals on the front of the Module. The Wiring Arm allows the Module to be removed from the Chassis without the need to disconnect user wiring.

The Analog Input Module is compatible with the requirements of the Instrument Society of America Standard ISA S50.1 (1975), Compatibility of Analog Signals for Electronic Industrial Process Instruments.

### INPUT CHANNELS

The Analog Input Module (8 bit) has 8 single-ended input channels. All input channels on an individual Module have the same voltage or current range. This range must

be specified when the Module is ordered. This specified input voltage or current range is factory set and adjusted.

When ordering an Analog Input Module, include the coded information listed in Table A. This information specifies either the voltage or current mode and the range of voltage or current values within that mode.

The voltage and current ranges given in the Specifications section are nominal. Precise voltage and current ranges for these nominal ranges are shown in Tables B and C. In addition, these Tables give the voltage- or current-per-bit for each range.

In the voltage mode, the Analog Input Module (8 bit) has input overvoltage protection to±35VDC, 25V RMS (sinusoidal). In the current mode, the maximum continuous current limit is±30mA. Exceeding these limits may damage the customer side of the Module. However, the controller logic circuitry is protected from the input overvoltage or overcurrent by 1500V opto-electrical isolation.

**TABLE A - Module Coding**

1771-IE 04

① Basic Catalog No.

② Identifying Code

| | Codes | Range |
|---|---|---|
| Voltage Mode | 01 | +1 to+5 Volts |
| | 02 | 0 to+5 Volts |
| | 03 | -10 to+10 Volts |
| | 04 | 0 to+10 Volts |
| Current Mode | 05 | +4 to+20 mA |
| | 06 | 0 to+20 mA |
| | 07 | -20 to+20 mA |

**TABLE B - Voltage Ranges**

| NOMINAL VOLTAGE RANGE | ACTUAL VOLTAGE RANGE | CORRESPONDING BCD VALUE | VOLTS PER BIT |
|---|---|---|---|
| +1 to+5V | +1 to+4.9844V | 000 to 255 | 15.6 mV/bit |
| 0 to+5V | 0 to 4.980V | 000 to 255 | 19.53 mV/bit |
| 0 to+10V | 0 to 9.96V | 000 to 255 | 39.06 mV/bit |
| -10 to+10V | -10 to+9.922V | 000 to 255 | 78.13 mV/bit |

**TABLE C - Current Ranges**

| NOMINAL CURRENT RANGE | ACTUAL CURRENT RANGE | CORRESPONDING BCD VALUE | CURRENT PER BIT |
|---|---|---|---|
| 0 to+20 mA | 0 to+19.922 mA | 000 to 255 | 0.078 mA/bit |
| +4 to+20 mA | 4 to 19.937 mA | 000 to 255 | 0.063 mA/bit |
| -20 to+20 mA | -20 to+19.844 mA | 000 to 255 | 0.156 mA/bit |

## PROGRAMMING

The Analog Input Module (8 Bit) Assembly (Cat. No. 1771-IE) can be used with the following Processors:

- Bulletin 1774 Remote I/O PLC Processor (Cat. No. 1774-RP1, -RP2, -RP3, -RP4)
- Bulletin 1772 PLC-2 Processor (Cat. No. 1772-LR, -LP1)
- Bulletin 1772 PLC-2 Mini-Processor Module (Cat. No. 1772-LN1, -LN2)

Depending on the Processor used, Module/Processor communication may have one of two modes:

- Block transfer
- Single-channel transfer

The block transfer mode is available with PLC-2 Processors of Cat. No. 1772-LP1. [1] When using the Analog Input Module (8 bit) Assembly with any of the other Processors listed here, the single-channel transfer mode is used. [2]

A user switch selection is made to determine the mode of data transfer. (Refer to SWITCH SETTING.)

The BCD value from each Module channel is contained in a 16-bit data word. This word also indicates overflow or underflow for the analog range and identifies the analog channel addressed. The 16-bit data word for each channel has the format shown in Figure 1.

## RESOLUTION

The term "8 bit" indicates that the resolution of the Module is 1 part in $2^8$ (1 part in 256). This defines how closely the converted BCD value approximates the actual analog value within a particular voltage or current range. For an analog value within the specified range, a proportional BCD value between 000 and 255 is generated by the Module.

The A/D converter on the Module has the following characteristics:

- **Type:** Successive Approximation, monotonic
- **Resolution:** 1 part in 256
- **Linearity:** ±0.1% of full scale (at 25°C)
- **Offset:** ±0.15% of full scale (at 25°C)
- **Gain:** ±0.15% of full scale (at 25°C)
- **Quantizing Error:** ±1/2 LSB (0.19% of full scale)
- **Absolute Accuracy**, including linearity, offset and gain at 25°C: 0.3% of full scale ±1/2 LSB
- **Stability** (drift) over the full temperature range: temperature coefficient = ±85 ppm/°C of full scale
- **Inaccuracy** due to internal electrical noise: 3 sigma noise = 0.2% RMS of full scale
- **Calibration:** Module calibration must be checked periodically. Maximum time between calibrations is 1 year. [3]

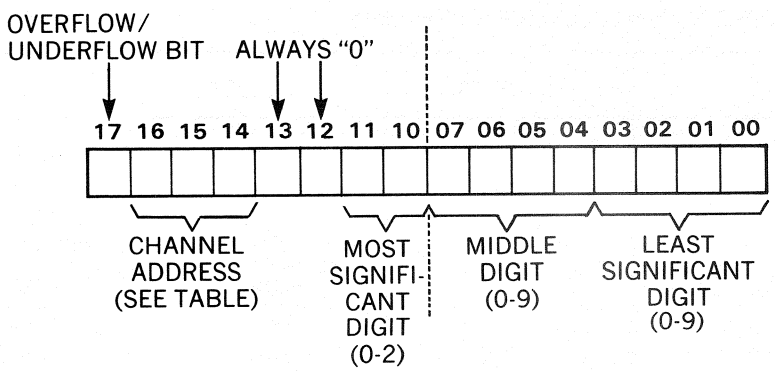
## DIAGNOSTICS

Module diagnostic circuitry monitors the analog-to-digital conversion process and the user-supplied power source voltage levels. Upon detection of a fault from any of these sources, the Module inhibits the transmission of channel data which might be inaccurate. Based upon the

[1] Available beginning first quarter, 1980.

[2] For a description of single-channel transfer programming, refer to Publication 1771-920, Single Channel Programming for the Analog Input Module (8 bit).
Block transfer programming will be described in a subsequent Publication.

[3] For information on Module calibration, refer to Publication 1771-921, Calibration Techniques, Analog I/O Modules.




CHANNEL ADDRESS CODES

| BITS 16 | 15 | 14 | CHANNEL NUMBER |
|---|---|---|---|
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 2 |
| 0 | 1 | 0 | 3 |
| 0 | 1 | 1 | 4 |
| 1 | 0 | 0 | 5 |
| 1 | 0 | 1 | 6 |
| 1 | 1 | 0 | 7 |
| 1 | 1 | 1 | 8 |

**FIGURE 1 — Analog Input Memory Word**

data transfer mode, the Module takes the following action upon fault detection:

- **Block transfer** - In the block transfer mode, the Analog Input Module stops data transmission when a fault is detected.
- **Single-channel transfer** - In the single-channel transfer mode, the Analog Input Module sets all data to 0 when a fault is detected. The user program must detect this condition in a fault situation. [1]

Data transfer can be restarted only when the fault condition has been removed.

Figure 1 shows the Analog Input memory word sent by each channel. Bit 17 of this word signals either overflow or underflow. When this bit is set to 1 (ON),the voltage or current value for the individual channel is either above or below range. In the program, it may be useful to check bit 17 for analog channels connected to critical application devices.

Whether a value is above or below range can be determined by the following:

- **Overflow** - Bit 17 set to 1; BCD value is 255.
- **Underflow** - Bit 17 set to 1; BCD value is 000.

When the analog value is within range, bit 17 is reset to 0.

## EXTERNAL POWER SUPPLY

The Analog Input Module requires Wiring Arm connection to a power supply separate from any other supply in the controller system. (Refer to the Connection Diagram.) Using a separate supply protects the analog signals against transients caused by the switching of digital circuits. Specifications for this external DC power source are listed in Table D.

The Power Supply (Cat. No. 1770-P1) is available as an external power source for the Analog Input Module. (Refer to Figure 2.) This Supply operates on either 120V AC or 220/240V AC input. It provides sufficient output power for 2 Analog Input Module (8 bit) Assemblies (Cat. No. 1771-IE).

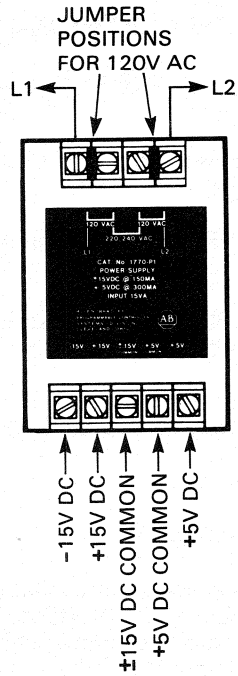



**FIGURE 2 — Power Supply Connections (Cat. No. 1770-P1)**

The PLC Remote Power Supply (Cat. No. 1778-P2) can also be used as the external power source to the Module. With this Supply, the user must also order the Analog I/O Power Cable (Cat. No. 1778-AM). Wiring Arm connections from this cable are illustrated in Figure 3.

The PLC Remote Power Supply can provide external power to a maximum of 10 Analog Input Modules (8 bit). If a Remote Supply is used to power these Modules, however, it must **not** be used for I/O Rack power at the same time.

It is recommended that no more than 5 Analog Input Modules be connected using a single Analog I/O Power Cable (Cat. No. 1778-AM).

[1] For a description of single-channel transfer programming, refer to Publication 1771-920, Single Channel Programming for the Analog Input Module (8 bit).

**TABLE D - Power Supply Requirements**

| SPECIFICATIONS | +5 VOLTS | +15 VOLTS | -15 VOLTS |
|---|---|---|---|
| Current (per Analog Input Module) | 150 mA | 70 mA | 70 mA |
| Voltage Tolerance | 1% | 1% | 1% |
| Regulation (type) | Linear (Series or shunt) | Linear (Series or shunt) | Linear (Series or shunt) |
| Line Regulation (for 10V AC RMS input change) | ±.02% | ±.02% | ±.02% |
| Load Regulation | ±.04% | ±.02% | ±.02% |
| Ripple | 1 mV | 1 mV | 1 mV |
| Overvoltage Protection | +7 volts | +18 volts | -18 volts |
| Current Limit (percent of full load) | 125% | 125% | 125% |

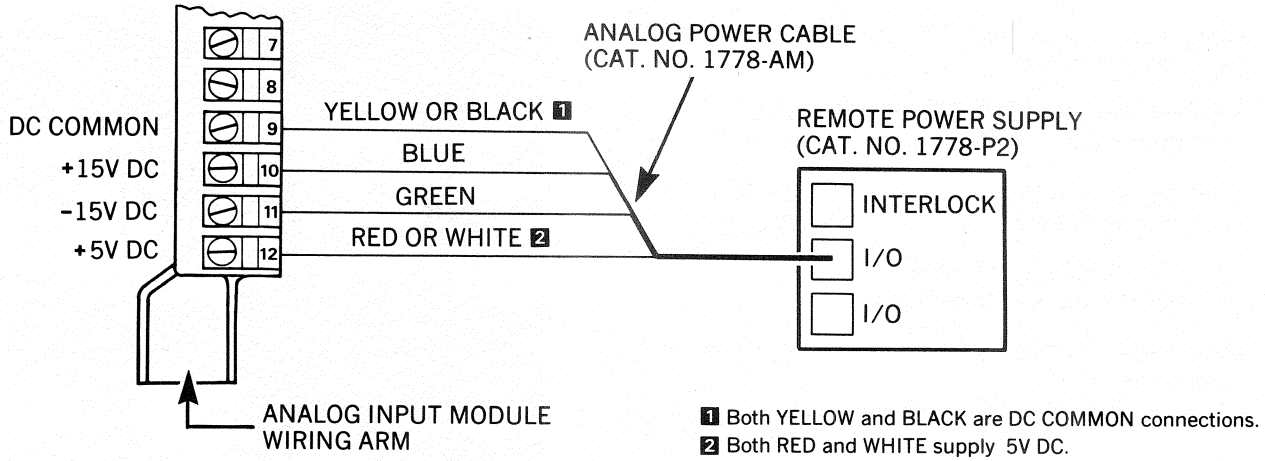



**FIGURE 3 — Analog I/O Power Cable Connections**

Power and common connections can be jumpered from one Analog Input Module to the next. Use stranded wire of at least AWG 20.

If a user-supplied power supply is chosen, its 5V DC COMMON terminal must be connected to the 15 V DC COMMON terminal. Thus, the Wiring Arm terminal labeled COMMON connects with the DC COMMON for both ±5V and ±15V DC. This terminal also connects with the SIGNAL RETURN wire from each analog device.

The PLC Remote Power Supply (Cat. No. 1778-P2) has this connection made internally. With the Power Supply (Cat. No. 1770-P1), both 5V DC COMMON and 15V DC COMMON terminals must be jumpered together, either at the Supply or at the Module.

Note: Do not confuse the SIGNAL RETURN wire with the cable shield. The SIGNAL RETURN wire is one of the insulated wires of the cable twisted-pair. Cable shield connection is described in WIRING.

## SWITCH SETTING

Before inserting the Analog Input Module (8 bit) into its I/O Chassis slot, the user must set a rocker switch on the Transfer Mode Switch Assembly. (Refer to Figure 4.) This switch setting determines the mode of data transfer of the Module: block or single-channel transfer.

To access the Transfer Mode Switch Assembly, the component-side cover must be removed from the Module. Four corner screws hold this cover in place.

Figure 4 shows the location and settings of this Switch Assembly on the Module. Note that this Switch Assembly has only **two** switches. (Other switch assemblies can be

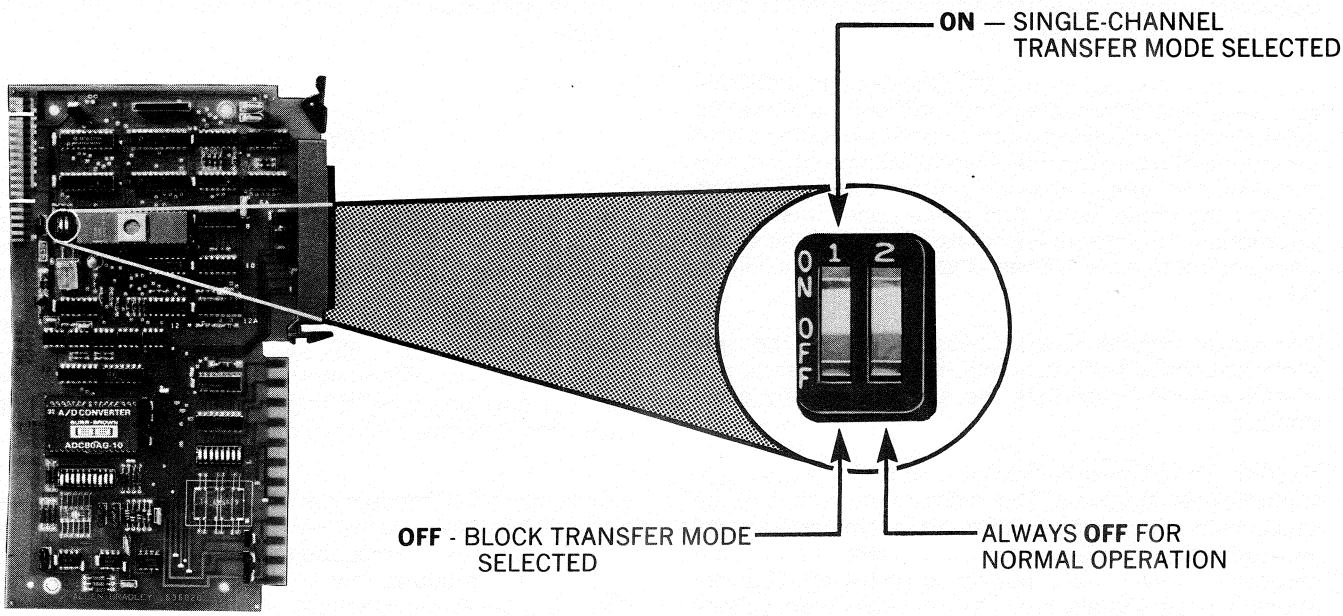



**FIGURE 4 — Transfer Mode Switch Assembly**

seen on the Module; these, however, are set only during calibration procedures.) The significance of these 2 switches is as follows:

- **Switch No. 1** - This switch determines the data transfer mode of the Module:
  - ON - Set this switch in the ON position if the single-channel transfer mode is to be used.
  - OFF - Set this switch in the OFF position if the block transfer mode is to be used.
- **Switch No. 2** - This switch must be set OFF for normal operation.

Use the tip of a ball-point pen to set these rocker switches ON or OFF.

## WIRING

**CAUTION:** Do not remove any Module from or insert any Module into the Chassis while controller power to the Chassis is ON. Failure to observe this rule may result in damage to Module circuitry.

The Analog Input Module may be placed in any I/O module slot of the I/O Chassis. However, to minimize noise, group Analog Input Modules together within an I/O Chassis whenever possible.

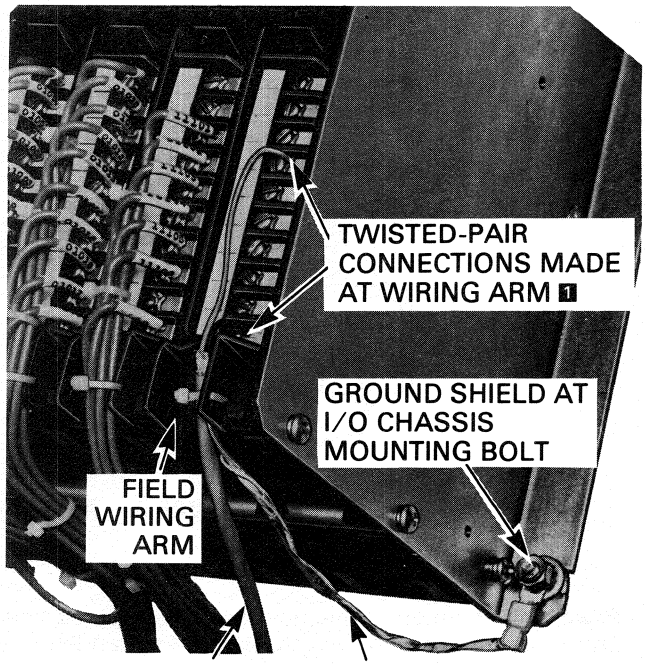
Use Belden No. 8761 or equivalent cable to connect user analog devices to the Module's Field Wiring Arm. Follow the Connection Diagram in this Publication.

This type of cable has a foil shield with a bare stranded drain wire. These are to be grounded at **one** end of the cable only. The best ground for this connection is usually the enclosure ground at an I/O Chassis mounting bolt or stud. At the other end of the cable, which connects to the user device, the shield must be cut short and taped back to insulate it from any electrical contact.

To ground the shield at the I/O Chassis end, carefully remove a length of cable jacket and pull back the foil shield from the insulated wires. Twist this shield and bare stranded drain wire together to form a single strand. Clip the insulated wires to extend not more than 2 inches beyond the cable jacket and make connection to the appropriate Wiring Arm terminals. Then, fold the shield back and route it to the Chassis ground. (Refer to Figure 5.)

The single ground at the Chassis must be the **only** electrical contact of the shield. Where necessary, use electrical tape to insulate the shield from any other contact.

Recommended maximum cable length for **voltage** mode input devices is 50 feet. This recommendation is based on considerations of noise immunity in typical industrial environments. Cable length for **current** mode input devices, however, need not be as restricted. (Current mode analog signals are less sensitive than voltage signals to noise induced along transmission cables.)




1 Refer to the Connection Diagram for exact twisted-pair terminal connections.

**FIGURE 5 — Cable Shield Grounding**

The user may mount a separate terminal near the Analog Input Module for DC COMMON and all SIGNAL RETURN wire connections.

This user-installed terminal should be mounted as close to the Module as possible for maximum shielding of the cable.

## KEYING

In initial design stages, the Analog Input Module may be inserted into any I/O module slot of the I/O Chassis. However, once specified slots have been designated for a module, care should be taken so that other types of modules will not be mistakenly placed into these slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for the user to key an I/O slot to accept only one type of module. Use of these keying bands is strongly recommended.

Each type of I/O module is slotted in two places at its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed solely to receive the Analog Input Module Assembly (Cat. No. 1771-IE).

For the Analog Input Module, position the keying bands on the upper backplane connector between these numbers printed on the backplane:

- Between 4 and 6
- Between 26 and 28

Refer to Figure 6.

The position of these bands may be changed by the user if subsequent system design and rewiring makes insertion of a different type of Module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

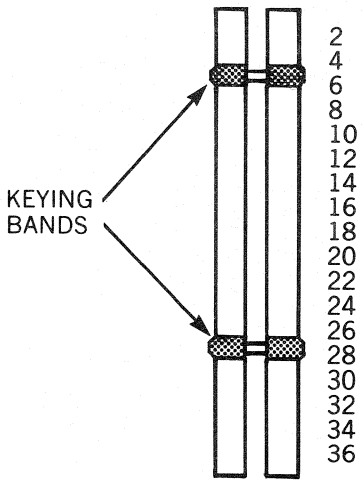
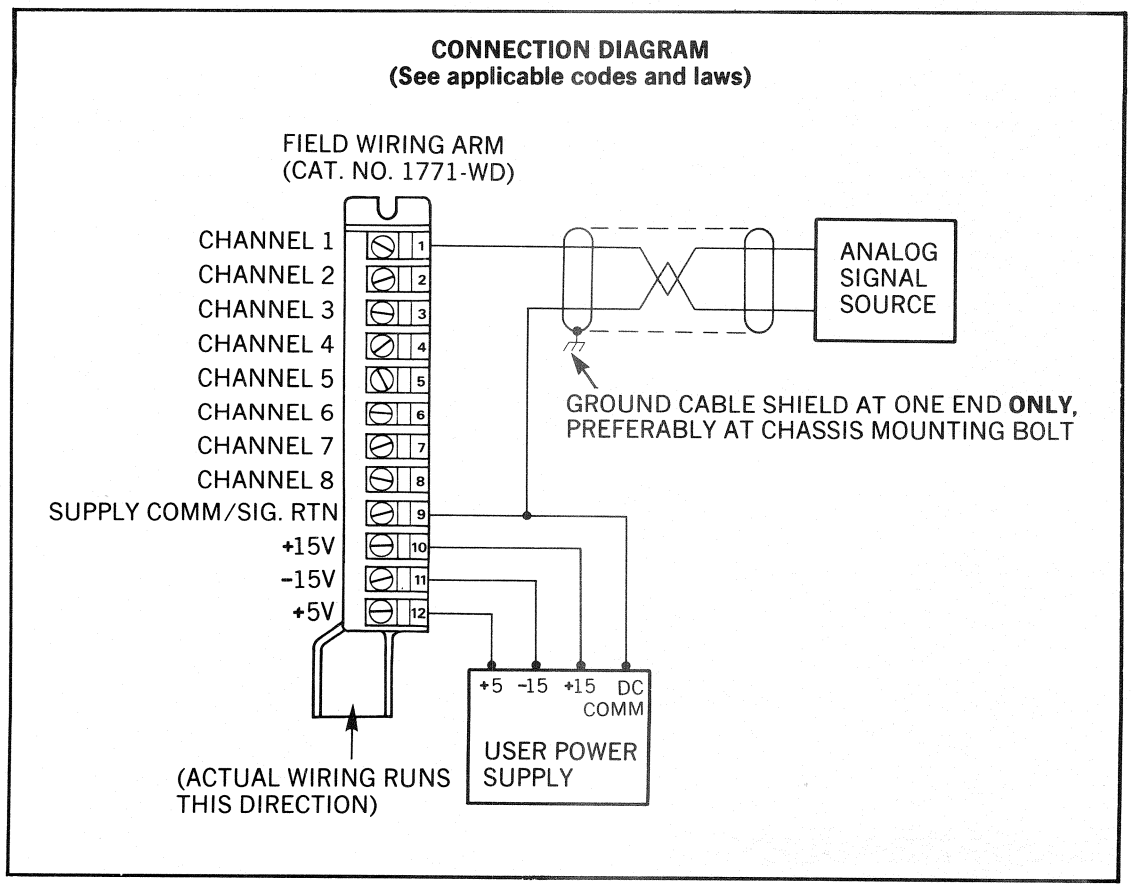



**FIGURE 6 — Keying Diagram**

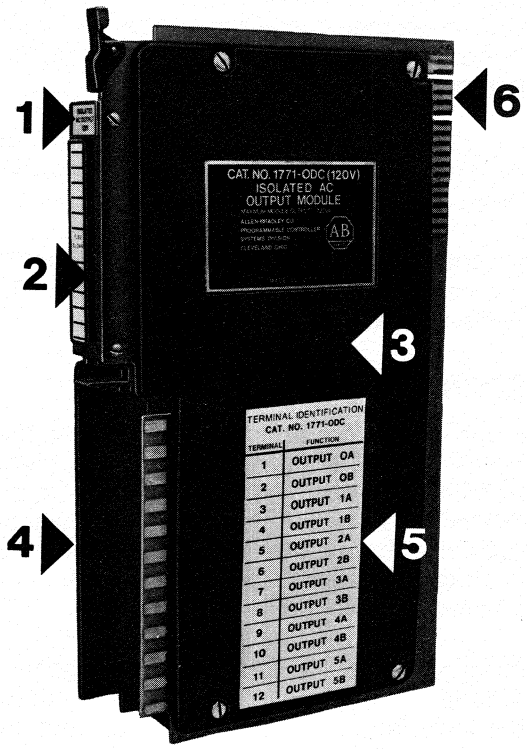


ALLEN-BRADLEY
Cleveland, Ohio 44143

P/N 636020-50

# ISOLATED AC (120V) OUTPUT MODULE ASSEMBLY

## Cat. No. 1771-OD




1. Orange identification label
2. Status indicators
3. Protective cover
4. Field Wiring Arm connects here
5. Labels indentify user devices
6. Slotted for I/O rack insertion only

### SPECIFICATIONS

**Outputs per Module**
6
**Module Location**
I/O Rack
**Nominal Output Voltage**
120V AC, 50/60 Hz
**Output Voltage Range**
92 to 138V AC
47-63 Hz
**Continuous Output Current Rating**
2A (max.) per output
(not to exceed 6A per Module)
**Surge Current (Max.)**
Series A: 18A (max) for 80 ms;
Series B: 20A (max) for 100 ms;
Repeatable every 5 seconds
(fuse-limited)
**Minimum Load Current**
60 mA
**ON State Voltage Drop**
2V @ 100 mA
**OFF State Leakage Current**
5 mA per output (max.)
**Power Supply Current Requirement**
225 mA per Module
**Electrical-Optical Isolation**
1500V RMS
Isolation is between power output and control logic.
**Ambient Temperature Rating**
0° to 60°C (operational)
—40° to 85°C (storage)
**Humidity Rating**
5 to 95%
(without condensation)
**Wire Size**
14 ga. stranded (max.)
3/64" insulation (max.)
**Keying**
Modules are slotted for placement in I/O slots only
**Fuses**
Series A: 5 Amp 8AG "Normal Blo"
Series B: 5 Amp 3AG "Normal Blo"

### DESCRIPTION

The Isolated AC (120V) Output Module Assembly (Cat. No. 1771-OD) allows the Controller to operate devices which might need separate AC power sources or different AC phase relationships. It can also provide circuit isolation for devices that are sensitive to electrical noise. Typical devices that can be controlled by the Module are: relays, solenoids, and motor starters. The Module, as a part of the 1771 Universal I/O Structure, is compatible with any member of the PC Controller family employing 1771 I/O Racks.

The Isolated AC (120V) Output Module Assembly includes the following units:

- Isolated AC (120V) Output Module (Cat. No. 1771-ODC)
- Field Wiring Arm (Cat. No. 1771-WD)

### STATUS INDICATORS

There are twelve indicators on the Module. The top six indicators show the state of each output. If a LED is ON, the corresponding output is energized. The output status indicators are driven by the logic circuitry on the Controller side of the Module.

The remaining six indicators display a blown fuse condition at the respective output. The neon indicators are driven by the customer power supply. Refer to Figure 1.

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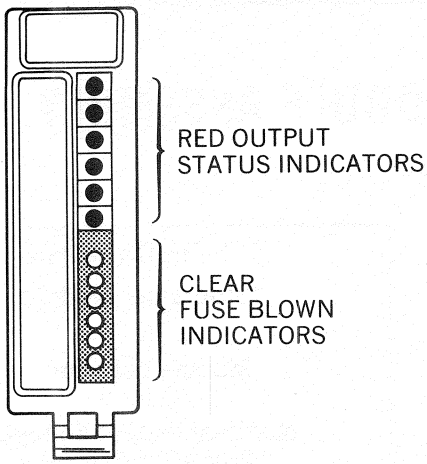



**Figure 1 - Status Indicators**

## MODULE POWER SUPPLY REQUIREMENTS

The logic circuitry for the Module draws its power from the power supply of the I/O rack. The Module uses 225 mA from the 5V DC output of this supply. This amount should be totalled with the current requirements of other modules in the rack to avoid overloading the supply.

## PROGRAMMING

The Module uses standard programming techniques; it responds to the following output instructions:

- ⊣ ⊢ OUTPUT ENERGIZE
- ⊣/⊢ OUTPUT DE-ENERGIZE (PLC Controller only)
- ⊣L⊢ OUTPUT LATCH
- ⊣U⊢ OUTPUT UNLATCH
- ⊣PUT⊢ PUT

The address of the module is determined by its location in the rack. For further information on addressing, see the Assembly and Installation Manual for the particular Controller being used.

## OUTPUT CIRCUITRY

The six electrically isolated outputs are individually fused to protect the customer's power supply. Each output has a continuous current rating of 2 amps. The outputs of the Series A module can tolerate a maximum inrush current of 18 amps for 80 ms, repeatable every 5 seconds. Each output is fused with a 5 Amp 8AG fuse. The Series B module can tolerate a maximum inrush current of 20 amps for 100 ms, repeatable every 5 seconds. It uses a 5 amp 3AG fuse. The Module's logic circuitry is protected by optical isolators that can withstand voltage transients of 1500VRMS. An output can drive an Allen-Bradley Size 5 motor starter, provided its supply voltage does not drop below 105V AC.

The switching device in the output circuit is a triac. There is a small leakage current in the OFF state due to both triac and capacitive characteristics. The maximum leakage current per output is 5 mA. The ON state voltage drop across the output terminals is no more than 2V AC at 100 mA.

The triac needs a minimum of 60 mA load current to stay ON. If the customer device pulls less than 60 mA, the triac will not operate correctly.

The total continuous current that the module will support is 6 amps. If this rating is exceeded, the Module will overheat and damage may occur.

## SUPPRESSION

Surge suppression circuitry is provided for the output triacs of the Module. To suppress high-voltage transients from the AC line, an MOV (metal-oxide varistor) is provided between each set of terminals on the Module. An RC network limits the effect of voltage transients from devices with hard contacts or inductive loads.

Loads with large inductive characteristics can generate substantial voltage transients, which could exceed the internal surge suppression protection of the Module. Additional surge suppression devices may be needed to provide protection for the logic circuitry. Since switching frequency and load impedance are important factors in selecting a suppression device, it is not possible to specify a particular device for every possible Module load. If noise problems do develop, refer to Figure 2 for some possible starting points for selecting a suppression device.

**FIGURE 2 - Suppressors**

| Allen-Bradley Equipment | Suppressor A-B Cat. No. |
|---|---|
| Motor Starter Bulletin 509 | 599-K04 |
| Relay Bulletin 700N | 700N5<br>700N9 |
| Motor Starter Bulletin 709 | 1401-N10 |
| General Purpose: | Electro Cube[1] P/N RG 1676-14 |

[1] Electro Cube, Inc.
1710 South Delmar Avenue
San Gabriel, CA 91776

## WIRING

There are twelve terminals on the Field Wiring Arm (Cat. No. 1771-WD) - two per output. The arm swings down for easy removal of the module without disturbing the wiring connections. The maximum wire size is 14 ga AWG stranded with 3/16" insulation. Refer to Figure 3.

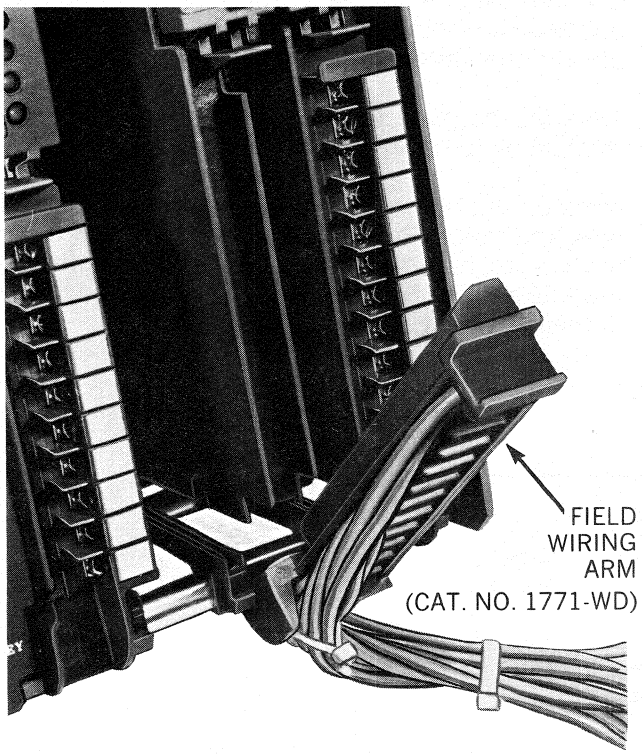



**Figure 3 - Field Wiring Arm**

Note: The labels on the Wiring Arm should be identified with the name or number of the device connected at each terminal.

An output of the Isolated AC (120V) Output Module of one Controller can be used to drive an input to a second Controller, provided proper voltage and phase relationships are maintained. However, a 2000 ohm, 20 watt resistor must be connected across the terminals of the output to allow for proper operation of the status indicator. Refer to Figure 4.

## KEYING

In early design stages the Isolated AC (120V) Output Module may be inserted into any I/O module slot of the I/O Chassis. However, once specific slots have been designated for a module, care should be taken so that other types of modules will not be mistakenly placed into these slots.

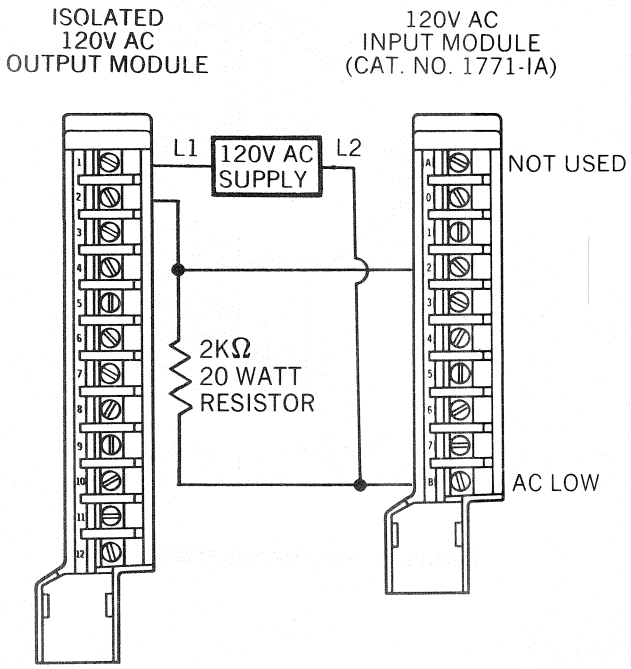



**Figure 4 - Connection Diagram for Interfacing Two Controllers**

Plastic keying bands, shipped with each I/O Chassis, provide an easy method for the user to key an I/O slot to accept only one type of I/O module. Use of these keying bands is strongly recommended.

Each type of I/O module is slotted in two places at its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed solely to receive the Isolated AC (120V) Output Module (Cat. No. 1771-OD).

For the Isolated AC Output Module, position keying bands on the upper backplane connector between these numbers printed on the backplane:

- Between 4 and 6
- Between 30 and 32

Refer to Figure 5.

The position of these bands may be changed by the user if subsequent system design and rewiring makes insertion of a different type of Module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

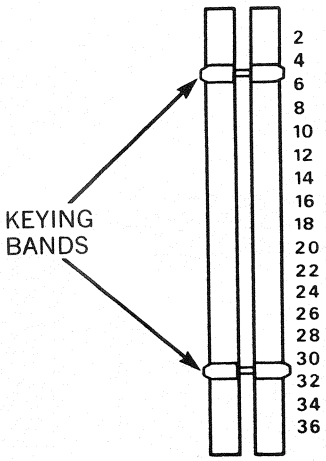



**Figure 5 - Keying Diagram**

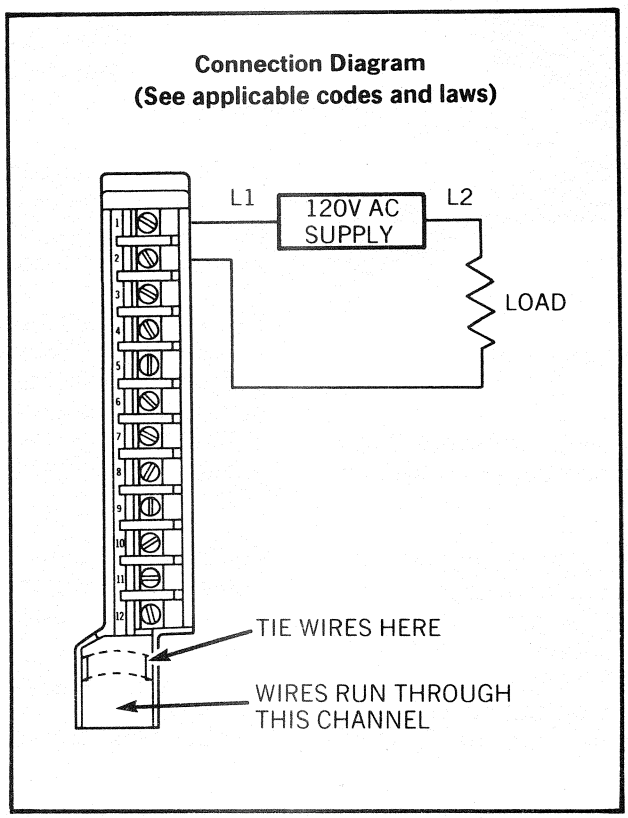
## FUSE REPLACEMENT

WARNING: For the safety of the operator, customer power should be turned off whenever any work is done at the rack. To prevent damage to the module, the module power supply should also be off.

If a Blown Fuse indicator for a particular output is ON, remove the Module from the I/O rack by pivoting the Field Wiring Arm away from the module and then pulling the module out.

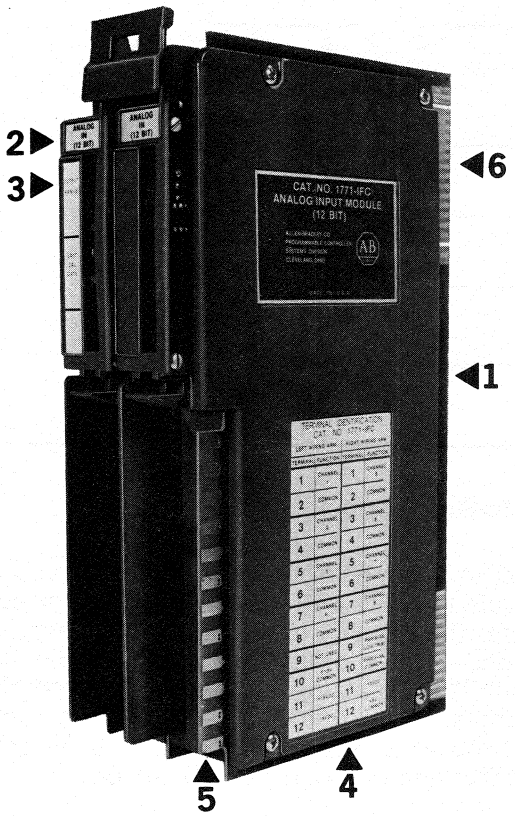
Take off the plate from the customer side of the module by removing the two slotted screws.

Replace the blown fuse with one of the specified type and rating. Reinstall the cover and return the module to its correct slot. Make sure both the module and the Field Wiring Arm are seated firmly in their sockets.



# ANALOG INPUT MODULE (12 BIT) ASSEMBLY

## Cat. No. 1771-IF




1. Protective cover
2. Pink Identification label
3. Status indicators
4. Label identifies user output connections
5. Field Wiring Arm connects here
6. Slotted for I/O slot insertion only

### DESCRIPTION

The Analog Input Module (12 bit) Assembly (Cat. No.1771-IF) measures analog signals at its inputs and converts this data to a proportional three digit BCD or twelve bit binary value. Up to eight analog devices, sensing such variables as temperature, pressure, light intensity, and position, can be connected to the Module. All the outputs of these devices should conform to the single voltage or current range for which the Module has been calibrated. When ordering, the customer should specify the required voltage or current range. The Module can be used with any PC Processor employing the 1771 I/O Structure.

The term "12 bit" indicates that the resolution of the Module is 1 part in $2^{12}$ ($4096_{10}$). This defines the

### SPECIFICATIONS

**Inputs per Module**
8 single-ended

**Module Location**
1771 I/O Rack — 2 slots

**Input Voltage Ranges (nominal)**
+1 to +5V DC
0 to +5V DC
—10 to +10V DC
0 to +10V DC

**Input Current Ranges (nominal)**
+4 to +20mA
0 to +20mA
—20 to +20mA

**Digital Resolution**
Selectable 3-digit BCD or 12-bit binary

**Input Overvoltage Protection**
±35V DC
±25V RMS (sinusoidal) with ±15, +5V maintained.

**Input Impedance**
$>10^9$ ohms for voltage ranges
250 ohms for current ranges

**Power Supply Current Requirements**
1.3 Amps

**BCD Output to Processor**
000 to $999_{10}$ for any input range

**Binary Output to Processor**
0000 to $4095_{10}$ for any input range

**Ambient Temperature Rating**
0° to 60°C (operational)
-40° to 85°C (storage)

**Humidity Rating**
5 to 95% (without condensation)

**Electrical-Optical Isolation**
1500V (transient)
Isolation between the input circuit and the control logic.

**Keying**
Module is keyed for insertion in I/O slots only:
Insert keys at

| Left Connector | Right connector |
|---|---|
| 6 and 8 | 4 and 6 |
| 22 and 24 | 32 and 34 |

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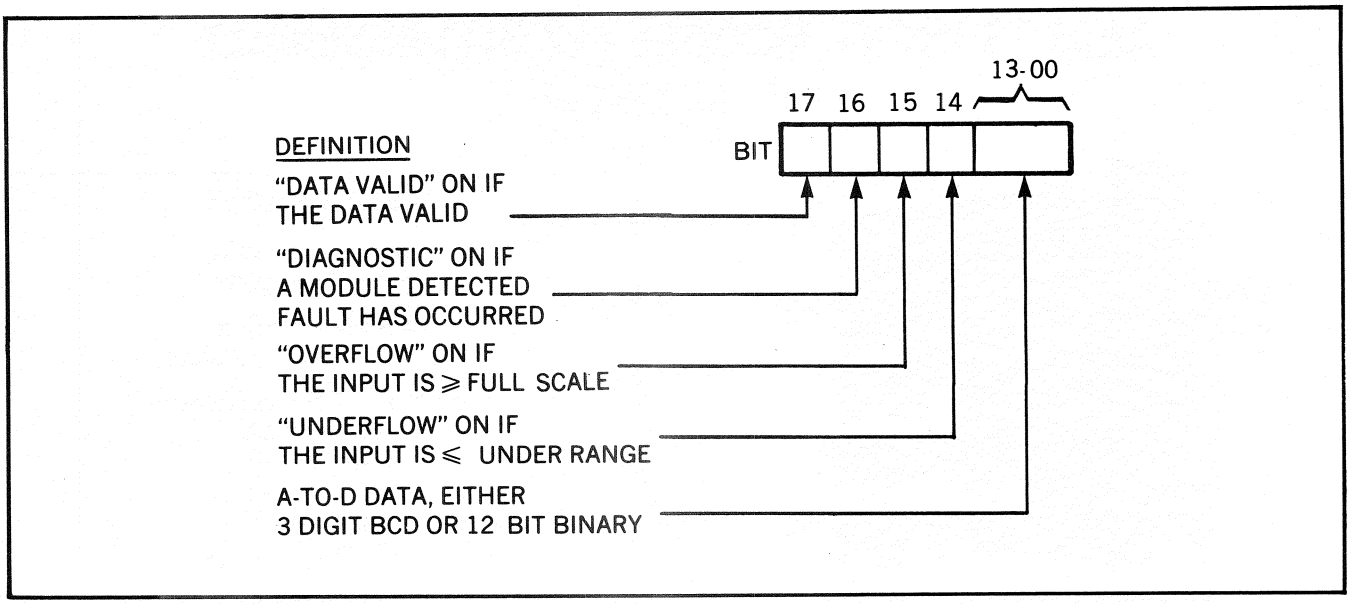



**FIGURE 1 — Channel Input Data Word Format**

number of units available to the Module in dividing up its particular voltage or current range. The conversion of the analog value to a BCD format, if selected, limits the resolution to 1 part in 1000.

The BCD or binary value from each channel is contained in a 16 bit input data word that is stored in the Module's memory. In addition to the channel value in the first twelve bits, the remaining four bits are used for diagnostic information (Figure 1).

The Analog Input Module (12 bit) Assembly includes the following units:

- Analog Input Module (12 bit) (Cat. No. 1771-IFC)
- Two Field Wiring Arms (Cat. No. 1771-WD)

The Analog Input Module (12 bit) is compatible with the requirements of the Instrument Society of America Standard ISA S50.1 (1975), Compatibility of Analog Signals for Electronic Industrial Process Instruments.

## SELECTION OF INPUT CHANNEL RANGES

The Analog Input Module (12 bit) has eight single-ended input channels. All input channels on an individual Module have the same voltage or current range. This range must be specified when the Module is ordered. Although this range is factory set and adjusted, the Module can be recalibrated according to procedures outlined in the Analog Input Module (12 bit) User's Manual (Publication 1771-803), provided the proper instrumentation is available.

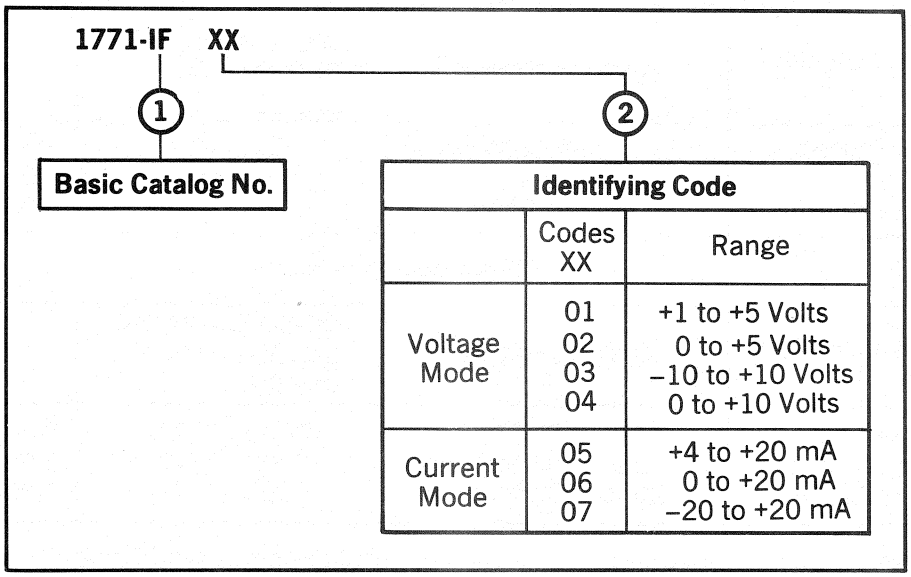
Refer to Table A. When ordering the Analog Input Module (12 bit) with a certain voltage or current range, the identifying code which specifies the needed voltage or current range should be appended to the catalog number of the Assembly. For example, if a +0 to +10 volt voltage range is required, then the Assembly should be ordered with this number: Cat. No. 1771-IF 04.

The voltage and current ranges given in the Specifications section are nominal. Precise voltage and current ranges for these nominal ranges are shown in Tables B and C. In addition, these Tables give the voltage-or-current-per-bit for each range. In the voltage mode, the Module has input overvoltage protection to ±35VDC, 25 V RMS (sinusoidal). In the current mode, the maximum continuous current limit is ±30mA. Exceeding these limits may damage the customer side of the Module. The Module's logic circuitry is protected from input overvoltage or overcurrent by 1500 V RMS optical isolators.

## SWITCH SELECTABLE PROGRAMMING OPTIONS

The incoming data in each channel word has the option of appearing at the Processor in either BCD or binary format. If the BCD format is selected, the Processor can directly manipulate this value in comparisons or arithmetic functions, but is limited to a resolution range of 000 to 999. The binary option allows an increased range of 0000 to $4095_{10}$ (0000 to $7777_8$), but certain processors must reconstruct the BCD number from its inputted binary value to make it compatible with arithmetic instructions. The Data Format option is switch selectable.

**TABLE A — Module Coding**




| Identifying Code | | |
|---|---|---|
| | Codes XX | Range |
| Voltage Mode | 01 | +1 to +5 Volts |
| | 02 | 0 to +5 Volts |
| | 03 | −10 to +10 Volts |
| | 04 | 0 to +10 Volts |
| Current Mode | 05 | +4 to +20 mA |
| | 06 | 0 to +20 mA |
| | 07 | −20 to +20 mA |

**TABLE B — Input Voltage Ranges**

| **3 Digit BCD Operating Mode:** | | | |
|---|---|---|---|
| **NOMINAL VOLTAGE RANGE** | **ACTUAL RANGE** | **CORRESPONDING BCD OUTPUT RANGE** | **△ V/BIT** |
| +1 to +5 volts | +1 to +4.996 volts | 000 - 999 | 4 mV/Bit |
| 0 to +10 volts | 0 to +9.990 volts | 000 - 999 | 10 mV/Bit |
| −10 to +10 volts | −10 to +9.980 volts | 000 - 999 | 12 mV/Bit |
| 0 to +5 volts | 0 to +4.995 volts | 000 - 999 | 5 mV/Bit |
| **12 Bit Binary Operating Mode:** | | | |
| **NOMINAL VOLTAGE RANGE** | **ACTUAL RANGE** | **CORRESPONDING BINARY OUTPUT RANGE** | **△ V/BIT** |
| +1 to +5 volts | +1 to +4.99902 volts | $0000 - 7777_8$ | 0.98 mV/Bit |
| 0 to +10 volts | 0 to +9.99756 volts | $0000 - 7777_8$ | 2.44 mV/Bit |
| −10 to +10 volts | −10 to +9.99512 volts | $0000 - 7777_8$ | 4.88 mV/Bit |
| 0 to +5 volts | 0 to +4.99878 volts | $0000 - 7777_8$ | 1.22 mV/Bit |

Note: The input voltage range is selectable for all eight channels as a unit, thus all channels function with the same input voltage range.

**TABLE C — Input Current Ranges:**

| 3 Digit BCD Operating Mode: | | | |
|---|---|---|---|
| **NOMINAL CURRENT RANGE** | **ACTUAL RANGE** | **CORRESPONDING BCD OUTPUT RANGE** | **△ I/BIT** |
| +4 to +20 mA<br>0 to +20 mA<br>−20 to +20 mA | +4 to +19.984 mA<br>0 to +19.980 mA<br>−20 to +19.960 mA | 000 - 999<br>000 - 999<br>000 - 999 | 0.016 mA/Bit<br>0.02 mA/Bit<br>0.04 mA/Bit |
| **12 Bit Binary Operating Mode:** | | | |
| **NOMINAL CURRENT RANGE** | **ACTUAL RANGE** | **CORRESPONDING OCTAL OUTPUT RANGE** | **△ I/BIT** |
| +4 to +20 mA<br>0 to +20 mA<br>−20 to +20 mA | +4 to +19.9961 mA<br>0 to +19.9951 mA<br>−20 to +19.9902 mA | $0000 - 7777_8$<br>$0000 - 7777_8$<br>$0000 - 7777_8$ | 0.0039 mA/Bit<br>0.0049 mA/Bit<br>0.0098 mA/Bit |
| Note: The input current range is selectable for all eight channels as a unit, thus all channels will function with the same input current range. | | | |

Single Transfer programming can be used with any Allen-Bradley PC Processor. This type of programming shifts a word of data each program scan from the Module's memory into an area designated in the Data Table. To use Single Transfer programming, the Transfer Mode switch on the Module must be set to Single Transfer.

Block Transfer programming, not available with all Allen-Bradley PC Processors, moves all eight channel words from the Module's memory to a designated area in the Data Table in a single scan. To use Block Transfer, the Transfer Mode switch on the Module must be set to Block Transfer.

Refer to Publication 1771-803, "Analog Input Module (12 bit) User's Manual" for details on programming and sample programs.

### Switch Settings

These programming features are selected on single switch assembly that is located on the PC board underneath the component cover.

To select these programming options, proceed as follows:

1. Refer to Figure 2. Take off the component (left side) cover by removing the four slotted screws.

2. Refer to Figure 3. Identify the Programming Option Switch Assembly.

3. Set Switches Two and Three (inset in Figure 3) according to the programming options that have been selected. Do not alter the settings of any other switches on the assembly.

4. Replace the cover and secure with the four slotted screws.

The tip of a ball-point pen can be used to set the rocker arms of a switch. Do not use a pencil, because the tip can break off and jam the switch.

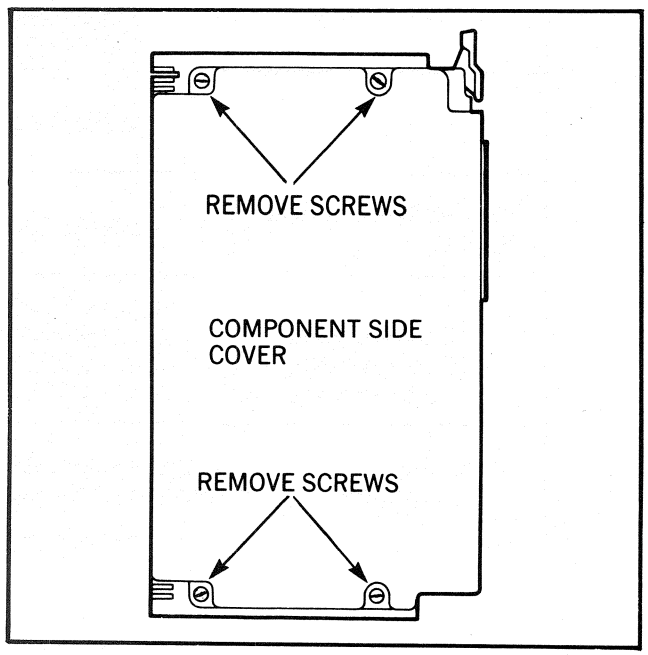



**FIGURE 2 — Remove Component Cover**

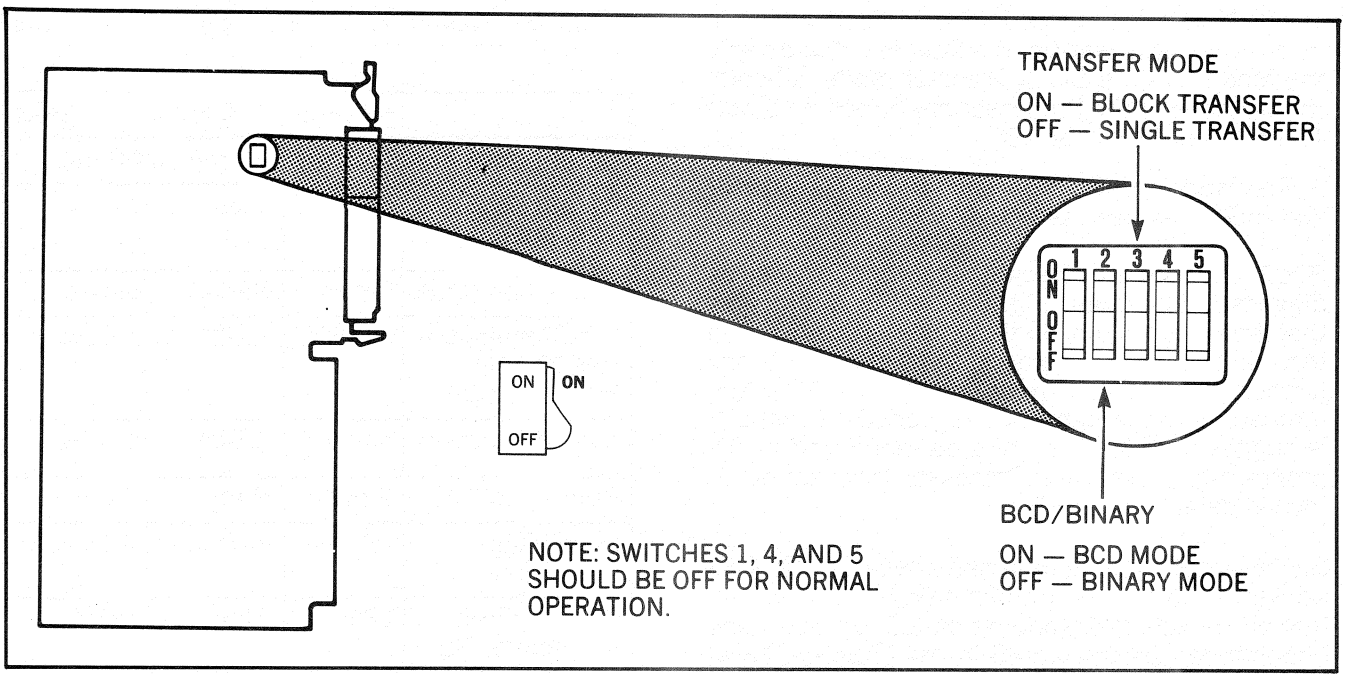



**FIGURE 3 — Switch Selectable Programming Options**

## SPECIFICATIONS for the A/D Converter

The A/D (Analog-to-Digital) Converter has the following specifications:

- Conversion time: Less than 0.6 ms per channel.
- The A/D module is guaranteed monotonic with no missing codes.
- Resolution: Selectable 3 Digit BCD (000-999), or 12 bit binary ($0000\text{-}4095_{10}$).
- Linearity (at 25°C): ±0.05% of full scale Relative Accuracy.
- Offset (at 25°C): ±0.05% of full scale.
- Gain (at 25°C): ±0.05% of full scale.
- Absolute Accuracy (at 25°C): ±0.1% of full scale ±½LSD (BCD mode), or ±½ LSB (Binary mode).
- Temperature Coefficient: <+45ppm/°C of full scale range for 0°C to 60°C ambient.
- Inaccuracy due to electrical noise (internal) Three Sigma Noise ≤ 0.15% RMS (of full scale)
- Recalibration time: Calibration should be checked at 6 month intervals to maintain specified accuracy.

## DIAGNOSTICS

The Module has certain diagnostic features that monitor the conversion and transmission processes for faults. This information can be displayed in several different ways: 1.) the diagnostic LED will illuminate; 2.) certain bits in the channel word will be set, or 3.) a combination of the two. The LED can be examined by removing the right-hand snap off cover on the front of the module (Figure 4). The LED will be ON under these conditions:

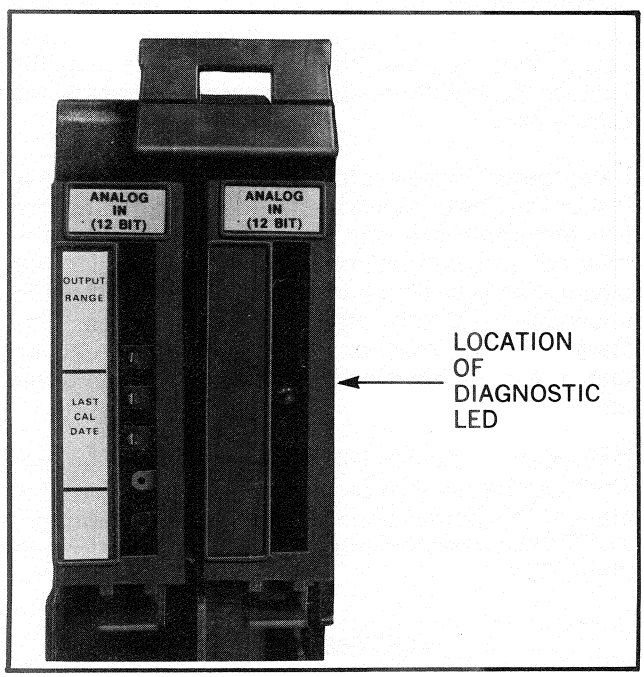



**FIGURE 4 — Location of Diagnostic LED**

1. The Module's microprocessor detects a fault in its memory at power-up. If a fault is detected with the Module in the Block Transfer mode, all communications to the Processor are halted. In Single Transfer, Bit 16 will be set.

2. The Module cannot perform Block Transfer (if that mode has been selected).

Bits 14 to 17 in the channel data word are used as diagnostic bits (Figure 1). Bit 14, if set, indicates that the analog signal for that channel has reached the minimum range value. If the signal drops any further, the Module cannot detect it. Bit 15, if set, indicates that the signal has exceeded the range. It is suggested that these bits be monitored in the program to prevent the Processor from acting on invalid data.

Bit 16 is set by a Module self-check on the A/D Converter and certain other processes. Because this bit reflects the Module's status, Bit 16 of any channel can be monitored in the program. However, since some of the fault conditions for this bit will also halt Block Transfer (if programmed in that mode), unless the Block Transfer function is also checked, a communication failure may go undetected. An additional program diagnostic should be developed using the Block Transfer Complete Bit (Bit 7) in the Input Image Table. Refer to the User's Manual for the Analog Input Module (12-bit), Publication 1771-803, for details on diagnostic programming using Block or Single Transfer.

When the diagnostic Bit 16 is set to ONE, all data being received from the Module is invalid. The Module's microprocessor will attempt to write zeroes into the input channel words. It is possible that the fault will not allow the Module to reset all bits to zero.

If customer 5V power to the front of the Module is lost or the Power Available signal is not present (or the terminals are not jumpered), Bit 17 of the channel word is reset to zero. Since loss of customer power affects all the channels, each channel should show Bit 17 at zero after one Module scan. This Data Valid Bit, from any of the channels, can be checked in the program to detect a loss of customer power.

If the data is invalid, Bit 17 in each input channel word will be reset to zero. Additionally, if Bit 17 is on, and this data is used in a mathematic function, it will inhibit certain mathematical instructions in the PLC.

## SYSTEM POWER

System Power is supplied through the I/O chassis backplane from the Rack Power Supply. The Module requires a current of 1.3 Amp from the 5V DC output of this supply. This amount should be totalled with the current requirements of other modules in the rack to avoid overloading the supply.

**TABLE D — Customer Power Supply Requirements [1]**

| | +5 Volts | +15 Volts | −15 Volts |
|---|---|---|---|
| Output Current | 150 mA | 60 mA | 60 mA |
| Output Voltage Tolerance | 5% | 1% | 1% |
| Regulation (type) | Series | Series | Series |
| Line Regulation (for 10V AC input change) | ±.02% | ±.02% | ±.02% |
| Load Regulation | ±.04% | ±.02% | ±.02% |
| Ripple (RMS) | 2 mv | 2 mv | 2 mv |
| Overvoltage Protection | +7 volts | +18 volts | −18 volts |
| Current Limit (percent of FL) | 125% | 125% | 125% |

[1] No protection on the module is provided for overvoltages from customer power.

## EXTERNAL POWER

The Analog Input Module (12 bit) requires Wiring Arm connection to a power supply separate from any other supply in the controller system. Refer to the Connection Diagram (Figure 9). Using a separate supply protects the analog signals against transients caused by the switching of digital circuits. Specifications for this external DC power source are listed in Table D.

The Power Supply (Cat. No. 1770-P1) is available as an external power source for the Analog Input Module. Refer to Figure 5. This Supply operates on either 120V AC or 220/240V AC input. It provides sufficient output power for 2 Analog Input (12 bit) Module Assemblies (Cat. No. 1771-IF).

The PLC Remote Power Supply (Cat. No. 1778-P2) can also be used as the external power source to the Module. With this Supply, the user must also order the Analog I/O Power Cable (Cat. No. 1778-AM). Wiring Arm connections from this cable are illustrated in Figure 6.

The PLC Remote Power Supply can provide external power to a maximum of 16 Analog Input (12 bit) Modules. If a Remote Supply is used to power these Modules, however, it must not be used for I/O Rack power at the same time.

It is recommended that no more than 5 Analog Input Modules be connected using a single Analog I/O Power Cable (Cat. No. 1778-AM).

Power and common connections can be jumpered from one Analog Input Module to the next.

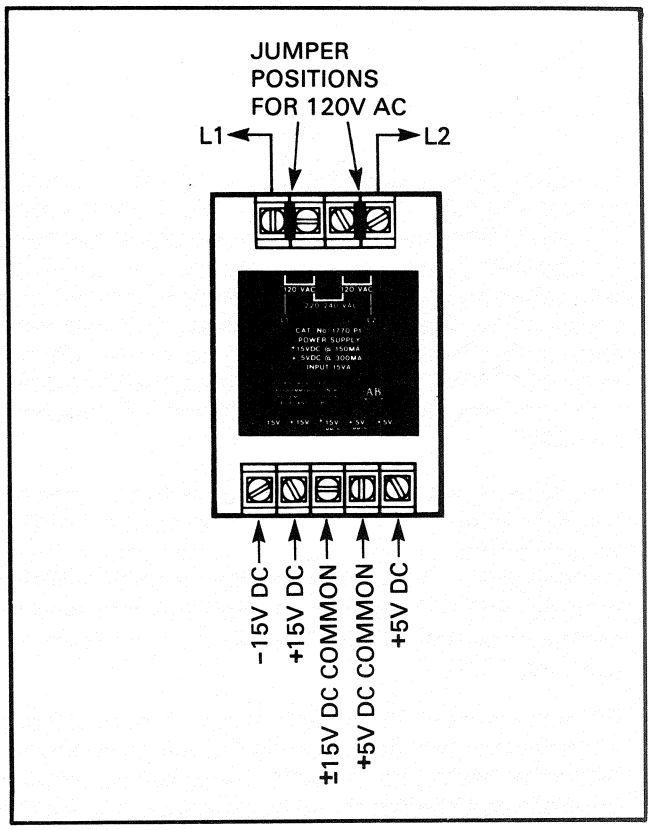



**FIGURE 5 — Power Supply Connections (Cat. No. 1770-P1)**

If another supply is chosen, this supply must also conform to the specifications listed in Table D.

Note: Do not confuse the SIGNAL RETURN wire with the cable shield. The SIGNAL RETURN wire will be one of the insulated wires encased by the cable shield.

Note that the POWER AVAILABLE terminal must be jumpered to the POWER AVAILABLE COMMON terminal in order for the Module to transfer data to the Processor. If the external power supply has a POWER AVAILABLE signal, then it can be tied directly to the POWER AVAILABLE terminal without jumpering the terminal.

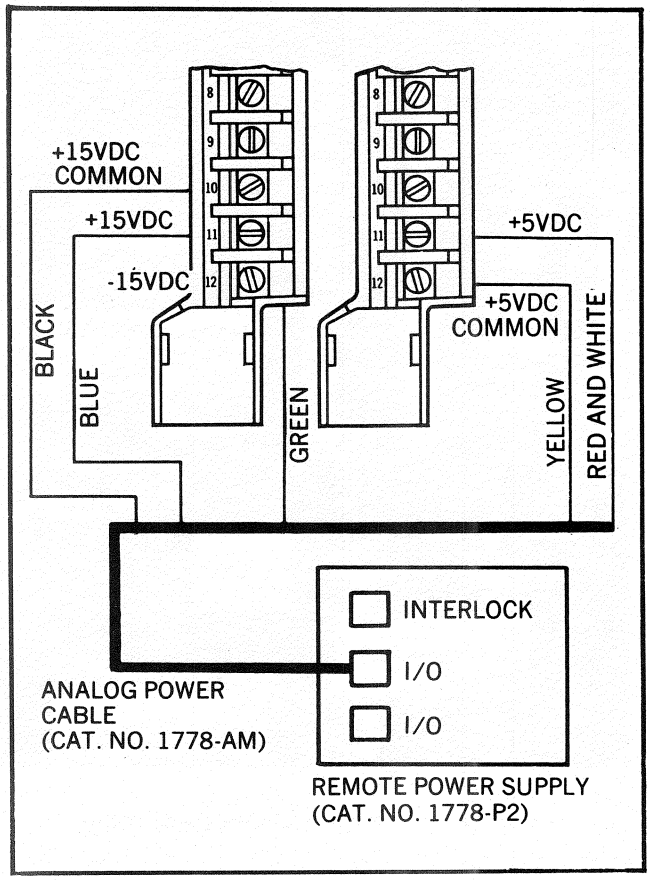



**FIGURE 6 — Connection of Field Wiring Arms to a Remote Power Supply (Cat. No. 1778-P2)**

## WIRING INPUT DEVICES

**CAUTION:** Do not remove or insert the Module into the Chassis while controller power to the Chassis is ON. Failure to observe this caution could result in damage to Module circuitry.

The Analog Input Module (12 bit) may be placed in any rack and any module group within a rack of the Controller being used. However, the Module must be inserted only in a single Module group; it cannot straddle two groups. To minimize noise, group Analog Input Modules together within an I/O Chassis whenever possible. Avoid placing Analog modules close to AC modules or high voltage DC modules.

Use Belden No. 8761 or equivalent cable to connect the analog devices to the Module's Field Wiring Arm. Refer to Figure 9, "Connection Diagram."

Refer to Figure 7. Belden 8761 or equivalent cable has a foil shield with a bare stranded drain wire. These are to be grounded at one end of the cable

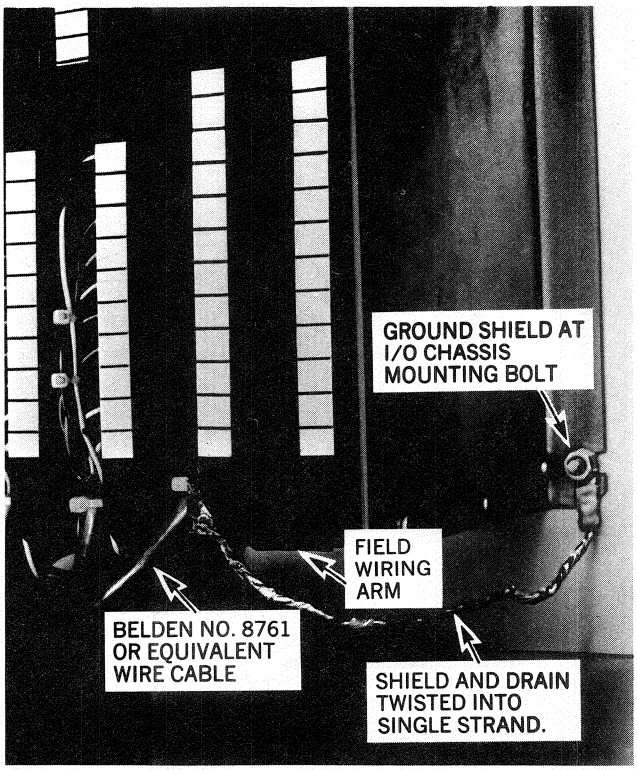



**FIGURE 7 — Cable Shield Grounding**

only. The best ground for this connection is usually the enclosure ground at an I/O Chassis mounting bolt or stud. At the other end of the cable, which connects to the device, the shield must be cut short and taped back to insulate it from any electrical contact.

The single ground at the Chassis must be the only electrical contact of the shield. Where necessary, use electrical tape to insulate the shield from any other contact.

Recommended maximum cable length for voltage mode input devices is 50 feet. This recommendation is based on considerations of signal degradation and noise immunity in typical industrial environments. Cable length for current mode input devices, however, need not be as restrictive. (Current mode analog signals are less sensitive than voltage signals to noise induced along transmission cables.)

Because the module is extremely sensitive to the analog signal, care should be taken to prevent noise and interference from destroying the integrity of the signal. For detailed installation instructions, refer to Publication 1771-803, "Analog Input Module (12 bit) User's Manual."

If noise problems do develop after installation, always check for the addition of new equipment or wiring rearrangement that might cause spurious readings before suspecting the module. In extreme cases of electrical interference or noise, the addition of a .01 $\mu$f ceramic capacitor across the input terminals of each used channel of the input module will increase the high frequency noise immunity caused by external capacitive coupling. It should be noted that certain analog sources, such as op-amps, may require a 1K$\Omega$ resistor in series with the analog input. The user should consult with the sensor manufacturer prior to the installation of external components.

## KEYING

In initial design stages, the Analog Input Module (12 bit) may be inserted into any I/O module group in the I/O Chassis. However, once a group has been designated for a module, care should be taken so that other types of modules will not be placed into these slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for keying I/O slots to accept only one type of module. Use of these keying bands is strongly recommended.

This type of I/O module is slotted in two places on the rear edge of each board. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed to receive the Analog Input Module (12 bit) Assembly (Cat. No. 1771-IF).

Refer to Figure 8. Because the Analog Input (12 bit) Module uses two slots, both slots have to be keyed. Snap the keying bands onto the upper backplane connectors between these numbers printed on the backplane:

- Left Connector

  Between 6 and 8
  Between 22 and 24
- Right Connector

  Between 4 and 6
  Between 32 and 34

The position of these bands may be changed if subsequent system design and rewiring makes insertion of a different type of Module necessary.

Needle-nose pliers maybe used to insert or remove keying bands.

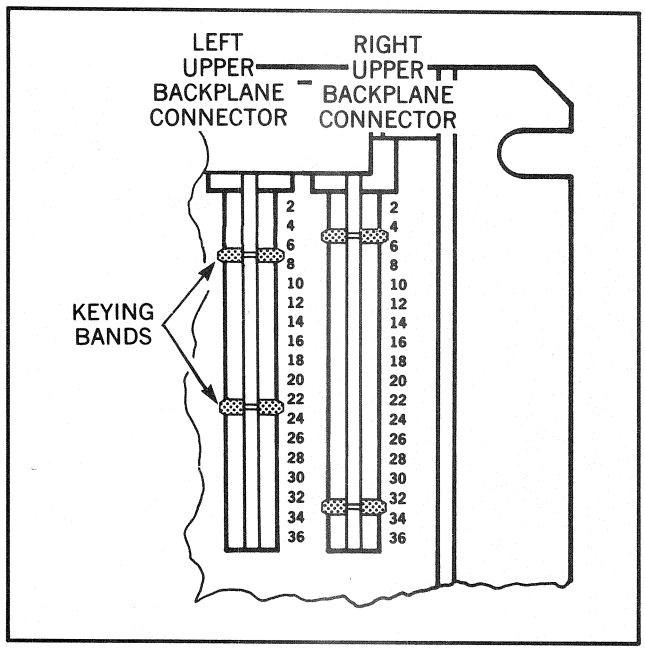
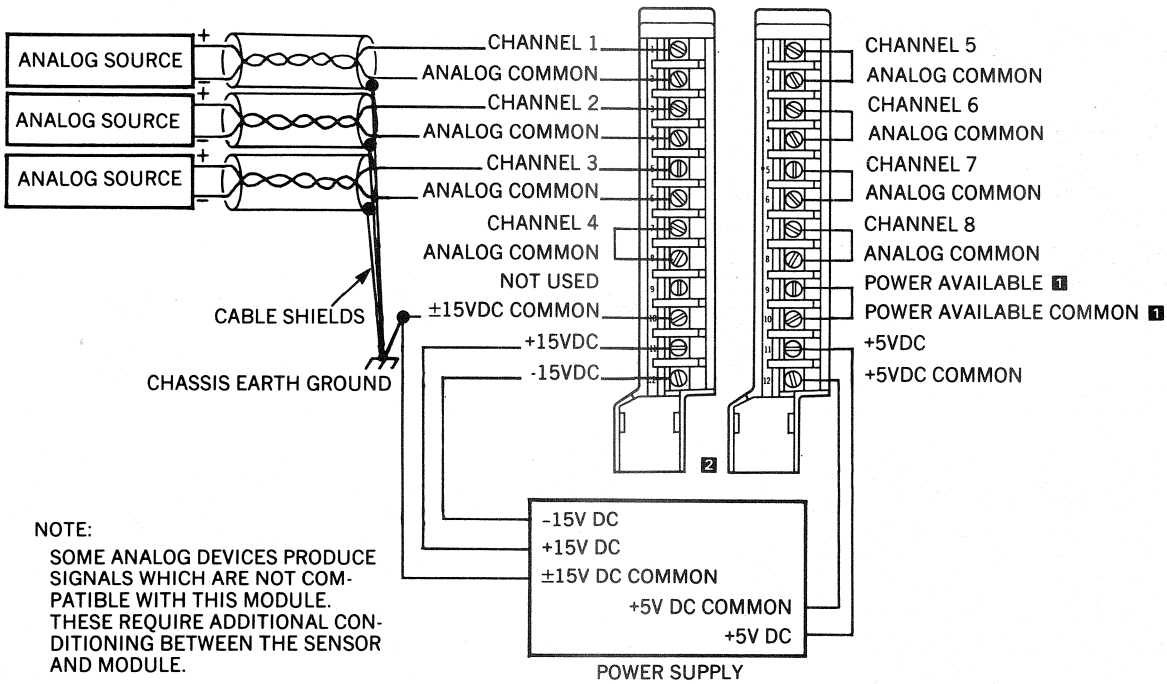



**FIGURE 8 — Keying Diagram**




1 Most terminal designations are self-explanatory. One exception is terminals 9 and 10 on the right swing arm. The POWER AVAILABLE and POWER AVAILABLE COMMON terminals are designed to be connected to a power supply which provides POWER AVAILABLE SIGNAL. If the power supply does not provide a POWER AVAILABLE SIGNAL, jumper terminals 9 and 10 together.

2 The 1771-IF Analog Module (12-bit) requires two slots in the 1771 I/O Rack. It must be positioned in one Module Group.

**FIGURE 9 — Connection Diagram**

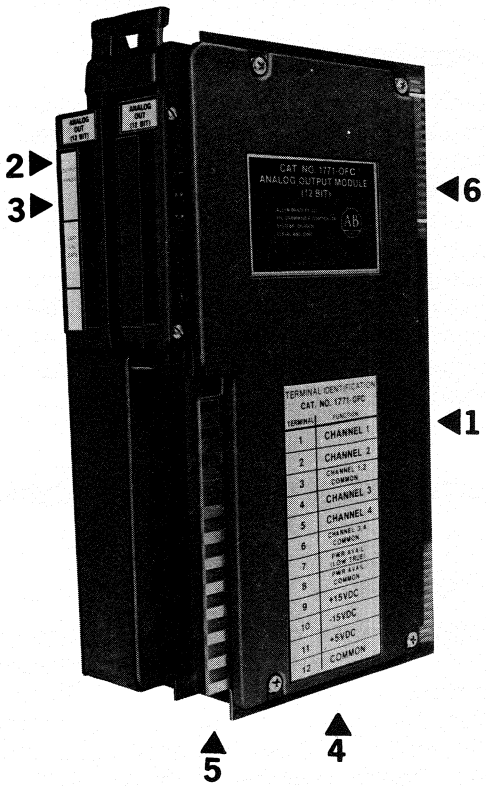



ALLEN-BRADLEY

Systems Division-PC Business
747 Alpha Drive, Cleveland, Ohio 44143

P/N 9550900-06

# ANALOG OUTPUT MODULE (12 BIT) ASSEMBLY
## Cat. No. 1771-OF




1. Protective cover
2. Yellow Identification label
3. Status indicators
4. Label identifies user output connections
5. Field Wiring Arm connects here
6. Slotted for I/O slot insertion only

### DESCRIPTION

The Analog Output Module (12 bit) Assembly (Cat. No. 1771-OF) produces smoothly varying analog signals at its outputs. Up to four independent devices can be connected to the Module. Such devices might typically be speed controllers, signal amplifiers, or valve positioners. Each output signal is directly proportional to a BCD or Binary Channel Output Value that is generated at the Processor and is transmitted to the Module using either Single Transfer or Block Transfer programming. The outputs of these devices should conform to the single voltage or current range for which the Module is calibrated.

The term "12 Bit" indicates that the resolution of the Module is 1 part in $2^{12}$ ($4096_{10}$). This defines the number of units available to the Module in dividing

### SPECIFICATIONS

**Outputs per Module**
4 single-ended

**Module Location**
1771 I/O Rack — 2 slots

**Output Voltage Ranges (nominal)**
+1 to +5V DC
0 to +5V DC
—10 to +10V DC
0 to +10V DC

**Output Current Ranges (nominal)**
+4 to +20mA
0 to +20mA
—20 to +20mA

**Digital Resolution**
3-digit BCD or 12-bit binary

**BCD Input from Processor**
000 to 999 for any output range

**Binary Input from Processor**
0000 to $7777_8$ for any output range

**Output Overload Protection**
All outputs are protected against short circuit load conditions.

**Output Impedance**
$\leq$0.25 Ohms for voltage outputs exclusive of contact and wiring resistance
$\geq$1.25 Megohms for current outputs

**Ambient Temperature Rating**
0° to 60°C (operational)
—40° to 85°C (storage)

**Humidity Rating**
5 to 95% (without condensation)

**Electrical-Optical Isolation**
1500V (transient) Isolation between the output circuit and the control logic.

**Keying**
The Module is keyed for I/O rack only.

Insert the keys between:

| Left Connector | Right Connector |
|---|---|
| 2 and 4 | 4 and 6 |
| 6 and 8 | 32 and 34 |

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Supersedes Publication 1771-918 — Dated January, 1981

up its particular voltage or current range. The conversion of the Channel Output Value, if it is in BCD format, limits the analog resolution to 1 part in 1000.

The Analog Output Module (12 bit) Assembly includes the following units:

- Analog Output Module (12 bit) (Cat. No. 1771-OFC)
- One 12 Terminal Field Wiring Arm (Cat. No. 1771-WB)

**CAUTION:** For any condition where I/O would be held OFF, such as when the Processor key switch is in PROGRAM or TEST mode, the output of the Module will return to the minimum value of its range. Care should be taken for positioning applications using the +10 to —10 volt range, because the OFF value would settle at —10 volts.

## SELECTION OF OUTPUT CHANNEL RANGES

The Analog Output Module (12 bit) has four output channels. All channels on an individual Module have the same voltage or current range. This range must be specified when the Module is ordered. Although this range is factory set and adjusted, the Module can be recalibrated according to procedures outlined in the Analog Output Module (12 bit) User's Manual (Publication 1771-804), provided the proper instrumentation is available. Refer to Table A. When ordering the Analog Output Module (12 bit) with a certain voltage or current range, the identifying code which specifies the needed voltage or current range should be appended to the catalog number of the Module. For example, if a +0 to +10 volt voltage range is required, then the Module should be ordered with this number: Cat. No. 1771-OF 04.

The voltage and current ranges given in the Specifications section are nominal. Precise voltage and current ranges for these nominal ranges are shown in Tables B and C. In addition, these Tables give the voltage-or-current-per-bit for each range.

### CHANNEL CONFIGURATION

Each channel is configured to accept a single ended device. The outputs are protected against short circuit load conditions. Outputs in the voltage mode are maintained at the specified accuracy for load currents of 10 mA or less. The output impedence in the voltage mode is less than .25 ohms, excluding contact and wiring resistance. Output impedence in the current ranges is greater than 1.5 megohms. The Module's logic circuitry is protected from input overvoltage or overcurrent by 1500 V RMS optical isolators.

## SWITCH SELECTABLE PROGRAMMING OPTIONS

### DATA FORMAT

The data for each output channel word has the option of being transmitted from the Processor in either BCD or binary format. If the BCD format is selected, the Processor can directly manipulate this value in comparisions or arithmetic functions, but is limited to a resolution range of 000 to 999. The binary option allows an increased range of 0000 to $4095_{10}$ (0000 to $7777_8$) The Data Format option is switch selectable.

### PROGRAMMING FORMAT

Single Transfer programming can be used with any Allen-Bradley PC Processor. This type of program-

**TABLE A — Module Coding**

1771-OF XX

① Basic Catalog No.

② Identifying Code

| | Codes XX | Range |
|---|---|---|
| Voltage Mode | 01 | +1 to +5 Volts |
| | 02 | 0 to +5 Volts |
| | 03 | —10 to +10 Volts |
| | 04 | 0 to +10 Volts |
| Current Mode | 05 | +4 to +20 mA |
| | 06 | 0 to +20 mA |
| | 07 | —20 to +20 mA |

**TABLE B — Output Voltage**

| 3 Digit BCD Operating Mode: | | | |
|---|---|---|---|
| **NOMINAL RANGE** | **OUTPUT CODE RANGE** | **OUTPUT VOLTAGE RANGE** | **△ V/BIT** |
| +1 to +5 volts | 000 - 999 | +1 to +4.996 volts | 4 mV/Bit |
| 0 to +10 volts | 000 - 999 | 0 to +9.990 volts | 10 mV/Bit |
| —10 to +10 volts | 000 - 999 | —10 to +9.980 volts | 20 mV/Bit |
| 0 to +5 volts | 000 - 999 | 0 to +4.995 volts | 5 mV/Bit |
| **12 Bit Binary Operating Mode:** | | | |
| **NOMINAL RANGE** | **OUTPUT CODE RANGE** | **OUTPUT VOLTAGE RANGE** | **△ V/BIT** |
| +1 to +5 volts | $0000 - 7777_8$ | +1 to +4.99902 volts | 0.98 mV/Bit |
| 0 to +10 volts | $0000 - 7777_8$ | 0 to +9.99756 volts | 2.44 mV/Bit |
| —10 to +10 volts | $0000 - 7777_8$ | —10 to +9.99512 volts | 4.88 mV/Bit |
| 0 to +5 volts | $0000 - 7777_8$ | 0 to +4.99878 volts | 1.22 mV/Bit |
| Note: The output voltage range is selectable for all four channels as a unit, thus all channels function with the same output voltage range. | | | |

**TABLE C — Output Current Ranges**

| 3 Digit BCD Operating Mode: | | | |
|---|---|---|---|
| **NOMINAL RANGE** | **OUTPUT CODE RANGE** | **OUTPUT CURRENT RANGE** | **△ I/BIT** |
| +4 to +20 mA | 000 - 999 | +4 to +19.984 mA | 0.016 mA/Bit |
| 0 to +20 mA | 000 - 999 | 0 to +19.980 mA | 0.02 mA/Bit |
| —20 to +20 mA | 000 - 999 | —20 to +19.960 mA | 0.04 mA/Bit |
| **12 Bit Binary Operating Mode:** | | | |
| **NOMINAL RANGE** | **OUTPUT CODE RANGE** | **OUTPUT CURRENT RANGE** | **△ I/BIT** |
| +4 to +20 mA | $0000 - 7777_8$ | +4 to +19.9961 mA | 0.0039 mA/Bit |
| 0 to +20 mA | $0000 - 7777_8$ | 0 to +19.9951 mA | 0.0049 mA/Bit |
| —20 to +20 mA | $0000 - 7777_8$ | —20 to +19.9902 mA | 0.0098 mA/Bit |
| Note: The output current range is selectable for all four channels as a unit, thus all channels function with the same output current range. | | | |

ming shifts a word of data each I/O scan from the Processor to the Module. Because there is data for four channels being multiplexed through a single location in the Output Image Table, the Processor must indicate to which channel the outgoing data is being sent. Refer to Figure 1. Bits 14 to 17 are Channel Select Bits in Single Transfer Programming and bits 00-13 contain the channel output

| Channel Word for Block Transfer | |
|---|---|
| 17 — 14 | 13 — 00 |
| Not Assigned | BCD or Binary Channel Value |
| **Channel Word for Single Transfer** | |
| 17 — 14 | 13 — 00 |
| Channel Select | BCD or Binary Channel Value |

**FIGURE 1 — Channel Word**

value. Refer to Table D for the correct bit pattern for the desired channel. To use Single Transfer programming, the Transfer Mode switch on the Module must be set to Single Transfer.

Block Transfer programming moves all four channel words from the Processor to the Module in a single scan. Instead of using Channel Select bits, as in Single Transfer, the identification of the channel data is determined by the order in the Data Table. Channel One appears as the first word in the designated section in the Timer/Counter Area, Channel Two appears next, and so on. For example, if the first word in the block of data was 050, then data for Channel One would be inserted there. Data for Channel Two would be at 051, Channel Three at 052, and Channel Four at 053. Bits 00-13 are used to store the channel output value. Bits 14-17 are not assigned (Figure 1). To use Block Transfer, the Transfer Mode switch on the Module must be set to Block Transfer.

## SWITCH SETTINGS

These programming features are selected on a switch assembly that is located on the PC board underneath the component cover.

To select these programming options, proceed as follows:

1. Refer to Figure 2 and take off the component (left side) cover by removing the four slotted screws.

2. Refer to Figure 3 and identify the Programming Option Switch Assembly.

3. Set Switches Two and Three (inset in Figure 3) according to the programming options that have been selected. Do not alter the settings for any other switches on the assembly.

4. Replace the cover and secure with the four slotted screws.

**TABLE D**

| CHANNEL NO. | 17 | 16 | 15 | 14 |
|---|---|---|---|---|
| Channel 1 | 0 | 0 | 0 | 0 |
| Channel 2 | 0 | 0 | 0 | 1 |
| Channel 3 | 0 | 0 | 1 | 0 |
| Channel 4 | 0 | 0 | 1 | 1 |

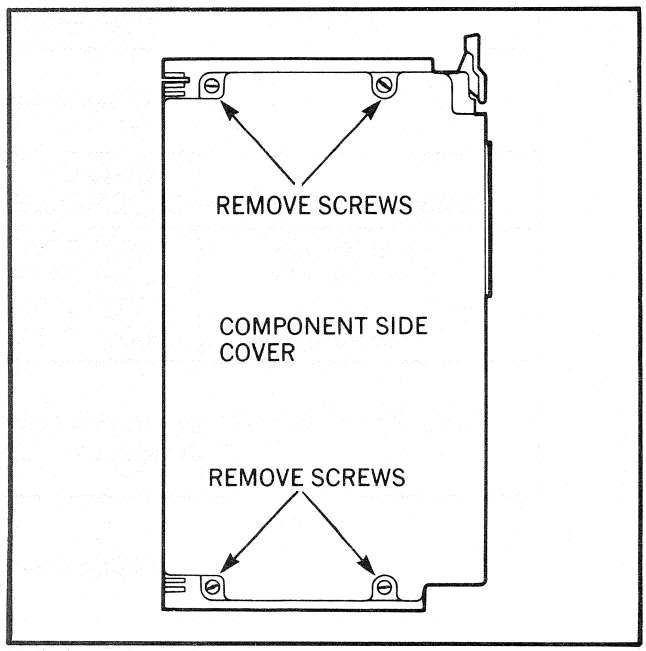



**FIGURE 2 — Remove Component Cover**

The tip of a ball-point pen can be used to set the rocker arms of a switch. Do not use a pencil, because the tip can break off and jam the switch.

## SPECIFICATIONS for the D/A converter

Settling Time: 100 $\mu$sec maximum for a resistive load

Resolution: 3 digit BCD (000-999)
or 12 bits Binary ($0000\text{-}4095_{10}$)
The D/A is monotonic.

Accuracy:
Absolute Accuracy
0.1% of full scale at 25°C

Temperature Coefficient:
±45 ppm/°C of full scale range.

Calibration: Calibration must be checked at six month intervals to maintain specified accuracy.

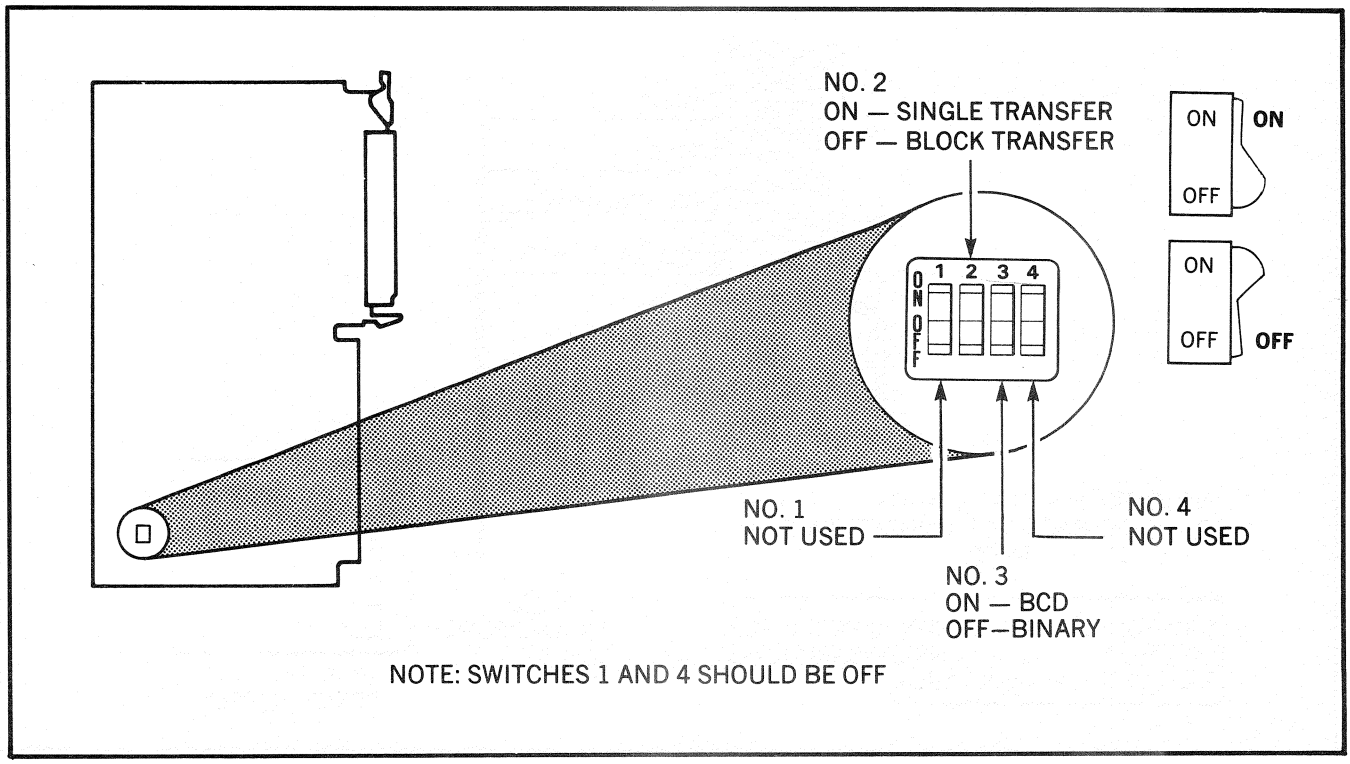



**FIGURE 3 — Switch Selectable Programming Options**

## DIAGNOSTICS

The Module has certain diagnostic features that monitor the transmission and conversion processes for faults. The diagnostic LED can be examined by removing the right hand snap off cover on the front of the module (Figure 4). The LED will be ON under these conditions:

1. The Microprocessor detects a fault in its memory at power-up. If a fault is detected with the Module in the Block Transfer mode, all communications with the Processor are halted.

2. The Module cannot perform Block Transfer (if that mode has been selected).

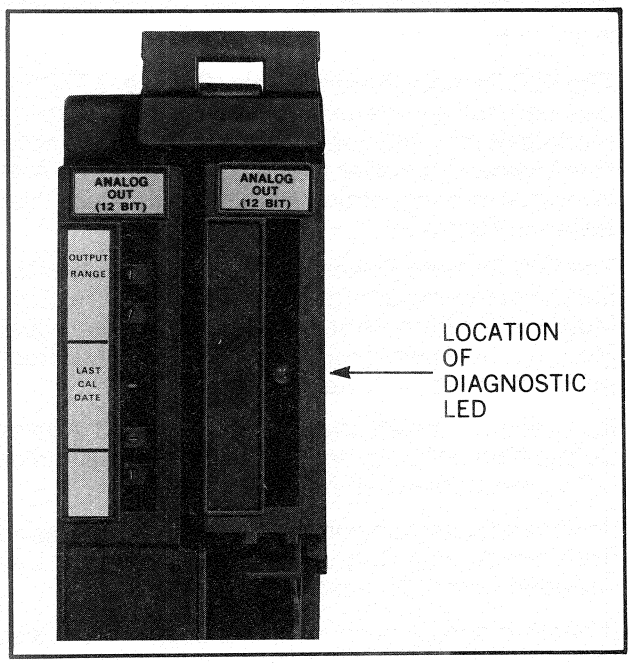



**FIGURE 4 — Location of Diagnostic LED**

## SYSTEM POWER

System power is supplied through the I/O chassis backplane from the Rack Power Supply. The Module requires a current of 1.4A from the 5V DC output of this supply. This amount should be totalled with the current requirements of other modules in the rack to avoid overloading the supply.

## EXTERNAL POWER SUPPLY

The Analog Output Module (12 bit) requires Wiring Arm connection to a power supply separate from any other supply in the controller system. Refer to the Connection Diagram (Figure 8). Using a separate supply protects the analog signals against transients caused by the switching of digital circuits. Specifi-

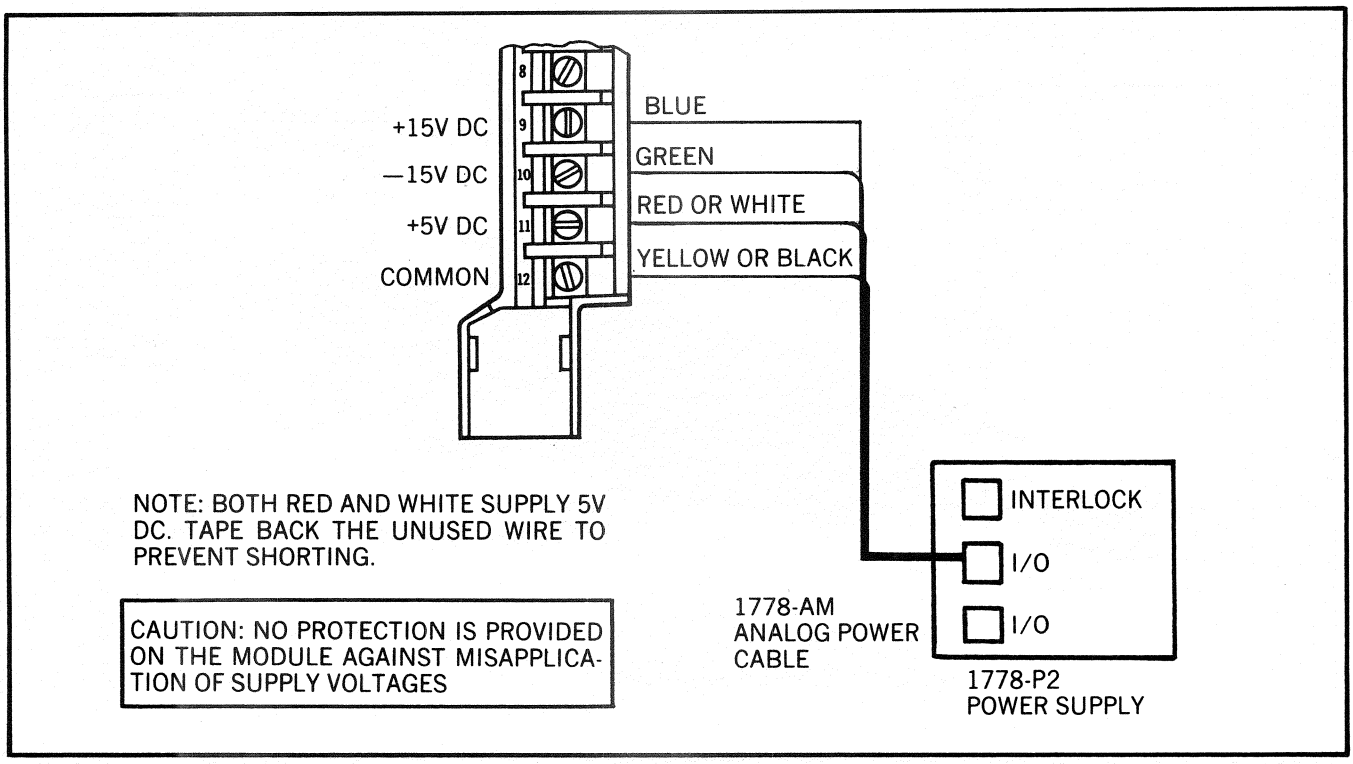



**FIGURE 5 — Connection of Field Wiring Arm to a Remote Power Supply (Cat. No. 1778-P2)**

cations for this external DC power source are listed in Table E.

The PLC Remote Power Supply (Cat. No. 1778-P2) can be used as the external power source to the Module. With this Supply, the user must also order the Analog I/O Power Cable (Cat. No. 1778-AM). Wiring Arm connections from this cable are illustrated in Figure 5.

The PLC Remote Power Supply can provide external power to a maximum of 6 Analog Output (12 bit) Modules. If a Remote Supply is used to power these Modules, however, it must not be used for I/O Rack power at the same time.

It is recommended that no more than 3 Analog Output Modules be connected using a single Analog I/O Power Cable (Cat. No. 1778-AM).

Power and common connections can be jumpered from one Analog Output Module to the next. Use stranded wire of at least AWG 20.

If another supply is chosen, this supply must also conform to the specifications listed in Table E.

Note: Do not confuse the SIGNAL RETURN wire with the cable shield.The SIGNAL RETURN wire is one of the insulated wires encased by the cable shield.

Note that the POWER AVAILABLE terminal must be jumpered to the POWER AVAILABLE COMMON terminal in order for the Module to transfer data to the Processor. If the external power supply has a POWER AVAILABLE signal, then it can be tied directly to the POWER AVAILABLE terminal, without jumpering the terminal.

**TABLE E — External Power Supply Requirements**

| | +5 Volts | +15 Volts | —15 Volts |
|---|---|---|---|
| Current | 400 mA | 250 mA | 250 mA |
| Voltage Tolerance | 5% | 1% | 1% |
| Regulation (type) | Series | Series | Series |
| Line Regulation (for 10 VAC input change) | ±.02% | ±.02% | ±.02% |
| Load Regulation (from no load to full load) | ±.04% | ±.02% | ±.02% |
| Ripple | 1 mv | 1 mv | 1 mv |
| Over Voltage Protection | +7 volts | +18 volts | —18 volts |
| Current Limit (percent of full load) | 125% | 125% | 125% |

## WIRING OUTPUT DEVICES

**CAUTION:** Do not remove or insert the Module into the Chassis while Controller power to the Chassis is ON. Failure to observe this caution could result in damage to Module circuitry.

The Analog Output Module (12 bit) may be placed in any rack and group within a rack of the Controller being used. However, the Module must be inserted only in a single Module group; it cannot straddle two groups. To minimize noise, group Analog Output Modules together within an I/O Chassis whenever possible. Avoid placing Analog modules close to AC modules or high voltage DC modules.

Use Belden No. 8761 or equivalent cable to connect the analog devices to the Module's Field Wiring Arm. Refer to Figure 8, "Connection Diagram."

Refer to Figure 6. Belden 8761 or equivalent cable has a foil shield with a bare stranded drain wire. These are to be grounded at one end of the cable only. The best ground for this connection is usually the enclosure ground at an I/O Chassis mounting bolt or stud. At the other end of the cable, which connects to the device, the shield must be cut short and taped back to insulate it from any electrical contact.

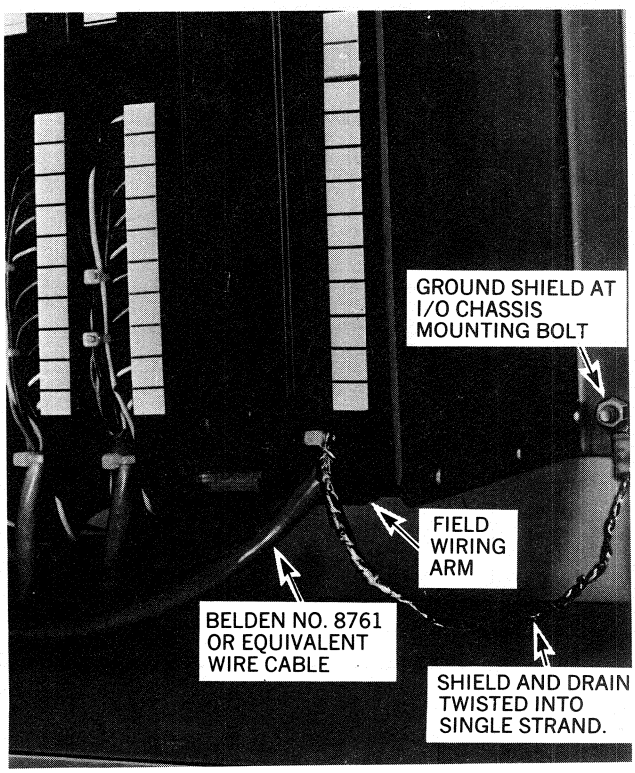



**FIGURE 6 — Cable Shield Grounding**

The single ground at the Chassis must be the only electrical contact of the shield. Where necessary, use electrical tape to insulate the shield from any other contact.

Recommended maximum cable length for voltage mode devices is 50 feet. This recommendation is based on considerations of noise immunity in typical industrial environments. Cable length for current mode devices, however, need not be as restrictive. (Current mode analog signals are less sensitive than voltage signals to noise and signal degradation induced along transmission cables.)

The signal return from the devices may be tied together at a terminal block and a single wire brought back to the Analog Common terminal. It should be located on or as near the rack as close as possible to provide maximum shielding.

## KEYING

In initial design stages, the Analog Output Module (12 bit) may be inserted into any I/O module group in the I/O Chassis. However, once a group has been designated for a module, care should be taken so that other types of modules will not be placed into these slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for keying I/O slots to accept only one type of module. Use of these keying bands is strongly recommended.

This type of I/O module is slotted in two places on the rear edge of each board. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed to receive the Analog Output Module (12 bit) Assembly (Cat. No. 1771-OF).

Refer to Figure 7. Because the Analog Output (12 bit) Module uses two slots, both slots should be keyed. Snap the keying bands onto the upper backplane connectors between these numbers printed on the backplane:

- Left Connector

  Between 2 and 4
  Between 6 and 8

- Right Connector

  Between 4 and 6
  Between 32 and 34

The position of these bands may be changed if subsequent system design and rewiring makes insertion of a different type of Module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

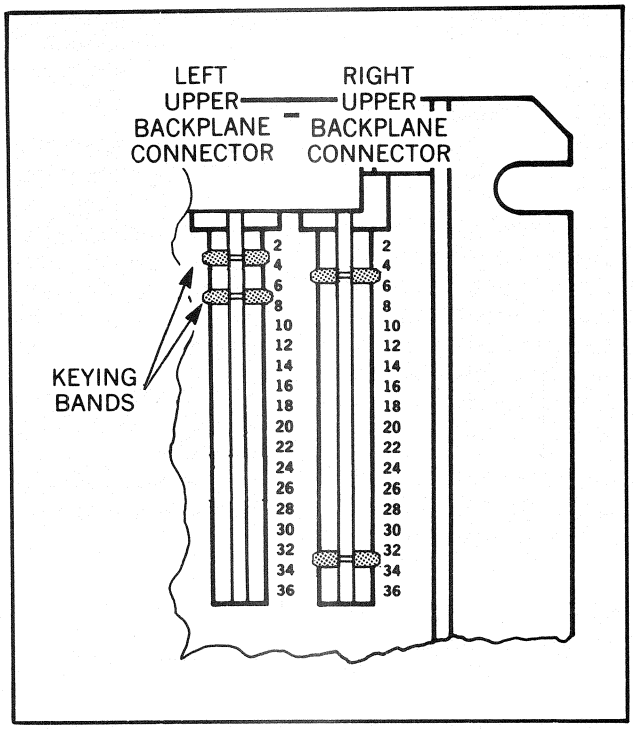



**FIGURE 7 — Keying Diagram**

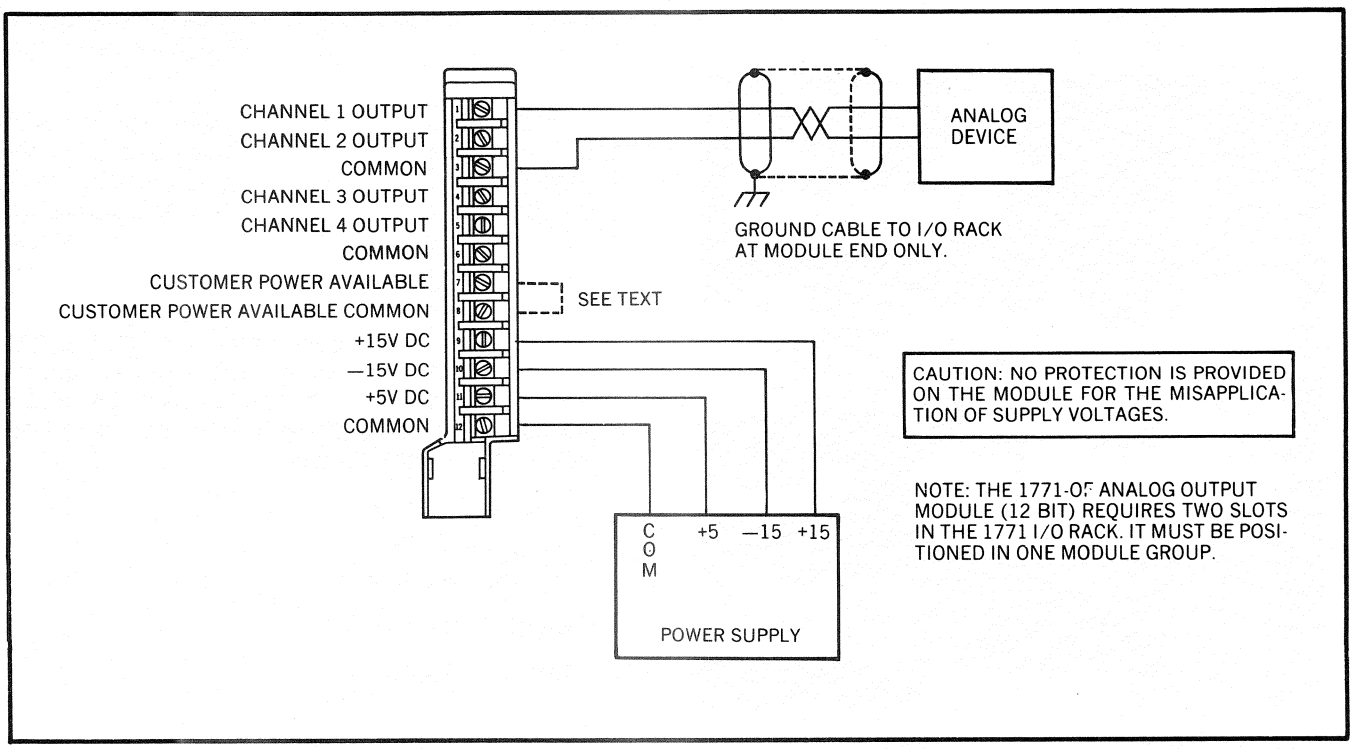
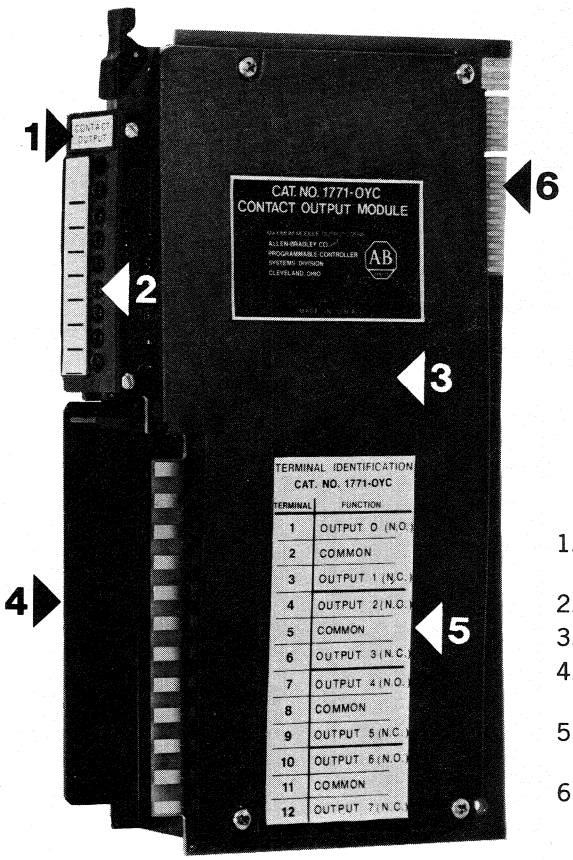



**FIGURE 8 — Connection Diagram**

# CONTACT OUTPUT MODULE ASSEMBLY

## Cat. No. 1771-OY




1. Orange identification label
2. Status indicators
3. Protective covers
4. Field Wiring Arm connects here
5. Labels identify output terminals
6. Slotted for I/O insertion only

### SPECIFICATIONS

**Outputs per Module**
8

**Module Location**
Bulletin 1771 I/O Chassis

**Voltage Rating**
0 - 150V AC
0 - 100V DC

**Peak Breakdown Voltage**
250V

**Current Rating**
1.0A (max.) per output

**Power Rating**
DC: 20VA
AC (suppressed): 30VA

**Contact Resistance**
Closed: ≤ 200 milliohms
Open: ≥ $10^9$ ohms

**Contact Life Expectancy**
$10^6$ operations (at rated power)

**System Supply Current Requirement**
420 mA (max.)

**Ambient Temperature Rating**
0°to 60°C (operational)
-40°to 85°C (storage)

**Humidity**
5% to 95%
(without condensation)

**Keying**
Module slotted for I/O slot insertion only

**Wire Size**
14 ga. (max.)
3/64 in. (max.) insulation

## DESCRIPTION

The Contact Output Module Assembly (Cat. No. 1771-OY) provides reed relay switching capability for a PLC, PLC-2 or Mini-PLC-2 programmable controller. The Module has 8 reed relay outputs, for use with a range of signal types. Each output is electrically isolated from Module logic circuitry.

The Contact Output Module can be used in those applications in which dry reed relays are desirable. These applications include:

- Switching small currents at low voltage (low-level switching)
- Multiplexing analog signals
- Interfacing with DC drives for controlling different voltage levels
- Combining relay logic and motor control with the logic of the PLC, PLC-2 or Mini-PLC-2 programmable controller, while maintaining electrical isolation between the two types of control.

The Contact Output Module Assembly (Cat. No. 1771-OY) consists of one of each of the following:

- Contact Output Module (Cat. No. 1771-OYC)
- Field Wiring Arm (Cat. No. 1771-WD)

User connections are made to the Field Wiring Arm. (Refer to the Connection Diagram.) The Wiring Arm, acting as a terminal strip, pivots on the I/O Chassis to connect with terminals on the front of the Module. The Wiring Arm allows the Module to be removed from the Chassis without the need to disconnect user wiring.

## OUTPUTS

The Contact Output Module has 4 normally-open (N.O.) and 4 normally-closed (N.C.) reed relay outputs. These outputs are arranged so that each N.O. set of contacts shares a common return with an N.C. set of contacts. This arrangement is shown in Figure 1.

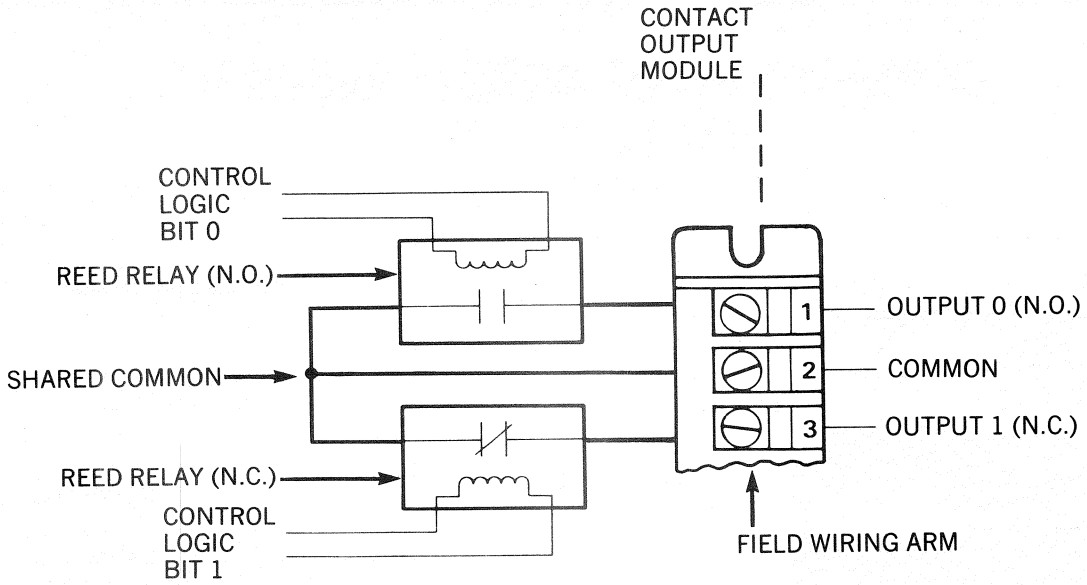



**FIGURE 1 — Module Relay Pair**

The Contact Output Module is capable of switching all 8 outputs simultaneously, each conducting a maximum of 1.0A continuous,at rated power. When operated at rated power, the number of contact closures for each Module output is rated at $10^6$ operations.

**CAUTION:** Do not exceed the specified voltage, current and power ratings for Module outputs. This can reduce the contact life of the reed relay in the Module and may cause failure or damage to the user's side of the Module.

For the same reason, do not attempt to increase load current beyond these ratings by connecting two or more Module outputs in parallel. The slightest variation in output relay switching time may cause one set of contacts to switch the total load current which exceeds the specified 1.0A rating.

Eight diagnostic indicators on the front of the Module represent the status of the output relays. (Refer to Figure 2.) Each indicator illuminates when its corresponding reed relay is energized.

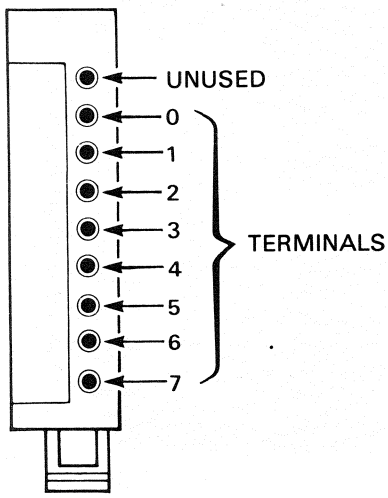



**FIGURE 2 — Status Indicators**

## PROGRAMMING

Each Module output can be controlled by one of these programmable controller Instructions:

- Output Energize
- Output De-Energize [1]
- Output Latch
- Output Unlatch
- PUT

The 4 **normally-open** outputs of the Module have 5-digit addresses ending in 0, 2, 4 and 6. When the Output Image Table bit at any of these addresses is energized (set to 1) the corresponding relay contacts are **closed.**[2]

The 4 **normally-closed** outputs of the Module have 5-digit addresses ending in 1, 3, 5, and 7. When the Output Image Table bit at any of these addresses is energized (set to 1) the corresponding relay contacts are **opened.**

## POWER SUPPLY REQUIREMENT

The controller or I/O Rack power supply, connected through the backplane of the I/O Chassis, powers the logic circuitry of the Contact Output Module. This supply also provides the necessary power to energize the coils of the Module reed relays. The maximum current drawn from this Supply when all coils on the Module are energized is 420 mA.

[1] Instruction available with Bulletin 1774 PLC Processors only.

[2] Table A lists Publications which describe memory structure for the PLC, PLC-2 or Mini-PLC-2 controllers.

**TABLE A — Publications on Memory Structure**

| PROCESSOR | CAT. NO. | PUBLICATION |
|---|---|---|
| PLC Processor | 1774-RP3, -RP4<br>1774-RP1, -RP2 | 1774-934<br>1774-921 |
| PLC-2 Processor | 1772-LP1, Series A<br>1772-LR, Series B<br>1772-LR, Series A | 1772-909<br>1772-907<br>1774-921 |
| PLC-2 Mini-Processor Module | 1772-LN1, -LN2 | 1772-700 |

## SUPPRESSION

Surge suppression may be necessary for some types of user output devices. Surge suppression is especially recommended when the Module switches inductive loads, such as motor starters and solenoids.

The transient voltage which results when an inductive load is switched OFF may be several times the value of the applied voltage. Transients which result from switching inductive loads can cause relay contact "arcing" and reduced contact life if they are not suppressed.

For an inductive DC load, diode or varistor suppression may be connected in parallel with the output device. (A 1N4004 diode is acceptable for most Contact Output Module applications.)

For an inductive AC load, an RC network or appropriately rated varistor may be used. (Refer to the Connection Diagram.) For these devices, both voltage and current ratings must be sufficient to suppress the switching transient that is characteristic of the particular inductive load. For most types of AC loads used with the Contact Output Module, the Contact Protector (Cat. No. 1691-N2) or equivalent device may be used.

Voltage and current ratings needed for suppression devices are based on the inductive characteristics of the load. In general, it is recommended that suppression devices be connected as close to the load as possible.

## KEYING

In initial design stages, the Contact Output Module may be inserted into any I/O module slot of the I/O Chassis. However, once specific slots have been designated for a module, care should be taken so that other types of modules will not be mistakenly placed into these slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for the user to key an I/O slot to accept only one type of I/O module. Use of these keying bands is strongly recommended.

Each type of I/O module is slotted in two places at its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed solely to receive the Contact Output Module Assembly (Cat. No. 1771-OY).

For the Contact Output Module, position keying bands on the upper backplane connector between these numbers printed on the backplane:

- Between 6 and 8
- Between 16 and 18
- Refer to Figure 3.

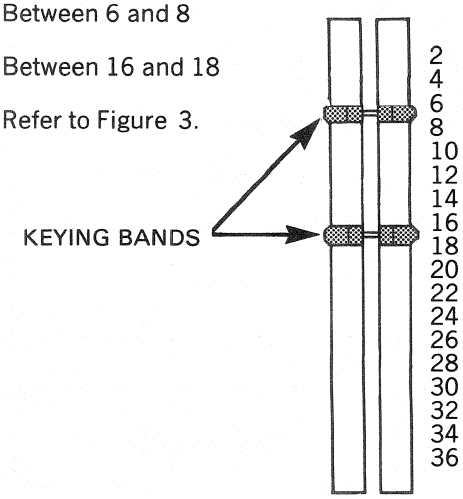
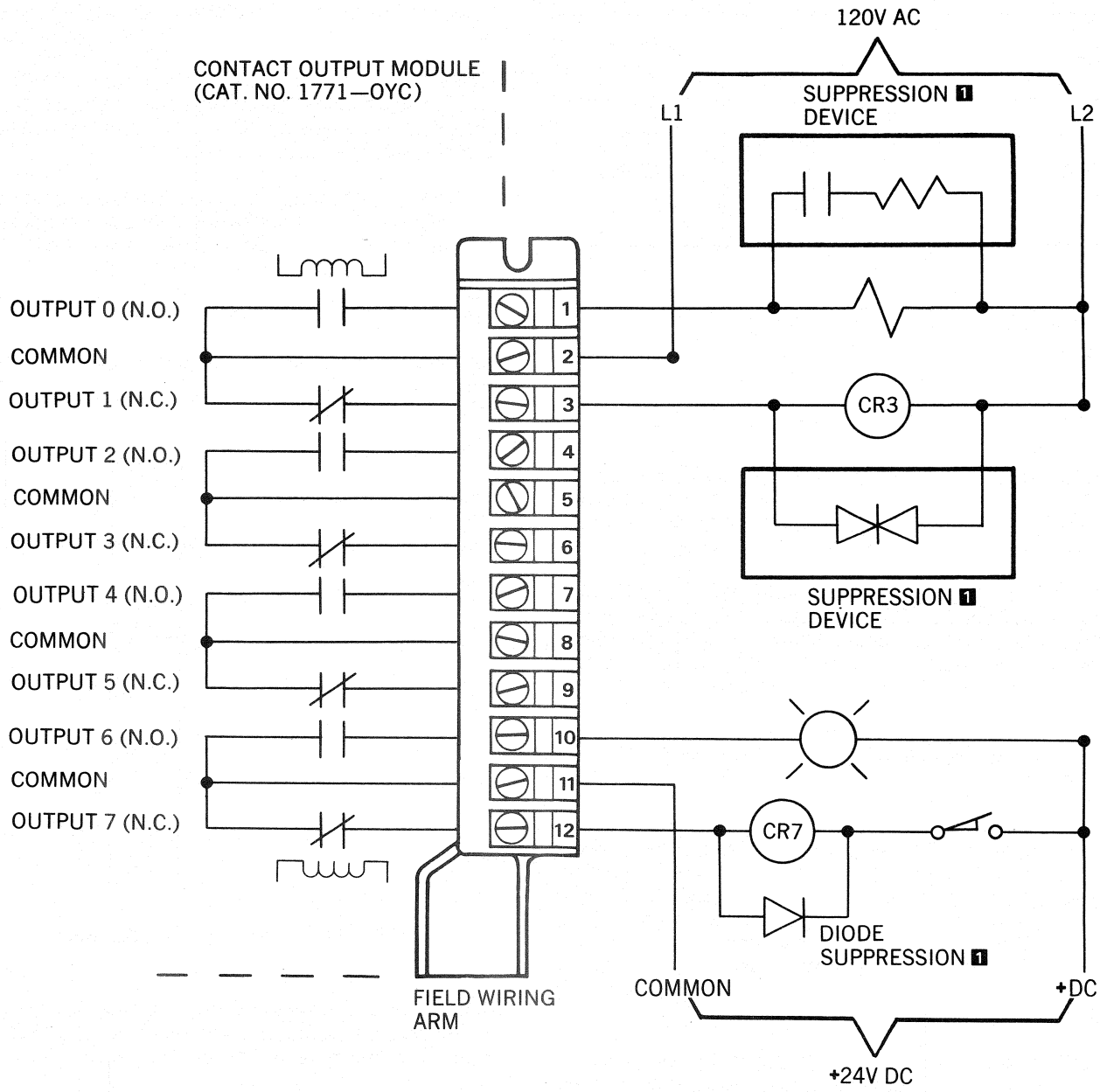



**FIGURE 3 — Keying Band Positions**

The position of these bands may be changed by the user if subsequent system design and rewiring makes insertion of a different type of Module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

**CONNECTION DIAGRAM**
**(See all applicable codes and laws)**




1 See SUPPRESSION

# SINGLE-CHANNEL PROGRAMMING FOR THE ANALOG INPUT MODULE (8 BIT)

## GENERAL

The Analog Input Module (8 bit) Assembly (Cat. No. 1771-IE) converts analog signals at its inputs to digital BCD data, useable by a programmable controller Processor. This Publication describes one of the programming methods for accessing BCD data from the Analog Input Module. This technique, termed single-channel transfer, is used when the Analog Input Module (8 bit) communicates with the following programmable controller Processors[1]:

- Bulletin 1774 Remote I/O PLC Processor (Cat. No. 1774-RP1, -RP2, -RP3, or -RP4)
- Bulletin 1772 PLC-2 Processor (Cat. No. 1772-LR)
- Bulletin 1772 PLC-2 Mini-Processor Module (Cat. No. 1772-LN1, -LN2)

Single-channel transfer follows the same general pattern with each of these Processors. The following programming concepts apply to single-channel programming in general:

- 16-bit channel word
- Bidirectional Processor/Module communication
- Overall program sequence and timing

Specific single-channel programming techniques vary slightly between PLC-2 and PLC Processors. For this reason, each Processor and associated techniques are described separately.

This Publication assumes a knowledge of ladder-diagram programming, I/O addressing, and memory structure for a PLC-2 or PLC programmable controller Processor. This information is readily available in other Allen-Bradley Publications. (Refer to Table 1.)

For application and installation information on the Analog Input Module (8 bit) Assembly, refer to Product Data Sheet 1771-915.

## CHANNEL DATA

For each of its 8 input channels, the Module converts the analog voltage or current value to a proportional binary-coded decimal (BCD) number. Because the Analog Input Module has 8-bit resolution, the BCD values for any analog range are 000-255. ($2^8$=256.)

For each input channel, the Module generates a 16-bit memory word. (Refer to Figure 1.) This word contains the following information:

- Converted BCD value (bits 00-13)[2]
- Channel address code (bits 14-16)
- Overflow/Underflow bit (bit 17)

Note that the Processor uses this same overall format to store any 3-digit BCD value: bits 00-13 store the value and, for most instructions, bits 14-17 store status or identifying information. Because it is represented in this standard arrangement, the 000-255 analog channel value is readily useable in the program. The value can be compared with other values in memory, displayed, transferred, or used in programmed arithmetic operations.

The analog input channel number is identified by the pattern of bits 14-16. The code for each of the 8 channel numbers is shown in Figure 1.

[1] Another mode of Processor/Module communication, the block transfer mode, is available with PLC-2/20 Processors with Cat. No. 1772-LP1. Subsequent Publications will describe this transfer mode

[2] Note that memory bits are numbered 00-07 and 10-17 (Refer to Figure 1.)

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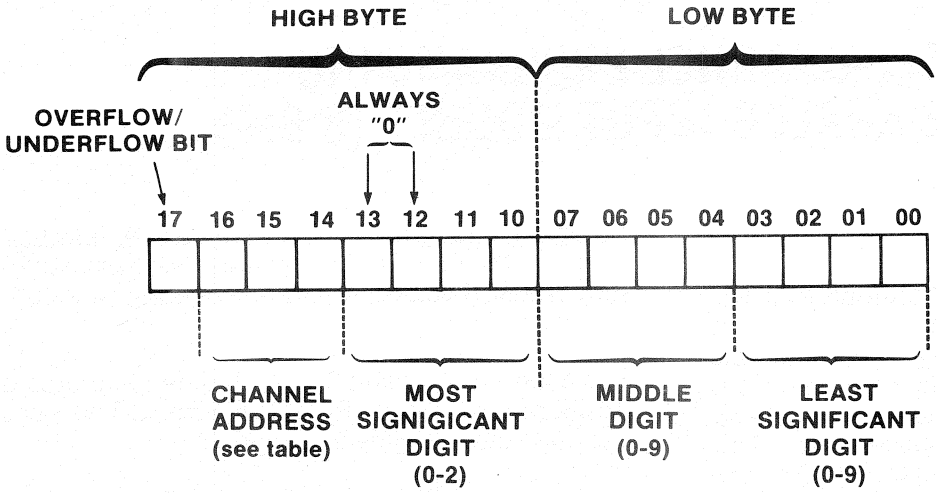



**FIGURE 1 — Analog Input Memory Word**

Table
CHANNEL ADDRESS CODES

| Bits | | | Channel No. |
|---|---|---|---|
| 16 | 15 | 14 | |
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 2 |
| 0 | 1 | 0 | 3 |
| 0 | 1 | 1 | 4 |
| 1 | 0 | 0 | 5 |
| 1 | 0 | 1 | 6 |
| 1 | 1 | 0 | 7 |
| 1 | 1 | 1 | 8 |

Bit 17 of the input channel word indicates either overflow or underflow. When this bit is set to 1, the input analog value is either above (overflow) or below (underflow) the range set for the Module, as follows:

- **Overflow**-Bit 17 set to 1, BCD value 255
- **Underflow**-Bit 17 set to 1, BCD value 000

Bit 17 is 0 when the sensed analog input value is within range.

When all 8 of its input channels are used, the Module generates 8 complete 16-bit words of data for use in the program. However, with single-channel transfer, the complete 16-bit word for an input channel cannot be read from the Module at one time. The Analog Input Module transmits **half** the 16-bit word per I/O scan. Subsequent Sections describe why this is the case and show how the program stores each half-word and then reconstructs the full 16-bit word for each channel.

## PROCESSOR/MODULE COMMUNICATION

The Analog Input Module (8 bit) both receives data from and sends data to the programmable controller Processor. The means for this bidirectional transfer of data is the I/O scan. This section describes the I/O scan and its significance in Processor/Module communication.

**TABLE 1 — Pertinent Publications**

| PROCESSOR | CAT. NO. | MEMORY STRUCTURE (Publication- ) | PROGRAMMING & OPERATIONS (Publication- ) |
|---|---|---|---|
| Bulletin 1772 PLC-2 Processor | 1772-LR, Series A<br>Series B | 1774-921<br>1772-907 | 1772-800 |
| Bulletin 1772 PLC-2 Mini-Processor Module | 1772-LN1, -LN2 | 1772-700 | 1772-821 |
| Bulletin 1774 Remote I/O PLC Processor | 1774-RP1, -RP2<br>1774-RP3 | 1774-921<br>1774-934 | 1774-800 |

An understanding of the internal workings of the Analog Input Module is important to the programmer. Module operation, focusing upon program-controlled aspects of Module activity is described below.

## I/O SCAN COMMUNICATION

Every I/O scan, the Processor writes one byte (8 bits) of data to each I/O module slot and reads one byte of data from each I/O module slot. A separate memory location is used for each of these operations. The data written to the module slot is stored in memory in the Output Image Table. The data read from the module slot is stored in memory in the Input Image Table. (Refer to Figure 2.)

In single-channel transfer, the program uses these memory locations for bidirectional Processor/Module communication, as follows:

- **Output byte**-The byte of data written to the Module from the Output Image Table, the output byte, is the means for program control of certain Module operations. CHANNEL, BYTE, and UPDATE SELECT commands are sent to the Module through bits of the output byte. (SELECT commands are described in Programming.)
- **Input byte**-The byte of data read from the Module and stored in the Input Image Table, the input byte, is the means by which the Module communicates all data to the Processor. Because the Module only transmits one byte of data at a time, special techniques are used to multiplex all 16 bytes of Module data through this single input byte. (Input data multiplexing is described in Programming.)

## MODULE OPERATION AND STRUCTURE

The Analog Input Module (8 bit) performs several different internal operations to make BCD data available to the Processor. These internal operations are illustrated in Figure 3.

Initially, the Module scans each of its 8 input channels, converts the signal from each channel to a proportional BCD value, and stores this value in its own memory circuitry. The conversion of analog to digital values continues as long as system and user power are supplied to the Module. This A/D conversion, therefore, is independent of program instructions.

The Module operations which make this data available to the Processor, however, are controlled by the program. Specifically, the program controls 2 internal operations of the Module:

- Update of converted value storage
- Channel/Byte data selection

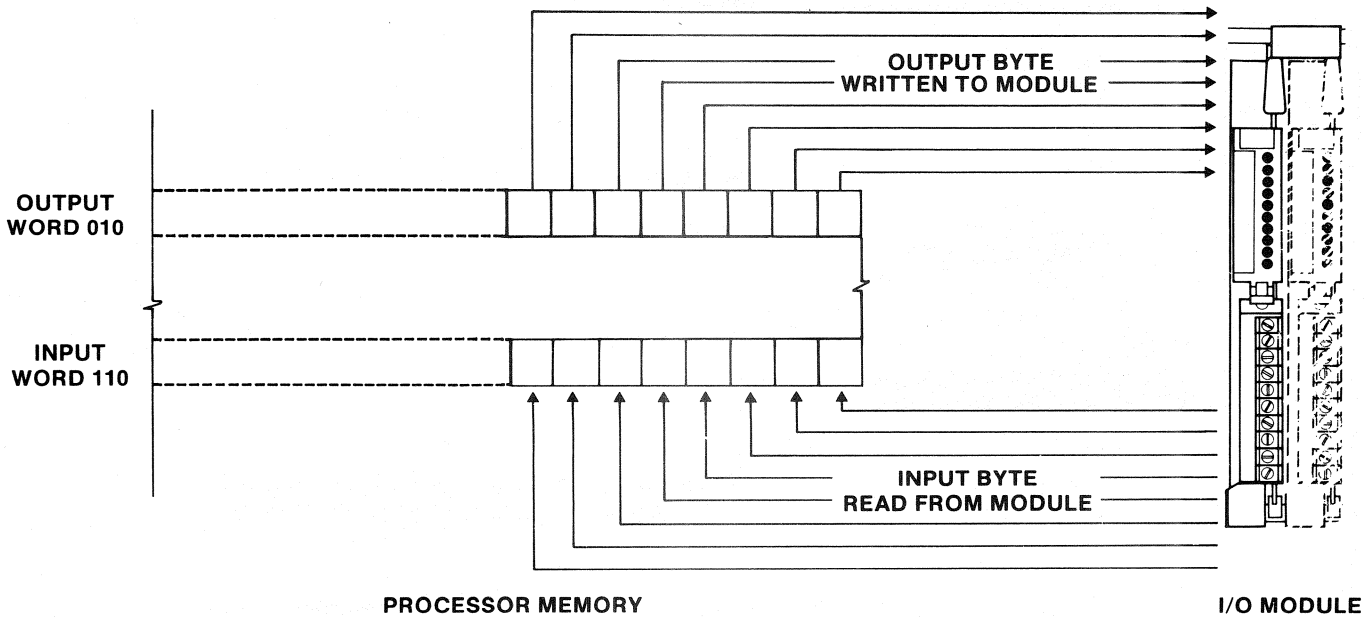


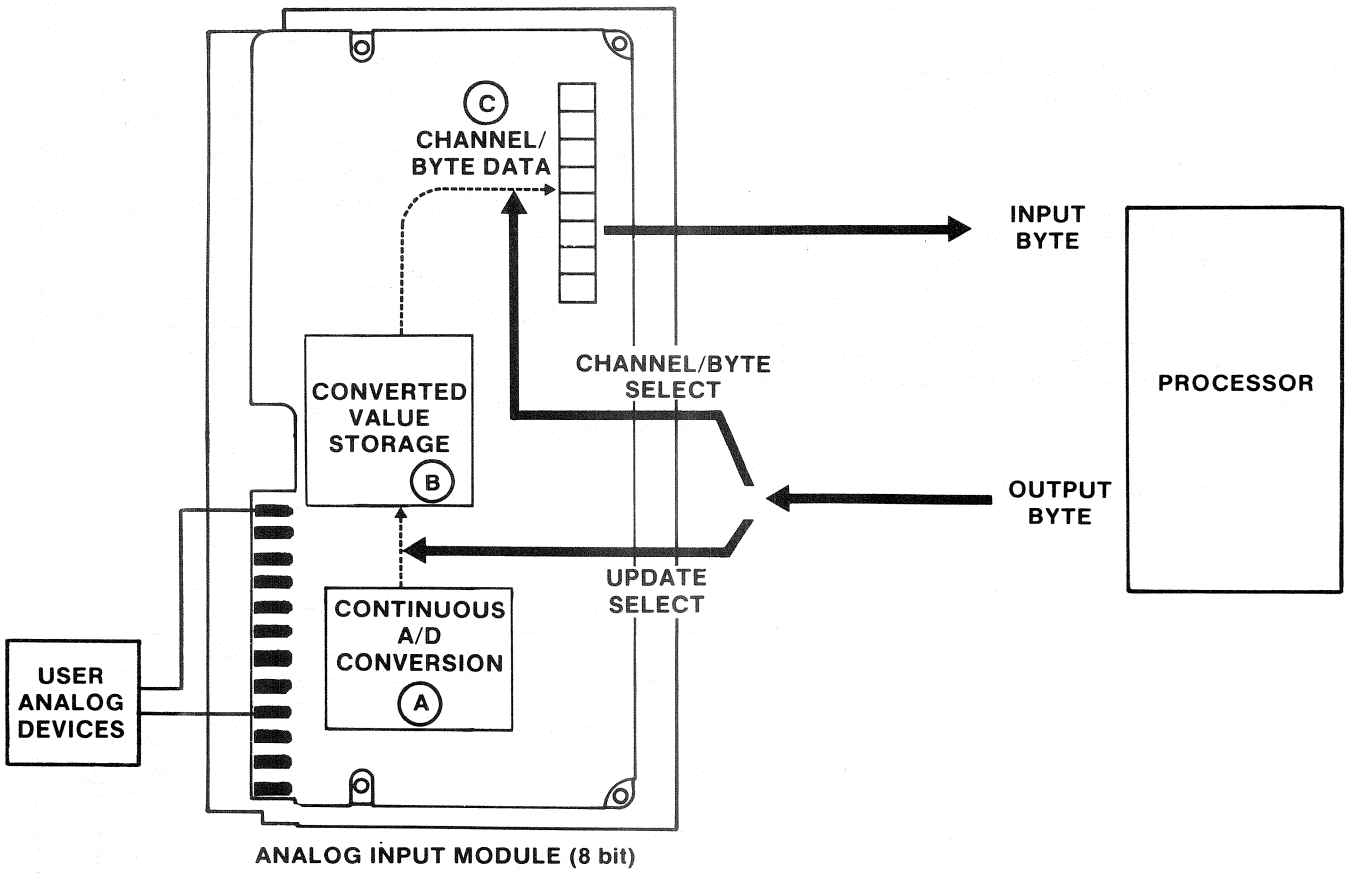

**FIGURE 2 — I/O Scan**

**Converted Value Storage**

Because the Module's A/D conversion process is continuous, input channel data is not transmitted to the Processor directly from the A/D conversion circuitry. Instead, the Module has a separate memory area for storage of the converted values for each channel. This converted value storage area holds the data which is available for transmission to the Processor. (Refer to Figure 3.)

The reason for this arrangement is twofold: it allows the A/D conversion process to continue uninterrupted and provides a buffer for the converted values. This is especially useful in preventing a condition in which data changes halfway through transmission to the Processor. (Recall that only a half-word of channel data is sent at one time.)

The converted value storage area must be periodically updated with the latest BCD channel values. A special combination of output byte bits is set in the program to give the UPDATE SELECT command to the Module. When the Module receives this command, it updates all 8 input channel values in this converted value storage area.




LEGEND:

(A) CONTINUOUS A/D CONVERSION and storage of converted values is done as long as system power is supplied to the Module. This function is independent of the program.

(B) CONVERTED VALUE STORAGE area stores converted BCD values from all 8 input channels for use by the Processor. The program controls update of this area by setting the UPDATE SELECT bits in the output byte.

(C) CHANNEL/BYTE DATA is sent to the Processor one byte at a time. The program specifies which byte is sent by setting CHANNEL/BYTE SELECT bits in the output byte.

**FIGURE 3 — Module Structure (Single-Channel Mode)**

After the Module receives the UPDATE SELECT command, it requires a certain amount of time for the update operation. The Sample Programs use scan counting as a measurement tool for allowing sufficient Module update time.

The frequency of the UPDATE SELECT command within the program is application-dependent. In the Sample Programs, all 8 channels are read by the Processor for a single UPDATE SELECT command. Alternately, the UPDATE SELECT command may be given before **each** channel value is sent, or at varying intervals, depending on how quickly analog values in the controlled process are likely to change.

### Channel/Byte Data

The Processor reads data from the Module, one byte at a time. Since up to 16 bytes of data can be required from the Module, the program specifies which byte is sent by the Module at any one time. To do this, CHANNEL and BYTE SELECT commands are sent to the Module through the output byte.

After it receives a CHANNEL and BYTE SELECT command, the Module needs a certain amount of time to respond with the required data. In the Sample Programs a scan counter is used to measure out sufficient Module response time.

## PROGRAMMING

The program coordinates the writing of commands to the Module and the reading and storage of input channel data. The following Paragraphs describe the programming concepts and techniques necessary for single-channel transfer using either the PLC-2 Controller Sample Program or the PLC Controller Sample Program.

### MEMORY USE

Certain memory locations must be set aside for exclusive use by the Analog Input Program. Figure 4 shows the memory areas used in the Sample Program for the PLC-2 Controller. These addresses

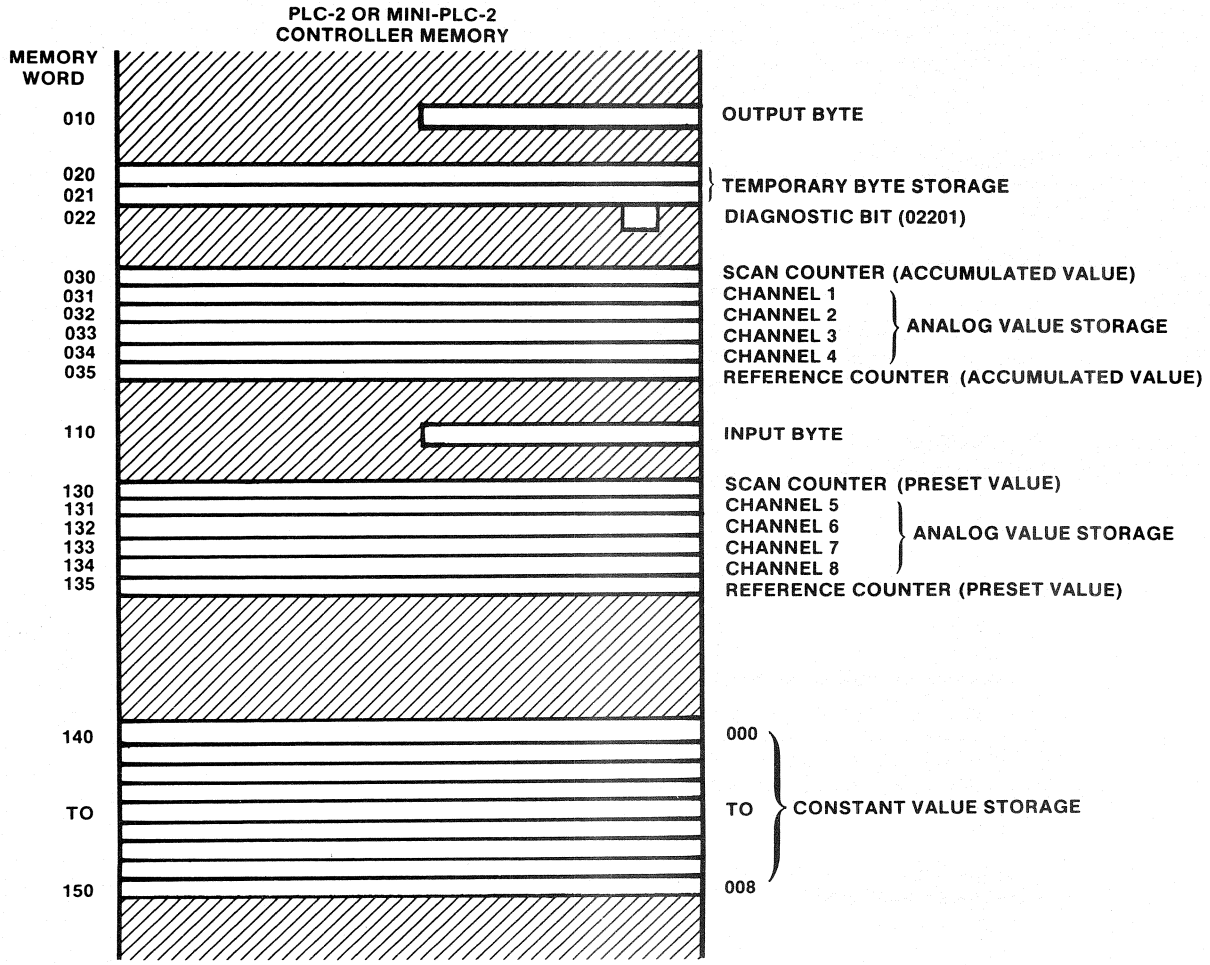



**FIGURE 4 — Memory Use (PLC-2 Controller Program)**

are valid for both the PLC-2 Processor and Mini-Processor Module. (For the PLC Processor the same types of memory locations are used, with appropriate addressing.)

The following types of memory locations are used:

- Input and output byte
- 2 counters
- A number of storage words

The input and output bytes associated with the Module are based upon the Module's slot position in the I/O Chassis.

As previously mentioned, a Scan counter (030) is used to coordinate the timing and sequence of the program. A second counter, termed the Reference counter (035), is used as a "pointer" in the program. The value of the Reference counter determines the channel number selected by the program.

Storage words are used for different purposes in the program. A word is used to store the 16-bit word from each analog channel that is used. (In Figure 4, the 8 words used for this purpose are 031-034 and 131-134.)

Words 020 and 021 are termed Temporary Byte Storage. The special function of these memory locations is described later.

Throughout the Sample Program, Comparison instructions such as GET/EQU are used. These Instructions compare the values of Scan and Reference counters to the constant values 000 through 008. To store these constant values in the Sample Program, words 140-150 have been used. However, the use of these storage words is optional. If memory space is not available for this constant value storage, a different programming method can be used. (Refer to Application Note 1.)

Where fewer than 8 input channels are used, not all storage locations shown in Figure 4 are necessary. (Refer to Application Note 2.)

## OUTPUT BYTE COMMANDS

Through the output byte written to the Module, the program specifies and controls Module operation. The output byte is used to send SELECT commands to the Module. These commands are:

- CHANNEL SELECT
- BYTE SELECT
- UPDATE SELECT

Figure 5 shows the necessary combination of output byte bits for each command.

**CHANNEL SELECT**-Bits 0-6 of the output byte are the CHANNEL SELECT bits. (Refer to Figure 5.) The CHANNEL SELECT command identifies the number of an input channel. When the Module receives a CHANNEL SELECT command through the output byte, it makes data from the specified channel available to the Processor.

In the Sample Programs, CHANNEL SELECT bits are controlled by the value of the Reference counter.

**BYTE SELECT**-Only one byte of channel data is available to the Processor at one time. The BYTE SELECT bit is used to specify which byte of the channel word is needed: high or low byte. Bit 7 of the output byte has this significance:

- 0 - Selects the low byte of the channel word
- 1 - Selects the high byte of the channel word

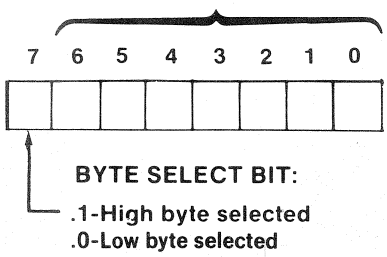
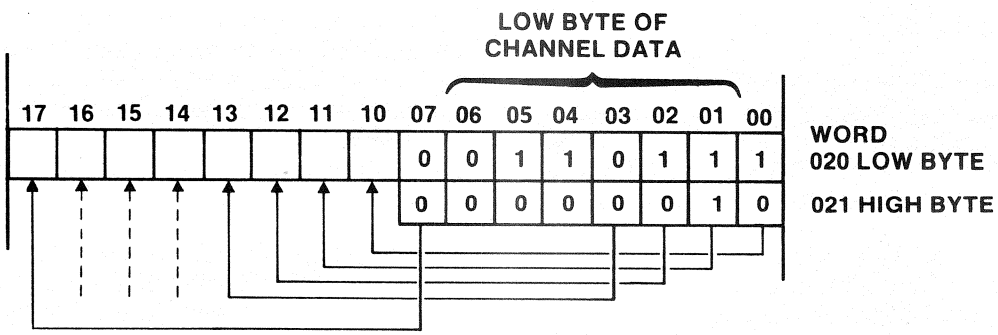



**Table - CHANNEL SELECT CODES** [1]

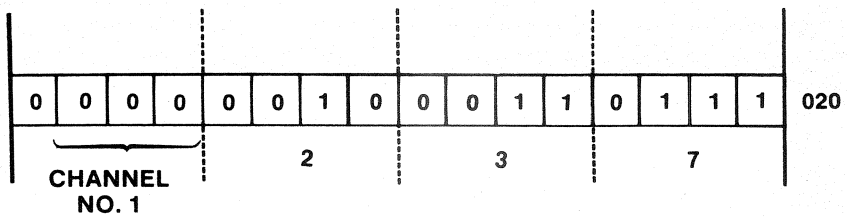
| Bit Status | | | | | | | Channel No. |
|---|---|---|---|---|---|---|---|
| 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 4 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 5 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 7 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |

[1] Any code with 2 or more of bits 0-6 set to 1 is an UPDATE SELECT command to the Module. (Refer to OUTPUT BYTE COMMANDS.)

**FIGURE 5 — Output Byte**




(a.) ACTION




(b.) RESULT

**FIGURE 6 — Reconstructing the Channel Word**

**UPDATE SELECT**- An UPDATE SELECT command is sent to the Module through bits 0-6 of the output byte. Whenever **two** or more of these bits are set to 1 at the same time, the UPDATE SELECT command is given. (Note that bits 0-6 are also used for channel selection. However, for the CHANNEL SELECT command, at most **one** of bits 0-6 is set to 1.)

As previously described, the Module converted value storage area must be updated periodically, as instructed by the program. The UPDATE SELECT command directs the Module to update this memory area with the latest A/D conversions for all 8 input channels.

## INPUT BYTE MULTIPLEXING

In the single-channel transfer mode, the Analog Input Module (8 bit) has as many as 16 bytes of channel data for transmission to the Processor. However, the Module can transmit only one byte of data through the input byte at a time. For this reason, the input byte must be "shared" in the program. This sharing of the input byte is called multiplexing.

The multiplexing of channel data requires that Processor/Module communication follow an orderly sequence. To provide this, a scan counter is programmed as a type of "clock". The Scan counter is also used to allow the Module sufficient time to respond to SELECT commands.

### Multiplexing Sequence

The following basic program steps are needed to multiplex the data from one analog channel through the input byte:

1. Set SELECT bits for the low byte.
2. Wait for Module data to be valid.
3. Store the low byte (word 020 in Figure 6(a)).
4. Set SELECT bits for the high byte.
5. Wait for Module data to be valid.
6. Store the high byte (word 021 in Figure 6(a)).

The time interval required for Steps 2 and 5 is measured in scan counts and depends on the Processor. For the PLC-2 Processor, this is one **program** scan. For the PLC Processor, this is two **I/O** scans.

### Reconstructing the Word

Once the program steps of the preceding paragraph have been completed, 2 memory words each store half of the full channel word, as shown in Figure 6(a). The complete 16-bit word for the channel must be reconstructed from these bytes.

In Figure 6(a), the high byte of Module data is stored in the low byte position (bits 00-07) of word 021. This byte must be transferred to bits 10-17 of word 020. Each bit is transferred singly to achieve this result. (The example shows a value of 237 for Channel 1.) Refer to the Sample Programs for rungs which reconstruct the channel word. In the PLC-2 Program, these are rungs 7-14. In the PLC Program, these are rungs 8-15.

The example of Figure 6 assumes the placement of the Module in the **left** slot of the Module Group. Note that the same basic approach is used if the Module is in the right slot. However, if this were the case, the low byte of channel data would be transferred from bits 10-17 of word 020 to the correct byte position of word 021.

## CHECKING DATA VALIDITY

The program should check Module data before it stores and uses this data in a subsequent operation. Once each channel word is reconstructed, it can be tested for a fault indication.

### Checking Fault Diagnostics

Module diagnostic circuitry detects various types of faults, including the following:

- Loss of externally-supplied power
- Fault in Module operation

When the Module detects one of these faults, it resets all data bits to 0. A single rung, as shown in Figure 7, checks for this type of fault situation. (The rung shown is from the PLC-2 Sample Program; the corresponding PLC Program rung differs only in addressing.)

When all data from the Module channel is 0, the rung in Figure 7 sets bit 02201, the Diagnostic bit, to 1. Bit 02201 is then used as a condition for channel value storage---when bit 02201 is ON, a Module-detected fault is indicated and value storage is inhibited. (For the PLC Sample Program, bit 02002 serves this purpose.)

Besides suspending Processor/Module communication, bit 02201 may also be used to signal an alarm condition or generate a diagnostic report for operations personnel.

### Overflow/Underflow Bit

For some input devices in the application, overflow or underflow conditions may require monitoring. Bit 17 of the channel word, the Overflow/Underflow bit, is used for this purpose. This bit may be examined in the program to alter a critical process or to set off an alarm or indicator when a specific analog value is out of range.

As previously described the Module generates a corresponding BCD value from 000 to 255 for each input analog signal. At the analog value which corresponds to 000, or below this value, bit 17 is set to 1 to indicate underflow. At the analog value which corresponds to 255, or above this value, bit 17 is set to 1 to indicate overflow.

**Both** bit 17 and the BCD value must be examined to determine under-or overflow status.

### Display Rung

Both Sample Programs end with a display rung. This rung, composed of GET instructions, shows the converted BCD value stored in each channel word. When viewed on a Program Panel, the display rung can be a useful diagnostic tool for troubleshooting analog devices.

At the programmer's option, the display rung may be omitted from the program.

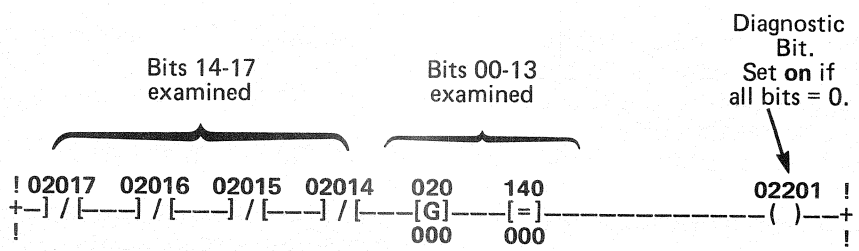



**FIGURE 7 — Fault Diagnostic Rung**

## SAMPLE PROGRAM - PLC-2 PROCESSORS

Programming techniques used in the Sample Program for the PLC-2 Processor and Mini-Processor Module include the following:

- Program scan counter
- IMMEDIATE I/O Instructions
- ZCL Zone programming

The following paragraphs describe these techniques, provide a flow chart, and give a Sample Program for the PLC-2 Processor and Mini-Processor Module.

### PROGRAM SCAN COUNTER

The Scan counter is used in the program to control the sequence of Processor/Module communication and to allow sufficient time for Module response to SELECT commands. The PLC-2 Controller Sample Program uses the Scan counter shown in Figure 8.

The rungs shown in this Figure and used in the Sample Program control Scan counter operation with bit 02200. The use of this bit or any other condition is not essential to the program. This merely illustrates the fact that a condition can be programmed to control the Scan counter, thus enabling or disabling Processor/Module communication.

The second rung of Figure 8 uses a single BRANCH END instruction as its condition. This instruction, when used by itself, is always FALSE. Because an Up-counter (CTU) increments for each FALSE to TRUE transition, CTU 030 registers one count each time the program scan occurs (provided that bit 02200 is ON).

In the Sample Program, the Scan counter is reset whenever bit 02200 is OFF. (Refer to Rung No. 36.)

### IMMEDIATE I/O INSTRUCTIONS

The IMMEDIATE INPUT and IMMEDIATE OUTPUT instructions transfer Input and Output Image Table data during the program scan, in advance of the normal I/O scan sequence.

These instructions are used so that input byte data from the Module can be stored in the program on the **next** scan after SELECT commands are sent to the Module.

### ZCL ZONE PROGRAMMING

The ZONE CONTROL LOGIC (ZCL) instruction is used to control multiple output instructions based on a set of overriding conditions. When these conditions are TRUE, the outputs within the zone are controlled by the conditions of their individual rungs. When the overriding conditions are FALSE, however, the outputs within the ZCL zone are held in their last state, whether ON or OFF.

In the PLC-2 Controller Sample Program, the ZCL zone begins with Rung No. 5 and ends at Rung No. 24. The rungs within this zone reconstruct and store the 16-bit word from each channel. The conditions of Rung No. 5 must be TRUE, that is, the Accumulated value of the Scan counter must equal 004, for the state of any output within the zone to be changed.

### FLOW CHART

The flow chart given in Figure 9 shows the sequence of the PLC-2 Controller Sample Program. Rung No. references are also given for these program steps.

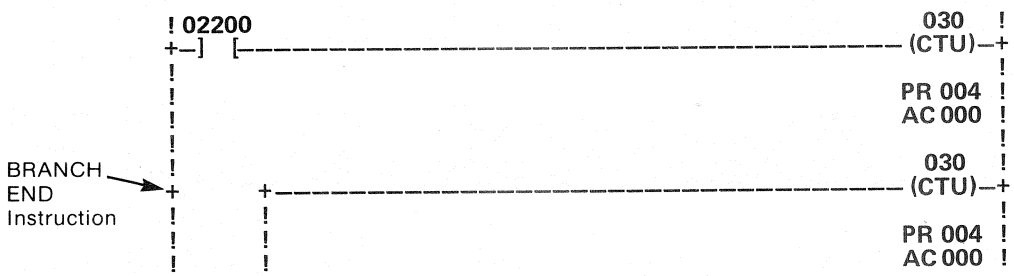



**FIGURE 8 — Program Scan Counter**

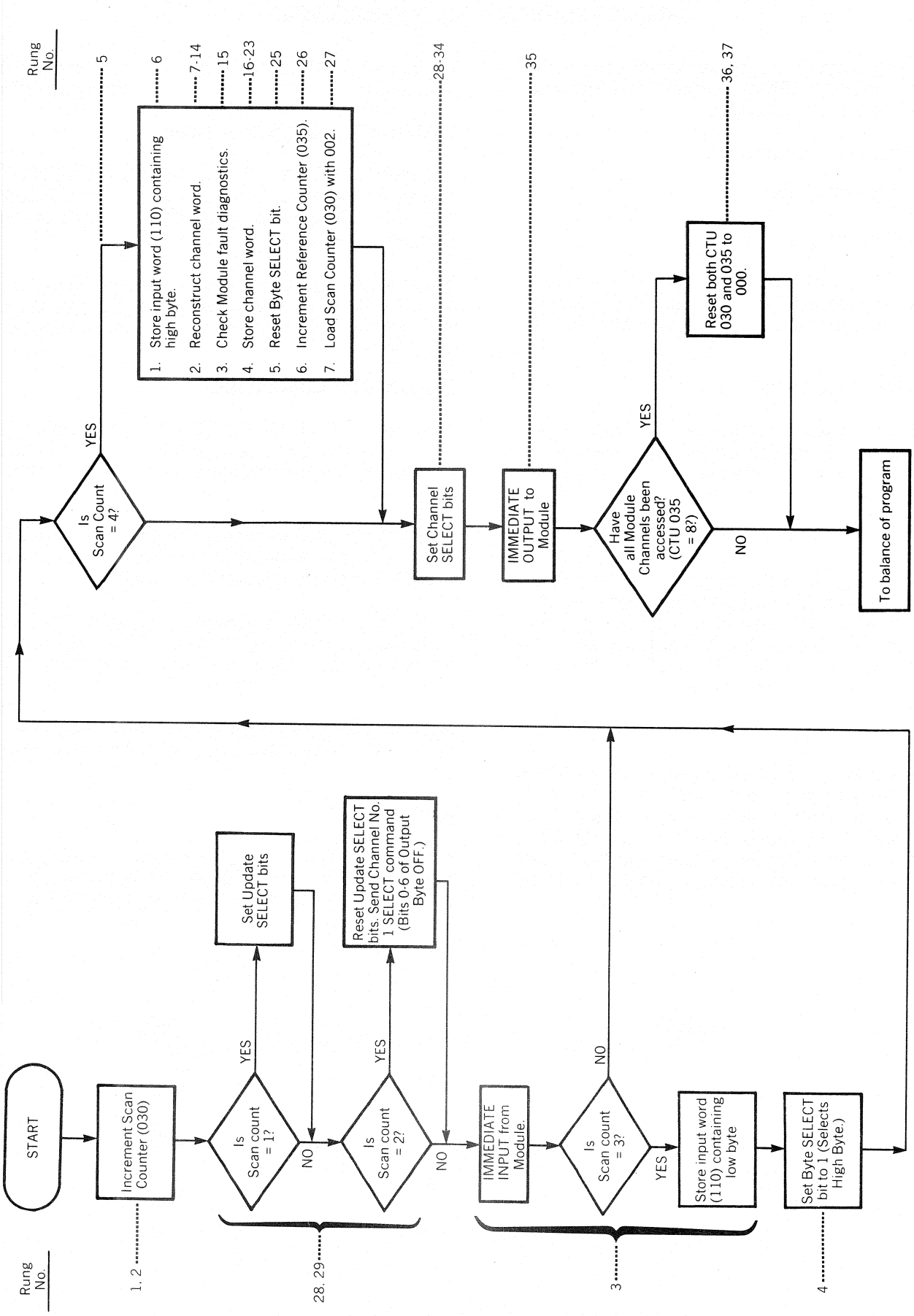
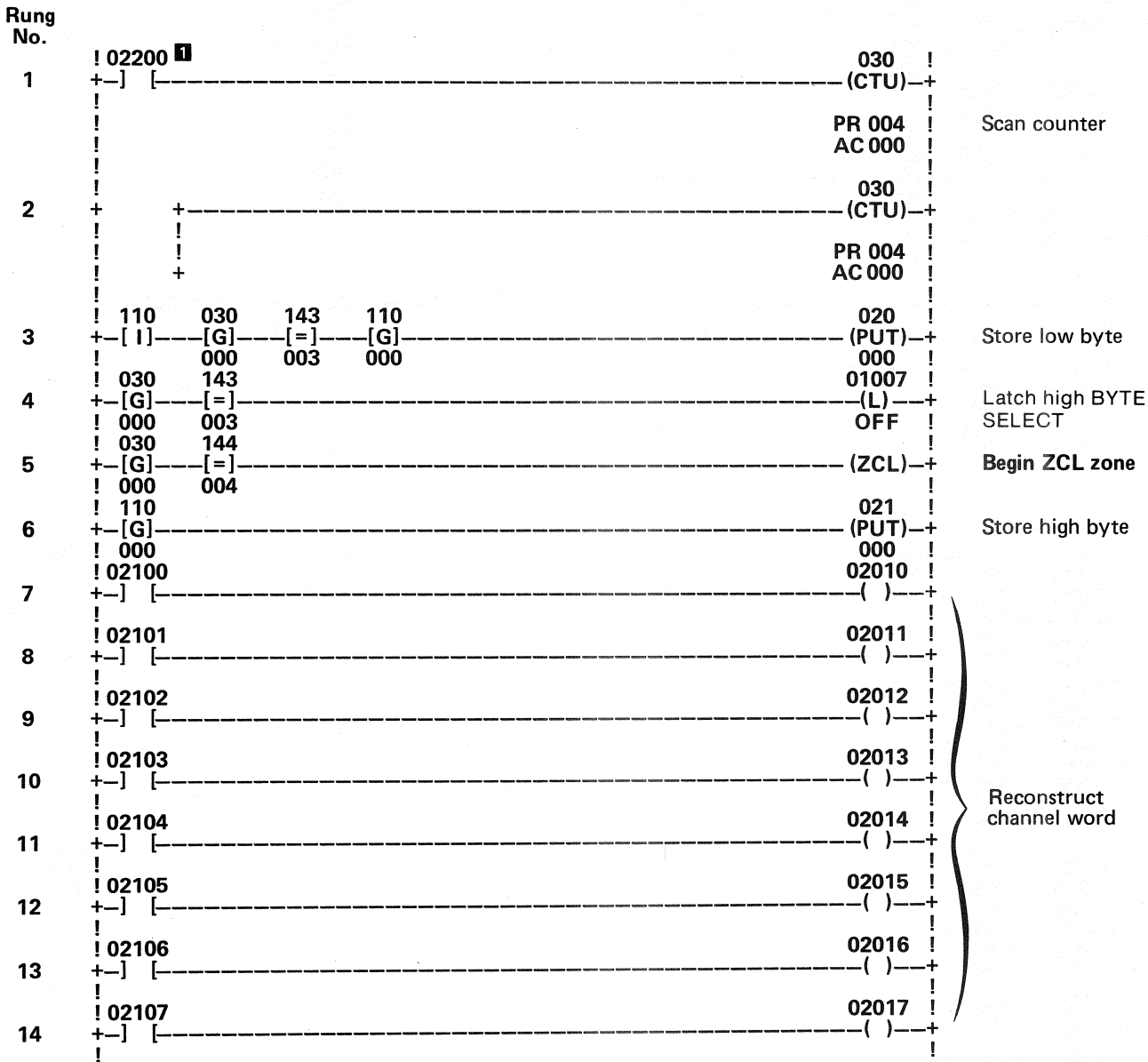



**FIGURE 9 — Flow Chart - PLC-2 Controller Sample Program**

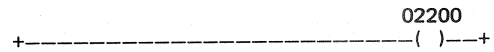
## SAMPLE PROGRAM

The Sample Program for PLC-2 Processors is given in Figure 10. For this program, the following assumptions are made:

- Analog Input Module (8 bit) in the **left** slot of Module Group 0 in the I/O Chassis.
- Memory bit 02200 must be set ON (1) to initiate Processor/Module communication. (Note that the Sample Program does **not** operate unless an additional rung is programmed to energize bit 02200.) When bit 02200 is OFF, data transfer is inhibited and the Scan counter is reset. (Refer to Rung No. 36.)
- All 8 Module channels are connected to analog devices (Should fewer than 8 channels be used, some rungs may be eliminated. Refer to Application Note 2.)




1 Set bit 02200 to 1 (ON) to allow Processor/Module communication. This bit, and any other programmed condition, can be used to allow or inhibit single-channel transfer. The following rung may be entered for demonstration purposes:




When bit 02200 is 0 (OFF), the Scan counter is reset. (Refer to Rung No. 36.)

**FIGURE 10 — Sample Program for PLC-2 and Mini-PLC-2 Controllers (Cont.)**

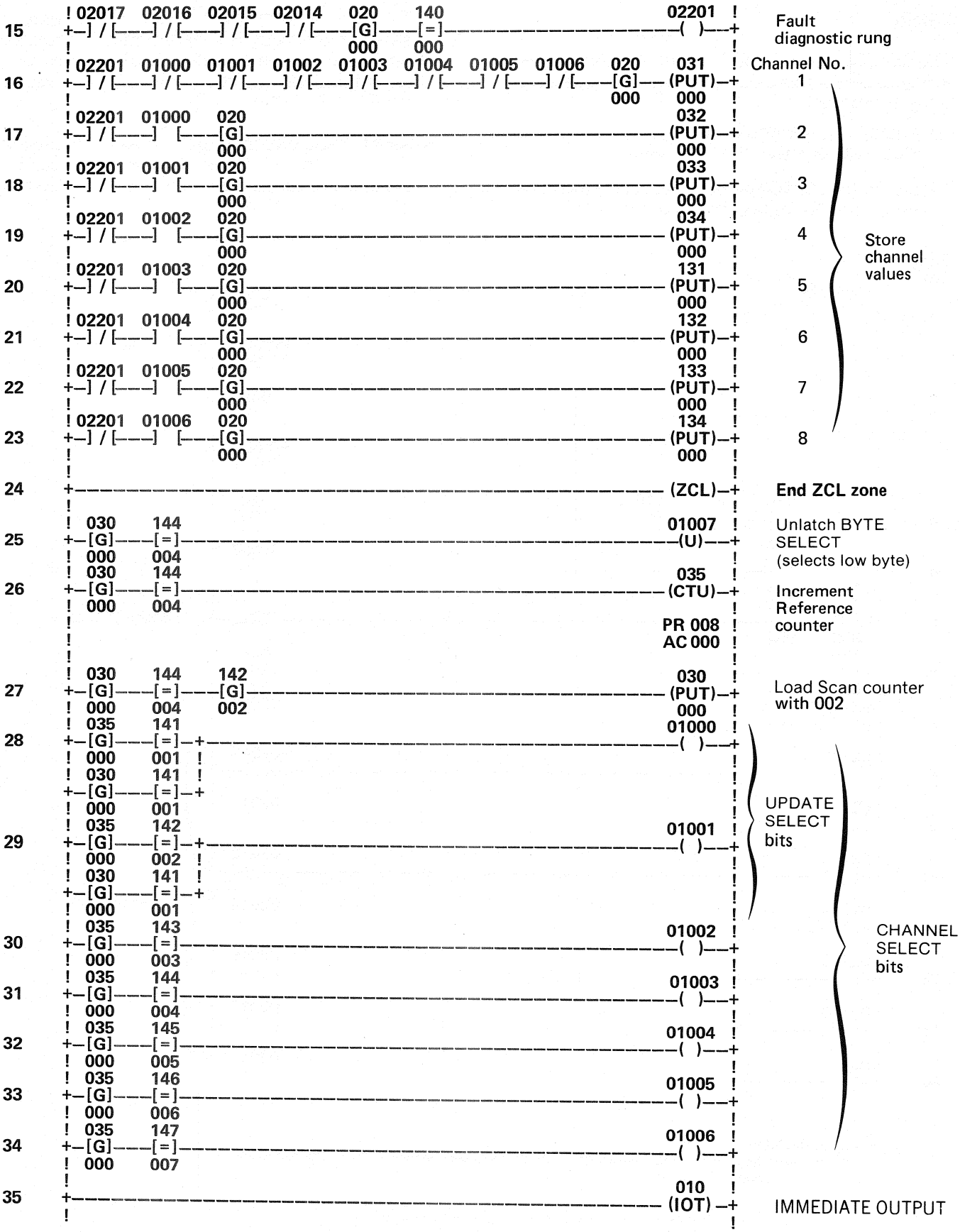



**FIGURE 10 — Sample Program for PLC-2 and Mini-PLC-2 Controllers (Cont.)**

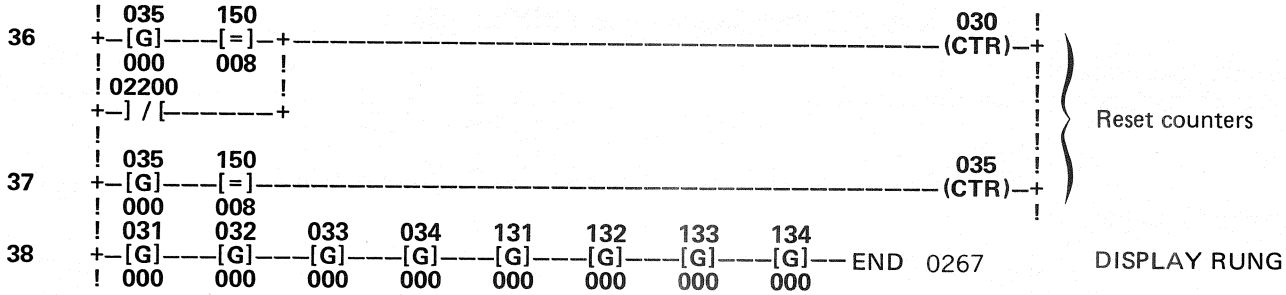



**FIGURE 10 — Sample Program for PLC-2 and Mini-PLC-2 Controllers (Cont.)**

## SAMPLE PROGRAM - PLC PROCESSOR

Programming techniques used in the Sample Program for the PLC Processor include the following:

- I/O Scan counter
- Use of Conditional Ignore Zone

The following Paragraphs describe these techniques, provide a flow chart, and give the Sample Program for the PLC Processor.

### I/O SCAN COUNTER

The Scan counter is used in the Sample Program to control the sequence of Processor/Module communication and to allow the Module sufficient time to respond to CHANNEL, BYTE, and UPDATE SELECT commands. The PLC Sample Program uses the type of scan counter shown in Figure 11.

(To simplify the discussion, bit 02200, examined as a Scan counter condition in the Sample Program, is not shown in Figure 11. The programmer may choose to use any bit or bits to condition the counter in a similar manner.) This scan counter increments only when **both** a program scan **and** an I/O scan have occurred. This is necessary because the I/O and program scans are carried out simultaneously by the PLC Processor and are **not** synchronous.

In order to keep track of both I/O and program scans, the I/O scan counter rungs manipulate a particular type of memory bit. This must be a bit in the Input Image Table which does **not** have a corresponding input device, so that the bit is turned OFF each I/O scan. Choose a bit which satisfies **both** of these conditions:

- Corresponds to an input address in the **same** I/O Rack as the Analog Input Module is located
- The input terminal at that address must be OFF at all times. It is **strongly** recommended that this terminal be connected to the L2(AC Low) or DC COMMON terminal on the input module wiring arm. (This aids in preventing the terminal from being connected to an input device at some later time.)

In Figure 11 and in the Sample Program, bit 11111 satisfies both of these conditions.

The I/O scan and program scan **both** manipulate bit 11111. In Rung No. 1,this bit is examined as an input condition for the Scan counter. When this bit is OFF, CTU 200 increments. When CTU 200 increments, bit 20017 is set ON. (Bit 17 of a CTU Accumulated value word is set to 1 (ON) whenever input conditions of the CTU rung are TRUE.) In Rung No. 2, bit 20017 latches bit 11111 ON. Then, in Rung No. 3, bit 20017 is turned OFF. Bit 11111 remains ON until the next I/O scan.

Note that CTU 200 cannot increment until both an I/O scan and program scan occur.

### CONDITIONAL IGNORE ZONE

A Conditional Ignore Zone is used to control multiple output instructions based on a set of overriding conditions. When these conditions are TRUE, the outputs within the zone are controlled by the conditions of their individual rungs. When the overriding conditions are FALSE, however, the zone outputs are held in their last state, whether ON or OFF.

In the PLC Controller Sample Program, the Conditional Ignore Zone begins with Rung No. 6 and ends with Rung No. 25. The rungs within this zone reconstruct and store the 16-bit word from each channel. The conditions of Rung No. 6 must be TRUE - that is, the Scan counter Accumulated value must equal 007 - for the state of any output within the zone to be changed.

### FLOW CHART

The flow chart given in Figure 12 shows the sequence of the PLC Controller Sample Program. Rung No. references are also given for these program steps.

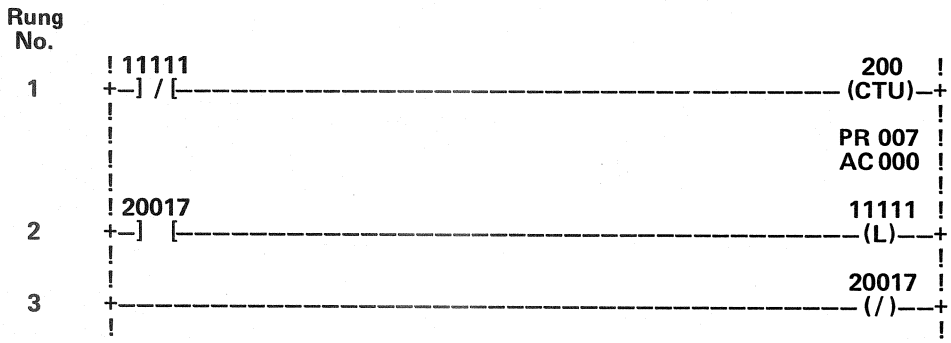



**FIGURE 11 — I/O Scan Counter**

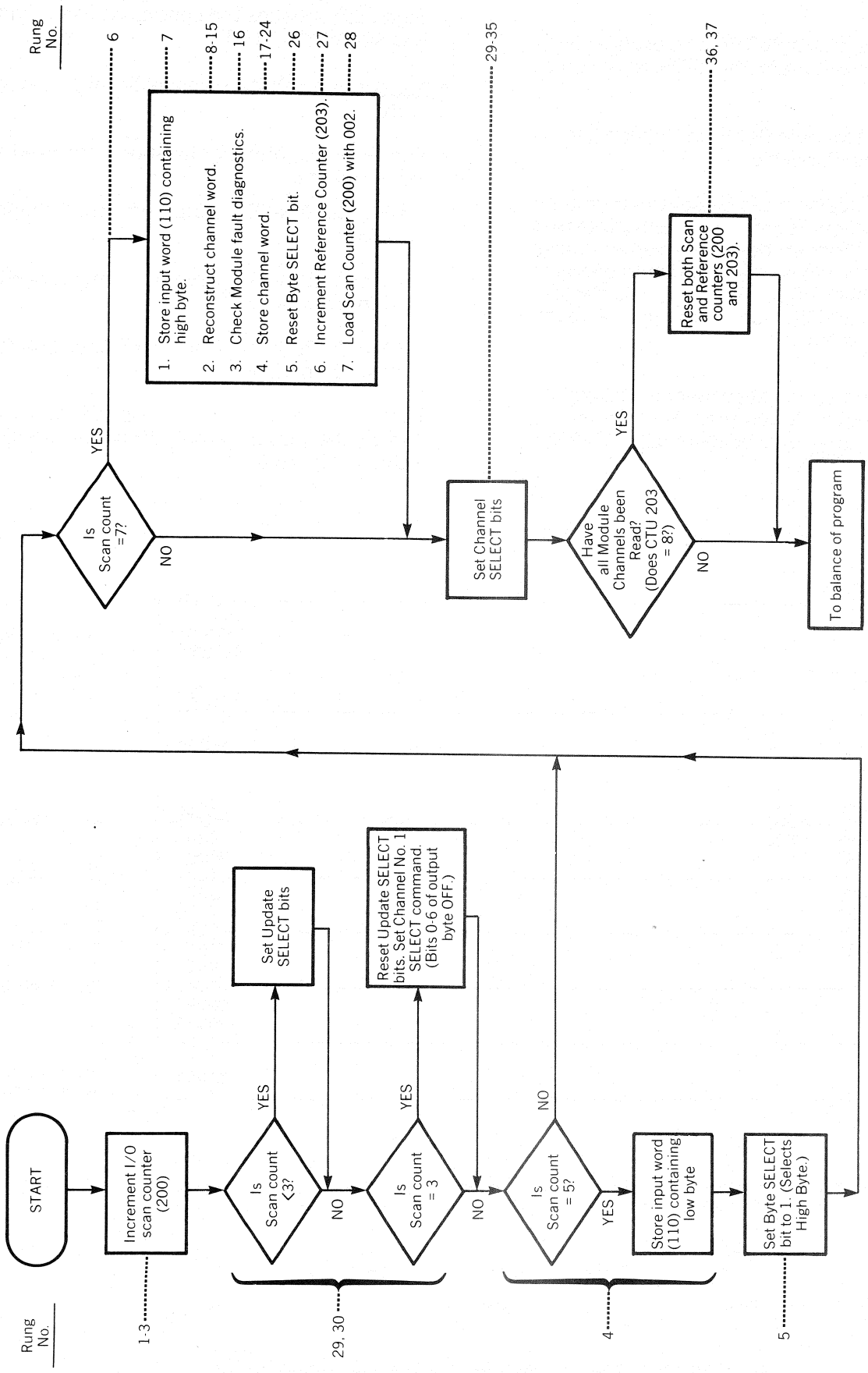


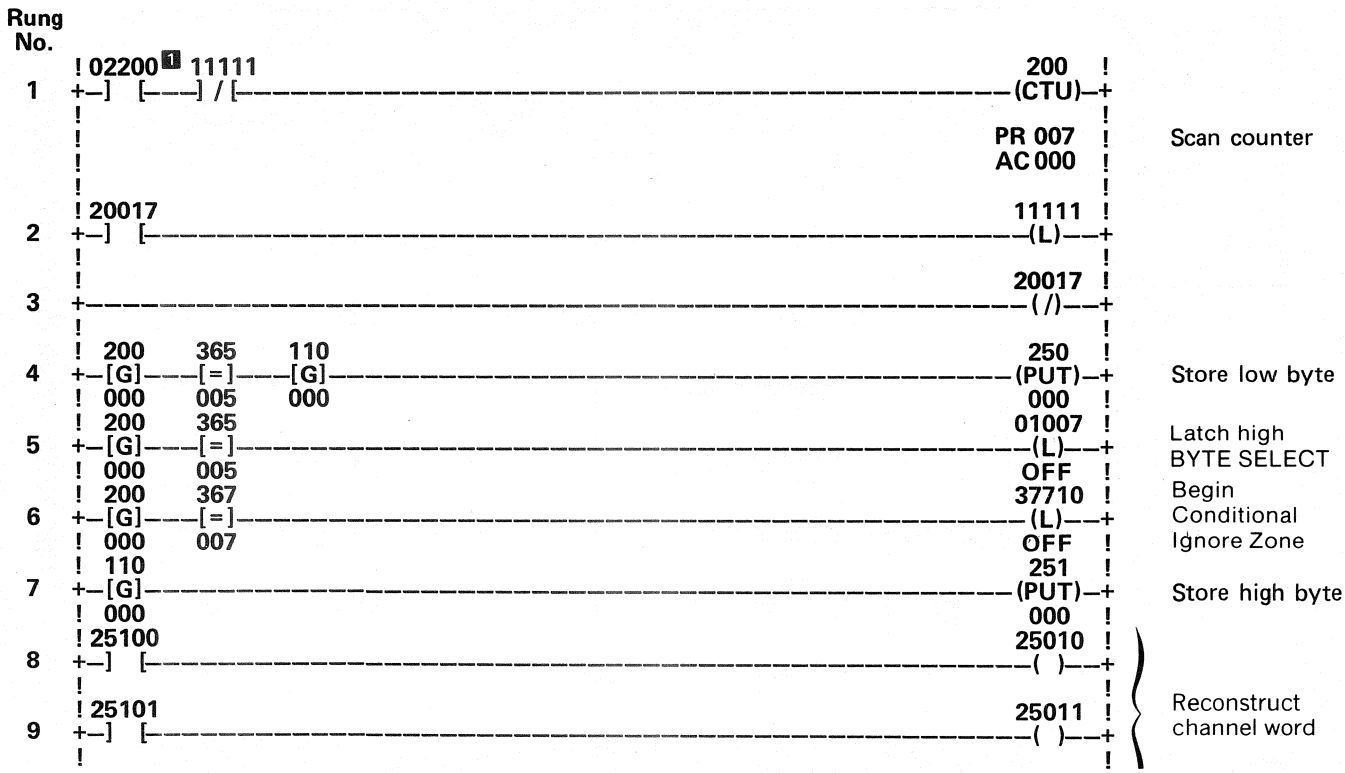

**FIGURE 12 — Flow Chart - PLC Controller Sample Program**

## SAMPLE PROGRAM

The Sample Program for PLC Processors is given in Figure 13. For this program, the following assumptions are made:

- Analog Input Module (8 bit) in Channel No. 1, Module Group 0, left slot.
- Memory bit 02200 must be set ON to initiate Processor/Module communication. (Note that the Sample Program does not operate unless an additional rung is programmed to energize bit 02200.) When bit 02200 is OFF, data transfer is inhibited and the Scan counter is reset. (Refer to Rung No. 36.)
- All 8 Module channels are connected to Module devices. (Should fewer than 8 channels be used, some rungs may be eliminated. Refer to Application Note 2.)
- Memory bit 11111 (or an alternate Input Image Table bit) satisfies the conditions listed under I/O SCAN COUNTER.
- Memory bit 02002 (Diagnostic bit) does **not** correspond to an I/O device.
- The following memory locations are used for value storage:
  - Words 260-267 store converted channel values
  - Words 250,251 serve as Temporary Byte Storage words
  - Words 360-370 store constants 000-008 for comparison

Each of these locations corresponds to a location in the PLC-2 Sample Program, as illustrated in Figure 4.




[1] Set bit 02200 to 1 (ON) to allow Processor/Module communication. This bit, and any other programmed condition, can be used to allow or inhibit single channel transfer. The following rung may be entered for demonstration purposes:




When bit 02200 is 0 (OFF), the Scan counter is reset. (Refer to Rung No. 36.)

**FIGURE 13 — Sample Program for PLC Controllers (Cont.)**

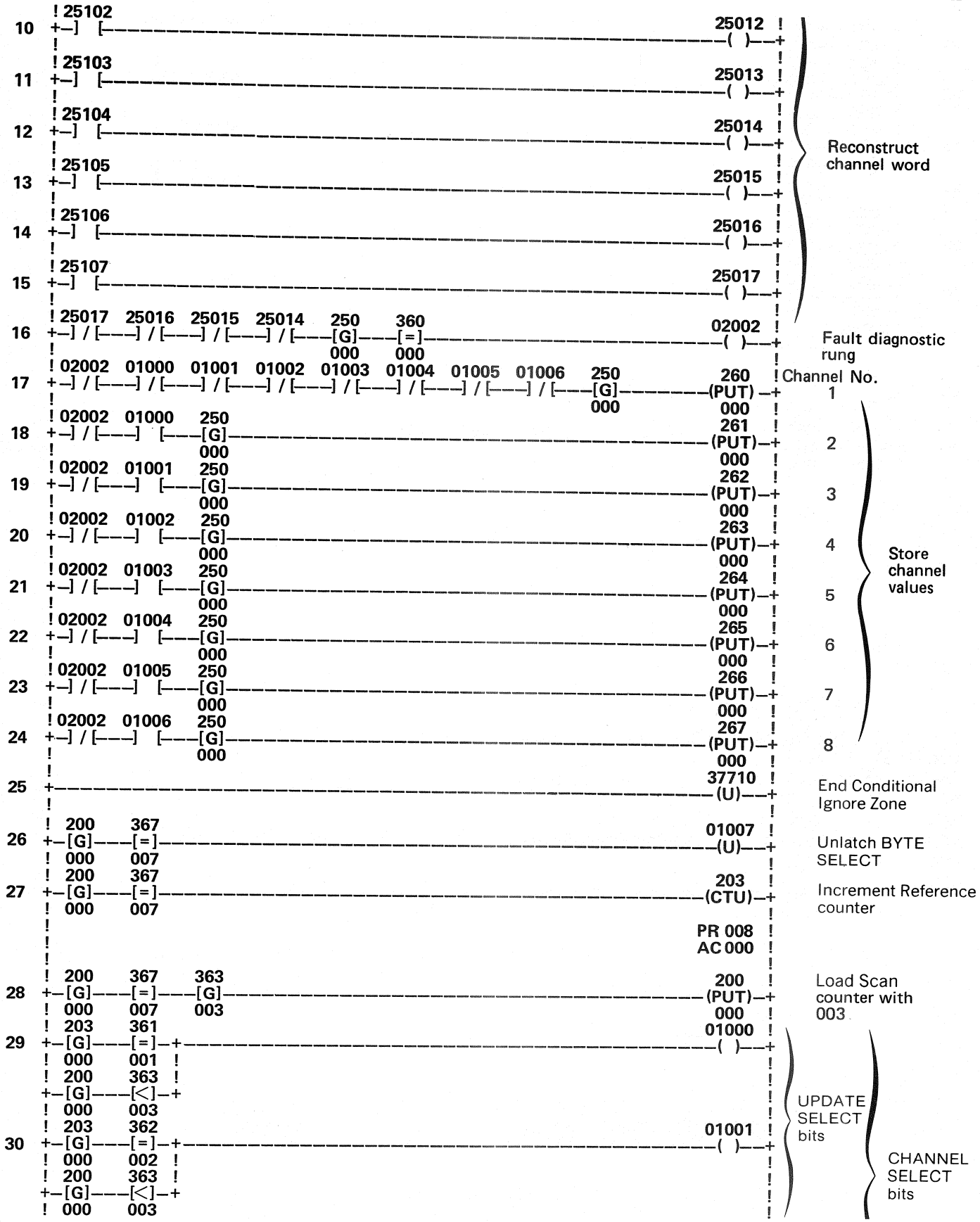



**FIGURE 13 — Sample Program for PLC Controllers (Cont.)**

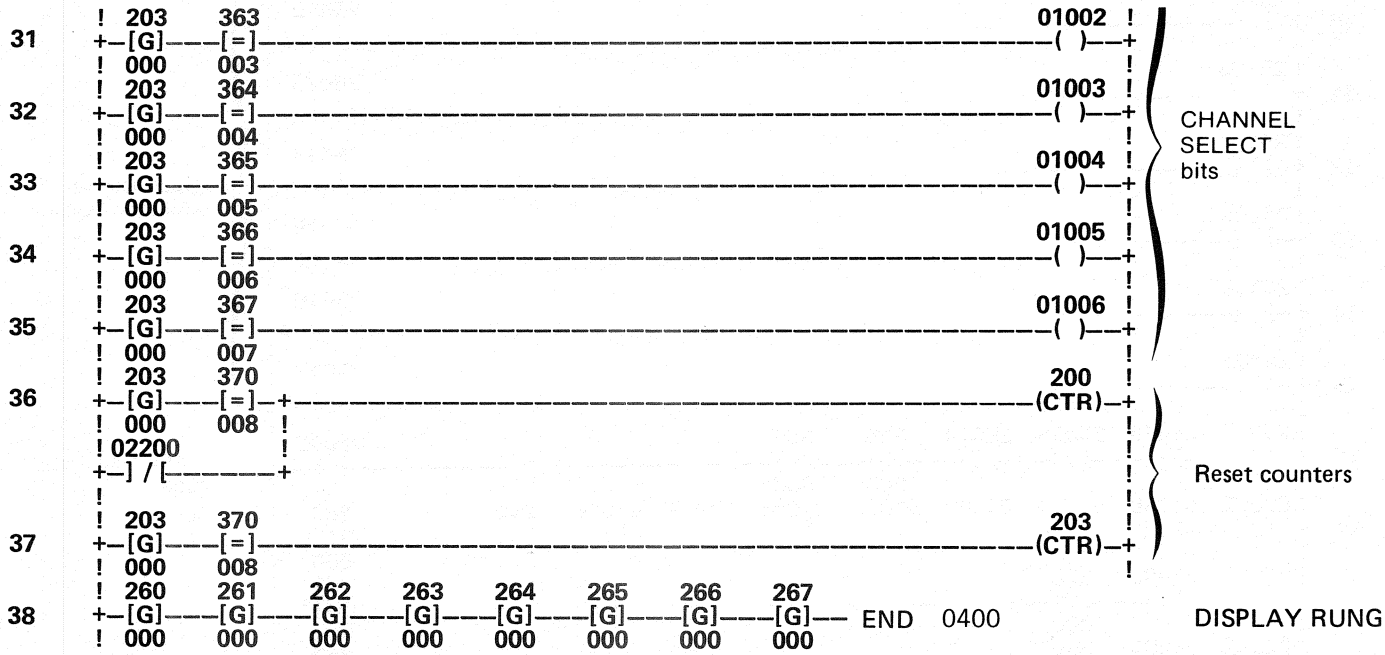



**FIGURE 13 — Sample Program for PLC Controllers (Cont.)**

## APPLICATION NOTES

1. In the Sample Programs, 9 Data Table words are used to store the constant values 000 through 008. These constants are used in Comparison instructions (GET/EQU, GET/LES) to keep track of Scan and Reference counter values. An alternate programming method can be used to eliminate the need for most of these storage words.

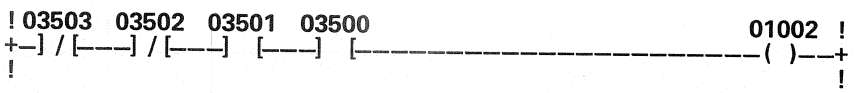
The least significant digit of the counter Accumulated value is stored in BCD format in bits 00-03. By examining each of these 4 bits, the value of this digit can be determined.

Using this method, the rung shown in Figure 14(b) may be substituted for the Sample Program rung shown in Figure 14(a). This eliminates the need to store the value 003 in Data Table word 143.

For quick reference, Table 2 shows the BCD codes for decimal numerals.




(a) Original Rung




(b) Alternate Rung

**FIGURE 14 — Alternate Programming for Comparison**

2. Often, fewer than 8 input channels are connected to a Module. To conserve memory space and increase the rate of data update, the program can be shortened in this instance. To reduce program size, first study the flow chart of the Sample Program. (This is Figure 9 for PLC-2 Controllers; Figure 12 for PLC Controllers.) Note the sequence of events required to update Module data and to read the data from each channel.

With this sequence in mind, the following program steps may be edited when fewer than 8 channels are used:

- SET CHANNEL SELECT BITS. Bits in the output byte are set as CHANNEL SELECT commands. To economize on program length, set SELECT bits only for those channels which are connected. CHANNEL SELECT commands should specify a connected channel at each count of the Reference counter.
- RESET SCAN AND REFERENCE COUNTERS. These counters should be reset when the Reference counter value equals the total number of channels which are connected.
- STORE CHANNEL WORD. Store only the values needed.

Both flow charts give Rung No. references for each program step.

**TABLE 2 — BCD Codes**

| BIT STATUS | | | | DECIMAL NUMBER |
|---|---|---|---|---|
| 03 | 02 | 01 | 00 | |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 2 |
| 0 | 0 | 1 | 1 | 3 |
| 0 | 1 | 0 | 0 | 4 |
| 0 | 1 | 0 | 1 | 5 |
| 0 | 1 | 1 | 0 | 6 |
| 0 | 1 | 1 | 1 | 7 |
| 1 | 0 | 0 | 0 | 8 |
| 1 | 0 | 0 | 1 | 9 |

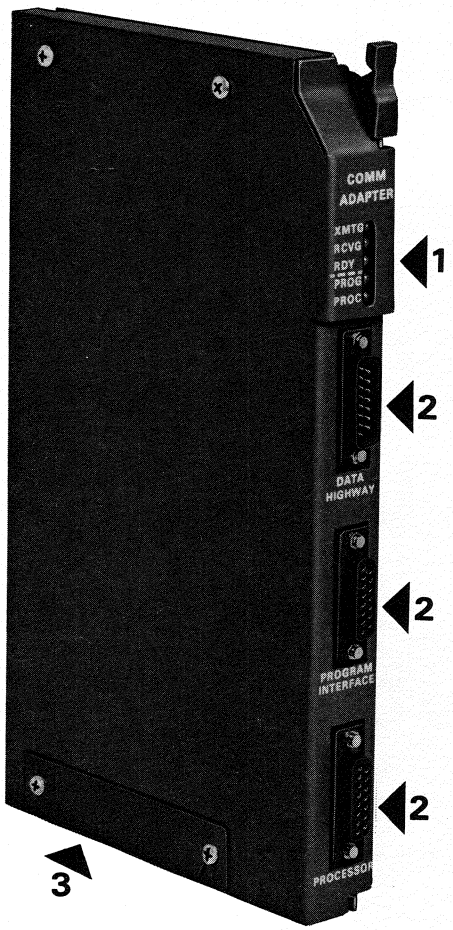
ALLEN-BRADLEY
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P/N 636020-51

# COMMUNICATION ADAPTER MODULE

## Cat. No. 1771-KA




1. Diagnostic indicators for troubleshooting
2. Sockets for cable connection
3. Switches allow Station No., capabilities selection

### MODULE SPECIFICATIONS

**Function**
Interfaces PLC-2/20, PLC-2, or Mini-PLC-2 Programmable Controller to Data Highway

**Location**
Bulletin 1771 I/O Chassis
(any slot but furthest left)

**Communication Channels**
To Data Highway
To Programming Terminal
To Processor

**Communication Rates**
To Data Highway: 57.6k baud
To Programming Terminal: 9.6k baud
To Processor: 19.2k baud
(for PLC-2/20 Processor or Mini-Processor Module)
9.6k baud (for PLC-2 Processor)

**Power Supply Requirement**
+5V DC at 1.2A (max.)

**Compatible Power Supplies**
System Power Supply (Cat. No. 1771-P1)
Auxiliary Power Supply (Cat. No. 1771-P2)
System Power Supply Module (Cat. No. 1772-P1, Series B or later)
Auxiliary Power Supply (Cat. No. 1777-P2, Series B or later)

**Ambient Temperature Rating**
0° to 60°C (operational)
–40° to 85°C (storage)

**Humidity Rating**
5% to 95% (without condensation)

**Keying**
Module slotted for I/O Chassis
Keying Band positioning
Positions 4-6, 22-24

## INTRODUCTION

The Allen-Bradley Data Highway extends Programmable Controller capability beyond control of a single machine or process to interaction as part of a larger integrated manufacturing network. It allows coordinated control between discrete Programmable Controllers, status reporting from independently operating Controllers to a central computer, and data transmission with higher-level communications systems. Its flexible, expandable interfacing allows the Programmable Controller user to optimize machine use and productivity in an automated manufacturing system.

The Allen-Bradley Data Highway allows the interconnection of up to 64 stations, each containing a Programmable Controller or a computer. With its central trunkline cable length of up to 10,000 feet, the Data Highway is designed for ease of user configuration and flexibility suited to individual application needs.

## MODULE FUNCTION

The Communication Adapter Module (Cat. No. 1771-KA) is the Data Highway station interface Module for the following Bulletin 1772 Programmable Controller Processors:

- PLC-2/20 Processor (Cat. No. 1772-LP1)
- PLC-2 Processor (Cat. No. 1772-LR)
- Mini-Processor Module (Cat. No. 1772-LN1, -LN2)

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Supersedes Publication 1771-922 Dated November, 1979

The Communication Adapter Module enables communication of memory data between these Processors and from any of these Processors to a Bulletin 1774 PLC Processor connected through a Communication Adapter Module (Cat. No. 1774-KA) or to a computer connected through a Communication Controller Module (Cat. No. 1771-KC, -KD).

The Data Highway station interface Modules — both Communication Adapter and Communication Controller Modules — have many design features in common. Their interconnection is made with low-cost shielded twinaxial cable. Each of these station interface Modules is transformer-coupled to this Data Highway Cable. This type of communication channel allows high-speed differential mode transmission of data signals between stations with a high level of noise immunity, ideally suited for industrial environments.

Control of this Data Highway Cable communication link is distributed among each station interface Module in a unique Floating Master arrangement. With this feature, mastership is not centered at any one station, but is shared by each Communication Adapter and Communication Controller Module, based on its need to send data. Using this arrangement, disconnection or faulted operation of a station does not disable communication between other operating stations, thus minimizing the need for redundancy in many applications.

## MODULE FEATURES

The Communication Adapter Module has the following features:

- Ease of programming using ladder-diagram instructions
- Memory write protection through programming and/or switch selection
- Communication control without need of a host computer
- Automatic error checking of received data
- Self-checking diagnostics
- LED status and diagnostic indicators
- Control of START/DONE and REMOTE/LOCAL FAULT memory bits as status and diagnostic indicators
- Automatic retries of incomplete or erroneous message transmissions
- Automatic recovery from master station fault condition
- Selectable priority levels for commands
- Downloading/uploading of user program through a host computer
- Compatibility with Industrial Terminal System and current Program Panels
- Ease of installation

## MODULE DESCRIPTION

The Communication Adapter Module contains the option switches, connection sockets, and LED indicators as described below (see Figure 1).

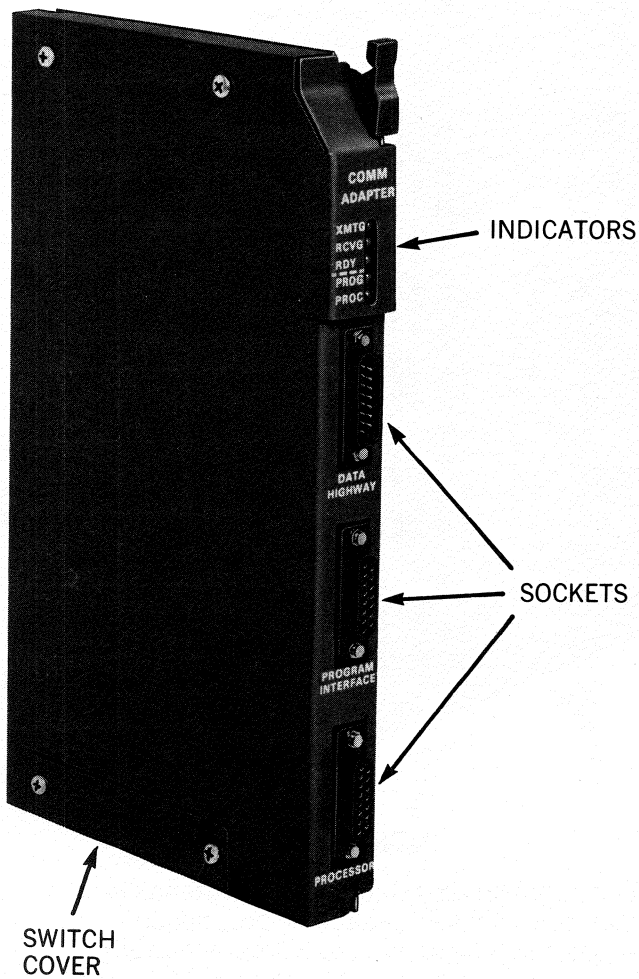



**FIGURE 1 — Communication Adapter Module (Cat. No. 1771-KA)**

### Switches

Rocker switches, accessible beneath a cover plate on the Module, allow user selection of various communication functions and capabilities. (Refer to Figure 2.) Switch-selected options include:

- Command capabilities
- Station No. of the Module
- Data Highway transmission rate (normally 57.6k baud)

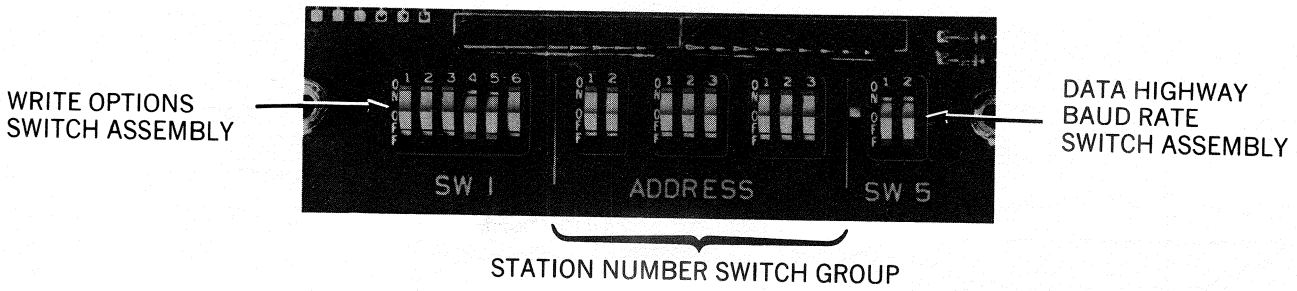



**FIGURE 2 — Module Switch Groups**

### Sockets

There are three socket connectors on the front edge of the Module (see Figure 1). These sockets are labeled:

- DATA HIGHWAY
- PROGRAM INTERFACE
- PROCESSOR

The DATA HIGHWAY socket connects directly to the station dropline of the Data Highway Cable. The PROGRAM INTERFACE socket enables the Module to be connected to a Program Panel or Industrial Terminal through the use of either a Program Panel Interconnect Cable (Cat. No. 1772-TC) or a Data Highway/Processor Cable (Cat. No. 1770-CR). The PROCESSOR socket connects to a PLC-2/20, PLC-2, or Mini-PLC-2 Processor by means of a Data Highway/Processor Cable (Cat. No. 1770-CN, -CO, or -CR).

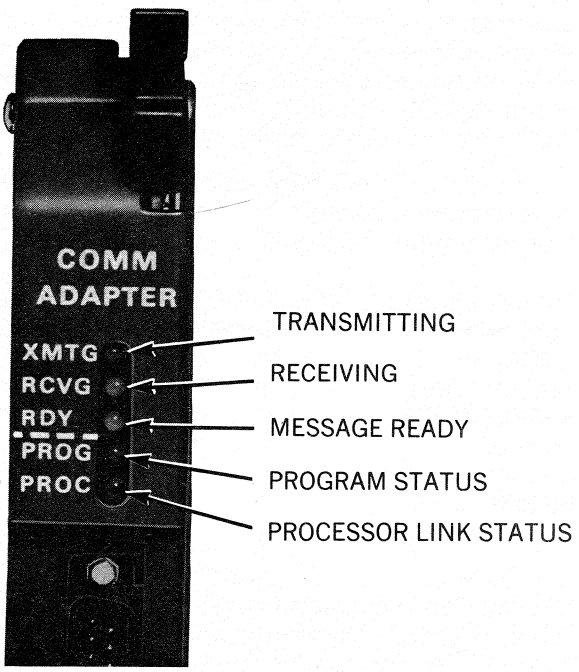



**FIGURE 3 — Module Diagnostic Indicators**

### Indicators

On the front edge of the Module, above the socket connectors, are five LED indicators (see Figure 3). The name and significance of each of these indicators are as follows:

- XMTG — indicates that the Module is transmitting a message over the data highway
- RCVG — indicates that the Module is receiving a message from the data highway
- RDY — indicates that the Module is waiting for mastership of the data highway in order to transmit its stored messages
- PROG — indicates errors in the Communication Zone rungs of user program
- PROC — indicates a fault in the connection between the Module and its local station Processor

## PROGRAMMING

The Communication Adapter Module transfers specific units of data based on user-programmed commands. The following commands can be programmed:

- Protected Write
- Protected Bit Write
- Unprotected Write
- Unprotected Bit Write
- Unprotected Read

Write and Read commands transfer one or more complete Data Table words between the local station Processor (the Processor connected to the sending Communication Adapter Module) and any remote station Processor. Bit Write commands control the ON/OFF status of individual memory bits at a remote station Processor.

The Write, Bit Write, and Read functions of these commands are shown in Figure 4.

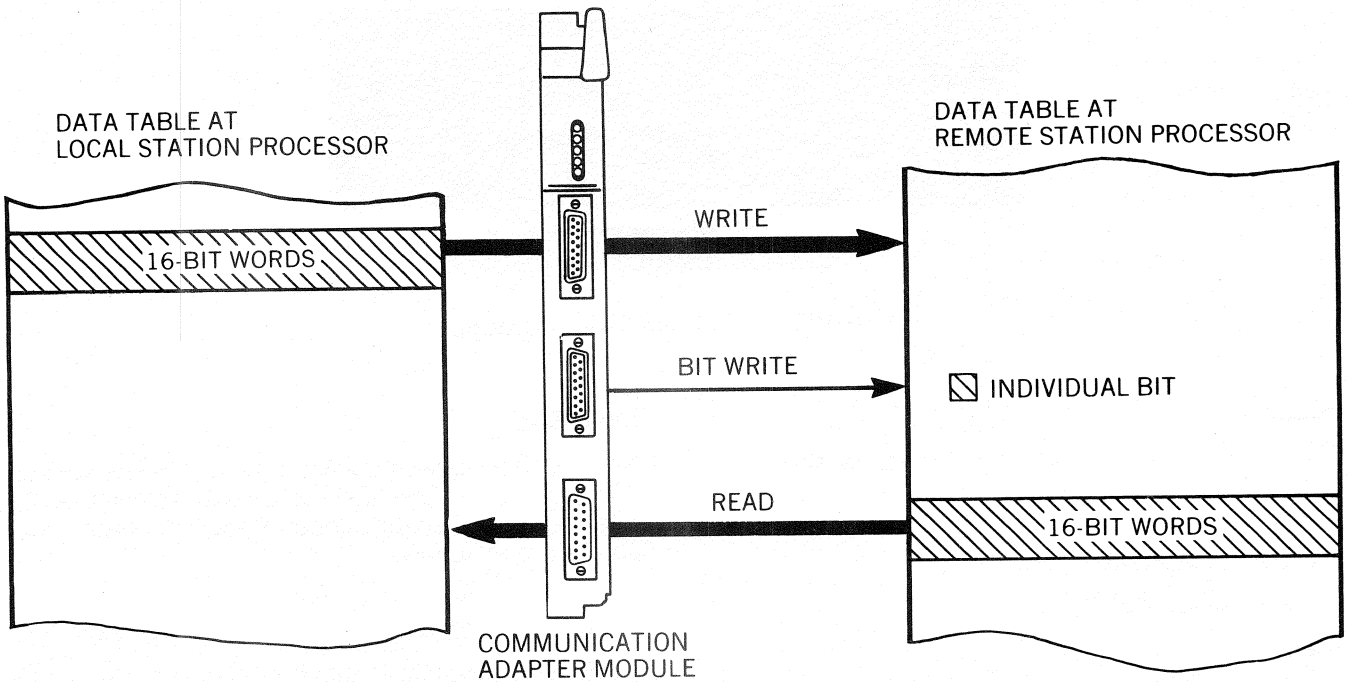



**FIGURE 4 — Module Command Functions**

Commands are programmed in a special area of the program, the Communication Zone, using standard ladder-diagram instructions. In this Zone, a Command rung specifies the command to be executed, the Station No. of the affected remote station, and the Data Table locations which are controlled by the command.

A prefix, "Protected" or "Unprotected", denotes the memory access capabilities of each command. The distinction between these types of commands is as follows:

- Protected — Protected commands are executed only if the receiving station is programmed to receive them. A Memory Access rung, programmed at the receiving station Processor, defines which memory areas in that Processor are accessible to Protected Write or Protected Bit Write commands.
- Unprotected — Unprotected commands are executed whether or not the receiving station is programmed to receive them.

For most Write and Bit Write operations, use of Protected commands is recommended. This type of command provides write protection, which gives the programmer an added degree of control over data transfer into the Data Table of the station Processor. Option switches on the Module provide additional write protection, allowing a hardware-selectable override of programmed Write and Bit Write commands.

The programmer designates a START and DONE bit for each command. To initiate a command operation, the user program manipulates the START bit. When this bit is turned ON, the Communication Adapter Module sends a command message to the remote station Communication Adapter or Communication Controller Module addressed in the command. When this remote station interface Module completes command execution, it sends a reply message back to the initiating Communication Adapter Module. This Module then sets a DONE bit to indicate command completion.

This START/DONE bit manipulation provides the programmer a useful check on command execution for timing and troubleshooting purposes.

By designating a START/DONE bit pair for each command, the programmer also selects a REMOTE/LOCAL FAULT bit pair for indicating faults which prevent message transmission. In addition, an ERROR CODE storage word is selected to aid in start-up and to provide fault diagnostic codes.

### Priority Commands

The programmer can designate selected commands as Priority commands. As the term implies, Priority commands are given special handling: When a station Communication Adapter Module has Priority command messages to transmit, it attains mastership to send these messages ahead of the sequence for normal messages.

## MODULE OPERATION

The Communication Adapter Module both sends and receives command and reply messages as it interacts with Communication Adapter and Communication Controller Modules at other stations. Central to the interaction of these station interface Modules is the concept of shared mastership — the Floating Master. With this arrangement, no single station is permanent master, controlling the data highway communication link at all times. Instead, each station bids for mastership, based on its need to send command or reply messages.

To transfer mastership between stations, an orderly polling scheme is used. This scheme gives preference to stations which are waiting to transmit Priority messages. After Priority messages are transmitted, polling then rotates mastership among stations with normal messages to transmit.

The advantage of Floating Master operation is that no single station disables communication on the data highway, as long as other stations continue to operate. This means that even with disconnection or faulted operation of a Communication Adapter or Communication Controller Module, or fault or disconnection of a Programmable Controller Processor, communication between other operating station interface Modules continues. This minimizes the need for redundancy in many applications.

Each Communication Adapter Module monitors the data highway communication link for normal Floating Master operation. Should a faulted condition prevent normal transfer of mastership, data highway operation is temporarily suspended with each station interface Module disconnecting itself and checking its own transmitting circuitry. After this check is completed, the faulted station interface Module remains disconnected from the data highway and normal communication is resumed.

In addition to this communication link monitoring, the Communication Adapter Module also checks all received messages for errors. This automatic error checking, transparent to user programming, checks the data frame of each received command or reply message. This error check minimizes the effect of errors due to noise which could be induced from the industrial environment.

The sending Communication Adapter Module checks for an acknowledgment from each receiving station immediately after it sends a message. Should message errors be detected or the intended Module be unable to receive the transmitted message, a negative acknowledgment, or no acknowledgment received by the sending station indicates some transmission fault. In this case, the sending Communication Adapter Module retries transmitting the message. The Communication Adapter Module (Cat. No. 1771-KA) attempts 3 retries of any command or reply message.

Should retries prove unsuccessful in transferring a message between stations, the sending Communication Adapter Module sets a diagnostic REMOTE or LOCAL FAULT bit. When one of these bits is set, some hardware fault — cable disconnection or faulted Module operation — is assumed. The programmer can use these bits to control an operator alarm or signal to indicate this type of condition.

## STATION CONFIGURATION

The Communication Adapter Module (Cat. No. 1771-KA) and its connected Bulletin 1772 PLC-2/20, PLC-2, or Mini-PLC-2 Processor make up a data highway station. Figure 5 shows the configuration for a station using the PLC-2/20 or PLC-2 Processor. Figure 6 shows the configuration for a station using the Mini-Processor Module.

As these Figures show, the Communication Adapter Module is mounted in a single Bulletin 1771 I/O Chassis slot. Power is supplied to the Module by the Power Supply to this I/O Chassis.

Additional equipment used for station set-up is:

- Data Highway/Processor Cable
- Data Highway Cable

The Data Highway/Processor Cable connects the lower socket of the Communication Adapter Module to the station Processor or Mini-Processor Module. It is available in 3 lengths:

- 1.5 ft. (Cat. No. 1771-CN)
- 3.5 ft. (Cat. No. 1771-CO)
- 10.5 ft. (Cat. No. 1771-CR)

Cables and cabling hardware are not supplied with the Module, but must be ordered separately.

### Cabling Hardware

The Data Highway Cable has 2 parts: a trunkline and droplines. The central transmission cable which links all stations together is termed the trunkline. At each station, a dropline connects a Communication Adapter or Communication Controller Module to the trunkline. Both trunkline and dropline segments of the Data Highway Cable are assembled by the user to fit his configuration of data highway stations.

The user constructs this cable using the following hardware:

- Twinaxial Cable (Cat. No. 1770-CD)
- Connector Kit (Cat. No. 1770-XG)
- Terminator Set (Cat. No. 1770-XF)

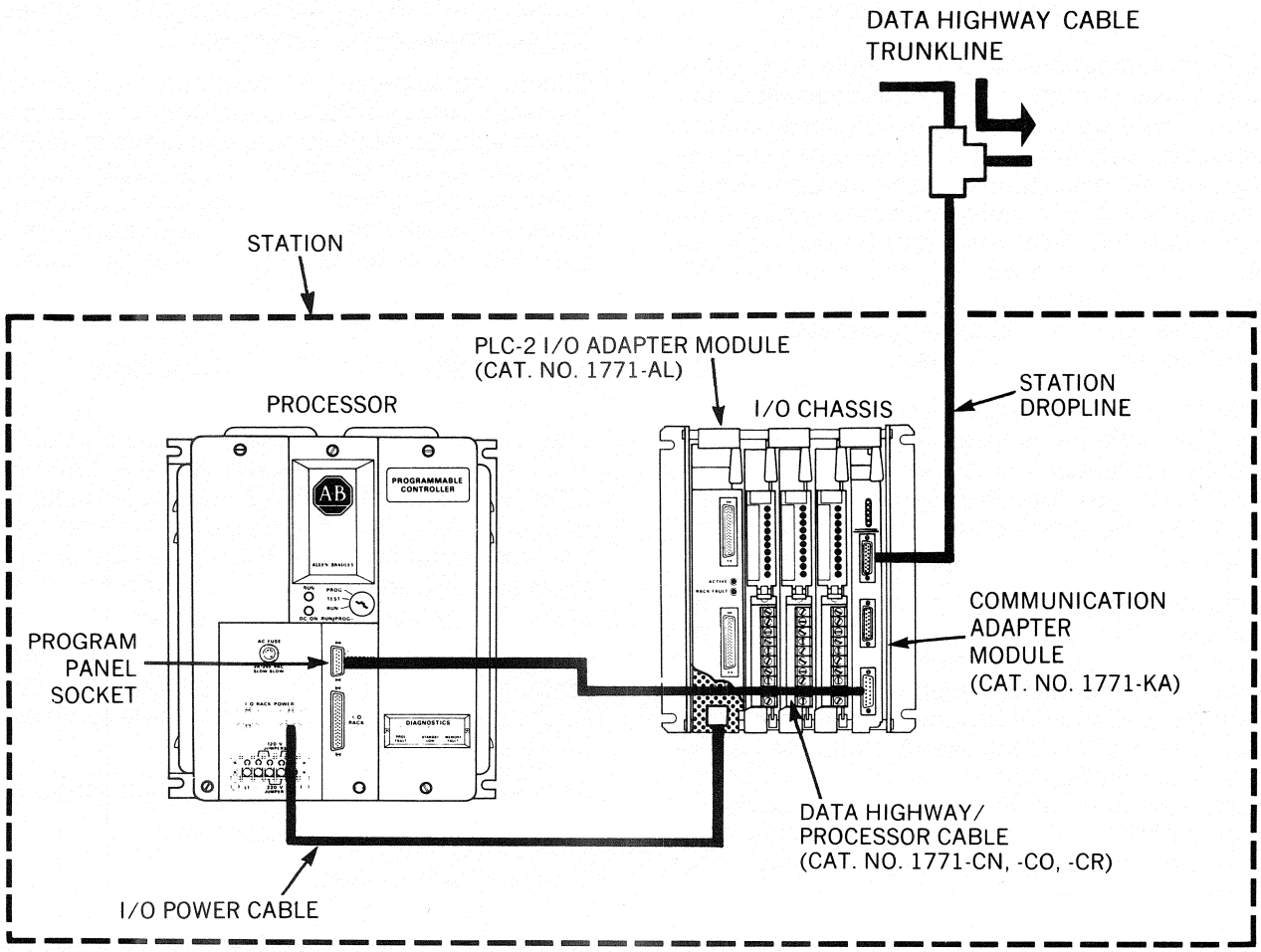



**FIGURE 5 — Typical Station Configuration-PLC-2/20 and PLC-2 Processors**

The Twinaxial Cable consists of a shielded twisted pair of conductors. Belden No. 9463 cable can be used. The Connector Kit provides junction connection hardware to connect dropline and trunkline segments of this cable. This Kit also includes the plug connector for the Communication Adapter Module socket. The Terminator Set provides a pair of terminating resistors for the extreme ends of the trunkline.

**Installation**

The procedures for station installation are relatively straightforward. For the Communication Adapter Module (Cat. No. 1771-KA) there are four steps:

- Installation of dropline and trunkline cable
- Setting of Module rocker switches
- Insertion of the Module into the I/O Chassis
- Connection of the dropline and Data Highway Processor Cable to the Module

The assembly and installation of the Data Highway Cable is outlined in Publication 1770-810, and the installation of the Module itself is described in Publication 1771-801.

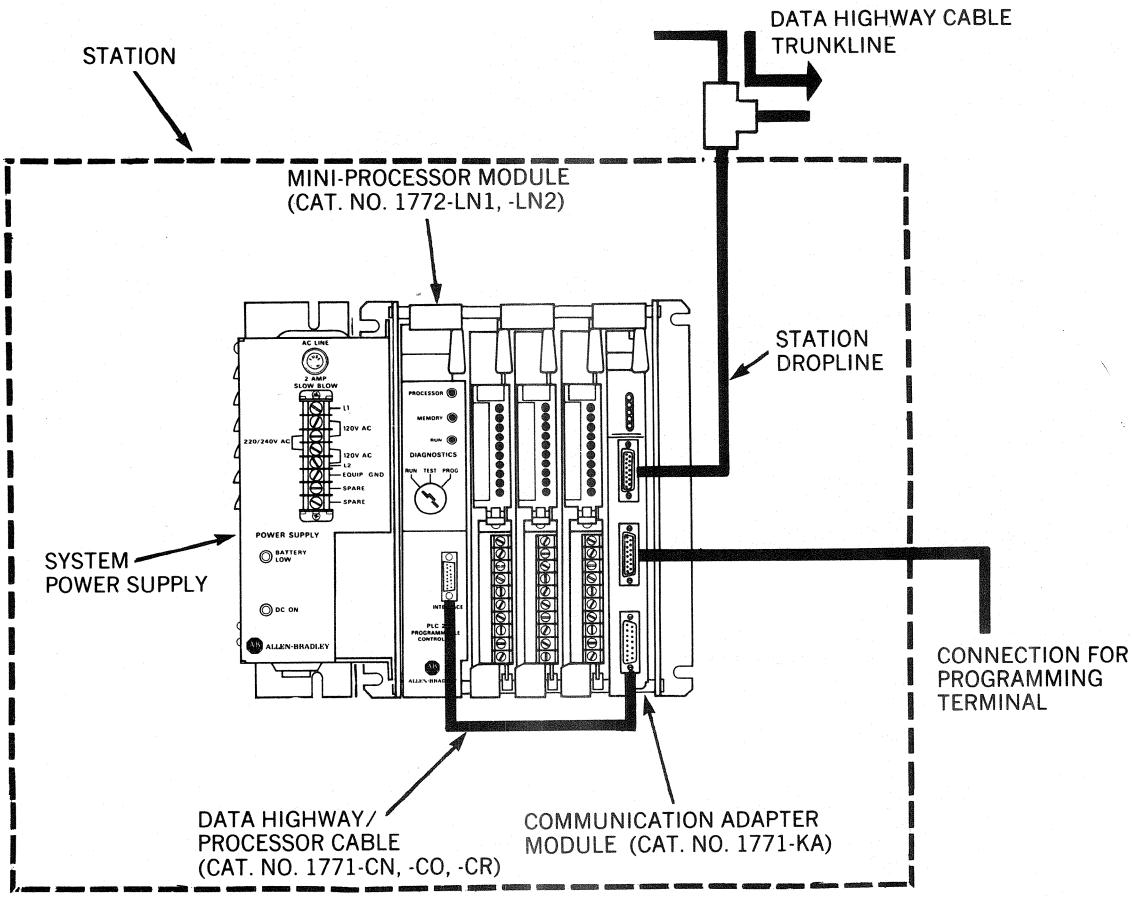



**FIGURE 6 — Typical Station Configuration-Mini-PLC-2 Controller**

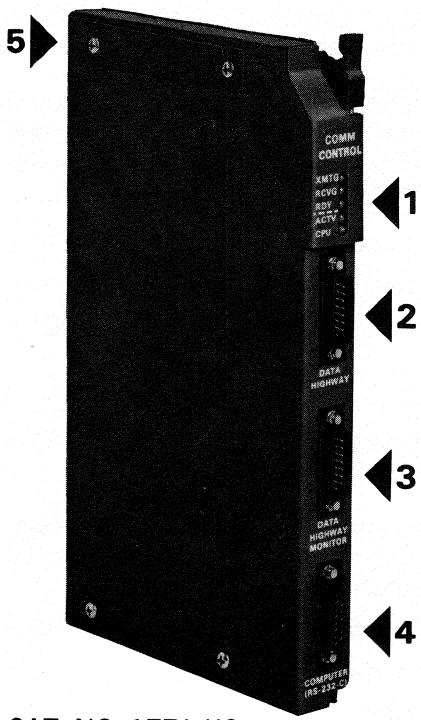



ALLEN-BRADLEY
Cleveland, Ohio 44143



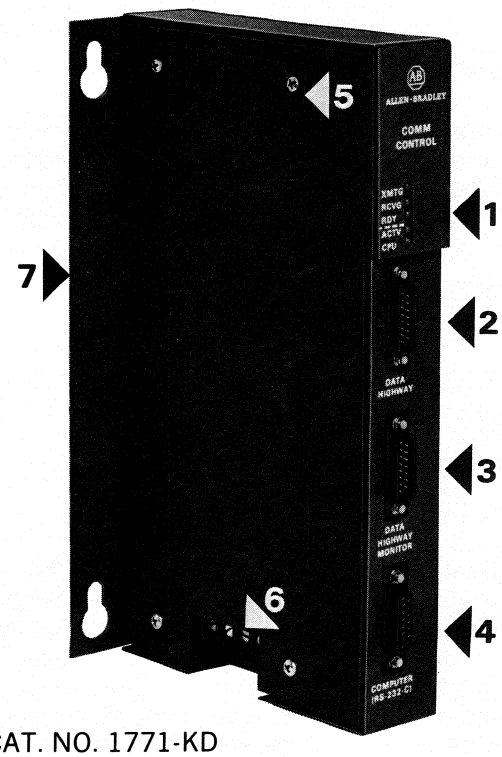

P/N 635478-60

# COMMUNICATION CONTROLLER MODULE
## (Cat. Nos. 1771-KC and 1771-KD)




CAT. NO. 1771-KC

1. Diagnostic indicators
2. DATA HIGHWAY socket
3. DATA HIGHWAY MONITOR socket
4. COMPUTER socket
5. Option Switches Cover Plate
6. Terminal Barrier Strip
7. Mounting Bracket




CAT. NO. 1771-KD

## SPECIFICATIONS

**Function**
Interfaces RS-232-C compatible Mini/Microcomputer device with Allen-Bradley Data Highway

**Location** [1]
Cat. No. 1771-KC: 1771 I/O Chassis
Cat. No. 1771-KD: industrial enclosure

**Communication Channels**
Two: One to Data Highway, one to RS-232-C Type D device

**Communication Rate**
RS-232-C Link: Switch-selectable 1.2k, 2.4k, 4.8k, or 9.6k baud;
Data Highway: 57.6k baud

**Maximum Cable Length**
To Computer: 50 feet [1]
Dropline to Highway: 100 feet
Data Highway trunkline: 10,000 feet

**Cable Type**
Highway Trunkline and Dropline: Belden 9463, or equivalent
To Computer: EIA Adapater Cable, Cat. No. 1770-CE

**Power Requirement**
1.2A @ 5V DC

**Power Source**
Cat. No. 1771-KC: 1771 I/O Rack Power Supply
Cat. No. 1771-KD: user supplied [2]

**Ambient Temperature Rating**
0° to 60°C (operating)

**Ambient Humidity Rating**
5 to 95%
(without condensation)

[1] Refer to "Location" in text.
[2] May be Allen-Bradley Power Supply. See "Location."

## INTRODUCTION

Note: The two Communication Controller Modules, Cat. Nos. 1771-KC and 1771-KD, function identically, differing only in the way they are installed and connected to a power supply. Therefore, except when these differences are being discussed, they will be referred to collectively as Cat. No. 1771-KC/KD.

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Publication 1771-923 — June, 1980

The Allen-Bradley Data Highway is a high-speed multi-point communications network that provides a data transfer path for up to 64 Programmable Controllers and mini/microcomputers. The Highway trunkline may be up to 10,000 feet in length with the communicating stations distributed anywhere along its length, allowing for a flexible systems configuration.

The communicating devices are connected to the Data Highway by droplines, which may be up to 100 feet in length each. The trunkline and droplines are low-cost shielded twinaxial cable.

Each Highway Station requires its own communication interface module. The Communication Adapter Module Cat. No. 1771-KA interfaces PLC-2, PLC-2/20 and Mini-PLC-2 Programmable Controllers to the Highway; Communication Adapter Module Cat. No. 1774-KA is used to interface PLC Programmable Controllers.

The Communication Controller Module (Cat. No. 1771-KC/KD) is used to interface a user's RS-232-C (Type D) compatible mini/microcomputer device to the Allen-Bradley Data Highway. Although a computer is not needed to control the Data Highway, which features a Floating Master, it allows greater access to the other Highway Stations. As the interface to the Data Highway, the Communication Controller Module enables a user's computer to:

- Access the Data Table and User Program of any Highway Programmable Controller
- Download or upload a program to or from any Highway Programmable Controller
- Maintain within its mass storage device master copies of each Highway Programmable Controller program.
- Verify Highway Programmable Controller programs by uploading and comparing with the master copy.
- Obtain Status information from all Highway Programmable Controllers and Communication Interface Modules, including its own 1771-KC/KD
- Generate Reports based on data received from any or all Highway Programmable Controllers
- Control the state of outputs for a Bulletin 1774 PLC connected to the Highway while loading a program into that Processor
- Access RAM (Random Access Memory) areas of all Highway communication interface modules

## DESCRIPTION

### Communications Channels

The Communication Controller Module is the intermediary for all command and reply messages transmitted between the user's computer and the other Highway Stations. In that capacity it operates through two different communication channels -- one to the computer, one to the Data Highway.

The transmission channel between the Module and the user's computer is for two-way simultaneous communication with an RS-232-C compatible device. This link employs:

- Differential, optically isolated transmission
- Asynchronous serial transmission
- Switch-selectable rate of 1200, 2400, 4800, or 9600 baud
- Full duplex
- Byte-oriented protocol based on D1 and F1 of ANSI Publication X3.28-1976.

Transmissions between the Module and other Highway Stations take place over a single twinaxial cable. This link features:

- Differential, transformer-isolated transmission
- Synchronous serial transmission
- 57,600 baud rate
- Half duplex
- Bit-oriented protocol

### Indicators

The Communication Controller Module has 5 LED status indicators located on its top front edge. The indicators are designed to aid the user in diagnosing transmission faults or errors. These indicators are:

- XMTG (Transmitting)
- RCVG (Receiving)
- RDY (Message Ready)
- ACTV (Computer Link Active)
- CPU (Computer Communication Error)

Refer to Figure 1.

In general, an ON condition for any of the top 3 LEDs signals the indicated situation exists for transmissions with the Data Highway. That is, the Module is either Transmitting a message to or Receiving a message from another Station, or has a message stored and Ready to send to another Station as soon as it receives mastership of the Highway. If both the XMTG and RCVG lights are ON,

the Module is in the process of polling the other Stations in order to transfer mastership as needed. (See "Operation.")

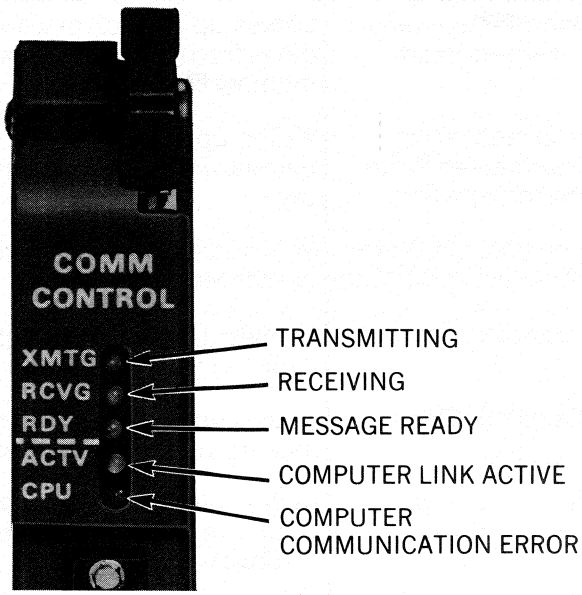



**FIGURE 1 — Status Indicators**

The bottom two indicators give the status of the communication link to the computer. When ON the ACTV light indicates the cable between the Module and its computer is properly connected and able to transmit messages. When this light flickers it indicates the cable is properly connected and transmission across the link is in progress.

The CPU light is normally OFF. It will come ON for about 1/2 second each time an error occurs in a message transmitted between the Module and its computer.

**Switches**

The Communication Controller Module has a number of options which are user-selected by setting rocker switches on the Module circuit board. These switches are easily accessed by removing the small switch cover plate on the side of the Module. (See Figure 2.)

With the first set of switches the user determines which Diagnostic Commands the Module will execute. For this determination, distinctions can be made between commands received from its connected computer and those received from a remote station computer (if more than one is used on the Highway), and between read-type and write-type Diagnostic Commands.

Other sets of rocker switches allow the user to select the Module's station identification number (used in message formats), and the baud rates for Data Highway transmissions (currently only 57,600 baud is recommended) and computer link transmissions.

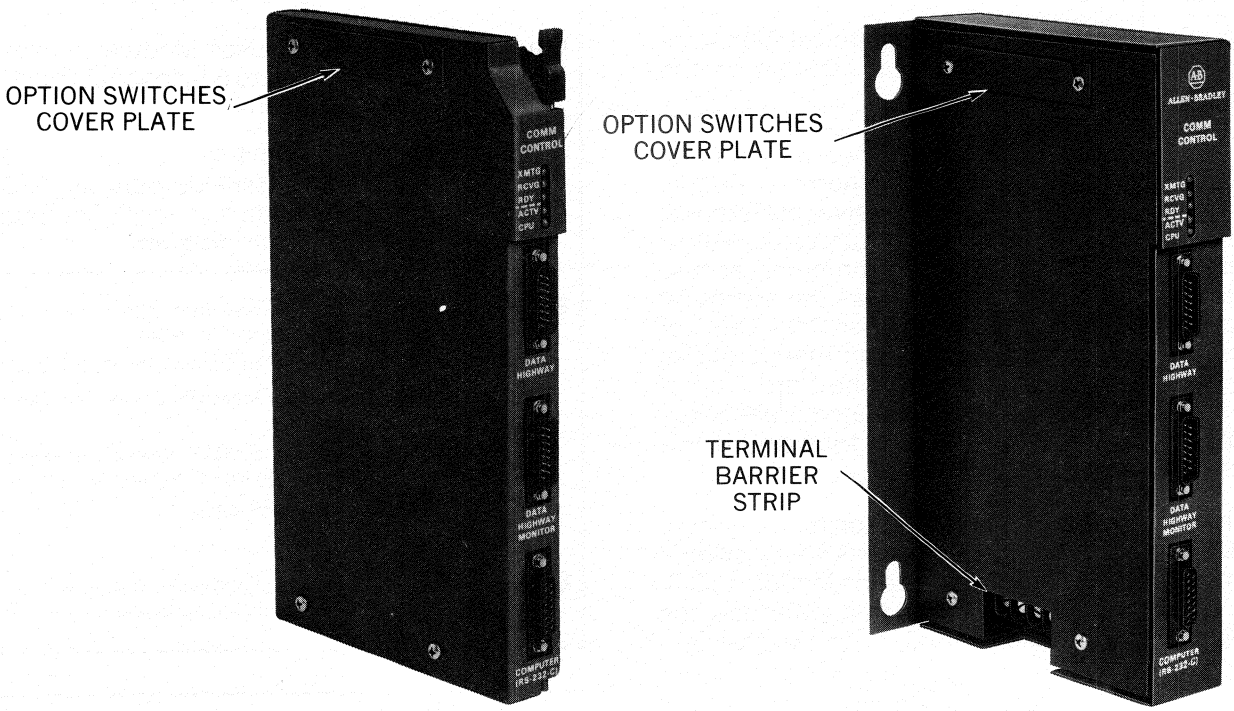



**FIGURE 2 — Switch Cover Plate**

## OPERATION

All messages sent from the computer for transmission on the Data Highway must conform to the ANSI DF1 Protocol as detailed in the Communication Controller Module User's Manual, Publication 1771-802.[1] Only messages conforming to that format will be acknowledged by the Module. Communications across this computer-Module link employ the following features:

- Retries of unacknowledged messages
- Acknowledgment of received messages
- Error checking of received messages
- Message-associated blocking format
- Message blocks up to 250 characters

Once a message transmitted from the computer is accepted by the Communication Controller Module, the message is reformatted for transmission on the Highway. This reformatting is completely transparent to the user. As with the other Communication Interface Modules, this Module has the following features for transmissions on the Data Highway:

- Retries of unacknowledged messages
- Acknowledgment of received messages
- Error checking of received messages
- Automatic recovery from a faulted current master station
- Automatic disconnect of a faulted station without disabling the remaining stations on the Data Highway

The user may determine whether a particular message is to be sent "priority" or "normal." Priority messages, as noted below, receive preferential treatment. Additionally, the user may select from 3 different Programmable Controller memory access levels. One set of commands allows the computer to access any part of the Processor Data Table or User Program. Another set of commands allows access only to the Data Table. The third type of command limits access to designated areas of the Data Table, selected by the user through his PC programming.

Further protection of PC Processor memory contents is provided by communications option switches on the Communication Adapter Modules (Cat. Nos. 1771-KA and 1774-KA) that interface the various Programmable Controllers to the Data Highway.

Refer to Table A for a complete list of commands that can be sent by a computer on the Data Highway.

**TABLE A — Computer-Initiated Commands on Data Highway**

| COMMAND [1] | FUNCTION |
|---|---|
| Unprotected Read<br>Privileged Read | Copies up to 245 bytes of data from PC Processor memory [2] |
| Protected Write<br>Unprotected Write<br>Privileged Write | Writes up to 243 bytes of data into PC Processor Memory |
| Protected Bit Write<br>Unprotected Bit Write | Sets/resets bits in PC Processor Memory |
| Diagnostic Loop | Echoes transmitted data back in reply message |
| Diagnostic Read | Copies up to 245 bytes of data from Module memory |
| Diagnostic Input | Reads Module input port values (e.g., option switch settings) |
| Diagnostic Status | Allows access to 28 bytes of PC Processor and Module status information |
| Diagnostic Write | Writes up to 242 bytes of data into Module memory |
| Diagnostic Output | Writes specified data into Module output port |
| Diagnostic Execute | Causes Module to execute up to 6 bytes of Z80 instructions |
| Output Control | Can turn Bulletin 1774 Processor outputs all OFF, or return control of outputs to user program |

[1] "Protected" Commands: Access limited to sections of Processor Data Table allowed by user program.

"Unprotected" Commands: Can access Processor Data Table.

"Privileged" Commands: Can access Processor Data Table and User Program.

"Diagnostic" Commands: Access RAM areas of message destination station Communication Interface Module.

All Commands have Reply messages.

"Byte" is an 8-bit byte.

[2] The total message may be up to 250 bytes. The number of bytes available for "data" depends on the particular command.

[1] For users interfacing a PDP-11 series computer with the RSX-11M operating system, software support is available from Allen-Bradley. (PDP and RSX are trademarks of Digital Equipment Corporation.)

### Floating Master

The Communication Controller Module shares with the other communication interface modules control of the Data Highway through the Floating Master feature, where each station bids for mastership based on its need to send messages. The transfer of messages among stations is done in an orderly polling process, where preference is given to Stations waiting to transmit user-determined Priority messages. After all Priority messages have been sent, mastership rotates among all Stations having normal messages to transmit.

A major benefit of the Floating Master is that no single Station is capable of disabling communications on the Data Highway, thus minimizing the need for redundancy in many applications.

Each communication interface module monitors all messages transmitted on the Data Highway in order to detect a faulted current master station that is preventing normal Floating Master operation. If a faulted operation is detected, each communication interface module momentarily disconnects itself from the Highway. All except the faulted station then reconnect themselves to the Highway, and normal communicatons are resumed.

### Message Error Detection

To help assure transmission integrity, the Communication Controller Module performs an error check on all messages it receives, both from the computer and from another Station. Messages with errors are automatically retransmitted. Originally there are 3 tries for messages on the Data Highway link and 10 on the computer link. The number of retries can be changed by the user through Diagnostic Write commands. (Note: The user determines retry conditions for messages sent by the computer to the Module.)

If retries are unsuccessful in completing communications, a fault flag bit is set to indicate why the error occurred. The fault flag may indicate a LOCAL error, that is, at the Module itself or a REMOTE error. Following is a list of REMOTE errors presently coded:

- Illegal command or command size
- Load/dump already in progress
- Interfaced device disconnected from interface module
- Interfaced device/interface module communication error
- "Privileged" command violation
- Requested function disallowed by option switches
- Processor in PROGRAM mode

The status of the fault bits is contained in every reply message, and therefore may be easily monitored by the computer to signal the faulted condition.

## INSTALLATION

A Highway Station consists of a communication interface module and the Programmable Controller or computer device it is interfacing to the Data Highway. Refer to Figure 3 for station configurations using the Communication Controller Module (Cat. No. 1771-KC/KD).

Installation of the Module into the Data Highway consists of 3 steps:

- Determining Module Location
- Connecting dropline to Module and Highway trunkline
- Connecting EIA Adapter Cable (Cat. No. 1770-CE)

Refer to Table B for a list of cabling parts. Items on this list are not included with the Module and must be ordered separately.

### Location

In order to give the user more flexibility in linking a computer to the Data Highway, two different Communication Controller Modules are available. Either Module must be located within 50 feet of the RS-232-C port of the computer, unless a line driver/receiver system is used to amplify the transmission signals, in which case the distance may be up to 10,000 feet.

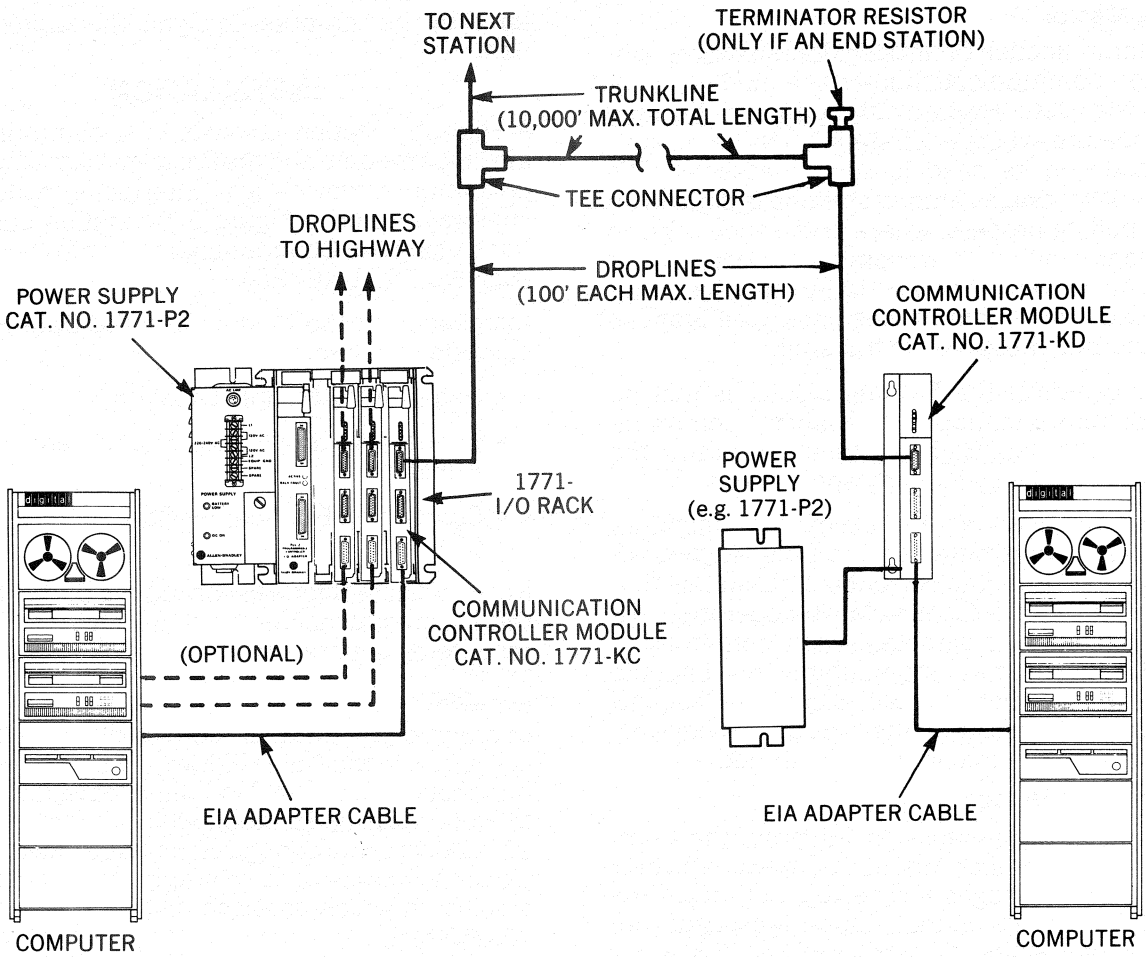
The Cat. No. 1771-KC Module must be mounted in any except the first slot of a Bulletin 1771 I/O Rack. (More than one 1771-KC may be mounted in one I/O chassis.) The first slot must contain either an I/O Adapter Module (Cat. No. 1771-AL, -AR) or a Mini-PLC-2 Processor Module (Cat. No. 1772-LN1, -LN2) in order to provide the proper combination of signals from the backplane to the 1771-KC. The 5V DC power required to drive the Module is obtained from the backplane of the I/O chassis. No further power hook-up is required.

Once the user has designated a specific slot for this Module, care should be taken so no other type of module is mistakenly inserted into that slot. For this purpose it is strongly recommended that the plastic keying bands, supplied with every I/O Rack, be used.

The Module has two slots in its rear edge. Positioning the keying bands to align with these slots will allow insertion of this type of Module only. A series of numbers is printed on the upper backplane of the I/O Rack. For this Module, the keying bands should be positioned:

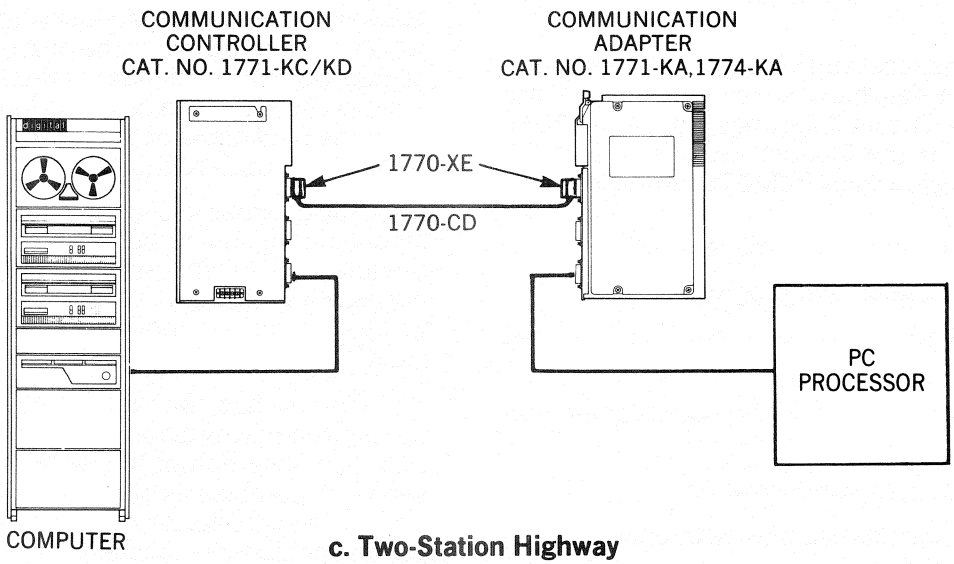
- Between 6 and 8
- Between 12 and 14

Refer to Figure 4.




**a. Using Cat. No. 1771-KC**

**b. Using Cat. No. 1771-KD**




**c. Two-Station Highway**

**FIGURE 3 — Computer Station Configurations (Typical)**

**TABLE B — Cabling Parts List**

| Product | Allen-Bradley Catalog No. | Part | Manufacturer | Manufacturer Part Number |
|---|---|---|---|---|
| Twinaxial Cable | 1770-CD | trunkline and dropline cable | Belden [1] | 9463 |
| Connector Kit | 1770-XG | tee connector | Trompeter [2] | BN 73 |
| | | jack connector | Trompeter [2] | BJ79-9 |
| | | plug connector | Trompeter [2] | PL75-9 |
| | | 15-pin female connector with hood | Cannon [3] | DA-15S DA-51211-1 |
| EIA Adapter Cable | 1770-CE | Module-to-Computer cable | Allen-Bradley | |
| Terminator Set [for end stations only] | 1770-XF | jack terminator | Trompeter [2] | 3005-0404-1-150 |
| | | plug terminator | Trompeter [2] | TNGI-1-150 |
| 15-Pin Connector Kit [2 Station configuration only] | 1770-XE | 15-pin female connector with hood | Cannon [3] | DA-15S DA-51211-1 |

[1] Belden Corporation
P.O. Box 1331
Richmond, Indiana 47374
(317) 966-6661

[2] Trompeter Electronics, Inc.
8936 Comanche Avenue
Chatsworth, California 91311
(213) 882-1020

[3] ITT Cannon Electric
A Division of International Telephone and Telegraph Corporation
666 East Dyer Road
Santa Ana, California 92702

Long-nose pliers may be used to insert or remove keying bands. The position of the bands may be changed if subsequent system design changes make insertion of a different type of module necessary.

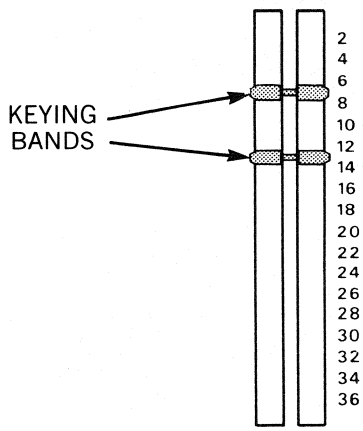



**FIGURE 4 — 1771-KC Keying Diagram**

The Stand-Alone Communication Controller Module, Cat. No. 1771-KD, has a bracket attached to its rear edge to allow for user-selected mounting in any appropriate industrial enclosure (NEMA type 12, or similar). When the Cat. No. 1771-KD Module is selected, the user must provide the 5V DC power necessary to drive the unit. This may be an Allen-Bradley Power Supply, such as the Cat. No. 1771-P2, or other. The electrical connections are made to an easily accessible terminal strip on the side of the Module. (Refer to Figure 2.)

## Dropline

Linking the Module to the Data Highway is done in two stages. First, using up to 100 feet of twinaxial cable (Cat. No. 1770-CD) the dropline is joined to the Highway trunkline using the tee connector provided in the Connector Kit (Cat. No. 1770-XG).

Second, the other end of the dropline is attached to the 15-pin connector, also provided in the Connector Kit, which is then inserted into the DATA HIGHWAY socket on the Module. (See Figure 5.)

If the Data Highway consists of only two Stations, a more direct connection may be made by using two 15-pin Connector Kits (Cat. No. 1770-XE) and the appropriate length of twinaxial cable. (Refer to Figure 3c.)

**EIA Adapter Cable**

The last step to installing the computer Station to the Data Highway is to connect the EIA Adapter Cable (Cat. No. 1770-CE). This cable is 3.5 feet long, with a 15-pin connector at one end and a standard RS-232-C compatible 25-pin female connector at the other. The 15-pin connector should be inserted into the COMPUTER socket on the Module; the 25-pin connector should be connected to the RS-232-C port of the computer, or to a cable that connects to that port.

Note: The middle socket on the front of the Module, labeled DATA HIGHWAY MONITOR, is presently reserved for future product use. Connections should not be made at this socket.

Complete installation information, as well as detailed information about other material covered in this Publication, are included in Data Highway Cable Installation and Assembly Manual, Publication 1770-810, or Communication Controller Module User's Manual, Publication 1771-802.

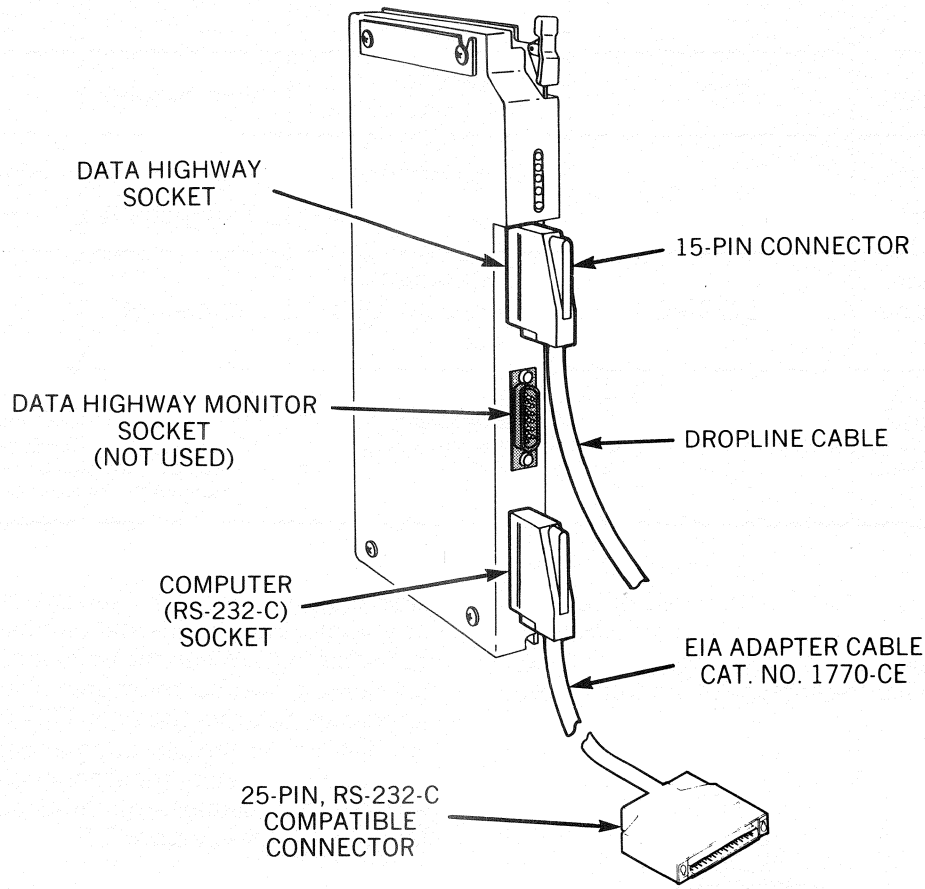
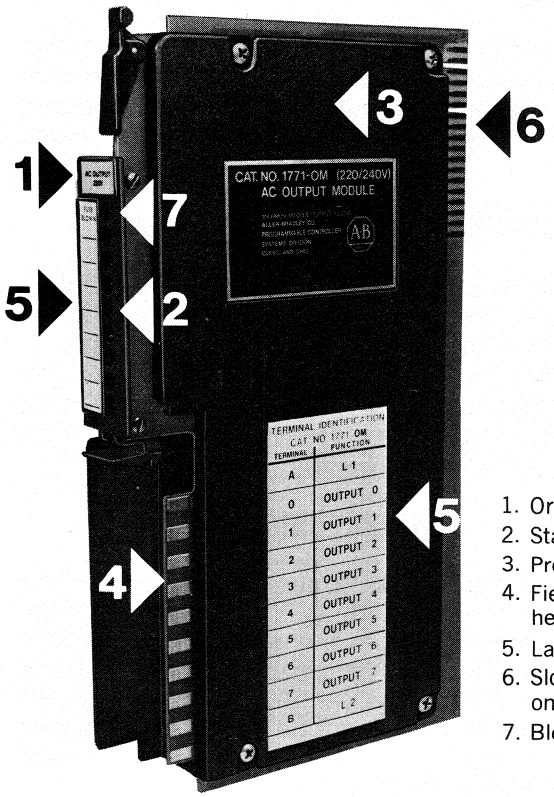



**FIGURE 5 — 1771-KC/KD Cable Connections**

# AC (220/240V) OUTPUT MODULE

## Cat. No. 1771-OM




1. Orange identification label
2. Status indicators
3. Protective cover
4. Field Wiring Arm connects here
5. Labels identify user outputs
6. Slotted for I/O slot insertion only
7. Blown fuse indicator

### DESCRIPTION

The AC (220/240V) Output Module (Cat. No. 1771-OM) provides 8 fused outputs for switching 220/240V AC to user devices. Using this Module, such output devices as solenoids, motor starters, and other 220/240V AC equipment can be controlled by the programmable controller Processor. As a unit of Bulletin 1771 I/O Equipment, the AC (220/240V) Output Module can be used with PLC-2, PLC-2/20, Mini-PLC-2, or Remote I/O PLC Programmable Controllers employing Bulletin 1771 I/O Racks.

In operation, the AC (220/240V) Output Module switches externally-provided power based upon user program instructions. The following instructions control the ON/OFF status of output devices:

- OUTPUT ENERGIZE
- OUTPUT DE-ENERGIZE [1]
- OUTPUT LATCH (Retentive)
- OUTPUT UNLATCH (Retentive)
- PUT

[1] OUTPUT DE-ENERGIZE instruction available with Bulletin 1774 PLC Processor only.

### SPECIFICATIONS

**Outputs per Module**
8

**Module Location**
I/O Chassis

**Nominal Output Voltage**
230V AC (50/60 Hz)

**Output Voltage Range**
184 to 276V AC

**Output Current Rating**
2A (max.) per output
(not to exceed 6A per Module)

**Surge Current**
20A (max.) for 100 ms;
Repeatable after 10 sec.
(Fuse-limited)

**Minimum Load Current** [1]
60 mA

**ON-State Voltage Drop**
2V AC (max.) at 100 mA

**OFF-State Leakage Current**
5 mA (max.) per output

**Power Supply Current Requirement** [2]
225 mA @ 5V DC per Module

**Electrical-Optical Isolation**
1500V RMS
Isolation is between logic and output circuitry.

**Ambient Temperature Rating**
0° to 60°C (operational)
—40° to 85°C (storage)

**Humidity Rating**
5 to 95%
(without condensation)

**Wire Size**
14 ga. stranded (max.)
3/64" insulation (max.)

**Keying**
Modules are slotted for placement in I/O slots only

**Fuses**
5A
Bussmann MTH5
Littelfuse 312005

[1] Applies to reactive and resistive loads.

[2] Refer to POWER SUPPLY REQUIREMENTS.

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Publication 1771-925 — April, 1980

## OUTPUT CIRCUITRY

The AC (220/240V) Output Module provides 8 triac outputs, each rated to drive a maximum of 2.0 amperes at 220/240V AC. However, the total maximum continuous output current per Module is 6.0 amperes.

Each Module output is fused for overload protection of the driving circuitry. Output fuses are rated for 5 amperes at 220/240V AC. Module fuses are easily accessed by removal of the front component-side cover.

In each output circuit, optical-electrical isolation separates the Module's logic circuitry from its power output circuitry to help guard against the possibility of damage to logic-level circuitry from user voltage levels or high-voltage transients along the user's line. Module optical-electrical isolation is rated at 1500V RMS.

Due to triac and capacitor characteristics, Module outputs have a small leakage current in the OFF state. The maximum OFF-state leakage current per output is 5mA. Thus, some voltage - less than 12V AC for 100 mA resistive loads-appears across the output in the OFF state.

## STATUS INDICATORS

On the front of the AC (220/240V) Output Module are 9 neon lamp status indicators.(Refer to Figure 1). The top indicator, labeled FUSE BLOWN, illuminates when any output fuse in the Module has blown. Module circuitry monitors and signals fuse blown condition as long as line power (L1, L2) is supplied to the Field Wiring Arm. (The controller need not be in RUN mode for this indicator to function.)

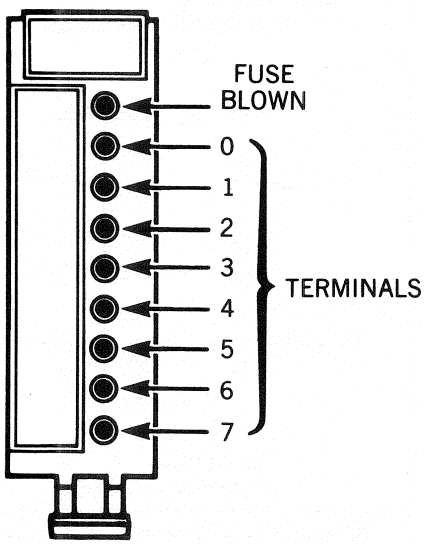



**FIGURE 1 — Status Indicators**

Each of the lower 8 indicators corresponds to a single Module output terminal. When an output terminal is ON, the corresponding status indicator illuminates. Note that an output terminal need **not** be connected to a load in order for its status indicator to illuminate.

These status indicators provide a useful troubleshooting aid. By comparing these indicators with their corresponding output devices, an operator can quickly isolate many types of hardware-related faults.

## POWER SUPPLY REQUIREMENT

The logic circuitry of the AC/DC (220/240V) Output Module is powered by the Power Supply which connects to the I/O Chassis backplane. This may be a PLC, PLC-2, PLC-2/20 or Mini-PLC-2 Programmable Controller Power Supply. The Module requires a maximum current of 225 mA from the +5V DC output of this Supply.

## SUPPRESSION

Surge suppression circuitry is provided for the output triacs of the Module. To help suppress high-voltage transients from the user AC line, an MOV (metal-oxide varistor) is provided between L1 and L2 on the Module. In each output circuit an RC network limits the magnitude of voltage transients which may occur when a device is wired in parallel or in series with hard contacts.

Loads with inductive characteristics may require additional suppression devices. Note that the impedance characteristic of the load is the most important factor in selecting a suppression device. Thus, no single suppression device can be recommended for every possible Module load. However, acceptable suppression devices for most typical Module loads are listed in Table A.

**TABLE A — Acceptable Suppression Devices [1]**

| ELECTRO CUBE P/N [2] | RATING |
|---|---|
| RG 1676-4<br>RG 1676-5<br>RG 1676-9 | ≥1 A |
| RG 1676-15<br>RG 1676-17 | <1 A |

[1] Equivalents also acceptable

[2] Electro Cube, Inc.
1710 South Delmar Avenue
San Gabriel, CA 91776

When using other Allen-Bradley Industrial Control products, optional surge suppressors can be ordered, as shown in Table B.

**TABLE B — Surge Suppressors for Allen-Bradley 220/240V AC Equipment**

| ALLEN-BRADLEY EQUIPMENT | SUPPRESSOR CAT. NO. |
|---|---|
| Motor Starter Bulletin 709 Series | 1401-NX1 |
| Relay Bulletin 700N | 700-NX 1 |

## CONNECTIONS

**CAUTION:** Module must **not** be removed from or inserted into the Bulletin 1771 I/O Chassis while system power is ON. Failure to observe this rule may result in damage to Module circuitry.

User devices are connected to a Field Wiring Arm (Cat. No. 1771-WA) which is a removable part of the Bulletin 1771 I/O Chassis. (Refer to Figure 2.) The Field Wiring Arm pivots on the front of the I/O Chassis to connect with Module terminals. Because wiring connections are made at the Field Wiring Arm, an I/O Module can be removed from the Chassis without the need to disconnect user wiring.

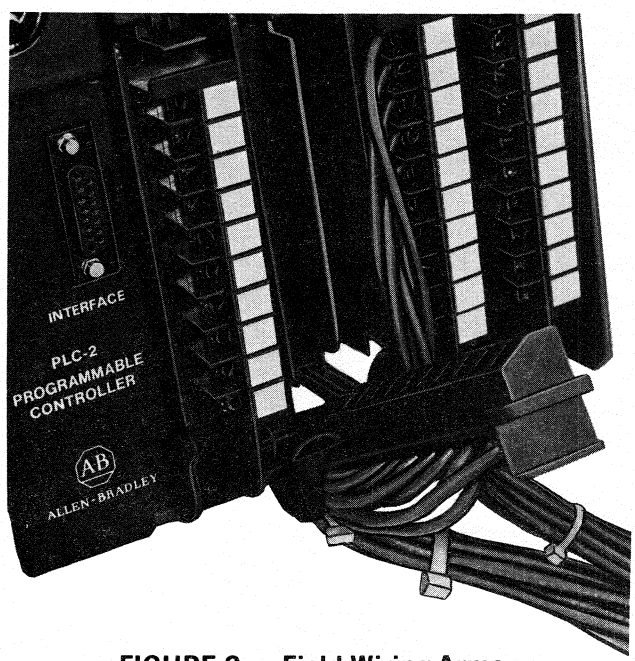



**FIGURE 2 — Field Wiring Arms**

The user connects 220/240V AC (L1) and AC LOW (L2) to the Field Wiring Arm of the Module. (Refer to the Connection Diagram.) User devices are connected to the output terminals and to AC LOW (L2). Module labels identify these terminal connections and provide space for the user to identify connected output devices.

Output terminals on the AC (220/240V) Output Module (Cat. No. 1771-OM) can be used to drive input terminals on the AC/DC (220/240V) Input Module (Cat. No. 1771-IM). However, for proper phase relationship of the AC voltage waveform, both Modules must be powered by the same AC source. Also, an external resistor must be connected between the Output Module terminal and AC LOW (L2). Typically, this is a 3.9K ohm, 20 watt resistor which is used to help assure proper status indicator operation. (Refer to Figure 3.)

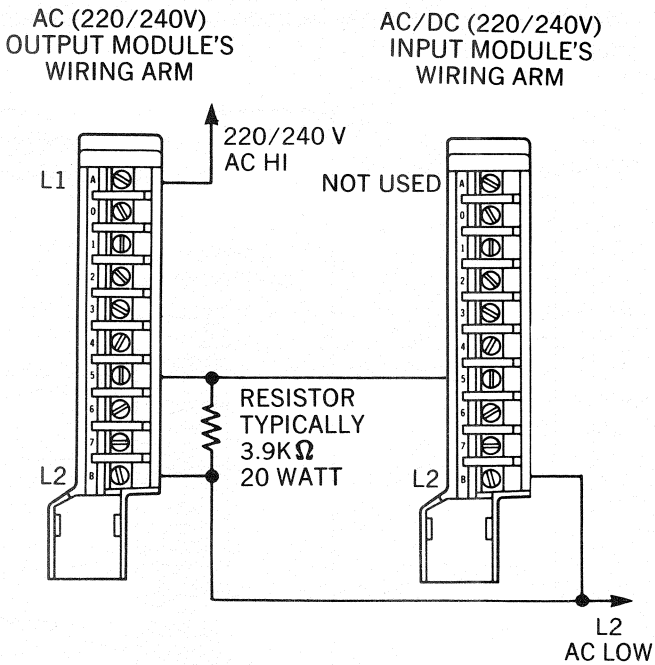



**FIGURE 3 — Driving an Input with an Output**

## KEYING

During initial Controller system design stages, the AC (220/240V) Output Module may be inserted into any I/O module slot of the I/O Chassis. However, once specific slots have been designated for a module, care should be taken so that other types of modules will not be mistakenly placed into these slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for the user to key an I/O slot to accept only one type of I/O module. Use of these keying bands is strongly recommended.

Each type of I/O module is slotted in two places at its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed solely to receive the AC (220/240V) Output Module (Cat. No. 1771-OM).

For the AC (220/240V) Output Module, position keying bands on the upper backplane connector between these numbers printed on the backplane:

- Between 6 and 8
- Between 28 and 30

Refer to Figure 4.

The position of these bands may be changed by the user if subsequent system design and rewiring make insertion of a different type of Module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

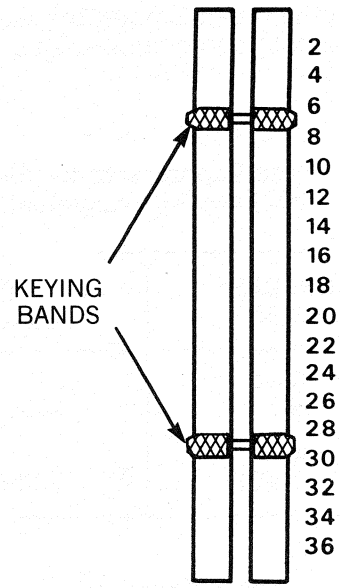
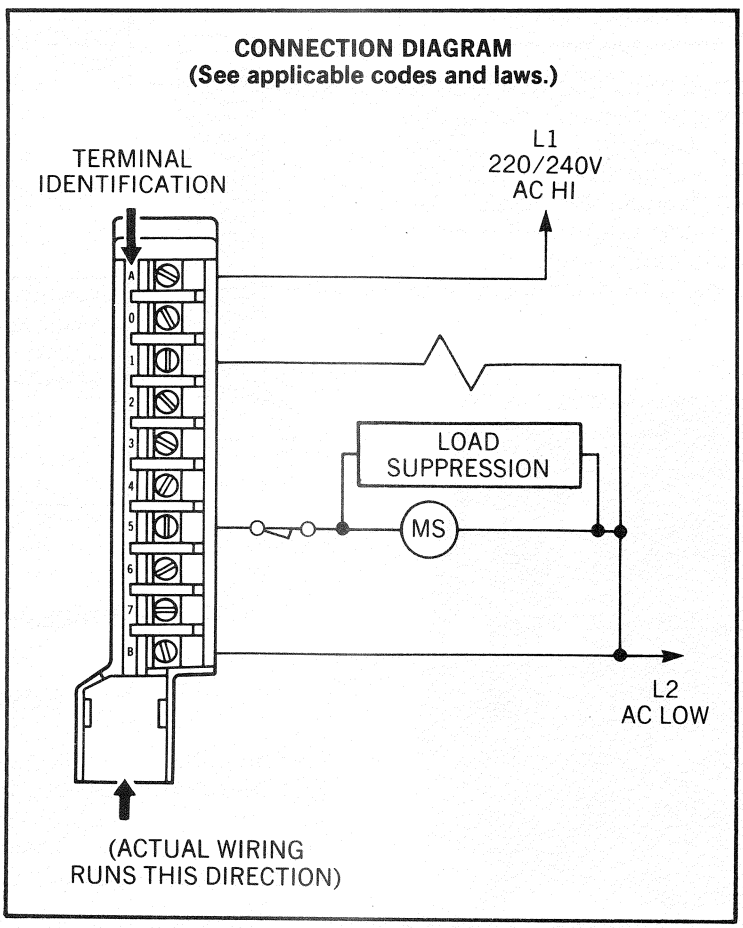



**FIGURE 4 — Keying Diagrams**

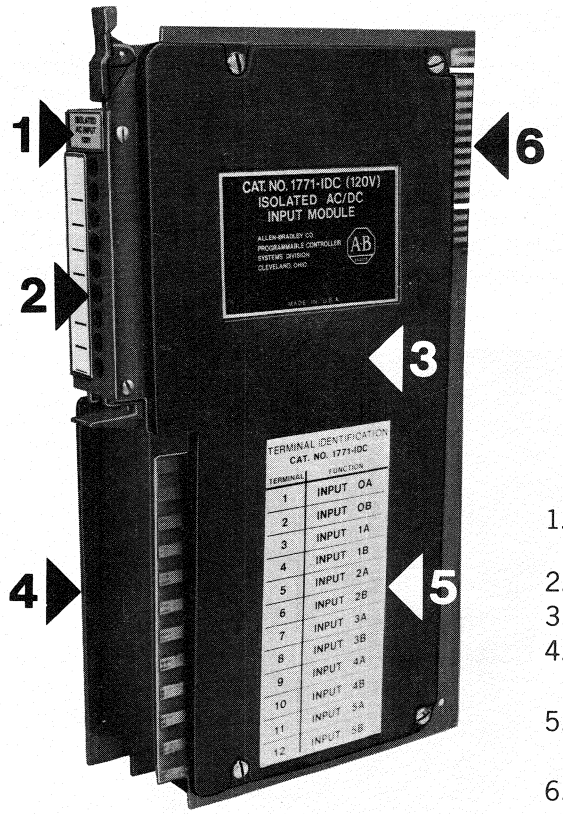



P/N 636045-60

ALLEN-BRADLEY
Cleveland, Ohio 44143

# ISOLATED AC/DC (120V) INPUT MODULE ASSEMBLY

## Cat. No. 1771-ID




1. Red identification label
2. Status indicators
3. Protective cover
4. Field Wiring Arm connects here
5. Labels indentify user devices
6. Slotted for I/O rack insertion only

### SPECIFICATIONS

**Inputs per Module**
6
**Module Location**
I/O Chassis
**Nominal Input Voltage**
120V AC, 60/50 Hz
120V DC
**Input Voltage Range**
(for logic "1")
92 - 138V AC/DC
(47-63Hz)
**Nominal Input Current**
(for logic "1")
DC: 4.5 mA
AC: 8 mA
**Input Filter Time Constant**
20 ms (±6ms)
**Electrical-Optical Isolation**
1500V RMS
Isolation is between the input circuitry and control logic circuitry
**Power Supply Current Requirement**
50 mA per Module
**Ambient Temperature Rating**
0° to 60°C (operational)
—40° to 85°C (storage)
**Humidity Rating**
5 to 95%
(without condensation)
**Keying**
Modules are slotted for insertion in I/O slots only
**Wiring**
14 ga. stranded (max.)
3/64" insulation (max.)

### DESCRIPTION

The Isolated AC/DC (120V) Input Module Assembly (Cat. No. 1771-ID) senses the ON/OFF voltage levels of up to six 120V AC or DC customer devices. It converts this voltage-level information to logic-level data while maintaining electrical isolation between each device. Input signals generally originate from such sources as limit, float and selector switches, and push buttons. The Module, as a part of the 1771 Universal I/O Structure, is compatible with any member of the PC Controller family employing 1771 I/O Racks.

The Isolated AC/DC (120V) Input Module Assembly includes the following units:

- Isolated AC/DC (120V) Input Module (Cat. No. 1771-IDC)
- Field Wiring Arm (Cat. No 1771-WD)

### STATUS INDICATORS

Six status indicators are located on the front of the Module. (Refer to Figure 1.) Each of these indicators corresponds to a single Module input terminal. When an input is ON, its corresponding status indicator illuminates.

These neon indicators provide a useful trouble-shooting aid. By comparing the indicator with its corresponding input device, an operator can quickly identify certain hardware-related faults.

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Publication 1771-926 — May, 1980

The Module status indicators are driven from the customer power supply. They will operate in any mode of the Controller.

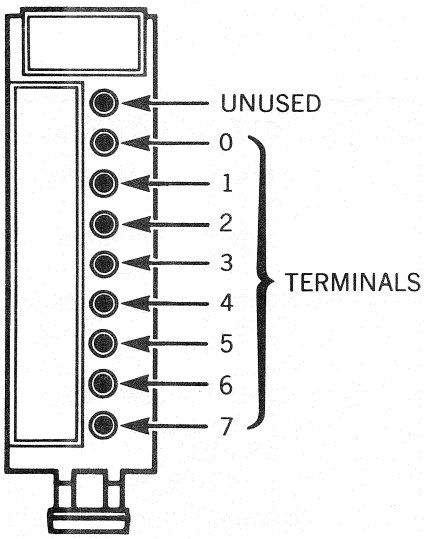



**FIGURE 1 - Status Indicators**

## POWER SUPPLY REQUIREMENT

The logic circuitry of the AC/DC Input Module is driven by the Power Supply which connects to the I/O Chassis backplane. The Module requires a current of 50 mA from the 5V DC output of this Supply. This amount should be totalled with the current requirements of other modules in the rack to avoid overloading the supply.

## PROGRAMMING

The Module uses standard programming techniques; the following instructions examine an input for a voltage condition:

-] [- EXAMINE ON

-]/[- EXAMINE OFF

## INPUT CIRCUITRY

The Isolated AC/DC (120V) Input Module provides 6 inputs. The Module senses the voltage at each set of terminals to determine the ON/OFF status of the connected device. The voltage range for each of these states is as follows:

- ON - 92-138V AC/DC
- OFF - 0-46V AC/DC

The Module has input filter circuitry to limit the effect of voltage transients. (Transients, common to noise-polluted industrial environments, could be falsely interpreted if input filtering is not provided.) This filtering introduces a typical signal delay of 20 msec (±6 msec).

In each input circuit, electrical-optical isolation provides protection for the Module's logic circuitry from high-voltage transients along the input line. The Module's electrical-optical isolation is rated at 1500V RMS.

## CONNECTIONS

Customer input devices connect to a Field Wiring Arm (Cat. No. 1771-WD) which can be removed from the Bulletin 1771 I/O Chassis. (Refer to Figure 2.) The Field Wiring Arm pivots on the front of the Chassis to connect with Module terminals. Because wiring connections are made on the Wiring Arm, a module can be removed from the I/O Chassis without the need to disconnect the wiring.

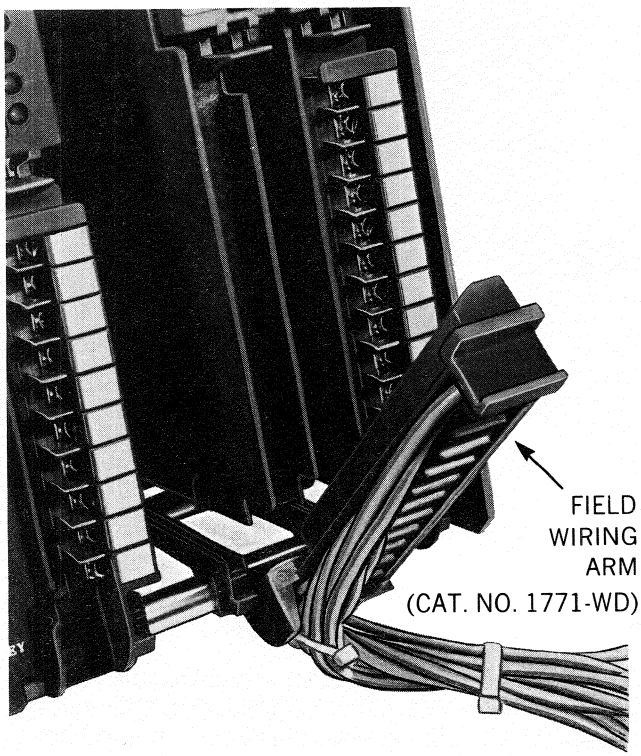



**FIGURE 2 - Field Wiring Arm**

The Connection Diagram illustrates AC/DC Input Module connections. A label on the side cover also identifies the Field Wiring Arm terminal connections to the Module. Additional space for user labeling is provided on the front of the Module and on the Wiring Arm itself.

Outputs on an AC Output Module can be used to drive inputs to the AC/DC Input Module provided proper voltage and phase relationships are maintained. However, an external resistor of 2000 ohms,

20 watts, must be connected between the Output Module terminal and AC LOW (L2). (Refer to Figure 3.)

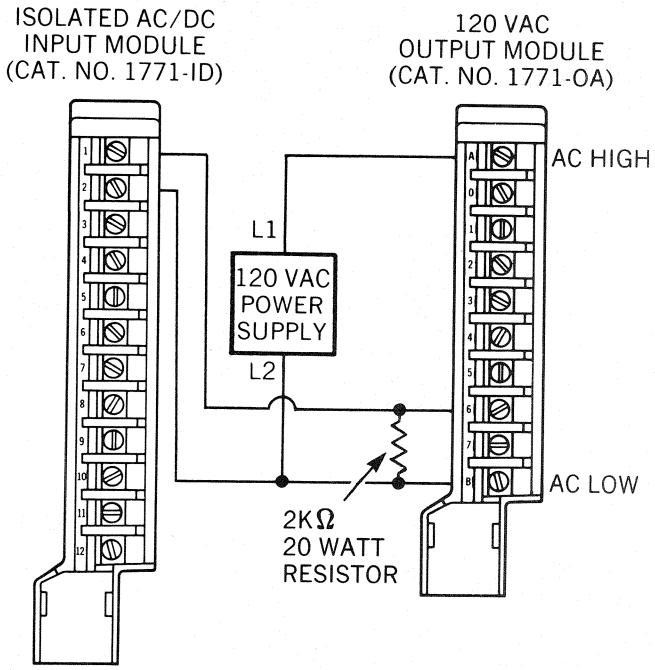



**FIGURE 3 - Connection Diagram for Interfacing Two Controllers**

## KEYING

In initial design stages, the Isolated AC/DC (120V) Input Module may be inserted into any I/O module slot of the I/O Chassis. However, once specific slots have been designated for a module, care should be taken so that other types of modules will not be mistakenly placed into these slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for the user to key an I/O slot to accept only one type of I/O module. Use of these keying bands is strongly recommended.

Each type of I/O module is slotted in two places at its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed solely to receive the Isolated AC/DC(120V) Input Module (Cat. No. 1771-ID).

For the Isolated AC/DC (120V) Input Module, position keying bands on the upper backplane connector between these numbers printed on the backplane:

- Between 4 and 6
- Between 28 and 30

Refer to Figure 4.

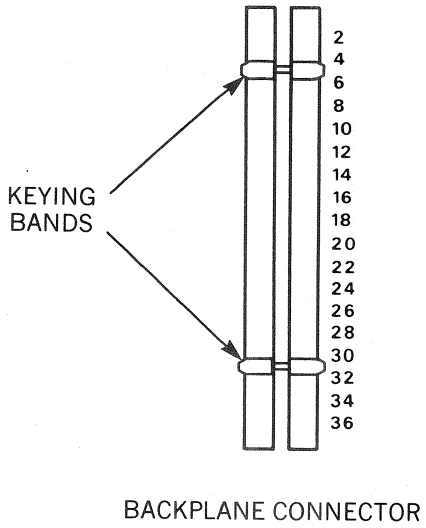
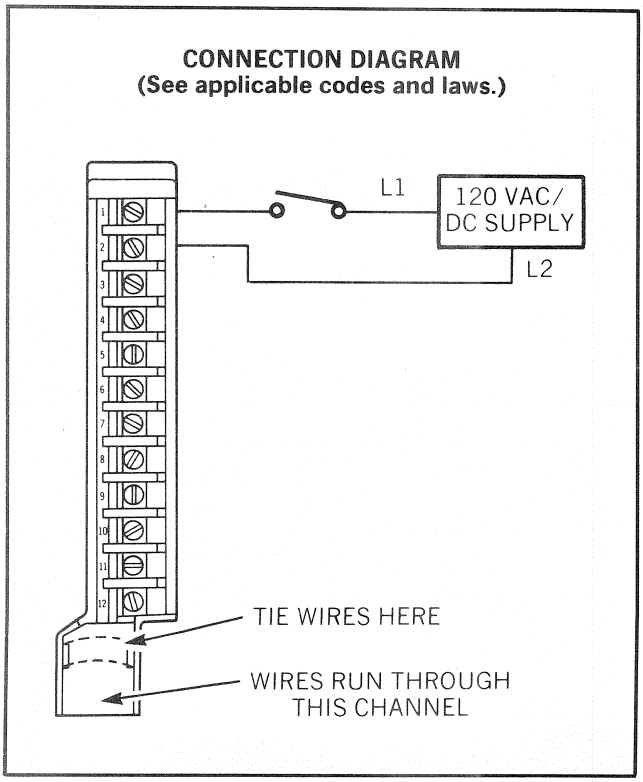



**FIGURE 4 - Keying Diagram**

The position of these bands may be changed by the user if subsequent system design and rewiring make insertion of a different type of Module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

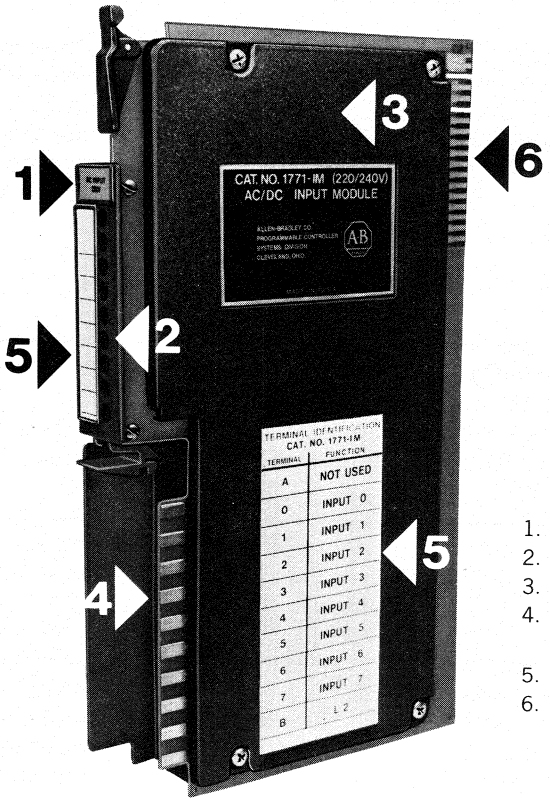


ALLEN-BRADLEY
Cleveland, Ohio 44143

P/N 636040-60

# AC/DC (220/240V) INPUT MODULE

## Cat. No. 1771-IM




1. Red identification label
2. Status indicators
3. Protective cover
4. Field Wiring Arm connects here
5. Labels identify user inputs
6. Slotted for I/O slot insertion only

## SPECIFICATIONS

**Inputs per Module:**
8

**Module Location**
I/O Chassis

**Nominal Input Voltage**
220/240V AC
240V DC

**Input Voltage Range**
184-276V AC or DC
(for ON or logic "1" state)

**Nominal Input Current**
3.5 mA (RMS) at 220V AC
3 mA at 220V DC
(for ON or logic "1" state)

**Input Delay**
20 ms (±6 ms)

**Electrical-Optical Isolation**
1500V RMS
Isolation is between the input circuitry and control logic circuitry

**Power Supply Current Requirement**
75 mA @ 5V DC

**Ambient Temperature Rating**
0° to 60°C (operational)
-40° to 85°C (storage)

**Humidity Rating**
5 to 95%
(without condensation)

**Wire Size**
14 ga. stranded (max.)
3/64" insulation (max.)

**Keying**
Modules are slotted for insertion into I/O slots only

## DESCRIPTION

The AC/DC (220/240 V) Input Module (Cat. No. 1771-IM) senses the ON/OFF voltage levels of up to eight 220/240V AC or DC user devices. It converts this voltage-level information to logic-level data for use by a programmable controller Processor. As a unit of Bulletin 1771 I/O Equipment, the AC/DC (220/240 V) Input Module can be used with PLC-2, PLC-2/20, Mini-PLC-2, or Remote I/O PLC Programmable Controller employing Bulletin 1771 I/O Racks.

Input signals generally originate in switch closures from such sources as limit, float and selector switches, and push buttons. Each input device connected to the AC/DC Input Module has a distinct 5-digit address in the user program. The ON/OFF status of any Module input is examined using this address with the following instructions:

EXAMINE ON

EXAMINE OFF

Any Module input may be examined in the program as many times as needed.

## INPUT CIRCUITRY

The AC/DC (220/240V) Input Module provides 8 input terminals. The Module senses the voltage at each terminal to determine the ON/OFF status of

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**Publication 1771-927 — July, 1981**
Supersedes Publication 1771-927 Dated April, 1980

the connected device. The voltage range for each of these states is as follows:

- ON: 184-276V AC/DC
- OFF: 0- 92V AC/DC

The AC/DC (220/240V) Input Module has input filter circuitry to limit the effect of voltage transients. (Transients, common to noise-polluted industrial environments, could be falsely interpreted if input filtering were not provided.) This filtering introduces a typical signal delay of 20 msec (±6 msec).

In each input circuit, optical-electrical isolation separates the Module's logic circuitry from its input sensing circuitry to help guard against the possibility of damage to Module logic-level circuitry from user voltage levels or high-voltage transients along the user's line. Module optical-electrical isolation is rated at 1500V RMS.

## STATUS INDICATORS

On the front of the AC/DC (220/240V) Input Module are 8 neon lamp status indicators. (Refer to Figure 1.) Each of these indicators corresponds to a single Module input terminal. When an input is ON, its corresponding status indicator illuminates.

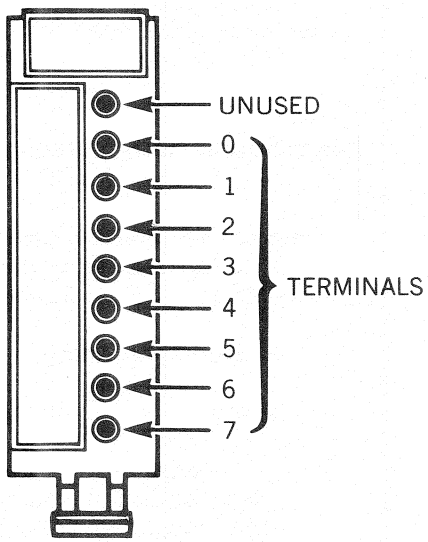



**FIGURE 1 — Status Indicators**

These status indicators provide a useful troubleshooting aid. By comparing these indicators with their corresponding input devices, an operator can quickly isolate many types of hardware-related faults.

The Module status indicators operate whether or not system power is connected to the Chassis backplane.

## POWER SUPPLY REQUIREMENT

The logic circuitry of the AC/DC Input Module is powered by the Power Supply which connects to the I/O Chassis backplane. This may be a PLC, PLC-2, PLC-2/20 or Mini-PLC-2 Programmable Controller Power Supply. The Module requires a typical current of 75 mA from the +5V DC output of this Supply.

## CONNECTIONS

**CAUTION:** The Module must **not** be removed from or inserted into the Bulletin 1771 I/O Chassis while system power is ON. Failure to observe this rule may result in damage to Module circuitry.

User input devices connect to a Field Wiring Arm (Cat. No. 1771-WA) which is a removable part of the Bulletin 1771 I/O Chassis. (Refer to Figure 2.) The Field Wiring Arm pivots on the front of the Chassis to connect with Module terminals. Because wiring connections are made on the Wiring Arm, a module can be removed from the I/O Chassis without the need to disconnect user wiring. This aids troubleshooting and allows ease of controller expansion.

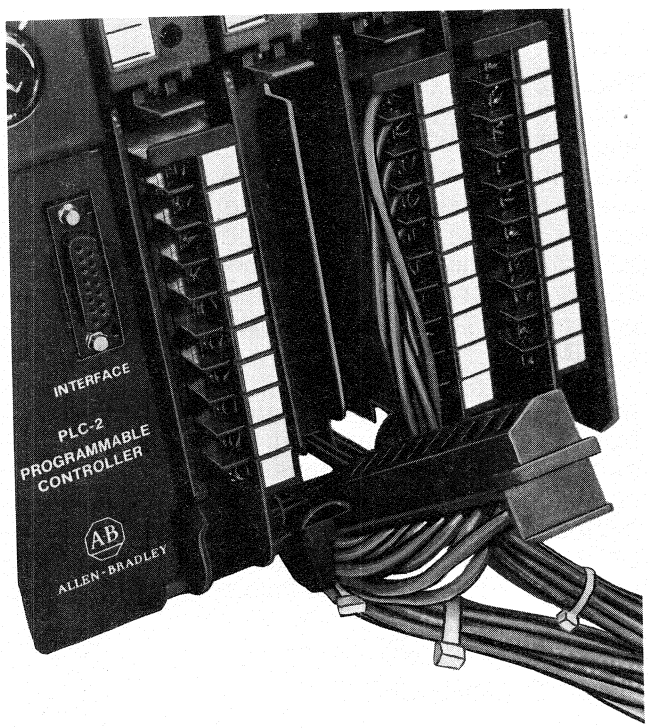



**FIGURE 2 — Field Wiring Arms**

The user must connect L1 (220/240V AC or DC) to each user input device and L2 (AC LOW or DC COMMON) to the appropriate Wiring Arm terminal. The Connection Diagram illustrates AC/DC Input Module connections. A label on the side cover also identifies the Field Wiring Arm terminal connections to the Module. Additional space for user labeling is provided on the front of the Module and on the Wiring Arm itself.

Output terminals on the AC (220/240V) Output Module (Cat. No. 1771-OM) can be used to drive input terminals on the AC/DC (220/240V) Input Module (Cat. No. 1771-IM). However, for proper phase relationship of the AC voltage waveform, both Modules must be powered by the same AC source. Also, an external resistor must be connected between the Output Module terminal and AC LOW (L2). Typically, this is a 3.3K ohm, 20 watt resistor which is used to help assure proper status indicator operation. (Refer to Figure 3.)

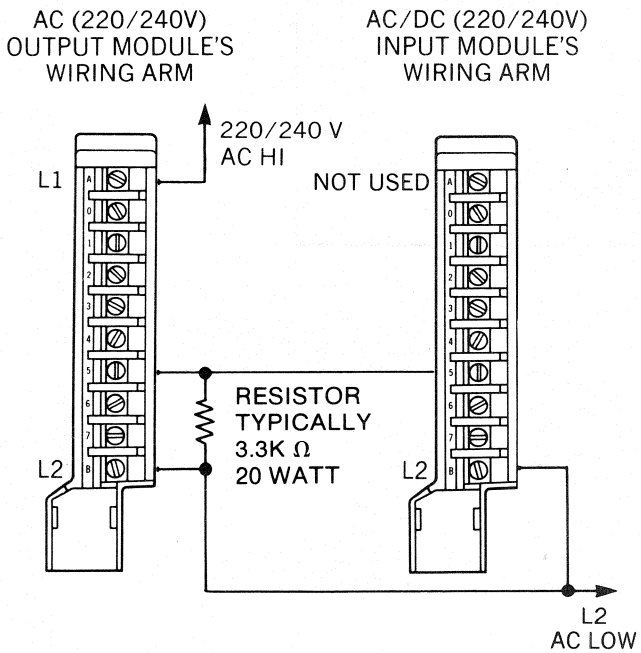



**FIGURE 3 — Driving an Input with an Output**

## KEYING

During initial Controller system design stages, the AC/DC (220/240V) Input Module may be inserted into any I/O module slot of the I/O Chassis. However, once specific slots have been designated for a module, care should be taken so that other types of modules will not be mistakenly placed into these slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for the user to key an I/O slot to accept only one type of I/O module. Use of these keying bands is strongly recommended.

Each type of I/O module is slotted in two places at its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed solely to receive the AC/DC (220/240V) Input Module (Cat. No. 1771-IM).

For the AC/DC (220/240V) Input Module, position keying bands on the upper backplane connector between these numbers printed on the backplane:

- Between 6 and 8
- Between 30 and 32

Refer to Figure 4

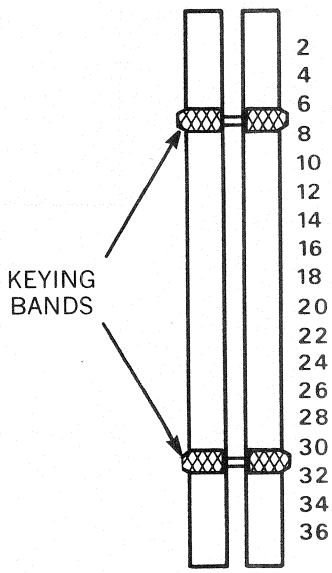
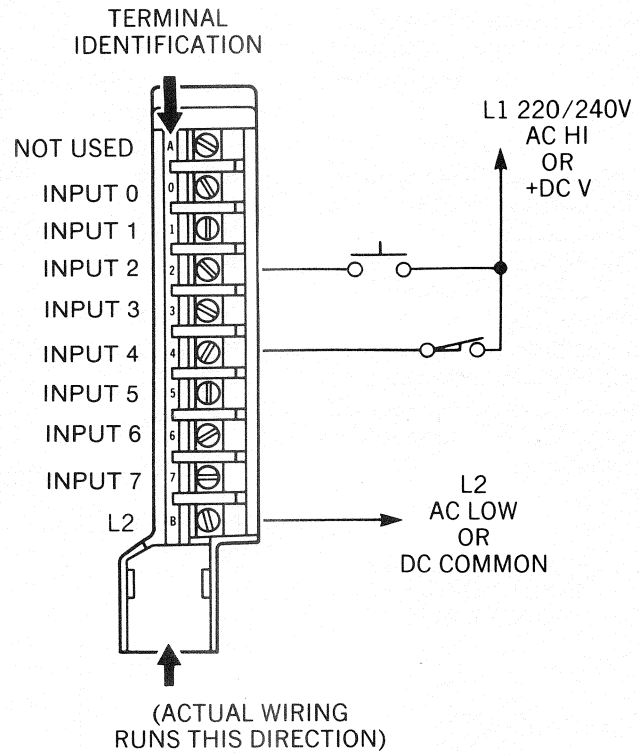



**FIGURE 4 — Keying Diagrams**

The position of these bands may be changed by the user if subsequent system design and rewiring make insertion of a different type of Module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

**CONNECTION DIAGRAM**
**(See applicable codes and laws.)**

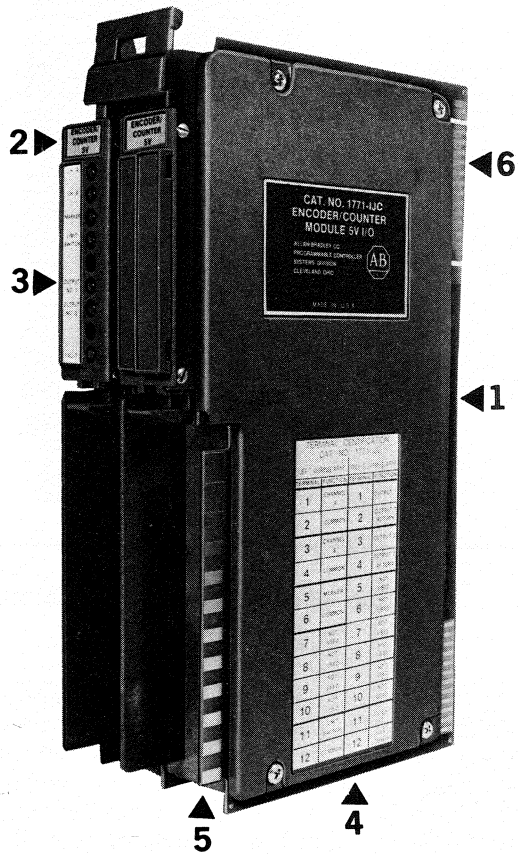



P/N 630046-60B

ALLEN-BRADLEY
Cleveland, Ohio 44143

# ENCODER/COUNTER MODULE ASSEMBLY

## Cat. No. 1771-IJ/IK




1. Protective cover
2. Brown identification label
3. Status indicators
4. Label identifies user output connections
5. Field Wiring Arm connects here
6. Slotted for I/O slot insertion only

### SPECIFICATIONS

**Counters per Module:**
1

**Counter Input (Switch Selectable):**
Single Channel (Counter)
Dual Channel (Encoder)

**Input Pulse Rate**
50K Hz max.

**Data Transfer Modes (Switch Selectable):**
Single Transfer Mode
Block Transfer Mode

**Power Supply 5V Current Requirements**
1.2 Amp typical
1.4 Amp (max.)

**I/O Isolation**
1500V

**TTL Input Ratings (1771-IJ)**
Input Current per channel: 16 mA
Input Voltage: $VI_H$ = 2.4 V (min.)
$VI_L$ = 0.6V (max.)

**12-24 Input Ratings (1771-IK)**
Input Current per Channel: 10mA at 12V
20mA at 24V

V Input for 12V: High = 7.2V (min.)
Low = 4.8V (max.)
V Input for 24V: High = 14.4V (min.)
Low = 9.6V (max.)

**Output Ratings**
Output Current: I (max) = 500mA per output (open collector outputs without internal pull-up resistors)
Output Voltage: (output high) = 30.0 volts (max.) (with external pull-up)
(output low) 0.5 volts max @ 500 mA

**Customer Supply:**
5 V DC ± 0.25V @ 140 mA max (1771-IJ)
12V @ 110 mA (1771-IK)
24V @ 200 mA
50 mV p-p ripple max

**Environmental:**
Temperature 0-60°C
Humidity 5-95%, no condensation

### DESCRIPTION

The Encoder/Counter Module Assembly (Cat. No. 1771-IJ or Cat. No. 1771-IK) maintains a count, independent of the Processor, of input pulses that may typically originate from such devices as quadrature type encoders, high speed optical beam counters, and certain types of switches. The Module is capable of making decisions based on the count total by comparing it to previously programmed values and activating either one or both of its outputs based on the results of the comparison. The Module can also return the accumulated count to the Processor for arithmetic computations or display. The Module is compatible with any Allen-Bradley PC Controller employing the 1771 I/O Structure.

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Publication 1771-928 — January, 1981

The Module also provides inputs for a marker signal from an encoder and a voltage level signal from a limit switch to allow for home positioning. In the count mode, the direction of the count can be changed either from the Processor or, for speed critical applications, at the Module itself through an external switch. The maximum detectable input pulse frequency to the Module is 50 kHz.

The Module will count in either BCD or binary numbers. In the BCD mode, the range is 000 to 999 with carry and borrow bits provided to cascade counters in the program the Binary mode allows a higher count total, with a range between 0000 and $4095_{10}$.

Additionally, the Module can improve the accuracy of certain types of encoders by totalling the count at both Channel A and Channel B (Times 2 mode), or by counting the rising and falling edges of both channel inputs to give a fourfold increase in the count (Times 4 mode).

The Encoder/Counter Module Assembly is available in two versions:

- Cat. No. 1771-IJ - uses a 5V DC external power supply that allows inputs to be TTL compatible. Outputs can either be driven from the 5V DC supply through the Module or from a separate load supply of a different voltage.
- Cat. No. 1771-IK - uses a 12-24V DC external power supply. Input devices should be compatible with the voltage of the customer power supply. Outputs can be driven either from the customer supply through the Module or from a separate load supply.

The Encoder/Counter Module Assembly includes:

- One Encoder/Counter Module (either Cat. No. 1771-IJ or Cat. No. 1771-IK).
- Two 12 terminal gold-plated Field Wiring Arms (Cat. No. 1771-WB).

Unless otherwise noted the following paragraphs refer to both versions of the Module.

## STATUS INDICATORS

Refer to Figure 1. There are seven status indicators on the front of the left half of the Module. The top four LEDs, corresponding to Channel A, Channel B, Marker, and Limit Switch inputs, illuminate when their respective input signals are high. The next two indicators show the state of the outputs. An output indicator is ON when the output circuit is activated. The bottom indicator illuminates when the Module has detected a fault.

When system power is turned on, the Module runs a self-test on its components. During power-up, it is normal for the fault indicator to flash on momentarily. If the LED does not turn off, the Module has detected a fault. The self-test includes checks to make sure that all counters and registers have been reset to zero and memory is cleared. If a breakdown of communication occurs during Block Transfer, the fault LED will also light. (Bit 14, as the Diagnostic bit in the Input Status word, is also set anytime the Fault LED is ON.)

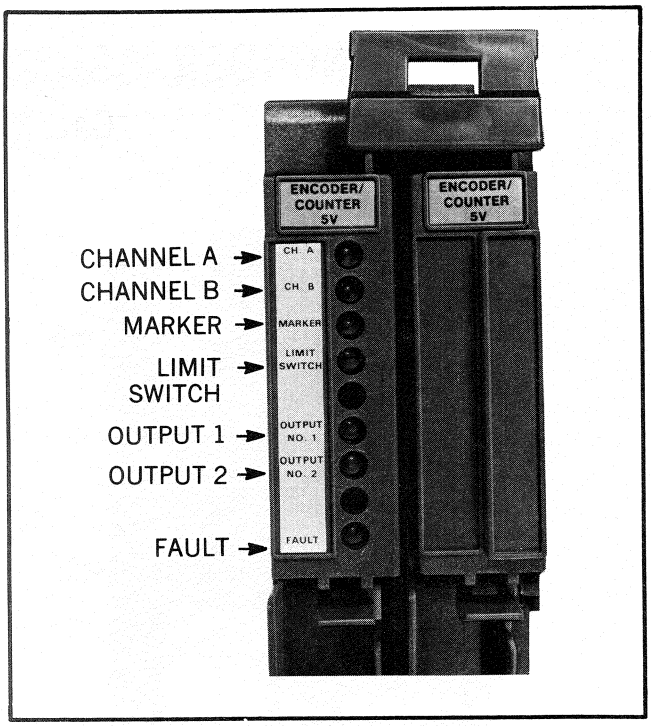



**FIGURE 1 — Red LED Status Indicators**

After power-up, the module will stay in its reset state (outputs disabled and counter held reset) until the necessary control bits are set in the program.

## SWITCH SELECTABLE PROGRAMMING OPTIONS

The Module has available certain programming options that are selected by setting the five switches on Switch Assembly 1. These options include the choices between encoder and counter operation, Block Transfer and Single Transfer, BCD and Binary Data Formats, and Count Resolution in the Encoder mode.

Block Transfer/ Single Transfer (Switch 1) -- Single Transfer programming can be used with any Allen-Bradley PC Processor. This type of programming shifts a single word of data each program scan from the Processor's Data Table to the Module. It therefore takes three program scans to send a new Control Word and the two Preset values to the Module. However, once new data has been sent to the Module, it will remain active until another

transfer updates it. The Input Status word will always appear at the proper address location in the Input Image Table. To use Single Transfer programming, the Transfer Mode switch (Switch 1) on Switch Assembly 1 must be set to Single Transfer (ON).

Block Transfer moves all three data words from the Processor to the Module in a single scan. (NOTE: Not available with all Allen-Bradley PC Products.) To use Block Transfer, the Transfer Mode Switch (Switch 1) must be set for Block Transfer (OFF). Refer to Publication 1771-807, "Programming for the Encoder/Counter Module" for further details.

Count Resolution (Switches 2 and 3) — In the Encoder mode, the accuracy of a quadrature type encoder can be improved by allowing the Module to count the pulse trains at both channel inputs. This doubles the number of pulses counted for the same degree of rotation at the encoder. A furthur improvement can be made by letting the Module count the leading and trailing edges of both pulse trains, thereby counting four times (Times 4) for the same degree of rotation. Certain applications may need the actual count and the Module should be set for Times 1 (the pulse is counted on its rising edge as high TRUE). The Count Resolution setting affects the total count kept at the Module and as it is sent back in the Status word. Programming manipulations of the Status word and the Preset values should take into account any multipliers. The Count Resolution setting may also be limited by the program scan time if the Carry or Borrow bits are used to cascade counters.

In the Counter mode, the Count Resolution setting has no effect on the count and can be ignored.

To set the Count Resolution for use with quadrature type encoders, refer to Table A.

**TABLE A — Count Resolution Settings**

| MULTIPLIER | SWITCH 2 | SWITCH 3 |
|---|---|---|
| TIMES 1 | ON | ON |
| TIMES 2 | ON | OFF |
| TIMES 4 | OFF | OFF |

Encoder/Counter Selection (Switch 4)-- In the Encoder mode, the Module counts the number of input pulses entering on Channel A from a quadrature type encoder. By comparing the phase relationship between input pulses on Channel A with the pulses appearing at Channel B, it knows whether to add or subtract the incoming count from the total (that is, whether to count up or down). Refer to Figure 2. The phasing between the Channels is determined by the direction in which the Encoder is turned. To use the Module in the Encoder mode, Switch 4 must be set to Encoder (ON).

In the Counter mode, the Module will total the incoming pulses on Channel A. The count is incremented on the rising edge of the pulse (high TRUE). The direction of the count can be controlled with either the control word or an external switch wired to Channel B. Channel B must be left unconnected if the count direction is to be software controlled. Typical input devices for counting might be high speed static switches and incremental encoders. Mechanical switches are not recommended as input counting devices interfaced to the 1771-IJ because the contact bounce might be counted as pulses. However, the 1771-IK can be used with a mechanical switch, provided the Module is configured for mechanical counting (filter has been cut in) and the counting frequency does not exceed 150 Hz. To use the Module in the Counter mode, Switch 4 must be set to Counter (OFF).

Binary/ BCD Data Format (Switch 5)-- The Preset values and the Accumulated Total in the Status word have the option of appearing in either BCD or Binary formats. If the BCD format is selected, the Processor can directly manipulate these values in comparisons or arithmetic functions, but the Accumulated value is limited to a count between 000 and 999.The binary option allows an increased range of 0000 to $4095_{10}$. With some processors the programming has to reconstruct a BCD number from the binary value. The data format is set to perform certain types of computations at Switch 5 on Switch Assembly 1. (Binary--ON, BCD --OFF)

## INPUT CONFIGURATION

Because different types of input devices are compatible with different voltage ranges, the 1771-IJ (5V DC) and 1771-IK (12-24V DC) input channels are configured differently.

### 1771-IJ

Because the Module is designed to work with 5 volt TTL type devices, each input channel and the Marker input can be set for single ended or differential line inputs. Refer to Table B for the correct settings on Switch Assembly 2. The input device should be capable of providing 16 mA of sink current. The Module detects a voltage of 2.4 VDC or above at either channel as Logic "1" or TRUE. A voltage below .6 VDC is considered a Logic "0" or FALSE.

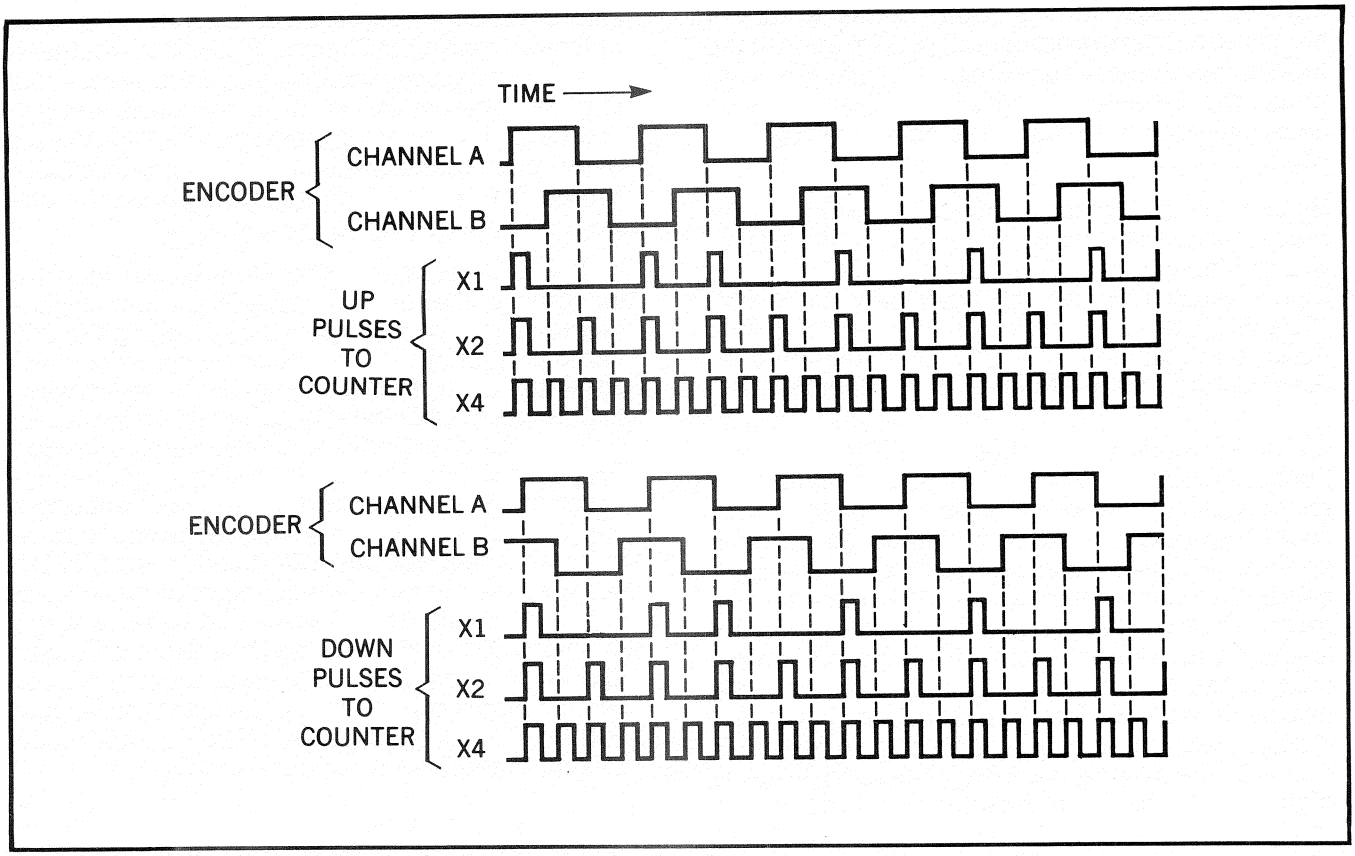



**FIGURE 2 — Input Pulses**

**TABLE B — Settings for Switch Assembly 2 (1771-IJ)**

| | 1 | 2 | 3 |
|---|---|---|---|
| | MARKER | CHAN. B | CHAN. A |
| **ON** | SINGLE ENDED | SINGLE ENDED | SINGLE ENDED |
| **OFF** | DIFFER-ENTIAL | DIFFER-ENTIAL | DIFFER-ENTIAL |

The Marker input registers as TRUE when the input pulse from the encoder is high.

The Limit Switch input senses a voltage of greater than 10 volts DC as a Logic "1", or ON and less than 5 volts DC as a Logic "0", or OFF . The input voltage that appears through the switch should be from a 12 to 48V DC customer supply that is capable of supplying 10 mA of source current at 48V DC. The limit switch input has a signal delay of 16 msec (±7msec) because of the filtering needed to protect against contact bounce.

The Channel B input can be used in the Counter mode to select count direction. If the Channel B Input terminal is not connected, the Control word in the output program selects the direction of the count. For external hardware control, the Count Direction bit in the Control word must be set to count up . Then if Channel B is allowed to float high or is driven high, the Module counts up; if it is pulled low, either through a gate or a transistor switch, it will count down.

No special filtering is provided on Channel B, since the filtering necessary for a mechanical switch would defeat the purpose of a very fast count direction change that is not dependent on the Processor scan time. Therefore, a transistor switch or gate should be used to pull the Channel B input low. The gate or switch must sink 16 mA of current to pull Channel B input low. The count changes direction in less than 10 microseconds from the time Channel B input changes state.

### 1771-IK

The Module is designed to accept several types of devices that will operate in the 12 to 24 volt range. Refer to Figure 3. Since most high voltage quadrature encoder outputs produce signals through an

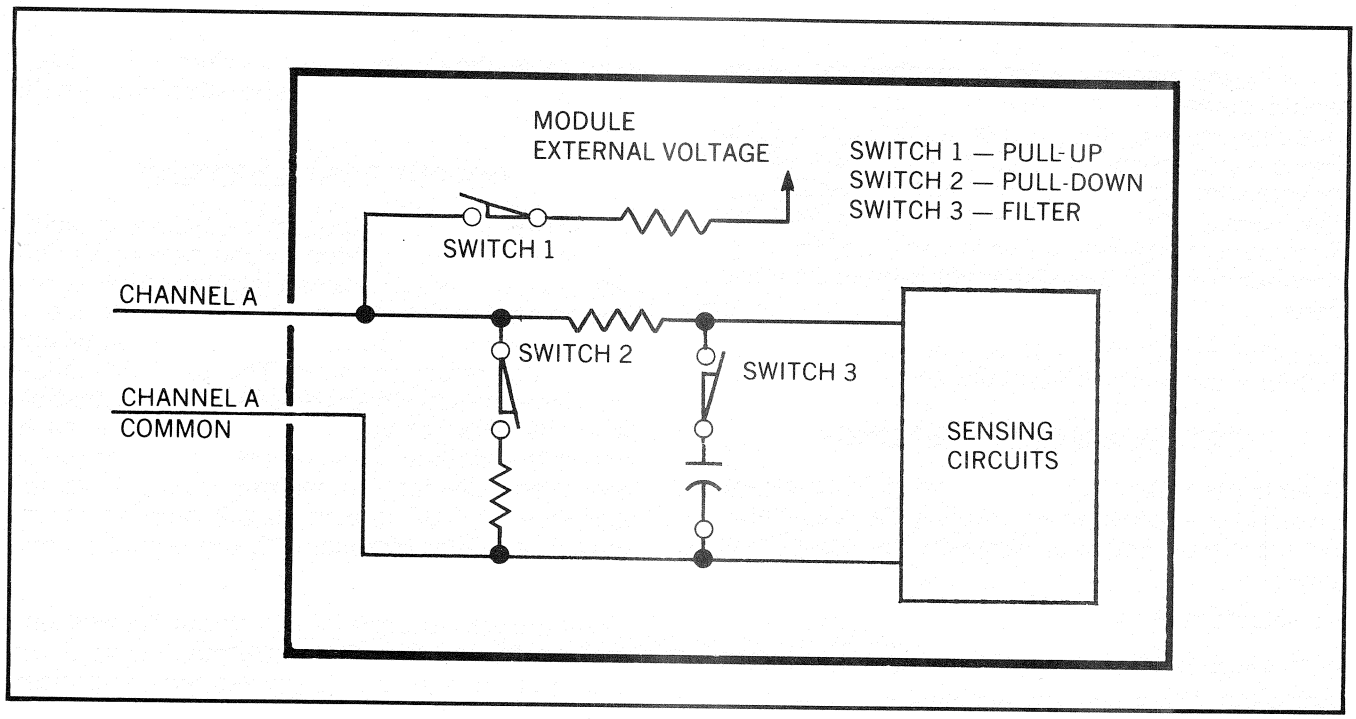



**FIGURE 3 — Switch Assembly 2-Input Configuration for Channel A of the 1771-IK**

open collector output, the Module is configured for a pull-up on Channel B. Channel A must be set for a pull-up by setting Switch 1 on Switch Assembly 2. Some counting devices may also use a pull-up arrangement. When Switch 1 is ON, Switch 2 should be OFF. Note that the seettings on Switch Assembly 2 are not the same on the 1771-IJ as they are for 1771-IK. Refer to Table C for switch settings.

**TABLE C — Settings for Switch Assembly 2 (1771-IK)**

| | 1 | 2 | 3 |
|---|---|---|---|
| **ON** | PULL-UP | PULL-DOWN | FILTER IN (150 Hz) |
| **OFF** | FLOAT | FLOAT | FILTER OUT (50K Hz) |

Certain counting devices may need an input designed to pull current down through the device. Switch 2 should be set ON for pull-down and Switch 1 left off. The Module detects a minimum of 7.2 VDC at its input channels as TRUE for a 12 VDC customer supply and 14.4 VDC at 24 VDC customer supply. A signal with a maximum voltage of 4.8 VDC is considered FALSE for a 12 VDC supply and 9.6 VDC is FALSE for a 24 VDC supply. Each input channel sinks 10 mA at 12 VDC and 20 mA at 24 VDC.

If it is necessary to debounce a contact type of device, such as a switch, the filter can be added across the inputs by setting Switch 3 ON. By adding the filter to the circuit, the maximum counting frequency the Module will detect is 150 Hz.

Channel B input and the Marker input are for open collector encoder drivers (the Channel B input has an internal pull-up) and are not switch selectable. The Marker input reads a signal as high TRUE.

The Limit Switch input senses a voltage of greater than 10 volts DC as a Logic "1", or ON and less than 5 volts DC as a Logic "0", or OFF. The input voltage that appears through the switch should be from a 12 to 48V DC customer supply that is capable of supplying 10 mA of source current at 48V DC. The limit switch input has a signal delay of 16 msec (±7 msec) because of the filtering needed to protect against contact bounce.

The Channel B input can be used in the Counter mode to select count direction. If the Channel B Input terminal is not connected, the Control word in the output program selects the direction of the count. For external hardware control, the Count Direction bit in the Control word must be set to count up . Then if Channel B is allowed to float high or is driven high, the Module counts up; if it is pulled low, either through a gate or a transistor switch, it will count down. Any gate or switch should be compatible with the customer voltage supply (12 to 24 VDC).

No special filtering is provided on Channel B, since the filtering necessary for a mechanical switch would defeat the purpose of a very fast count direction change that is not dependent on the Processor scan time. Therefore, a transistor switch or gate should be used to pull the Channel B input low, sinking 10mA at 12V DC or 20 mA at 24V DC. The count changes direction in less than 10 microseconds from the time Channel B input changes state.

Refer to the Connection Diagrams (Figures 11 and 12) for interfacing different devices.

## SWITCH ASSEMBLY SETTINGS

Switch Assembly Settings -- These features are selected on two switch assemblies that are located on the circuit board underneath the component cover.

To select these options, proceed as follows:

1. Take off the component cover by removing the four slotted screws. Refer to Figure 4.

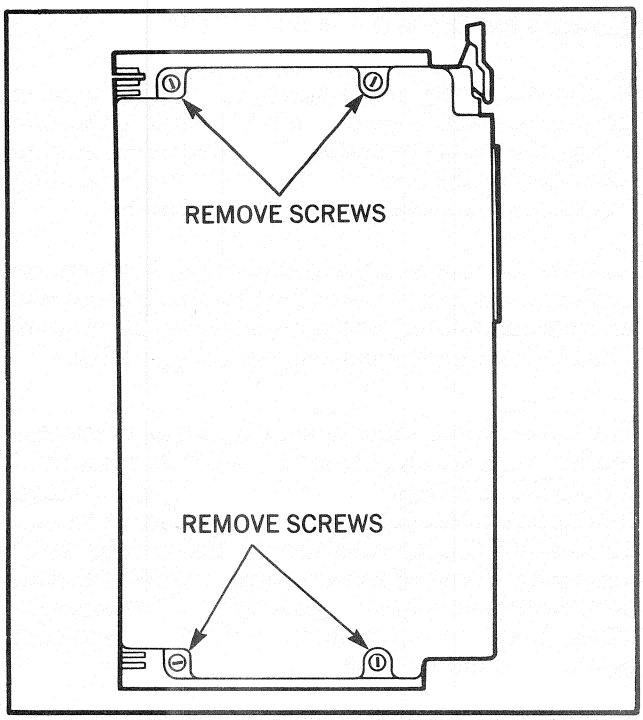



**FIGURE 4 — Removing Component Cover**

2. Refer to Figure 5. Identify the Programming Option Switch Assembly (Switch Assembly One) and the Input Configuration Switch Assembly (Switch Assembly Two).

3. Set the five switches (inset in Figure 5) according to the programming options that have been chosen. The settings for the Count Resolution switches (Times 1, 2, or 4) do not matter if the Counter mode has been selected. The tip of a ball point pen can be used to set the rocker arm of a switch. Do not use a pencil because the point can break off and jam the switch.

## OUTPUT CONFIGURATION

The selection of the output device that is connected to the Module is dictated by the type of Module being used. The 1771-IJ can interface directly to a device that operates at 5V DC. The device is connected directly across the output terminal and the output return terminal. The 1771-IK Module interfaces directly to any device that is compatible with the external voltage supply being used to power the Module. The outputs on both Modules are open-collector (no internal pullups). At full load, only .5V DC maximum will drop across an output on either Module, with the output on and conducting.

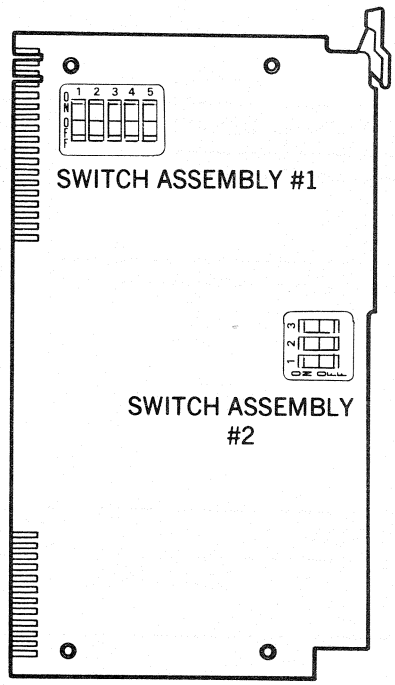
There are connections for two output devices, one at Output 1 and the other at Output 2. Output 1 is activated when the previously defined comparison relating to a value in Preset 1 is TRUE. Output 2 is activated when the comparison relating to the value in Preset 2 is TRUE. However, they may be disabled at any time by resetting the Output Enable Bit (Bit 12 in the Control Word). The outputs are also turned off whenever the Processor keyswitch is in the "Program Load" or "Test Monitor" positions.

Output devices on either Module can be of any voltage, up to 30 VDC, provided an external load power supply is used. However, the maximum current through either output is 500 mA and should not be exceeded, otherwise damage to the Module may occur.

With loads that have inductive characteristics, such as relays or solenoids, it is recommended to use external suppression devices. These devices should be connected across the terminals of the load, not across the output terminals of the Module. Failure to use supression devices with inductive loads may result in damage to the modules.

## PROGRAMMING

The Module uses four words of data to communicate with the Processor. Three words, the Control word and two Preset values, are sent from the Processor to the Module as output words and one, the Status word, is returned as an input word. The following discussion will explain the functon of the control bits. Although the information conveyed in the Output words are the same, the format varies between Single Transfer and Block Transfer. Refer to Figures 6 and 7 for specific location of the bits. Further programming information describing block transfer and single transfer applications is available in Publication 1771-807, "Programming for the 1771-IJ/IK.




**Switch Assembly "1" Settings for 1771-IK and 1771-IJ**

| | 1 | 2 3 | 4 | 5 |
|---|---|---|---|---|
| **ON** | SINGLE TRANSFER | SEE TABLE A | ENCODER MODE | BINARY |
| **OFF** | BLOCK TRANSFER | MULTIPLIER FOR COUNT RESOLUTION | COUNTER MODE | BCD |

**Switch Assembly "2" Settings for 1771-IJ**

| | 1 | 2 | 3 |
|---|---|---|---|
| | MARKER | CHAN. B | CHAN. A |
| **ON** | SINGLE ENDED | SINGLE ENDED | SINGLE ENDED |
| **OFF** | DIFFER-ENTIAL | DIFFER-ENTIAL | DIFFER-ENTIAL |

**Switch Assembly "2" Settings for 1771-IK**

| | 1 | 2 | 3 |
|---|---|---|---|
| **ON** | PULL-UP | PULL-DOWN | FILTER IN (150 Hz) |
| **OFF** | FLOAT | FLOAT | FILTER OUT (50K Hz) |

**FIGURE 5 — Switch Assembly Locations and Settings**

## OUTPUT WORD SELECT

**Single Transfer** programming Word Select (Bits 14, 15, 16, and 17) — In Single Transfer programming, since each of the three output words is sent to the Module through the single Output Image Table word, they must be labeled so the Module can identify which word it is receiving. For example, Bit 17 is set for the Output Control Word and Bits 15 and 16 are zero. Bit 16 is set to identify Preset 1 and Bit 15 is set to identify Preset 2. Refer to Figure 6.

| 17 | 16 | 15 | |
|---|---|---|---|
| 1 | 0 | 0 | Control Word |
| 0 | 1 | 0 | Preset 1 |
| 0 | 0 | 1 | Preset 2 |

Since **Block Transfer** moves words of data simultaneously, rather than one at a time, there is no need to label which word of data is being transferred. Therefore, the function of the Word Select bits (Bits 15, 16, and 17) in the Output words has been replaced and the output words restructured. Refer to Figure 7.

However, the Module will identify the output words by their order in the Data Table. The Control word must always be the first word in the block of data, followed immediately by the Preset 1 word, then the Preset 2. Since the Module uses bi-directional Block Transfer, the Input Status word will not appear in the Input Image Table. The appropriate programming must therefore be developed for the Input Status word, and a location assigned to it in the Data Table.

**SINGLE TRANSFER — CONTROL WORD**

WORD SELECT

A = ACC
B = PRESET

| 17 | 16 | 15 | 14 | 13 | 12 | 11 10 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | UP/ DOWN [1] | ENABLE OUTPUTS | FUNCTION CONTROL | HOME LATCH ENABLE | NOT ASSIGNED | A>B | A=B | A<B | A>B | A=B | A<B |
| | | | | | | | | | PRESET #2 → | | | ← PRESET #1 | | |

[1] ASSIGNED IN COUNTER MODE ONLY.

**PRESET 1**

WORD SELECT

| 17 | 16 | 15 | 14 | 13 — 10 | 07 — 04 | 03 — 00 |
|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 0 | BCD — MSD | BCD — MIDDLE DIGIT | BCD — LSD |

**PRESET 2**

WORD SELECT

| 17 | 16 | 15 | 14 | 13 — 10 | 07 — 04 | 03 — 00 |
|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0 | BCD — MSD | BCD — MIDDLE DIGIT | BCD — LSD |

**INPUT STATUS WORD**

| | 17 | 16 | 15 | 14 | 13-00 |
|---|---|---|---|---|---|
| INPUT WORD - INPUT FROM MODULE TO PROCESSOR | HOME | CARRY | BORROW | DIAGNOSTIC BIT | ENCODER ACCUMULATED VALUE |

**FIGURE 6 — Single Transfer Input and Output Words**

**BLOCK TRANSFER — CONTROL WORD**

| 17 16 15 14 13 12 11 10 07 06 05 | 04 | 03 | 02 | 01 00 |
|---|---|---|---|---|
| ← NOT ASSIGNED → | HOME LATCH ENABLE | UP/ DOWN [1] | ENABLE OUT-PUTS | FUNC-TION CON-TROL |

[1] ASSIGNED IN COUNTER MODE ONLY

**PRESET 1**

| 17 | 16 | 15 | 14 | 13 — 00 |
|---|---|---|---|---|
| ACC > PRESET 1 | ACC = PRESET 1 | ACC < PRESET 1 | NOT USED | PRESET 1 |

**PRESET 2**

| 17 | 16 | 15 | 14 | 13 — 00 |
|---|---|---|---|---|
| ACC> PRESET 2 | ACC = PRESET 2 | ACC < PRESET 2 | NOT USED | PRESET 2 |

NOTE: THE THREE OUTPUT WORDS MUST APPEAR IN THIS ORDER IN THE DATA TABLE

**INPUT STATUS WORD**

| | 17 | 16 | 15 | 14 | 13-00 |
|---|---|---|---|---|---|
| INPUT WORD - INPUT FROM MODULE TO PROCESSOR | HOME | CARRY | BORROW | DIAGNOSTIC BIT | ENCODER ACCUMULATED VALUE |

**FIGURE 7 — Block Transfer Input and Output Words**

## OUTPUT CONTROL BITS

Comparisons for Output 1 - Setting one or more of these bits define the onboard comparison between the Accumulated and Preset 1 values. Whenever the comparison is true, Output 1 will turn on. For example, if Bits 01 and 02 in Single Transfer are set (Logic "1"), then Output 1 is energized when the Accumulated number of pulses (in either the Encoder or Counter mode) is equal to or greater than the Preset value as sent from the Processor in Preset 1 Output Word. Note that in Block Transfer the comparison is carried in the corresponding Preset word.

Comparisons for Output 2 — Setting one or more of these bits define the comparison between the Accumulated and Preset 2 values. Whenever the comparison is true, Output 2 will turn on. For example, if Bits 04 and 05 in Single Transfer are set (Logic "1"), then Output 2 is energized when the Accumulated number of pulses (in either the Encoder or Counter mode) is equal to or greater than the Preset value as sent from the Processor in Preset 2 Output Word.

Home Latch Enable — This bit must be set (Logic "1") and the Marker and Limit Switch inputs must be high (ON) for the Home bit in the Input Status word to be set. The counter will reset and stay reset as long as the Home Latch Enable Marker, and Limit switch are all TRUE. The Home Latch Enable bit can be set from the program by comparing the Accumulated value in the Status word with some fixed value in the program, or it can be set from some external device. This allows the Processor to ignore the Marker signal until it is close to Home. This bit works in either the Encoder or Counter mode. Once set, the Home bit will remain set until the Home Latch Enable bit is reset.

Function Control — These bits determine when the Module will count or be reset. They operate in either the Encoder or Counter Mode. Notice that both bits cannot be set at the same time.

| SINGLE TRANSFER | | | BLOCK TRANSFER | |
|---|---|---|---|---|
| 11 | 10 | | 01 | 00 |
| 0 | 0 | Count | 0 | 0 |
| 0 | 1 | Reset, and hold the Accumulated count at zero. | 0 | 1 |
| 1 | 0 | Return the Accumulated count to zero and begin counting immediately. | 1 | 0 |
| 1 | 1 | Invalid, Module retains previously programmed function. | 1 | 1 |

Enable Outputs --This bit must be set (Logic "1") for the outputs to be energized. Resetting this bit to zero will turn off both outputs.

Count Direction -- This bit is functional only when the Module is in the Counter mode. This bit needs to be set for the Module to count up. If it is reset (Logic "0"), the Module will count down. If external count direction from a device wired to Channel B is used, then the Count Direction Bit must be set (Logic "1").

Bits 06 and 14 of the control word in Single Transfer are unassigned and have no effect on the operation of the Module.

In Block Transfer Bits 5 through 17 of the Control Word and Bit 14 in the Presets are unassigned and have no effect on the operation of the Module.

## OUTPUT PRESET VALUES

There are two Preset words; each one functions in the appropriate comparison established in the Control word. When the Accumulated value is within the limits defined by the Control, the corresponding Output is made TRUE and is turned on, provided the Output Enable bit is set.

The first twelve bits of each Preset word contain the Preset value. If the Programming Option switch is set for BCD, then these bits contain the value as a Binary Coded Decimal. The maximum number that can be inserted in BCD is 999. If a non-valid BCD code is inserted into one of the 4 bit BCD groups, the entire value is set to 000 by the Module. If the switch is set for Binary, then the first twelve bits will be interpreted by the module as a binary number. The Input Status word will also display the Accumulated value in binary. At this time, each bit must be set individually. The maximum number that can be inserted in binary is $4095_{10}$.

In Single Transfer, Bit 16 is set to identify Preset 1 word to the Module. Bit 15 is set to identify Preset 2 to the Module. All other unassigned bits are left at zero.

## INPUT STATUS WORD

This word will appear in the Input Image Table at the Module's address in Single Transfer. It can be monitored from that location or shifted eslewhere in the Data Table. The format is the same for Block Transfer and Single Transfer.

The first twelve bits (Bits 00 to 13) contain the Accumulated value as it is stored in the Module's memory at the time of the transfer. Since the speed of the transfer is dependent on scan time, the Accumulated value as it appears at the Processor may not be the actual count at the Module. If high speed decisions must be performed, the comparisions established in the Control word that will

energize the hardwired output of the Module allow a very fast response by the control system.

Diagnostic (Bit 14) — If this bit is set, it means that the Module has detected a fault in its internal processes. If the Diagnostic LED is illuminated, Bit 14 will also be set. This bit should be monitored in the program to signal the operator if there is a fault.

Borrow (Bit 15) -- This bit indicates that the Accumulated value, in counting down, has reached zero and decremented once more. As this bit is set, the count changes to 999 in BCD, or 4095 (decimal) in Binary. The Borrow bit can be used to cascade counters in the program to register a much larger count than that kept on the Module. This bit will stay set until the count reaches zero again and is decremented once more, at which time it will toggle back to zero. The bit will continue changing state as long as the count decrements past zero. The bit will also reset anytime the Module is powered-up. It will not reset from the Function Control bits or from setting the Home bit.

Carry (Bit 16)--This bit indicates that the Accumulated value, as kept on the Module, has counted past the maximum value of the data format (999 in BCD or 4095 in binary). . As this bit is set, the Module resets to zero and continues counting. The Carry bit can be used to cascade counters in the program to register a much larger count than that kept on the Module. This bit will stay set until the count reaches the maximum again, at which time it will reset and the count will again go to zero. This bit will continue changing state as long as the count keeps cycling past its maximum value. The bit will also reset at power-up. It will not reset from the Function Control bits or from setting the Home bit.

Note: The cycling of the Carry or Borrow bit should be long enough to be detected by the program. Since the program scan time is application dependent, no specific values can be given. However, the Carry or Borrow bit will toggle at 1/1000 the frequency of the input pulses (in BCD) at a Times 1 Count Resolution setting. The reciprocal of this value, that is the period of time the Carry or Borrow bit is in its ON or OFF state, should be longer than the program scan plus any I/O update time. With the Count Resolution set for Times 2 or Times 4, or with a long program, it may be necessary to request the Input Status word several times during the program scan with Immediate I/O instructions (not available on the PLC Processor).

Home (Bit 17)--The Home bit is set whenever the Marker input is high, the Limit Switch input detects a TRUE voltage, and the Home Latch Enable bit in the Control word is set. This allows the control system to establish a reference point, or home position. The Accumulated count is also reset to zero and held there until either the Marker or the Limit Switch inputs return to a Logic "0" state. However, the Home bit will stay set, even if the Marker or Limit Switch are reset, until the Home Latch Enable bit in the Control word is reset to Logic "0". This permits the Processor to detect the Home bit, even if the Marker signal is very short. The Home Latch Enable bit can be toggled in the program if necessary to turn off the Home bit.

## SYSTEM POWER

System power is supplied through the I/O chassis backplane from the Rack Power Supply. The Module requires a current of 1.4 Amp from the 5V DC output of this supply. This amount should be totalled with the current requirements of other modules in the rack to avoid overloading the supply.

## EXTERNAL POWER

The Module requires an external power supply connected to the Field Wiring Arm. For the 1771-IJ, the supply must be able to deliver 140 mA at 5V DC with less than 50 mV ripple, peak-to-peak. The 1771- IK requires 110 mA at 12V DC or 200 mA at 24V DC, with less than 50 mV ripple, peak-to-peak. These requirements are for the Module only. The current requirements of all output devices, if they are to be driven directly from the Module, must be added to the requirements of the Module.

It is also possible to drive output devices from a separate load supply, using the output on the Module only as a switch. When the output is ON and conducting, a maximum of .5V DC is dropped across it. The load supply voltage should not exceed 30V DC. Refer to Figure 8 for the necessary modifications to the wiring diagram.

The power for the input device can be provided by the Module's external power supply, but, unlike the power for the output device, this is not available through the Module. If a high degree of isolation is needed, a separate input power supply can be used.

If the Limit Switch is used, the Limit Switch input is configured to accept an ON voltage of 12 to 48V DC, requiring a maximum of 10 mA at 48V DC.

## WIRING

**CAUTION:** Do not remove the Module from or insert the Module into the Chassis while the I/O rack power is ON. Failure to observe this rule may result in damage to the Module's circuitry.

The Module may be placed in any 1771 I/O rack and group with a rack. However, the Module must only be inserted in a single Module group; it cannot straddle two groups. To mimimize noise, group low voltage input modules together within a single I/O chassis whenever possible.

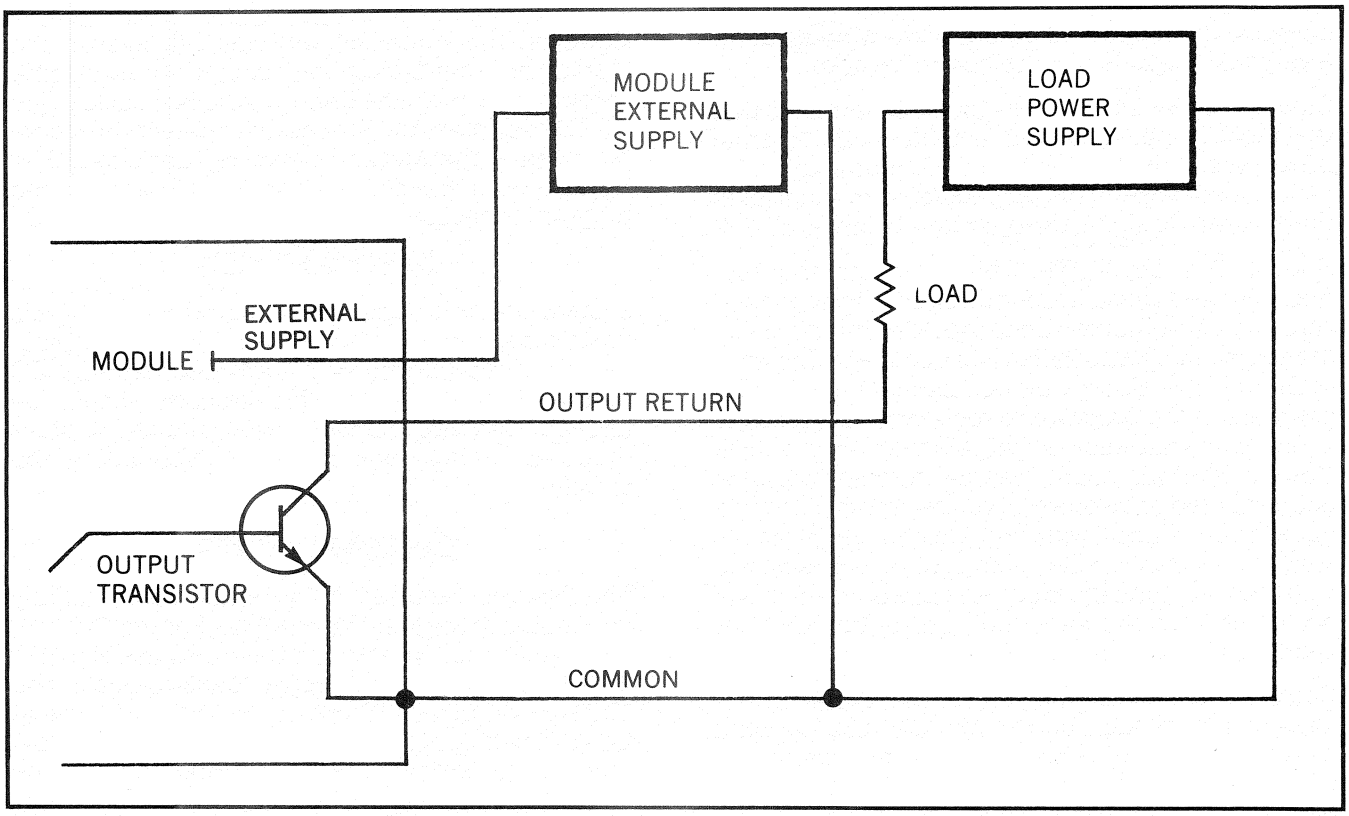



**FIGURE 8 — Modification of Output Circuit for Application of Separate Loads Power Supply**

Use the proper cable to connect the input devices to the Module's Field Wiring Arm. Follow the appropriate Connection Diagram (Figures 11 and 12). Input devices cannot be more than 40 cable feet from the Module.

Belden 8761 cable can be used for applications with a signal below 20K Hz; Belden 9182 cable is recommended for higher frequencies. Belden 8725 cable is a 4-twisted pair cable recommended for encoder applications below 20K Hz.

Refer to Figure 9. Belden 9182 cable has a foil shield with a bare drain wire. The drain wire should be connected to the enclosure ground at an I/O chassis mounting bolt or stud. However, no more than two inches should be cut back from the cable ends. Only one end of the cable ground should be connected. The foil and drain at the other end of the cable, which connects to the device, should be cut short and taped back to insulate it from any electrical contact.

## KEYING

In initial design stages, the Encoder/Counter Module (Cat. No. 1771-IJ or Cat. No. 1771-IK) may be inserted into any I/O module group in the I/O chassis. However, once a group has been designated for a module, care should be taken so that other types of modules will not be placed into these

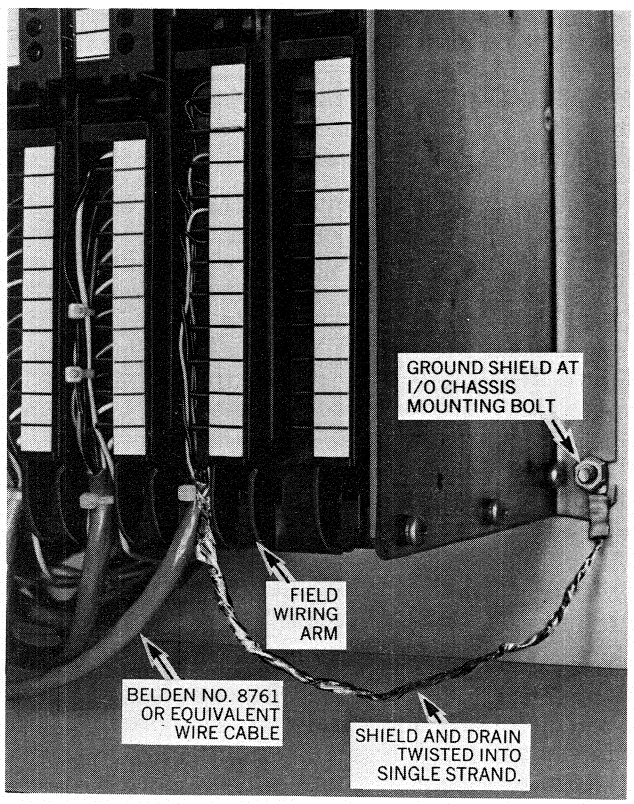



**FIGURE 9 — Wiring of Shield to Chassis**

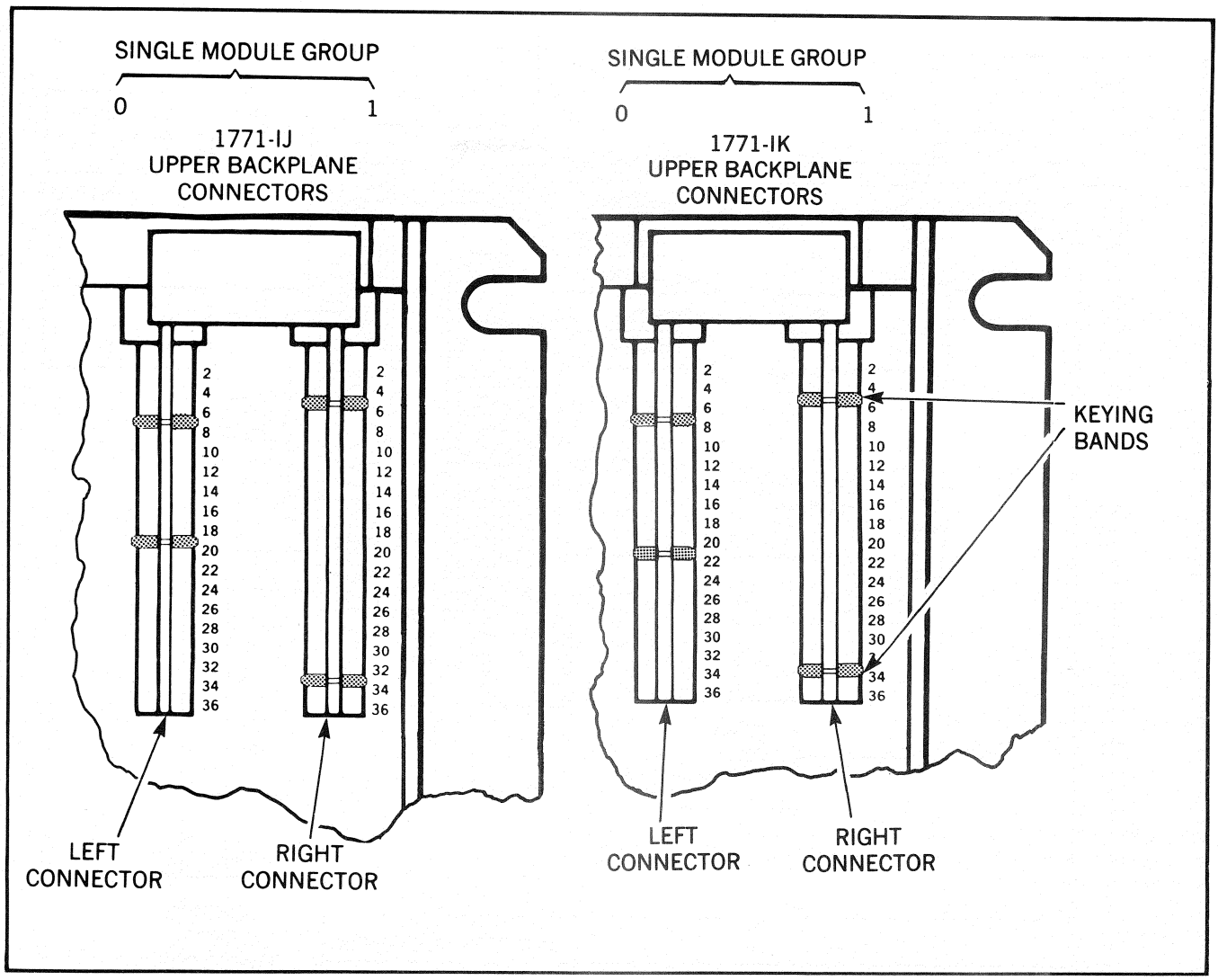



**FIGURE 10 — Keying Positions**

slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for keying an I/O slot to accept only one type of module. Use of these keying bands is strongly recommended.

The module is slotted in two places on its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. The I/O rack backplane connectors of any module group can be keyed to accept the Encoder/Counter Module Assembly.

Refer to Figure 9. Because the Module uses two slots, both slots have to be keyed. Snap the keying bands on the upper backplane connectors between these numbers printed on the backplane. The keying is different for the 1771-IJ and the 1771-IK:

| Left Connector | Right Connector |
|---|---|
| 1771-IJ | |
| 6 and 8 | 4 and 6 |
| 18 and 20 | 32 and 34 |
| 1771-IK | |
| 6 and 8 | 4 and 6 |
| 20 and 22 | 32 and 34 |

The position of the these keying bands may be changed if subsequent system design and rewiring makes insertion of a different type of module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

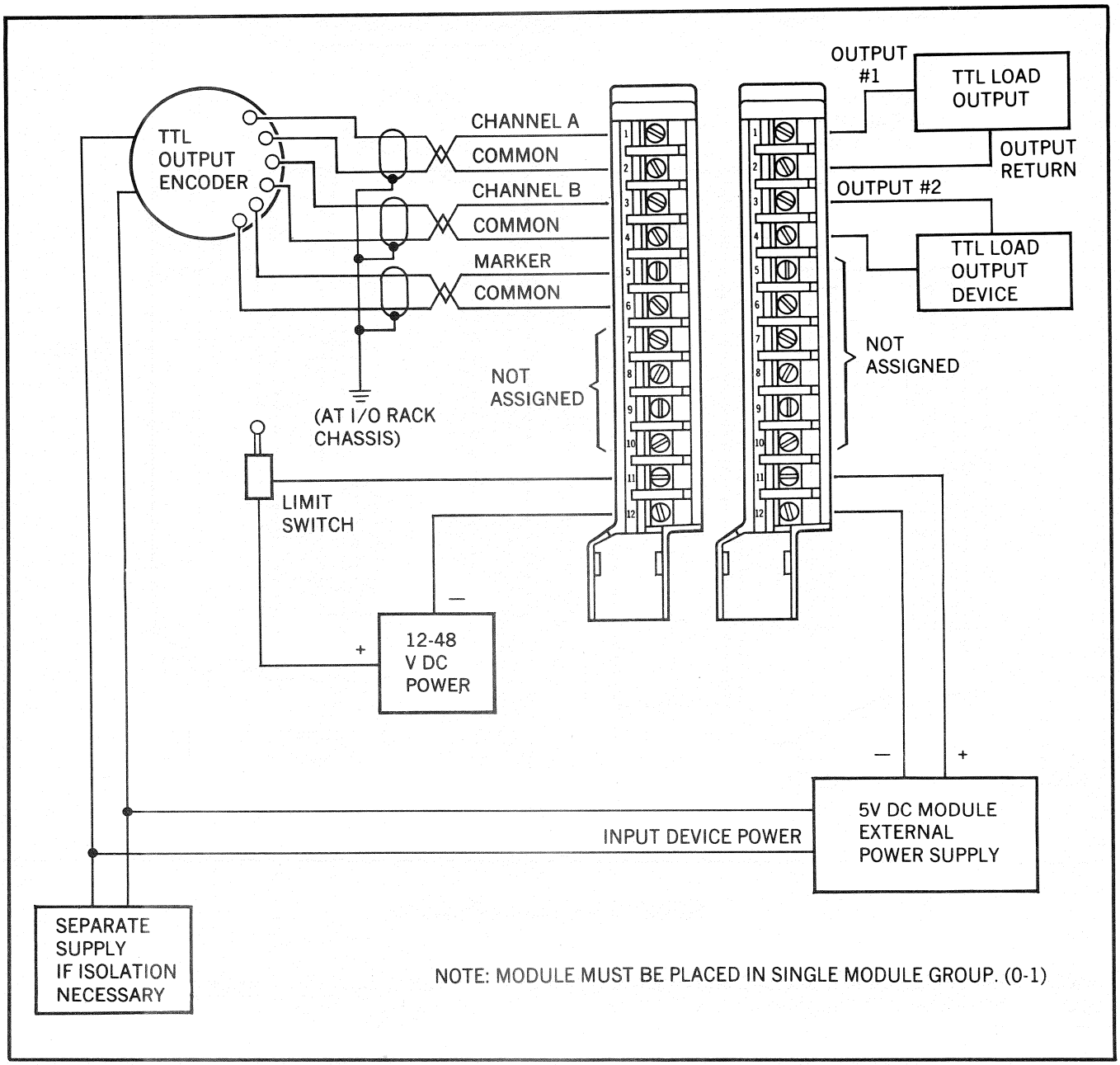



**FIGURE 11 — Connection Diagram Showing Typical 1771-IJ Encoder Application**

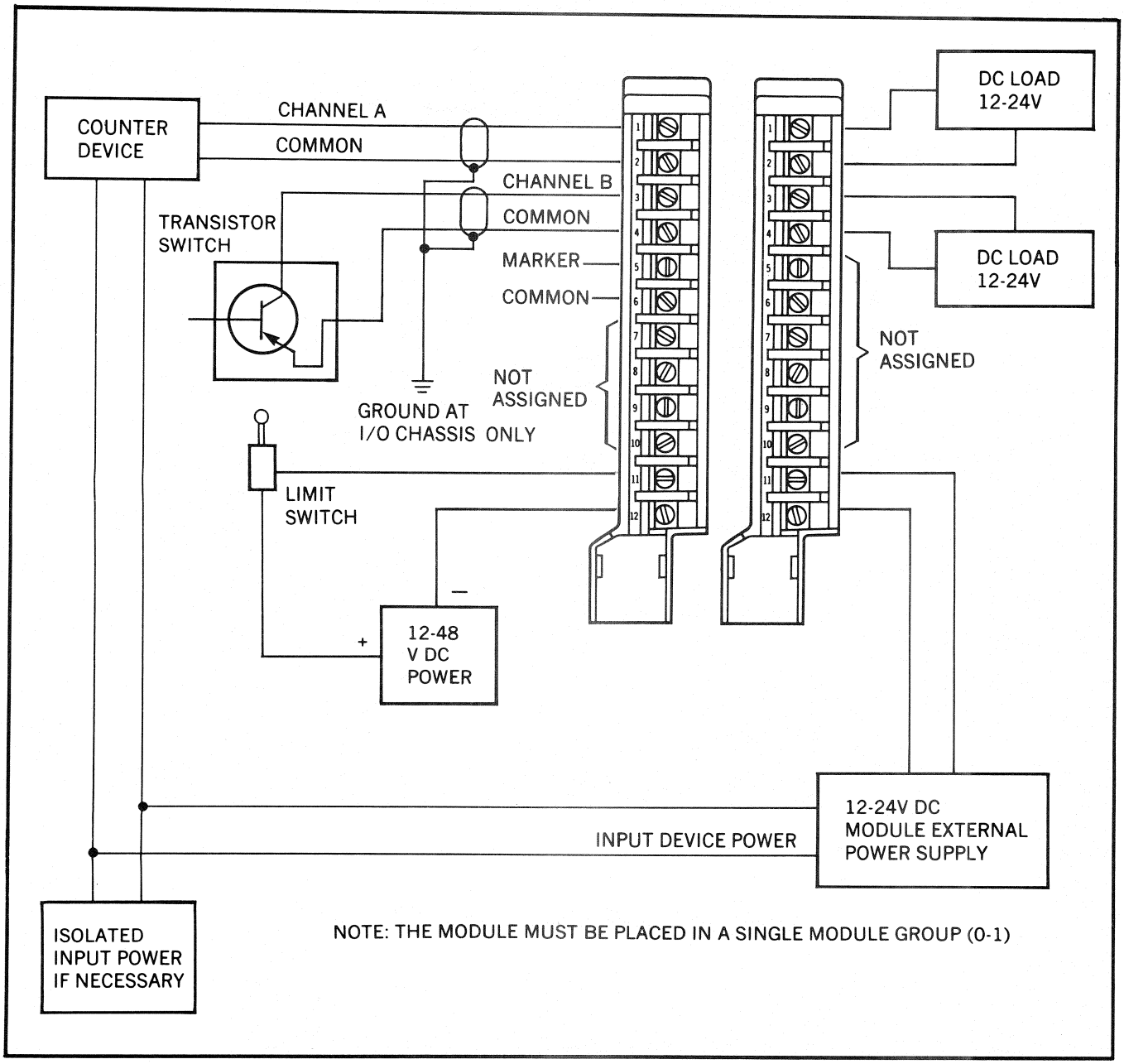


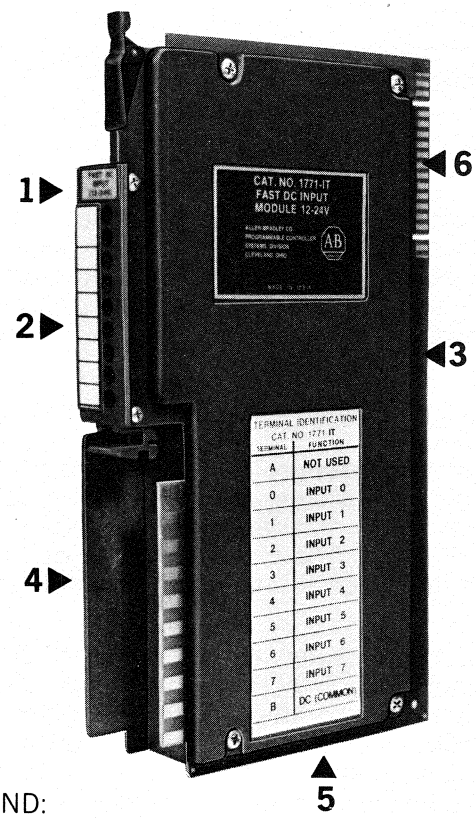

**FIGURE 12 — Connection Diagram Showing Typical 1771-IK Counter Applications with External Count Direction**

ALLEN-BRADLEY
Cleveland, Ohio 44143

P/N 955090-04

# FAST RESPONSE DC INPUT MODULE

## Cat. No. 1771-IT




LEGEND:

1. Blue identification label
2. Status indicators
3. Protective cover
4. Field Wiring Arm connects here
5. Labels identify user devices
6. Slotted for I/O rack insertion only

## DESCRIPTION

The Fast Response DC Input Module (Cat. No. 1771-IT) converts, with a maximum one millisecond delay time, the voltage levels from customer devices to logic levels that are compatible with the Programmable Controller Processor. Typical devices that benefit from this very short delay are photoelectric switches, incremental encoders, and DC proximity switches. The Module, as part of the 1771 I/O Structure, is compatible with any member of the PC Controller family employing 1771 I/O Racks.

**CAUTION:** The Fast Response DC Input Module may not be suitable for use with hard contact devices because its fast response could register contact sources as input data. A DC Input Module (Cat. No. 1771-IB) is recommended for interfacing with hard contact switches.

## SPECIFICATIONS

**Inputs per Module**
8

**Module Location**
I/O Chassis

**Nominal Input Voltage**
12-24V DC

**Input**
Voltage Range

| Logic 0 | | Logic 1 | |
|---|---|---|---|
| Min | Max | Min | Max |
| 0V | 4V | 10V | 27V |

**Nominal Input Current**
12V DC: 8 mA
24V DC: 24 mA

**Input Signal Delay (Typical)**
1ms maximum

**Input Impedance**

| ON | OFF |
|---|---|
| 1K-2K ohms | 2K-3K ohms |

**Electrical-Optical Isolation**
1500V RMS
Isolation is between the input circuitry and control logic circuitry

**Power Supply Current Requirement**
74 mA per Module

**Ambient Temperature Rating**
0° to 60°C (operational)
— 40° to 85°C (storage)

**Humidity Rating**
5 to 95%
(without condensation)

**Keying**
Modules are slotted for insertion into I/O slots only.
Insert keys between 6 and 8, 32 and 34

**Wire Size**
14 ga. stranded (max.)
3/64" insulation (max.)

## STATUS INDICATORS

Eight status indicators are located on the front of the Module. (Refer to Figure 1.) Each of these indicators corresponds to a single Module input terminal. When an input is ON, its corresponding status indicator illuminates.

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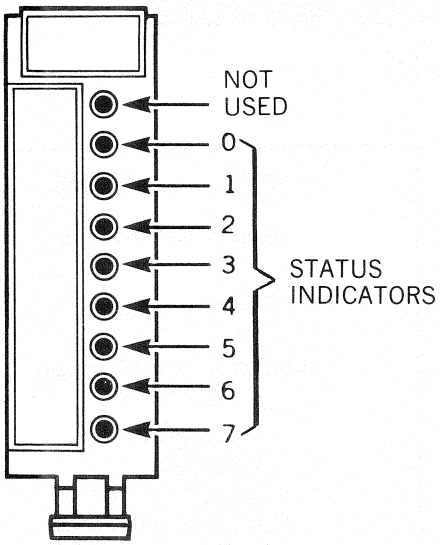



**FIGURE 1 - Status Indicators**

These LED indicators provide a useful troubleshooting aid. By comparing the indicator with its corresponding input device, an operator can quickly identify certain hardware-related faults.

The Module status indicators are driven from the customer power supply.

## POWER SUPPLY REQUIREMENTS

The logic circuitry of the Fast Response DC Input Module is driven by the Power Supply which connects to the I/O Chassis backplane. The Module requires a current of 74 mA from the 5V DC output of this supply. This amount should be totalled with the current requirements of other modules in the rack to avoid overloading the supply.

## PROGRAMMING

Although an input on the Module may be examined by standard programming techniques, the fast response time is most advantageously used with Immediate I/O instructions. When designing a quick response control system, care should be taken in choosing devices that have a pulse width that can be sensed by the Controller. Without the Immediate Input instructions a signal should be present for at least one I/O scan. This delay is a function of the type of Processor and the size of the particular program. With the Immediate Input instruction, the signal should be present for at least 5 msec. These considerations, plus the update time of the output module and the 1 msec delay of the Fast Response DC Input Module, contribute to the total response time of the control system.

Programming instructions that can be used to examine an input for a voltage condition are:

- ] [ Examine ON
- ]/[ Examine OFF
- [I] Immediate Input (not available with the PLC Controller)

## INPUT CIRCUITRY

The Fast Response DC Input Module provides eight inputs for DC devices. The module senses the voltage at each input terminal to determine the ON/OFF status of the connected device. The voltage range for each of these states is as follows:

- ON — 10V-27V DC
- OFF — 0-4V DC

The input filter circuitry limits the effects of voltage transients. (Transients, common to noise-polluted industrial environments, could be falsely interpreted if input filtering is not provided.) This filtering introduces a maximum signal delay of 1 msec.

In each input circuit, electrical-optical isolation provides protection for the Module's logic circuitry from high-voltage transients along the input line. The electrical-optical isolation is rated at 1500 VRMS. The module also has circuitry to guard against damage from the application of reverse DC voltage.

The signal source must be capable of driving a minimum of 8 mA of source current at 12V or 24 mA of source current at 24V.

The OFF state leakage current of an input device should not exceed 1 mA at the indicated input impedance. Additionally, the input devices must be capable of driving the minimum source current into the indicated input impedance.

## CONNECTIONS

Customer input devices connect to a Field Wiring Arm (Cat. No. 1771-WA) which can be removed from the Bulletin 1771 I/O Chassis. (Refer to Figure 2.) The Field Wiring Arm pivots on the front of the Chassis to connect with Module terminals. Because wiring connections are made on the Wiring Arm, a module can be removed from the I/O Chassis without the need to disconnect the wiring.

The Connection Diagram illustrates the Fast Response DC Input Module connections. A label on the side cover also identifies the Field Wiring Arm terminal connections to the Module. Additional space for user labeling is provided on the front of the Module and on the Wiring Arm itself.

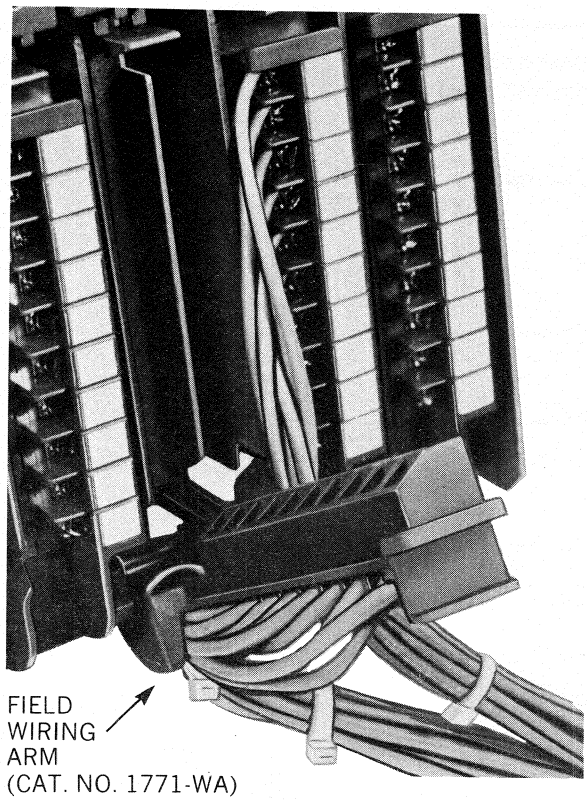



**FIGURE 2 - Field Wiring Arm**

Outputs from a DC Output Driver Module (Cat. No. 1771-OB) can be used to directly drive inputs to the Fast Response DC Input Module provided proper voltage levels are maintained. It is recommended that the same DC supply drive both Modules to assure that the common is at the same potential. (Refer to Figure 3).

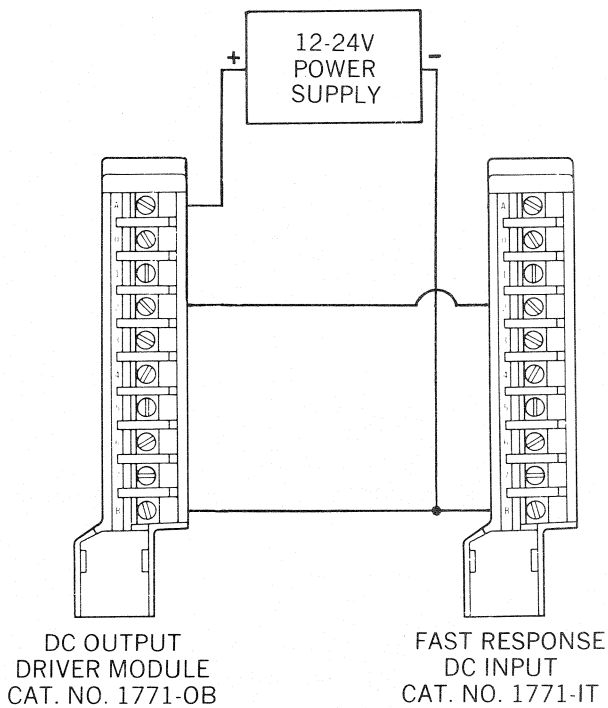



**FIGURE 3 - Connection Diagram for Interfacing Two Controllers**

## KEYING

In initial design stages, the Fast Response DC Input Module may be inserted into any I/O module slot of the I/O Chassis. However, once specific slots have been designated for a module, care should be taken so that other types of modules will not be placed into these slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for keying an I/O slot to accept only one type of I/O module. Use of these keying bands is strongly recommended.

Each type of I/O module is slotted in two places at its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed solely to receive the Fast Response DC Input Module (Cat. No. 1771-IT).

Refer to Figure 4. Snap the keying bands onto the upper backplane connector between these numbers printed on the backplane:

- Between 6 and 8
- Between 32 and 34

The position of these bands may be changed if subsequent system design and rewiring make insertion of a different type of Module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

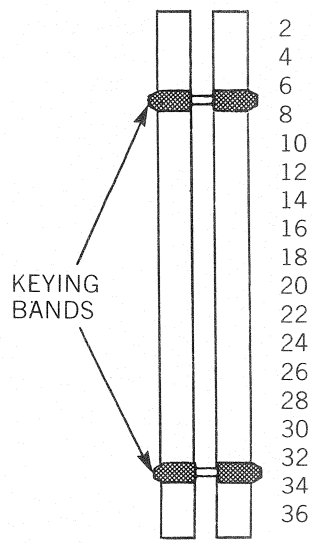
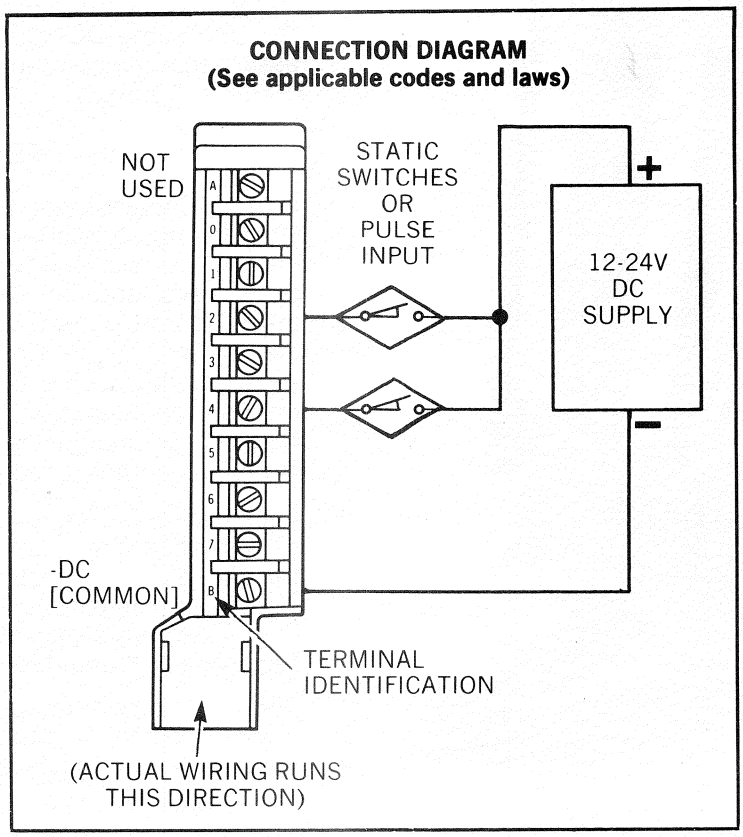


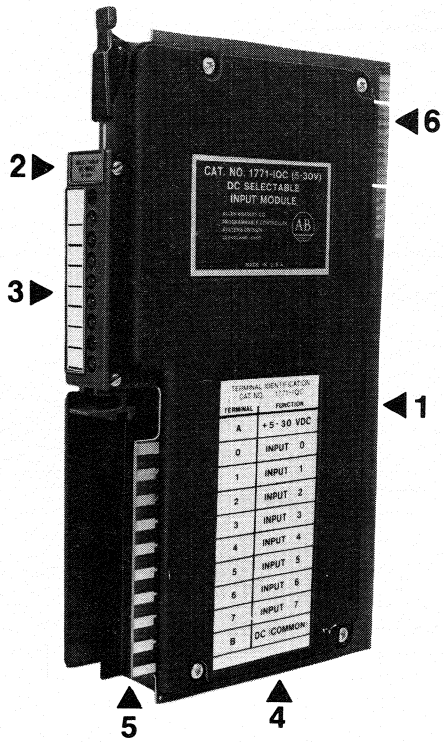

**FIGURE 4 - Keying Diagram**




ALLEN-BRADLEY
Cleveland, Ohio 44143

P/N 636047-60

# ALLEN-BRADLEY
# DC (5-30V) SELECTABLE INPUT MODULE ASSEMBLY
## Cat. No. 1771-IQ




1. Protective cover
2. Blue identification label
3. Status indicators
4. Label identifies user connections
5. Field Wiring Arm connects here
6. Slotted for I/O slot insertion only

### DESCRIPTION

The DC (5-30V) Selectable Input Module Assembly (Cat. No. 1771-IQ) contains interface circuitry required to convert 8 inputs to the logic levels required by the PC Processors. Each input circuit is individually selectable for current source or current sink capability with customer DC input devices. With current flowing from the DC input device to the Module Input (Figure 1a), the Module Input is defined as sinking current. With the current flowing from the Module Input to the DC input device (Figure 1b), the Module Input is defined as sourcing current.

The Module may be selected to operate with either HIGH TRUE or LOW TRUE logic with an input delay of either 1 ms maximum or 12 ms typical.

With this Module, the Controller can interface with a wide variety of input devices: limit, selector, push-button, proximity and photoelectric switches, and TTL compatible devices. Open collector TTL current sinking devices may be interfaced to a Module current sourcing input.

The DC (5-30V) Selectable Input Module Assembly (Cat. No. 1771-IQ) consists of one each of the following units:

- DC (5-30V) Selectable Input Module (Cat. No. 1771-IQC)
- 10 Terminal Field Wiring Arm (Cat. No. 1771-WC)

### PROGRAMMING

The status of an individual input is examined by the Instructions in the user's program. Programming instructions that can be used to examine an input are:

-] [- Examine input for an energized (ON) state

-]/[- Examine input for a de-energized (OFF) state

### SPECIFICATIONS

**Inputs Per Module**
8

**Module Location**
I/O Rack

**Maximum Allowable Input**
Logic Voltage Range
5-30V DC

**Input Voltage Rating**
HIGH = TRUE
ON > 40% of
Customer Supply Voltage
OFF < 20% of
Customer Supply Voltage
LOW = TRUE
ON < 20% of
Customer Supply Voltage
OFF > 40% of
Customer Supply Voltage

**Nominal Input Current**
per Input (ON)
5V DC: 5 mA
30V DC: 25 mA

**Input Impedance**
1.2K Ohms Nominal

**Selectable Input Delay**

| Normal | Fast |
|---|---|
| 5 ms (min) | 1 ms (max) |
| 12 ms (typical) | |
| 26 ms (max) | |

**Customer Power Supply Current Requirements**
(All inputs ON and connected for source capability)
100 mA per Module @ 5V DC
350 mA per Module @ 30V DC

**Electrical-Optical Isolation**
1500V
Isolation is between input circuitry and control logic circuitry

**Ambient Temperature Rating**
0° to 60°C (operational)
—40° to 85°C (storage)

**(continued)**

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**SPECIFICATIONS (continued)**

**Humidity Rating**
5 to 95%
(without condensation)

**Wire Size**
14 ga. stranded (max.)
3/64" insulation (max.)

**Keying**
Modules are slotted for insertion into I/O slots only. Insert keys between 6 and 8, 24 and 26

## STATUS INDICATORS

Eight status indicators (Figure 2) are located on the front of the Module. Each of these indicators corresponds to a single circuit within the Module. When the input to a specific circuit is TRUE (whether the Module is selected for HIGH TRUE or LOW TRUE logic), its corresponding status indicator will illuminate.

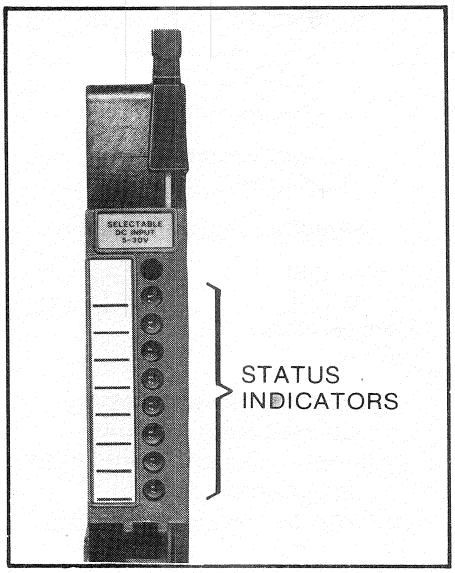



**FIGURE 2 — Status Indicators**

## SWITCH SELECTABLE OPTIONS

The Module (Figure 3) has certain options that are selected by setting switches on the following switch assemblies:

- Module Option Switch Assembly (SW-1) — Refer to Figure 3. Switches on this assembly determine whether the Module may operate with either HIGH TRUE or LOW TRUE logic and with an approximate input delay of 1 ms maximum to 12 ms typical.
- Input Sink Capability Switch Assembly (SW-2) — Refer to Figure 3 and Table A. Switches on this assembly individually select an input to operate with Sink capability.
- Input Source Capability Switch Assembly (Sw-3) — Refer to Figure 3 and Table B. Switches on this assembly individually select an input to operate with source capability.

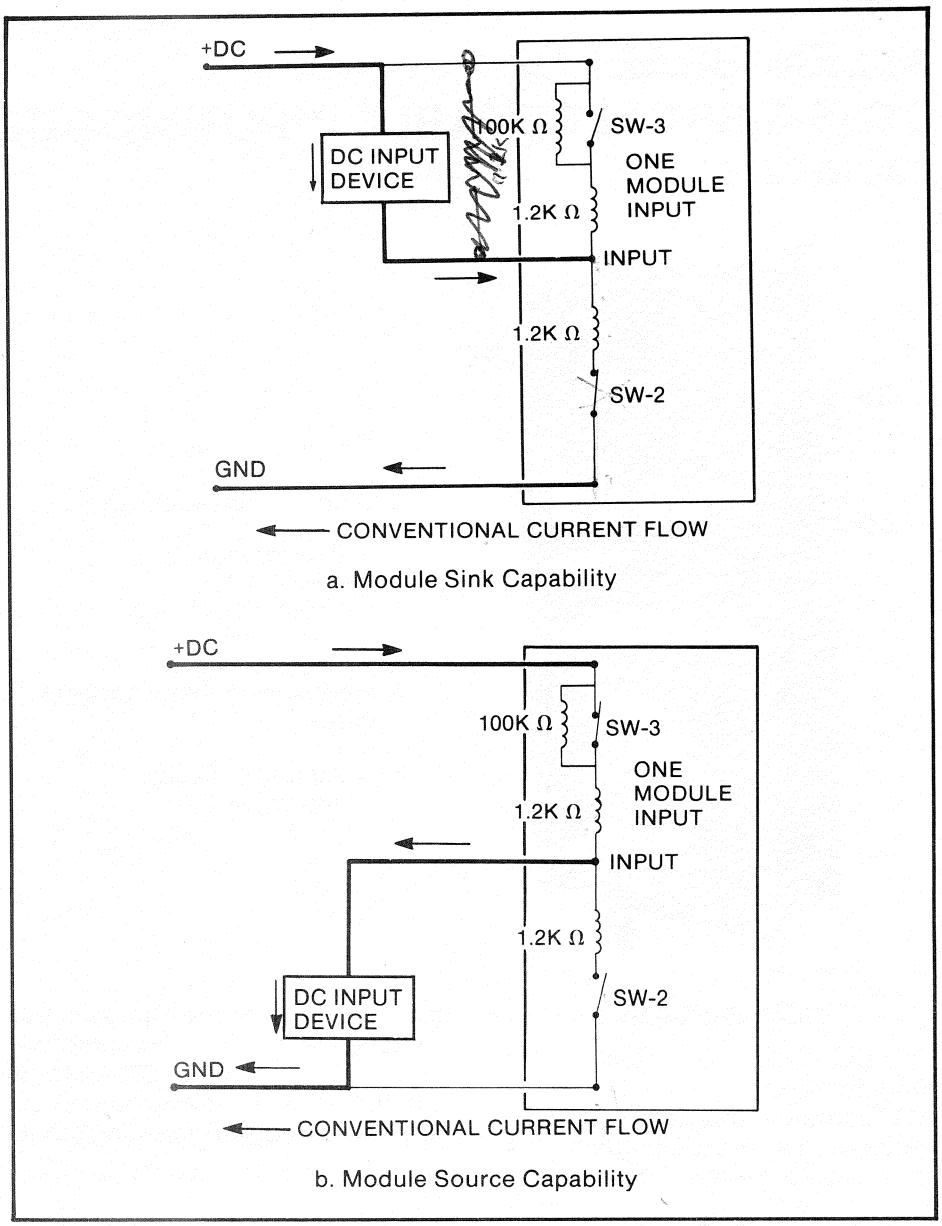



**FIGURE 1 — Sink and Source Capability**

## POWER SUPPLY REQUIREMENT

The logic circuitry of the DC (5-30V) Selectable Input Module (Cat. No. 1771-IQ) is powered by the Power Supply which connects to the I/O Chassis backplane. The Module requires a maximum current of 150 mA from the +5V DC output of this Supply. This amount should be totalled with the current requirements of other modules in the rack to avoid overloading I/O rack or power supply.

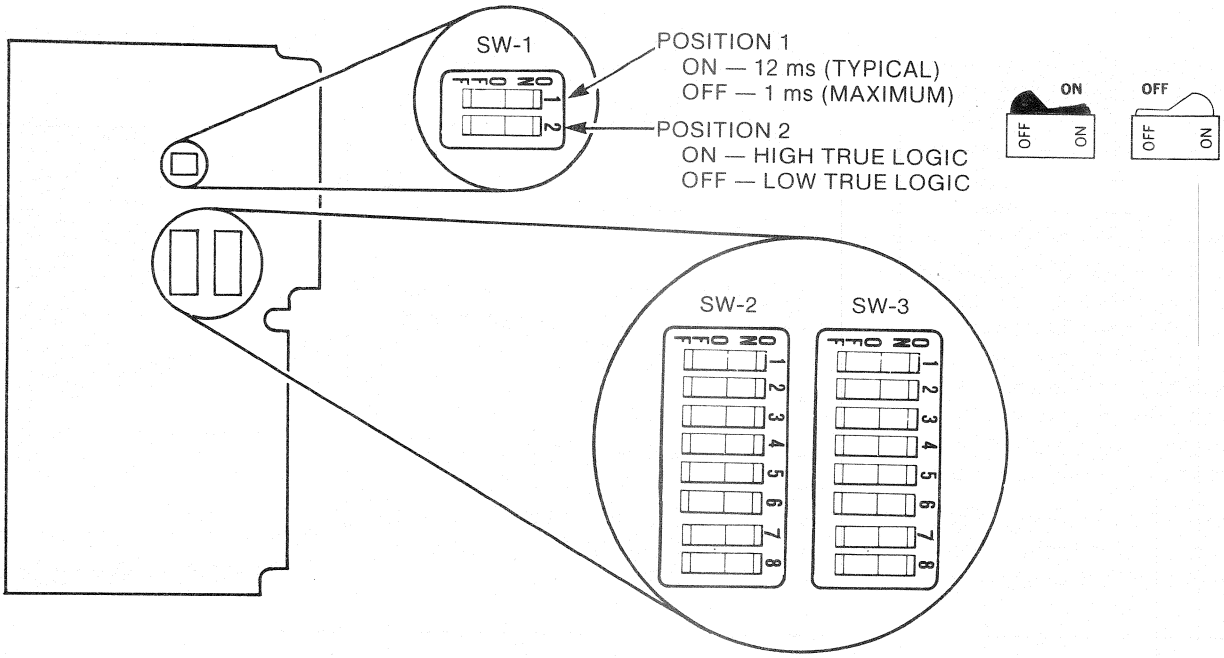



**TABLE A — Input Sink Capability Switch Settings**

| | SW-2 SINK | SW-3 SOURCE |
|---|---|---|
| Input 0 — Switch 1 | ON | OFF |
| Input 1 — Switch 2 | ON | OFF |
| Input 2 — Switch 3 | ON | OFF |
| Input 3 — Switch 4 | ON | OFF |
| Input 4 — Switch 5 | ON | OFF |
| Input 5 — Switch 6 | ON | OFF |
| Input 6 — Switch 7 | ON | OFF |
| Input 7 — Switch 8 | ON | OFF |

**TABLE B — Input Source Capability Switch Settings**

| | SW-2 SINK | SW-3 SOURCE |
|---|---|---|
| Input 0 — Switch 1 | OFF | ON |
| Input 1 — Switch 2 | OFF | ON |
| Input 2 — Switch 3 | OFF | ON |
| Input 3 — Switch 4 | OFF | ON |
| Input 4 — Switch 5 | OFF | ON |
| Input 5 — Switch 6 | OFF | ON |
| Input 6 — Switch 7 | OFF | ON |
| Input 7 — Switch 8 | OFF | ON |

**FIGURE 3 — DC (5-30V) Selectable Input Module Switch Assemblies**

## CONNECTIONS

**CAUTION:** The Module must not be removed from or inserted into the Bulletin 1771 I/O Chassis while system power is ON. Failure to observe this rule may result in damage to Module circuitry.

A single customer DC power supply is required to power the user side of the Module.

User input devices connect to a Field Wiring Arm (Cat. No. 1771-WC) which is a removable part of the Bulletin 1771 I/O Chassis. (Refer to Figure 4.) The Field Wiring Arm pivots on the front of the Chassis to connect with the Module printed circuit board. Because wiring connections are made on the Wiring Arm, a module can be removed from the I/O Chassis without the need to disconnect user wiring. This aids troubleshooting and allows ease of controller expansion.

The user must connect each user input device to the appropriate Wiring Arm terminal. The typical Connection Diagram (Figure 6) illustrates Module connections. A label on the side cover also identifies the Field Wiring Arm terminal connections to the Module. Additional space for user labeling is provided on the front of the Module and on the Wiring Arm itself.

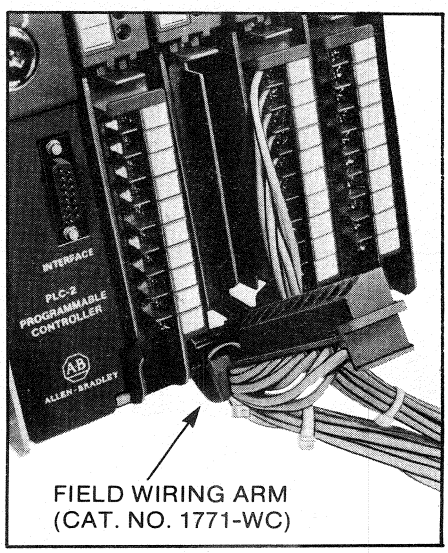



**FIGURE 4 — Field Wiring Arms**

## KEYING

During initial Controller system design stages, the DC (5-30V) Selectable Input Module may be inserted into any I/O module slot of the I/O Chassis. However, once specific slots have been designated for a module, care should be taken so that other types of modules will not be mistakenly placed into these slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for the user to key an I/O slot to accept only one type of I/O module. Use of these keying bands is strongly recommended.

Each type of I/O module is slotted in two places at its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed solely to receive the DC (5-30V) Selectable Input Module (Cat. No. 1771-IQC).

Refer to Figure 5. For the DC (5-30V) Selectable Input Module, position keying bands on the upper backplane connector between these numbers printed on the backplane:

- Between 6 and 8
- Between 24 and 26

The position of these bands may be changed by the user if subsequent system design and rewiring make insertion of a different type of Module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

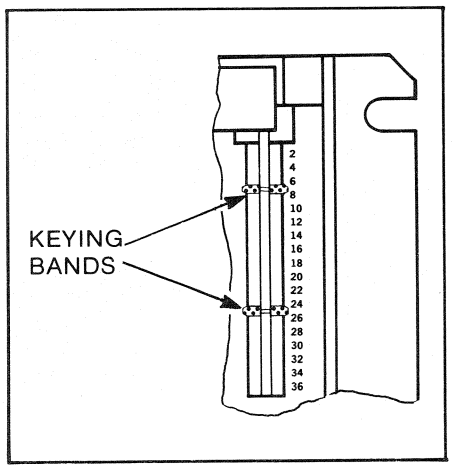



**FIGURE 5 — Keying Diagram**

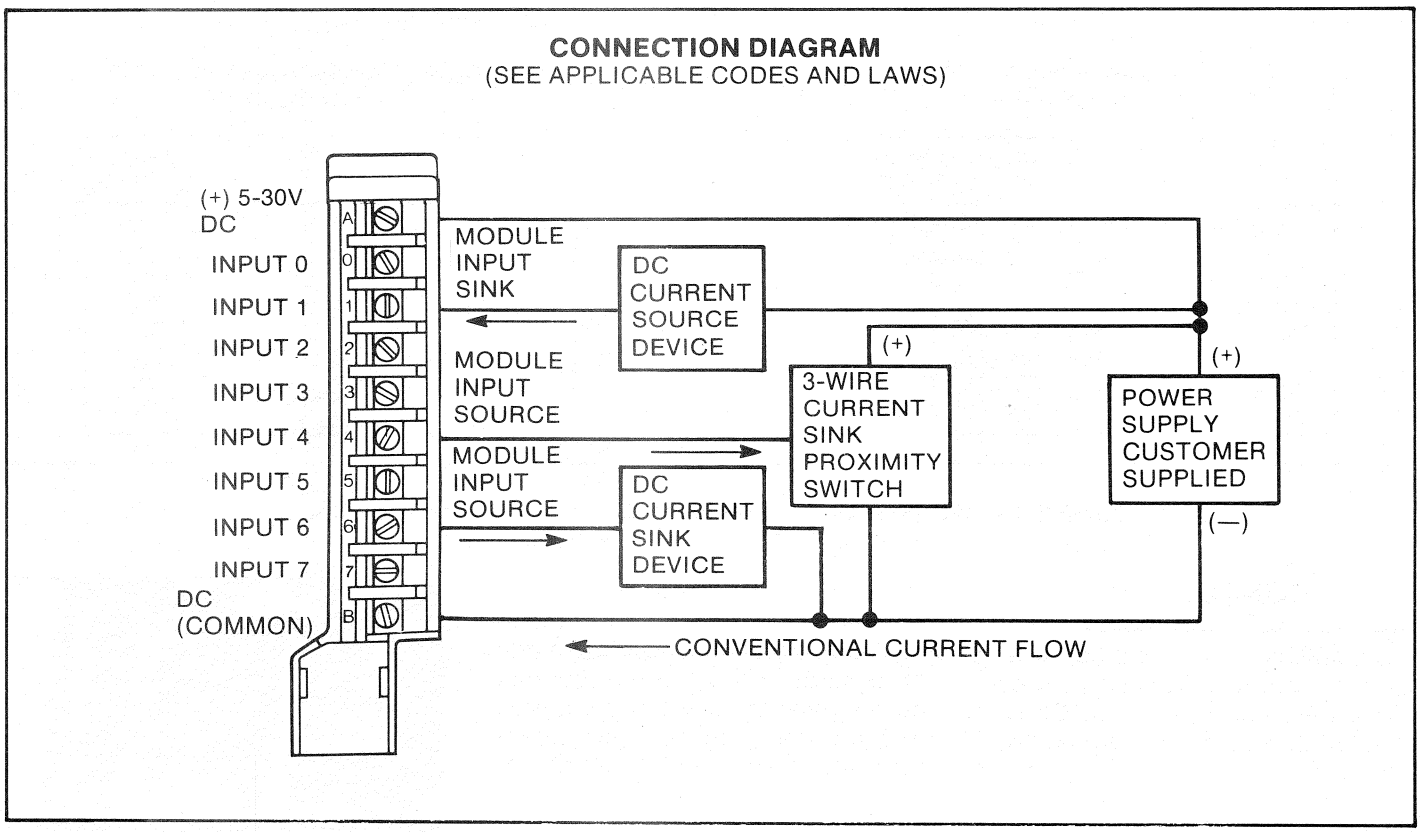
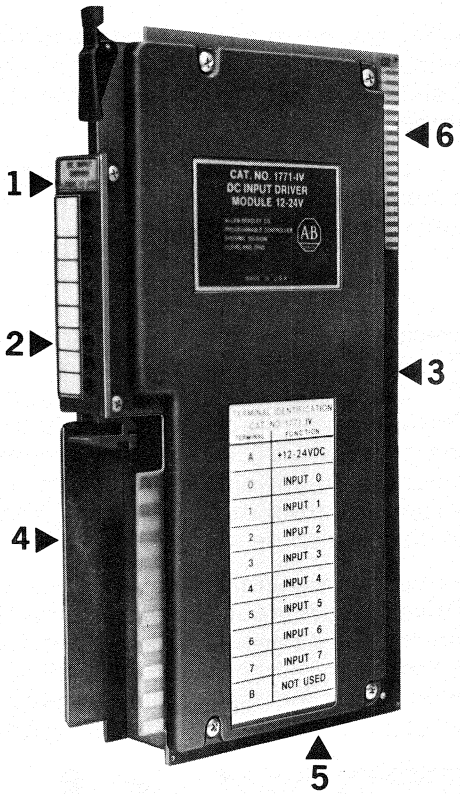



**FIGURE 6 — DC (5-30V) Selectable Input Module Connection Diagram**

ALLEN-BRADLEY

# DC (12-24V) DRIVER LOGIC INPUT MODULE

## Cat. No. 1771-IV




LEGEND:

1. Blue identification label
2. Status indicators
3. Protective cover
4. Field Wiring Arm connects here
5. Labels identify user devices
6. Slotted for I/O rack insertion only

### SPECIFICATIONS

**Inputs per Module**
8

**Module Location**
I/O Chassis

**Nominal Input Voltage**
12-24V DC

**Input**
Voltage Range

| Logic 1 | | Logic 0 | |
|---|---|---|---|
| Min | Max | Min | Max |
| 0V | 4V | 10V | 27V |

**Nominal Input Current (sinking), ON State**
12V DC: 8 mA
24V DC: 24 mA

**Input Signal Delay**
15 msec. ±7 msec.

**Input Impedance**

| ON | OFF |
|---|---|
| 1K-2K ohms | 2K-3K ohms |

**Electrical-Optical Isolation**
1500V
Isolation is between the input circuitry and control logic circuitry

**Power Supply Current Requirement**
74 mA per Module

**Ambient Temperature Rating**
0° to 60°C (operational)
— 40° to 85°C (storage)

**Humidity Rating**
5 to 95%
(without condensation)

**Keying**
Modules are slotted for insertion into I/O slots only.
Insert keys between 8 and 10, 12 and 14

**Wire Size**
14 ga. stranded (max.)
3/64" insulation (max.)

### DESCRIPTION

The DC (12-24V) Driver Logic Input Module (Cat. No. 1771-IV) senses DC voltage levels from sensor devices and converts them into logic data. Input devices that might be connected to the Module include DC proximity switches, photoelectric sensors, and limit and selector switches. The Module, as part of the 1771 I/O Structure, is compatible with any member of the PC Controller family employing 1771 I/O Racks.

### STATUS INDICATORS

Eight status indicators are located on the front of the Module (Figure 1). Each of these indicators corresponds to a single Module input terminal. When an input is ON, its corresponding status indicator illuminates.

These LED indicators provide a useful troubleshooting aid. By comparing the indicator with its corresponding input device, an operator can quickly identify certain hardware-related faults.

The Module status indicators are driven from the customer power supply.

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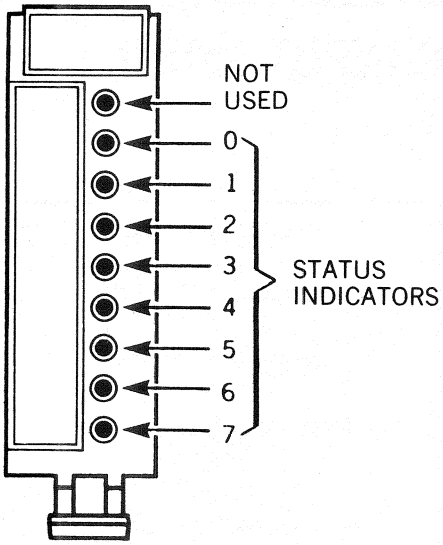



**FIGURE 1 - Status Indicators**

## POWER SUPPLY REQUIREMENTS

The logic circuitry of the DC (12-24V) Driver Logic Input Module is driven by the Power Supply which connects to the I/O Chassis backplane. The Module requires a current of 74 mA from the 5V DC output of this supply. This amount should be totalled with the current requirements of other modules in the rack to avoid overloading the supply.

## PROGRAMMING

The Module uses standard programming techniques; the following instructions examine an input for a voltage condition:

- -] [- EXAMINE ON
- -]/[- EXAMINE OFF

## INPUT CIRCUITRY

The DC (12-24V) Driver Logic Input Module provides eight inputs for DC devices. The Module senses the voltage at each input terminal to determine the ON/OFF status of the connected device. The voltage range for each of these states is as follows:

- ON — 0-4V DC
- OFF — 10V-27V DC

The input filter circuitry limits the effects of voltage transients. (Transients, common to noise-polluted industrial environments, could be falsely interpreted if input filtering is not provided.) This filtering introduces a typical signal delay of 15 msec (±7 msec.).

In each input circuit, electrical-optical isolation (rated at 1500V RMS) provides protection for the Module's logic circuitry from high-voltage transients along the input line. The Module also has circuitry to guard against damage from the application of reverse DC voltage.

The signal source must be capable of driving a minimum of 8 mA of sinking current at 12V or 24 mA of sinking current at 24V into the indicated input impedance.

The OFF state leakage current of the input device should not exceed 1 mA at the indicated input impedance.

## CONNECTIONS

Input devices connect to a Field Wiring Arm (Cat. No. 1771-WA) which can be removed from the Bulletin 1771 I/O Chassis. (Refer to Figure 2.) The Field Wiring Arm pivots on the front of the Chassis to connect with Module terminals. Because wiring connections are made on the Wiring Arm, a module can be removed from the I/O Chassis without the need to disconnect the wiring.

The Connection Diagram illustrates the DC (12-24V) Driver Logic Input Module connections. A label on the side cover also identifies the Field Wiring Arm terminal connections to the Module. Additional space for user labeling is provided on the front of the Module and on the Wiring Arm itself.

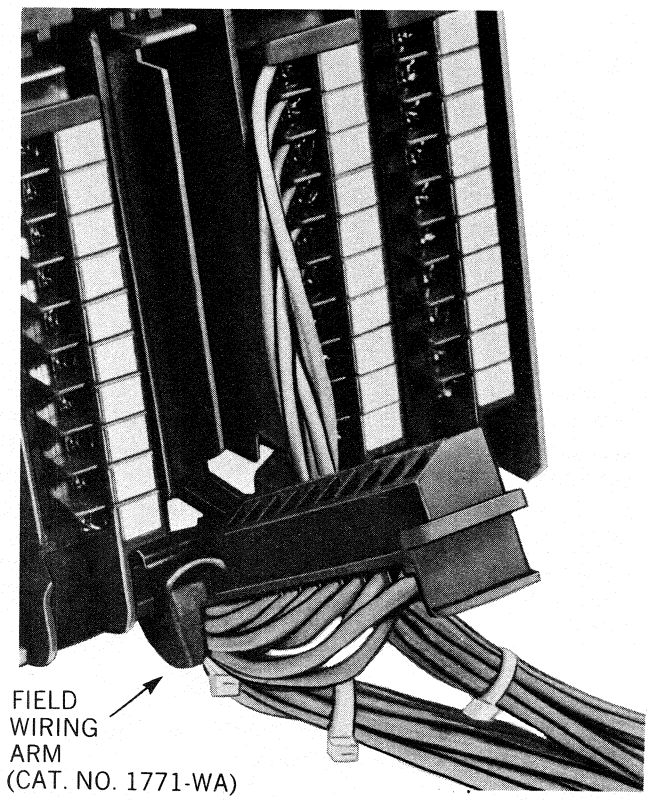



**FIGURE 2 - Field Wiring Arm**

## KEYING

In initial design stages, the DC (12-24V) Driver Logic Input Module may be inserted into any I/O module slot of the I/O Chassis. However, once specific slots have been designated for a module, care should be taken so that other types of modules will not be placed into these slots. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for keying an I/O slot to accept only one type of I/O module. Use of these keying bands is strongly recommended.

Each type of I/O module is slotted in two places at its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. Any I/O Rack connector may be keyed to receive only the DC (12-24V) Driver Logic Input Module (Cat. No. 1771-IV).

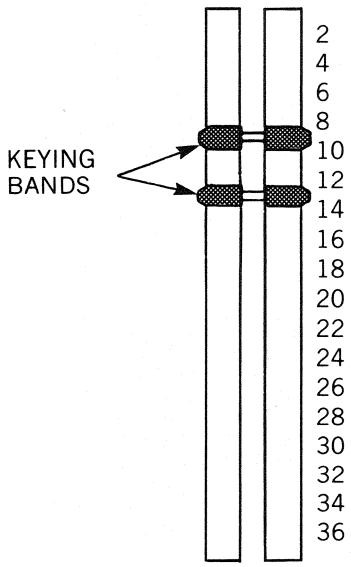


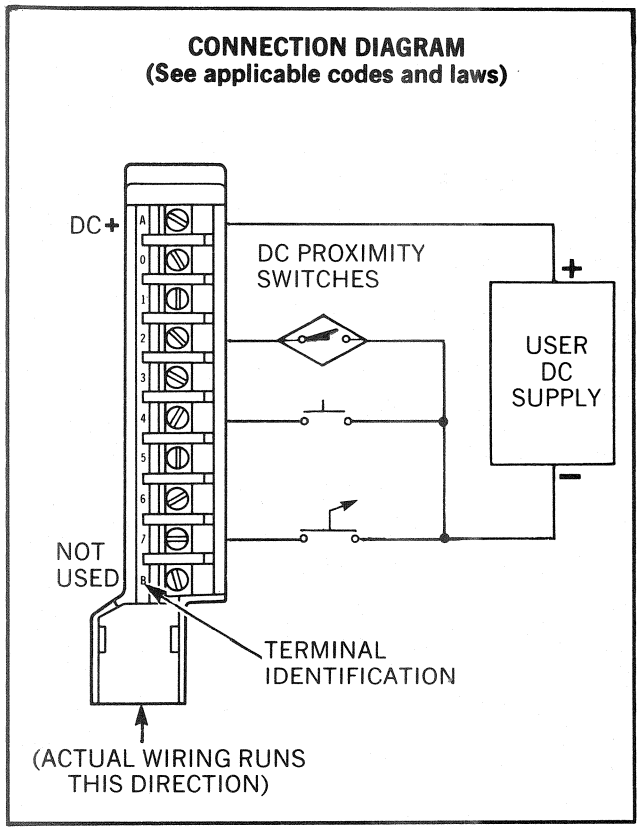

**FIGURE 3 - Keying Diagram**

Refer to Figure 3. Snap the keying bands onto the upper backplane connector between these numbers printed on the backplane:

- Between 8 and 10
- Between 12 and 14

The position of these bands may be changed if subsequent system design and rewiring make insertion of a different type of Module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

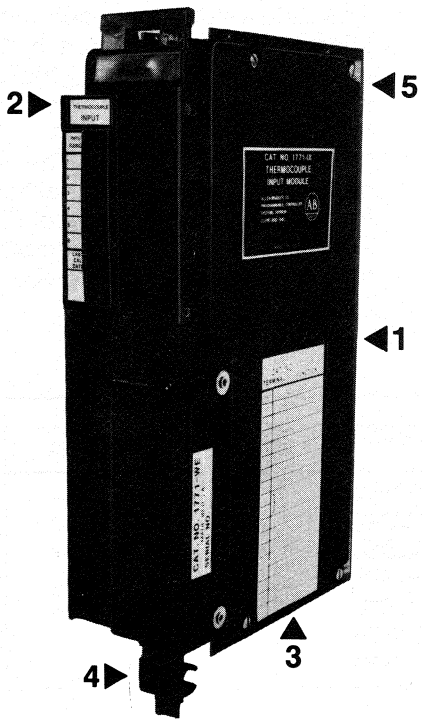


ALLEN-BRADLEY
Cleveland, Ohio 44143

P/N 636048-60

# ALLEN-BRADLEY THERMOCOUPLE INPUT MODULE ASSEMBLY

## Cat. No. 1771-IX




1. Protective cover
2. Pink identification label
3. Label identifies user connections
4. Field Wiring Arm connects here
5. Slotted for I/O slot insertion only

### SPECIFICATIONS

**Inputs per Module**
6 differential, fully floating

**Module Location**
Bulletin 1771 I/O Rack;
any I/O module group

**Thermocouple Input Types**
Type E*, chromel/constantan
Type J*, iron/constantan
Type *K, chromel/alumel
Type T*, copper/constantan
Type B*, Pt-6% Rh/Pt-30% Rh
Type R*, Pt/Pt-13% Rh
Type S*, Pt/Pt-10% Rh

**Resolution**
1 part in 1999

**Millivolt Input Ranges**
0 to ±12.5 millivolts
0 to ±25.0 millivolts
0 to ±50.0 millivolts
0 to ±100.0 millivolts

**Input Overvoltage Protection**
120 volts RMS @ 60 Hz,
continuous, differential

**Differential Input Resistance**
⩾10 megohms at DC.

**5V Current Requirement**
(from system power supply or
supply to I/O rack)
2 amperes max.

**Ambient Temperature Rating**
0° to 50° C (operational)
-40° to 85° C (storage)

**Humidity Rating**
5% to 95%
(without condensation)

**Electrical Isolation**
1000 volts (transient) isolation
between each input circuit
and control logic

**Keying**
Position keys between

| Left | Right |
|---|---|
| 8-10 | 8-10 |
| 18-20 | 20-22 |

* ANSI C96.1-1975 Symbols

### DESCRIPTION

The Thermocouple Input Module Assembly (Cat. No. 1771-IX) senses thermocouple and millivolt signals at its six inputs and converts these to BCD or binary values for use by the Programmable Controller Processor. The Thermocouple Input Module accepts thermocouple and millivolt signals in one or more user selected thermocouple or millivolt ranges. Thus it allows interface between a programmable controller and several thermocouples and/or millivolt devices, sensing such variables as temperature (directly), pressure, flow, RPM, load, light intensity, or position.

The Thermocouple Input Module Assembly includes:

- Thermocouple Input Module (Cat. No. 1771-IXC)
- Thermocouple Field Wiring Arm (Cat. No. 1771-WE).

User wiring connections are made to the Thermocouple Field Wiring Arm (refer to the Connection Diagram, Figure 5). The wiring arm, acting as a terminal strip, pivots on the I/O chassis to connect with terminals on the front of the module. The wiring arm allows the module to be removed from the chassis without the need to disconnect user wiring. The Thermocouple Input Module Assembly (Cat. No. 1771-IX) is directly compatible with the Thermocouple Input Expander Module Assembly (Cat. No. 1771-IY). Up to eight Thermocouple Input Expander Modules may be used in conjunction with each Thermocouple Input Module.

### INPUT CHANNELS

The Thermocouple Input Module has six fully-floating differential input channels. Each channel on an individual module is user se-

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Publication 1771-933 — November, 1981

lected for a given thermocouple or millivolt range. Input channel ranges may be changed at any time to meet the application requirements at the time.

The temperature and millivolt ranges for the Thermocouple Input Module are shown in Tables A, B and C. Each input channel of the Thermocouple Input Module is further characterized by the following specifications.

Normal Mode Rejection Ratio: 80 dB @ 60 Hz; 60 dB @ 50 Hz

Common Mode Rejection Ratio: 160 dB @ 60 Hz with 1 kilohm source imbalance

Maximum Common Mode Voltage: 1000 volts DC; 750 volts RMS

Bias Current: 40 ±10 nanoamperes maximum

Input Connections: Thermocouple Field Wiring Arm

Lead Resistance Effect: Included in maximum error for total lead resistance up to 100 ohms; -50 nanovolts per ohm or 0.005° C per ohm, worst case for total lead resistance in excess of 100 ohms.

Calibration: Module calibration must be checked periodically. Maximum time between calibrations is 1 year.

**DATA FORMAT**

The data format for all channels of a module is user selectable as either BCD, or Binary; ÷1 or ÷2. In addition, the data format for all temperature channels of a module is user selectable as either °C or °F (refer to Range/Data Format Selection). The data value from each module channel is contained in a 16-bit processor data word. This word also indicates polarity, overflow for the temperature/millivolt range, and thermocouple burnout. The 16-bit data word for each channel has the format shown in Figure 1A or Figure 1B. Input Word Diagnostic bit patterns are shown in Table 1C.

**TABLE A — Centigrade Ranges**

| TC TYPE | °C RANGE | MAXIMUM ERROR* (AT 25°C) | TEMP. COEFF. °C/°C (0-50°C) |
|---|---|---|---|
| E | -230° to 1000° | ±(0.15% of range + ½LSB) | ±0.10 |
| J | -210° to 760° | ±(0.15% of range + ½LSB) | ±0.08 |
| K | -200° to 1200° | ±(0.14% of range + ½LSB) | ±0.14 |
| T | -260° to 400° | ±(0.21% of range + ½LSB) | ±0.05 |
| B | 400° to 1820° | ±(0.17% of range + ½LSB) | ±0.26 |
| R | 0° to 1768° | ±(0.13% of range + ½LSB) | ±0.22 |
| S | 0° to 1768° | ±(0.13% of range + ½LSB) | ±0.25 |

**TABLE B — Fahrenheit Ranges**

| TC TYPE | °F RANGE | MAXIMUM ERROR* (AT 25°C) | TEMP. COEFF. °F/°C (0-50°C) |
|---|---|---|---|
| E | -382° to 1832° | ±(0.15% of range + ½LSB) | ±0.18 |
| J | -346° to 1400° | ±(0.15% of range + ½LSB) | ±0.14 |
| K | -328° to 1990° | ±(0.14% of range + ½LSB) | ±0.21 |
| T | -436° to 752° | ±(0.21% of range + ½LSB) | ±0.09 |
| B | 752° to 1999° | ±(0.17% of range + ½LSB) | ±0.47 |
| R | 32° to 1999° | ±(0.13% of range + ½LSB) | ±0.40 |
| S | 32° to 1999° | ±(0.13% of range + ½LSB) | ±0.45 |

**TABLE C — Millivolt Ranges**

| NOMINAL RANGE | ACTUAL RANGE | CORRESPONDING BCD OUTPUT | MAXIMUM ERROR* (AT 25°C) | TEMP. COEFF (0-50°C) |
|---|---|---|---|---|
| ±12.5mV | ±12.49375mV | ±1999 | ±(0.10% of range + ½LSB) | ±0.008% fsr/°C |
| ±25.0mV | ±24.98750mV | ±1999 | ±(0.08% of range + ½LSB) | ±0.006% fsr/°C |
| ±50.0mV | ±49.975mV | ±1999 | ±(0.06% of range + ½LSB) | ±0.005% fsr/°C |
| ±100.0mV | ±99.950mV | ±1999 | ±(0.05% of range + ½LSB) | ±0.004% fsr/°C |

* Maximum Error with thermal shroud installed includes one year aging, cold junction compensation, conformity error, conversion uncertainty, and source resistance less than or equal to 100 ohms. "Range" is negative full scale to positive full scale.

## PROGRAMMING

The Thermocouple Input Module Assembly (Cat. No. 1771-IX) can be used with the following processors:

- Bulletin 1774 Remote I/O PLC Processor (Cat. No. 1774-RP1, -RP2, -RP3)
- Bulletin 1772 PLC-2, PLC-2/20, PLC-2/30 Processor (Cat. No. 1772-LR, -LP1, LP-2, LP-3)
- Bulletin 1772 Mini-PLC-2 and PLC-2/15 Mini-Processor Module (Cat. No. 1772-LN1, -LN2, -LN3, -LV)
- Bulletin 1775 PLC-3 Processor

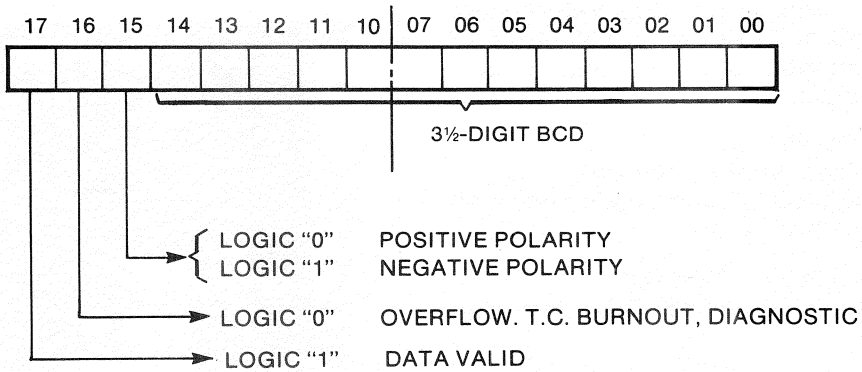
Depending on the processor used, module/processor communication may have one of two modes:

- Block Transfer
- Single Transfer

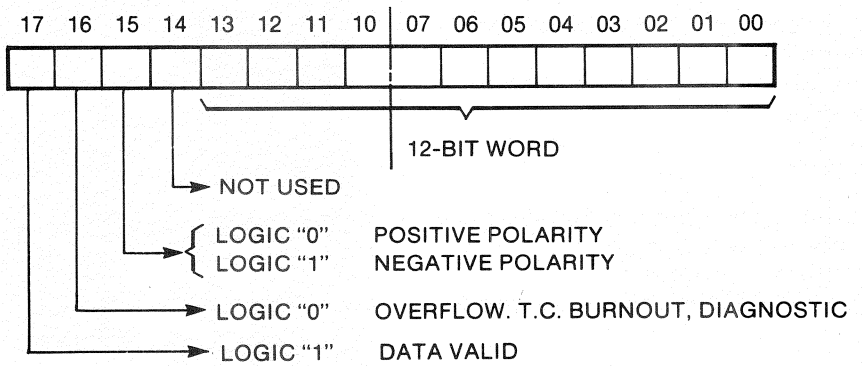
The Block Transfer mode is available with PLC-2/20 or later Processors (Cat. No. 1772-LP1), Mini-Processor Module (Cat. No. 1772-LN3 or later), and PLC-3 Processors. When using the Thermocouple Input Module Assembly with any of the other Processors listed here, the Single Transfer mode is used.

Refer to Thermocouple Module User's Manual, Publication 1771-805, for detailed programming instructions.

A user switch selection is made to determine the mode of data transfer (refer to Range/Data Format Selection).




1A — BCD WORD




1B — BINARY WORD

| CONDITION | 17 | 16 | 15 | 14-00 |
|---|---|---|---|---|
| Good Data | 1 | 1 | 0/1 | Data |
| Invalid Range | 0 | 0 | 1 | Zeros |
| Channel Not Present | 0 | 1 | 0 | Zeros |
| Out of Range | 1 | 0 | 0/1 | Data |
| Communication Fault | 0 | 0 | 0 | Zeros |
| Power Up Initialization | 0 | 1 | 1 | Zeros |

1C — INPUT WORD DIAGNOSTICS

**FIGURE 1 — 16-bit Data Word for Each Channel**

## DIAGNOSTICS

Module diagnostic circuitry monitors the analog-to-digital conversion process, expander module communications, logic/memory operation, and block transfer operation. Upon detection of a fault from any of these sources, an LED "DIAGNOSTIC" indicator on the module front panel will be turned on, and bit 17 (data valid) of the data word will be de-energized.

## RANGE/DATA FORMAT SELECTION

Before inserting the Thermocouple Input Module into its I/O chassis slot, the user must select the correct range for each input channel and select the desired data format for all channels. Block or Single Transfer mode is also selected at this time.

The Data Format Programming plugs are as follows:

Master1/Master 2 — This plug determines whether the module is Master 1 or Master 2 in the I/O rack. Position this plug in Master 1 if the module is the only Master in the I/O rack. NOTE: Only one Thermocouple Input Master may be present in any given I/O Rack.

Centigrade/Fahrenheit — This plug determines the temperature scale (°C or °F) of output data for all channels set for thermocouple inputs.

BCD/BINARY — The plug determines whether the output is 3½-digit BCD (binary coded decimal) or 12-bit binary.

Divide by 1/Divide by 2 — When the Module is set for BCD, this plug determines whether the output is 3½ digit (Divide by 1) or 3 digit (Divide by 2).

Block Transfer/Single Transfer — This plug determines the communication mode to the Processor.

To access the data format programming plugs, the component side cover (left side of module) must be removed from the module. Four corner screws hold the cover in place.

Figure 2 and Table D shows the locations and positioning of the data format programming plugs on this module. Note that there are 5 plugs for these functions.

To access the range programming plugs, the solder side cover (right side of module) must be removed from the module and the exposed PC board removed. Four corner screws hold this cover and board in place.

**TABLE D — Data Format Programming Plug Positions**

| MODE SELECTION | JUMPER PIN NO. | TO PIN NO. |
|---|---|---|
| Master 1 | 2 | 3 |
| Master 2 | 1 | 2 |
| Centigrade | 4 | 5 |
| Fahrenheit | 5 | 6 |
| Divide by 1 | 8 | 9 |
| Divide by 2 | 7 | 8 |
| BCD | 10 | 11 |
| Binary | 11 | 12 |
| Block Transfer | 14 | 15 |
| Single Transfer | 13 | 14 |

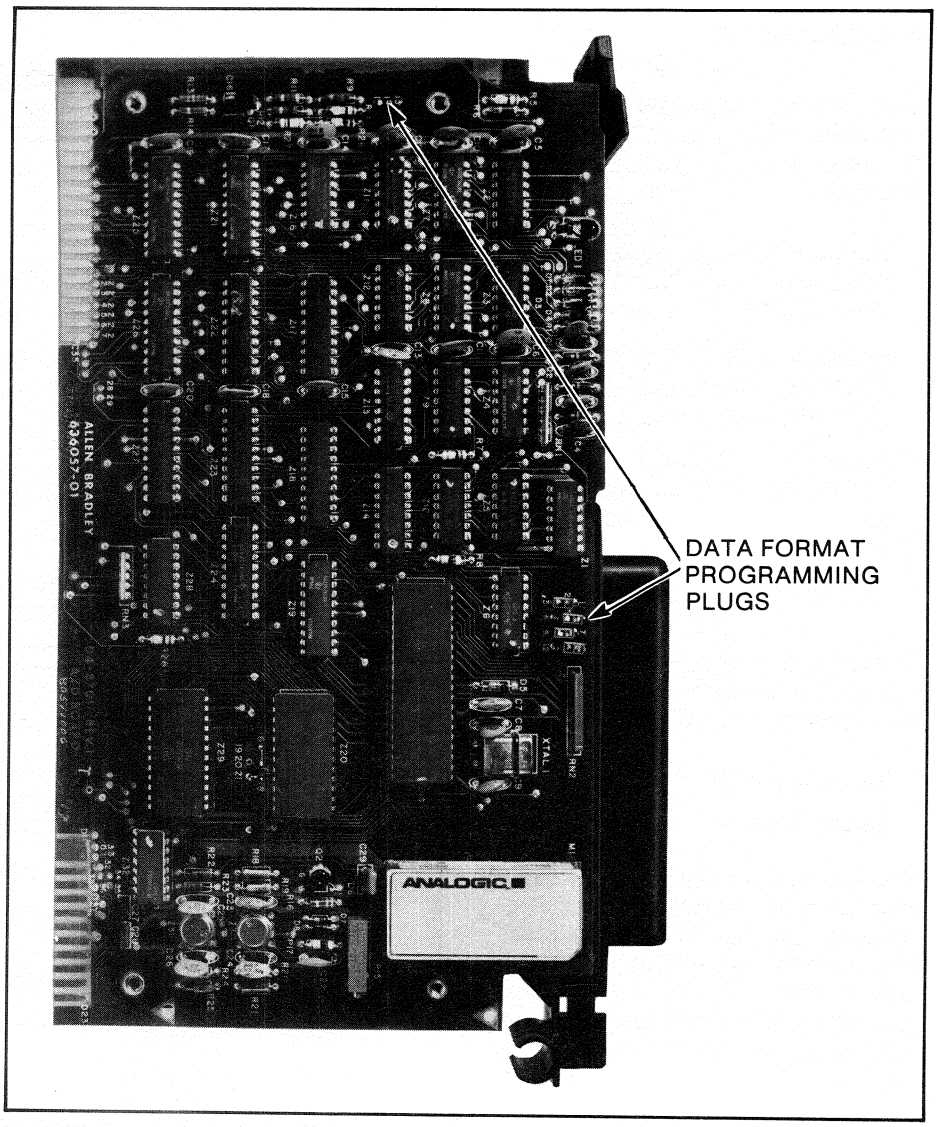



**FIGURE 2 — Data Format Programming Plug Locations**

Figure 3 and Table E shows the locations and positioning of the range programming plugs on this module. There are four range programming plugs for each channel. The range programming plug placement scheme is the same for all channels.

NOTE: Master select plug must be set for Master 1 or Master 2 as selected for Data Format programming plug. Expander select plug must be set for Expander 0.

NOTE: Spare programming plugs should not be required, as the plug used to program "HI" may be removed without affecting system operation. Thus, "HI" plugs are available as "spares."

## WIRING

**CAUTION:** Do not remove any module from or insert any module into the chassis while controller power to the chassis is ON. Failure to observe this rule may result in damage to the module circuitry.

The Thermocouple Input Module may be placed in any I/O module group of the I/O chassis. However, to minimize noise and temperature effects, group Thermocouple and analog Input Modules together within an I/O chassis whenever possible.

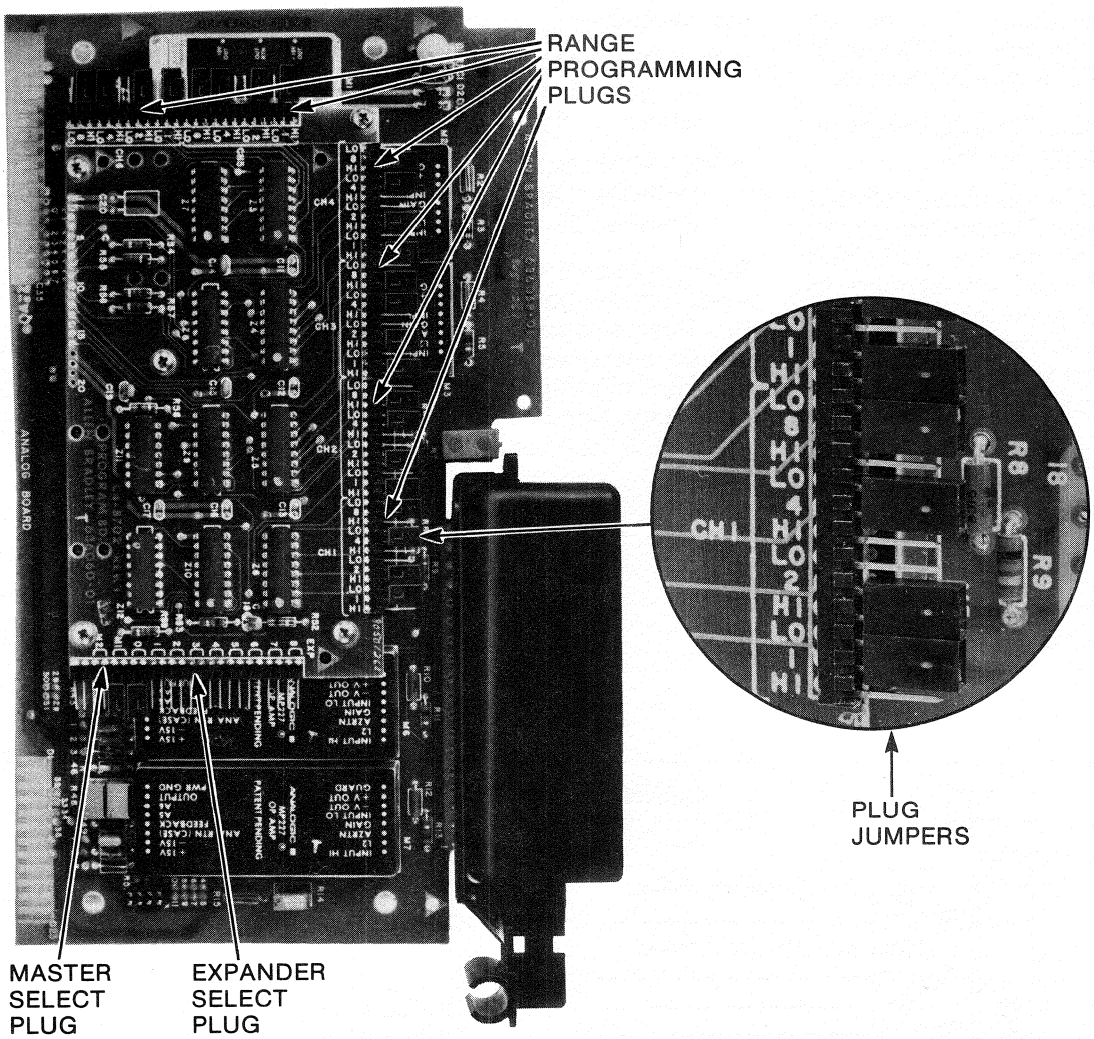



**FIGURE 3 — Positioning of Range Programming Plugs**

**TABLE E — Range Programming Plug Positions**

| RANGE/TYPE | | PROGRAM CODE | | | |
|---|---|---|---|---|---|
| | | 8 | 4 | 2 | 1 |
| Thermocouple Type | Type E | LO | LO | LO | LO |
| | Type J | LO | LO | LO | HI |
| | Type K | LO | LO | HI | LO |
| | Type T | LO | LO | HI | HI |
| | Type B | LO | HI | LO | LO |
| | Type R | LO | HI | LO | HI |
| | Type S | LO | HI | HI | LO |
| Linear Range | ±100mV | HI | LO | LO | LO |
| | ±50mV | HI | LO | LO | HI |
| | ±25mV | HI | LO | HI | LO |
| | ±12.5mV | HI | LO | HI | HI |
| Channel not present | | HI | HI | HI | HI |

## KEYING

**CAUTION:** The Thermocouple Input Module must be inserted in the I/O chassis such that both halves of the Module are in the same I/O module group. Failure to observe this rule will result in faulty module operation and may result in damage to module circuitry.

In initial design stages, the Thermocouple Input Module may be inserted into any I/O module group location of the I/O chassis. However, once specified slots have been designated for a module, care should be taken so that other types of modules will not be mistakenly placed into these slots. Plastic key-

ing bands, shipped with each I/O chassis, provide an easy method for the user to key an I/O slot to accept only one type of module.

Use of these keying bands is strongly recommended.

Each type of I/O module is slotted at its rear edge. The position of the keying bands on the backplane connectors must correspond to these slots to allow insertion of the module. Any I/O rack module group may be keyed solely to receive the Thermocouple Input Module.

NOTE: Early production units do not have keying slots. Use caution when changing these modules in an I/O Rack.

For the Thermocouple Input Module, position the keying bands on the upper backplane connectors between these numbers printed on the backplane.

- Left Connector
  Between 8 and 10
  Between 18 and 20
- Right Connector
  Between 8 and 10
  Between 20 and 22

Refer to Figure 4. The position of these bands may be changed by the user if subsequent system design and rewiring makes insertion of a different type of module necessary. Needle nose pliers may be used to insert or remove keying bands.

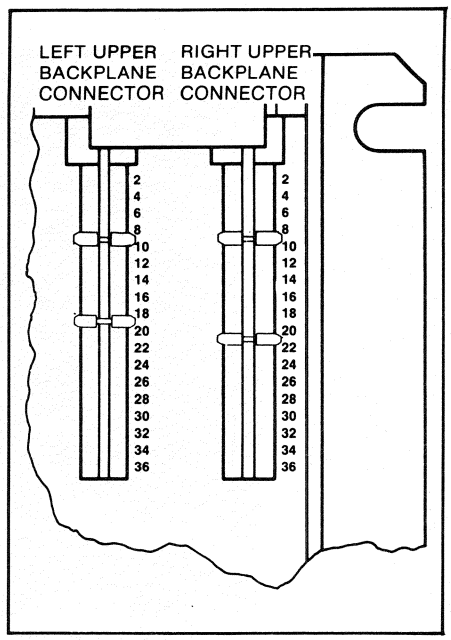



**FIGURE 4 — Keying Diagram**

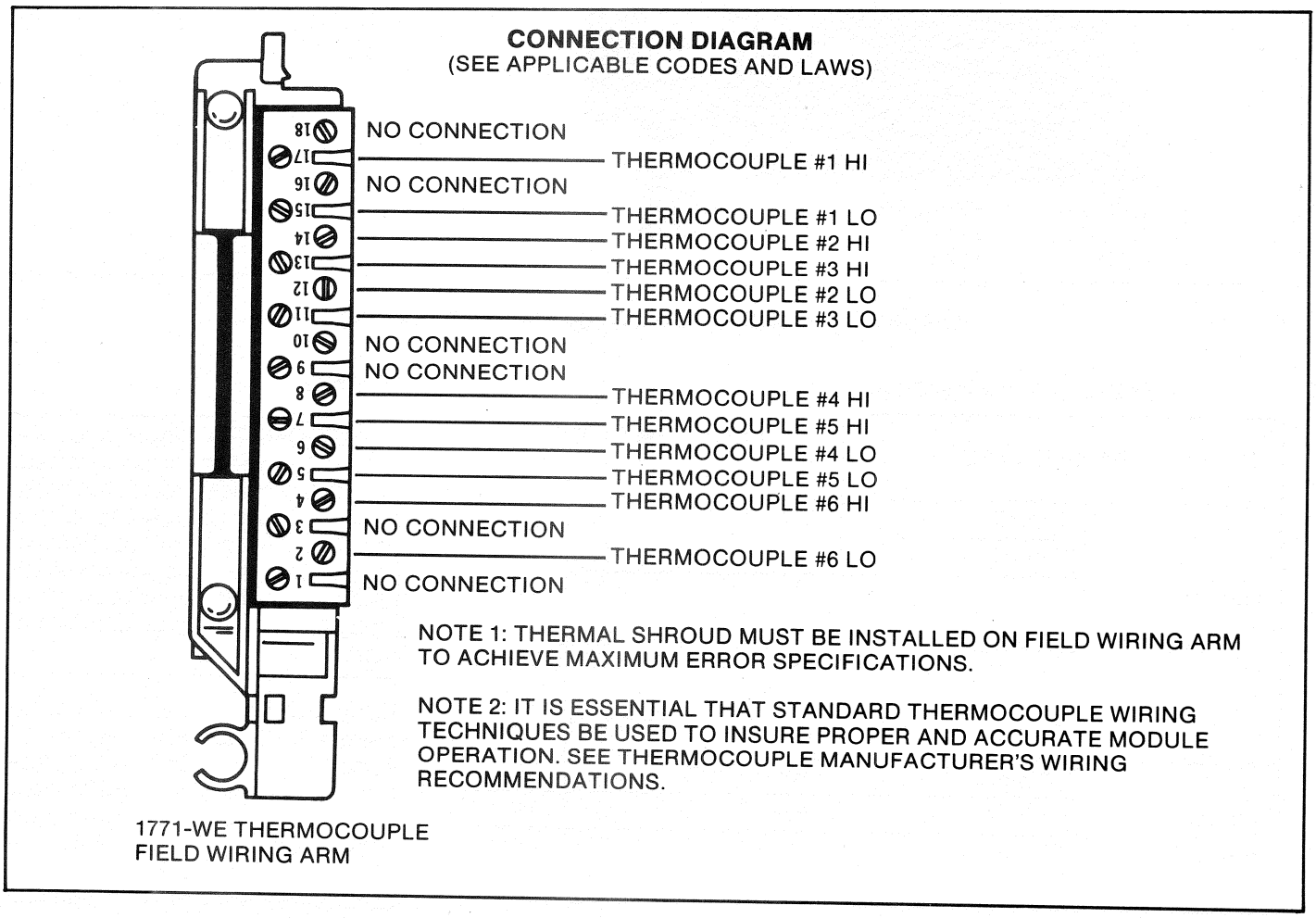



**FIGURE 5 — Connection Diagram**



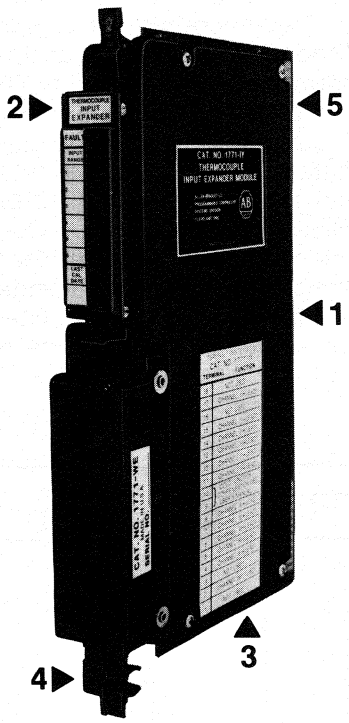

ALLEN-BRADLEY

Systems Division-PC Business
747 Alpha Drive, Cleveland, Ohio 44143

P/N 955090-21A

# ALLEN-BRADLEY THERMOCOUPLE INPUT EXPANDER MODULE ASSEMBLY

## Cat. No. 1771-IY




1. Protective cover
2. Pink identification label
3. Label identifies user connections
4. Field Wiring Arm connects here
5. Slotted for I/O slot insertion only

### DESCRIPTION

The Thermocouple Input Expander Module Assembly (Cat. No. 1771-IY) is used in conjunction with the Thermocouple Input Module Assembly (Cat. No. 1771-IX) to increase the number of thermocouple/millivolt inputs to a system. Thermocouple and millivolt signals sensed at the six inputs of the Thermocouple Input Expander Module Assembly (Cat. No. 1771-IY) are amplified and interfaced to the Thermocouple Input Module Assembly (Cat. No. 1771-IX) where they are converted to BCD or Binary values for use by the Programmable Controller Processor. The Thermocouple Input Expander Module accepts thermocouple and/or millivolt signals in one or more user selected thermocouple or millivolt ranges. Thus it allows interface between a Programmable Controller and several thermocouples and/or millivolt devices, sensing such variables as temperature (directly), pressure, flow, RPM, load, light intensity, or position.

The Thermocouple Input Expander Module Assembly includes:

- Thermocouple Input Expander Module (Cat. No. 1771-IYC)
- Thermocouple Field Wiring Arm (Cat. No. 1771-WE)

User wiring connections are made to the Thermocouple Field Wiring Arm (refer to the Connection Diagram, Figure 4). The Wiring Arm, acting as a terminal strip, pivots on the I/O chassis to connect with terminals on the front of the module. The wiring Arm allows the module to be removed from the Chassis without the need to disconnect user wiring.

The Thermocouple Input Expander Module Assembly (Cat. No. 1771-IY) must be used in conjunction with the Thermocouple Input Module Assembly (Cat. No. 1771-IX). Up to eight (8) Thermocouple Input Expander Modules may be used in conjunction with each Thermocouple Input Module.

### SPECIFICATIONS

**Inputs per Module**
6 differential, fully floating

**Module Location**
Bulletin 1771 I/O Rack;
any I/O module slot

**Thermocouple Input Types**
Type E*, chromel/constantan
Type J*, iron/constantan
Type *K, chromel/alumel
Type T*, copper/constantan
Type B*, Pt-6% Rh/Pt-30% Rh
Type R*, Pt/Pt-13% Rh
Type S*, Pt/Pt-10% Rh

**Millivolt Input Ranges**
0 to ±12.5 millivolts
0 to ±25 millivolts
0 to ±50.0 millivolts
0 to ±100.0 millivolts

**Input Overvoltage Protection**
120V RMS @ 60 Hz,
Continuous, Differential

**Differential Input Resistance**
≥10 megohms at DC.

**5V Current Requirement**
(from system power supply or supply to I/O rack)
0.5 Ampere maximum

**Ambient Temperature Rating**
0° to 50° C (operational)
-40° to 85° C (storage)

**Humidity Rating**
5% to 95%
(without condensation)

**Electrical Isolation**
1000 volts (transient) isolation between each input circuit and control logic

**Keying**
Position keys between
8-10
20-22

* ANSI C96.1-1975 Symbols

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Publication 1771-934 — November, 1981

## INPUT CHANNELS

The Thermocouple Input Expander Module has six fully-floating differential input channels. Each input channel on an individual module is user selected for a given thermocouple or millivolt range. Input channel ranges may be changed at any time to meet application requirements.

The temperature and millivolt ranges for the Thermocouple Input Expander Module are shown in Tables A, B and C. Each input channel of the Thermocouple Input Expander Module is further characterized by the following specifications.

Normal Mode Rejection Ratio: 80 dB @ 60 Hz; 60 dB @ 50 Hz

Common Mode Rejection Ratio: 160 dB @ 60 Hz with 1-kilohm source imbalance

Maximum Common Mode Voltage: 1000 volts DC; 750 volts RMS

Bias Current: 40 ±10 nanoamperes maximum

Input Connections: Thermocouple Field Wiring Arm

Lead Resistance Effect: Included in maximum error for total lead resistance up to 100 ohms; -50 nanovolts per ohm or 0.005° C per ohm, worst case for total lead resistance in excess of 100 ohms.

Calibration: Module calibration must be checked periodically. Maximum time between calibrations is 1 year.

## DATA FORMAT

The data format for all channels of a Thermocouple Input Expander Module is the same as the data format selected on the Thermocouple Input Module with which the Expander Module is used. The data value from each Module channel is contained in a 16-bit Processor data word. This word also indicates polarity, overflow for the temperature/millivolt range, and thermocouple burnout. The 16-bit data word for each channel has the

**TABLE A — Centigrade Ranges**

| TC TYPE | °C RANGE | MAXIMUM ERROR* (AT 25°C) | TEMP. COEFF. °C/°C (0-50°C) |
|---|---|---|---|
| E | -230° to 1000° | ±(0.15% of range + ½LSB) | ±0.10 |
| J | -210° to 760° | ±(0.15% of range + ½LSB) | ±0.08 |
| K | -200° to 1200° | ±(0.14% of range + ½LSB) | ±0.14 |
| T | -260° to 400° | ±(0.21% of range + ½LSB) | ±0.05 |
| B | 400° to 1820° | ±(0.17% of range + ½LSB) | ±0.26 |
| R | 0° to 1768° | ±(0.13% of range + ½LSB) | ±0.22 |
| S | 0° to 1768° | ±(0.13% of range + ½LSB) | ±0.25 |

**TABLE B — Fahrenheit Ranges**

| TC TYPE | °F RANGE | MAXIMUM ERROR* (AT 25°C) | TEMP. COEFF. °F/°C (0-50°C) |
|---|---|---|---|
| E | -382° to 1832° | ±(0.15% of range + ½LSB) | ±0.18 |
| J | -346° to 1400° | ±(0.15% of range + ½LSB) | ±0.14 |
| K | -328° to 1990° | ±(0.14% of range + ½LSB) | ±0.21 |
| T | -436° to 752° | ±(0.21% of range + ½LSB) | ±0.09 |
| B | 752° to 1999° | ±(0.17% of range + ½LSB) | ±0.47 |
| R | 32° to 1999° | ±(0.13% of range + ½LSB) | ±0.40 |
| S | 32° to 1999° | ±(0.13% of range + ½LSB) | ±0.45 |

**TABLE C — Millivolt Ranges**

| NOMINAL RANGE | ACTUAL RANGE | CORRESPONDING BCD OUTPUT | MAXIMUM ERROR* (AT 25°C) | TEMP. COEFF (0-50°C) |
|---|---|---|---|---|
| ±12.5mV | ±12.49375mV | ±1999 | ±(0.10% of range + ½LSB) | ±0.008% fsr/°C |
| ±25.0mV | ±24.98750mV | ±1999 | ±(0.08% of range + ½LSB) | ±0.006% fsr/°C |
| ±50.0mV | ±49.975mV | ±1999 | ±(0.06% of range + ½LSB) | ±0.005% fsr/°C |
| ±100.0mV | ±99.950mV | ±1999 | ±(0.05% of range + ½LSB) | ±0.004% fsr/°C |

* Maximum Error with thermal shroud installed includes one year aging, cold junction compensation, conformity error, conversion uncertainty, and source resistance less than or equal to 100 ohms. "Range" is negative full scale to positive full scale.

format shown in Figure 1A or Figure 1B. Figure 1C summarizes the Input Word Diagnostic bit patterns.

## PROGRAMMING

The Thermocouple Input Expander Module programming is achieved through the Thermocouple Input Module. Refer to the Thermocouple Input Module Assembly (Cat. No. 1771-IX) Product Data Sheet for detailed programming information (Publication 1771-933).

## DIAGNOSTICS

Thermocouple Input Expander Module diagnostic monitoring is achieved through the Thermocouple Input Module. Refer to the Thermocouple Input Module Assembly (Cat. No. 1771-IX) Product Data Sheet for detailed diagnostic monitoring information (Publication 1771-933).

## RANGE SELECTION

Before inserting the Thermocouple Input Expander Module into its I/O Chassis slot, the user must select the correct range for each input channel. To access the range programming plugs, the component side cover (left side of module) must be removed from the module. Four corner screws hold this cover in place.

The Expander Module Range Programming plugs are as follows:

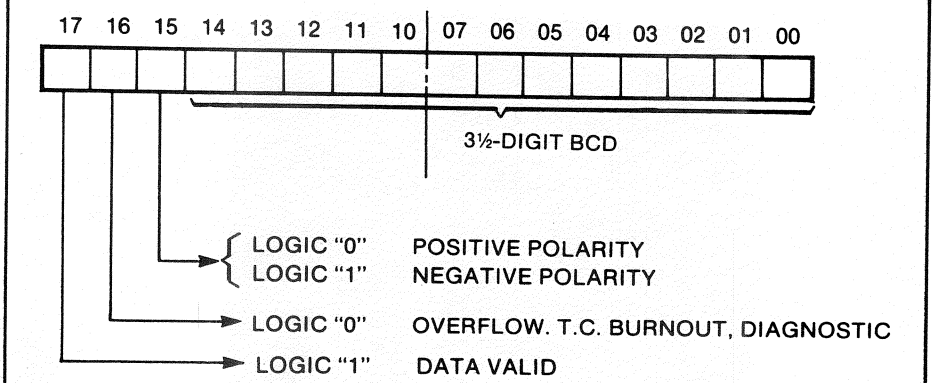
Master 1/Master 2 — This plug must be positioned to correspond with the associated Input Module. If the Input Module was selected for Master 1, the Expander Module must be Master 1.

Expander Number — This plug identifies the Expander Module association with the Input Module. Since up to 8 additional Expander Modules can be connected to one Input Module set this plug to 1 for the first Expander, 2 for the second Expander and so on.

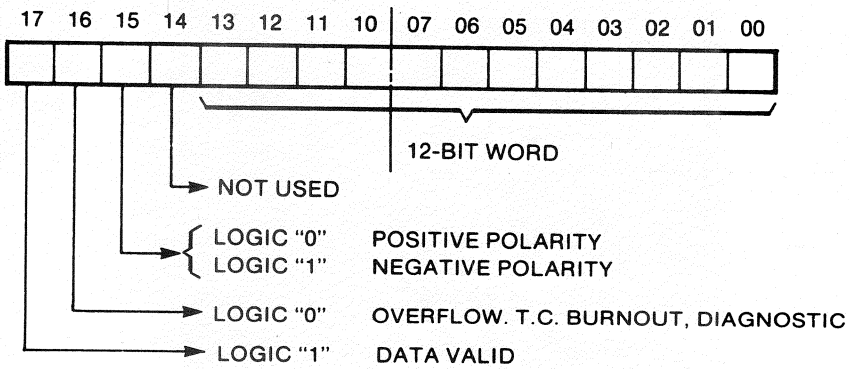
Range Programming — These plugs are used to select the correct input range for each channel.

Figure 2 and Table D show the locations and positioning of the range programming plugs on this module. Note that there are four range programming plugs for each channel. The range programming plug placement scheme is the same for all channels.

NOTE: Spare programming plugs should not be required, as the plug used to program "HI" may be removed without affecting system operation. Thus, "HI" plugs are available as "spares."




1A — BCD WORD




1B — BINARY WORD

| CONDITION | 17 | 16 | 15 | 14-00 |
|---|---|---|---|---|
| Good Data | 1 | 1 | 0/1 | Data |
| Invalid Range | 0 | 0 | 1 | Zeros |
| Channel Not Present | 0 | 1 | 0 | Zeros |
| Out of Range | 1 | 0 | 0/1 | Data |
| Communication Fault | 0 | 0 | 0 | Zeros |
| Power Up Initialization | 0 | 1 | 1 | Zeros |

1C — INPUT WORD DIAGNOSTICS

**FIGURE 1 — 16-Bit Data Word for Each Channel**

## WIRING

**CAUTION:** Do not remove any module from or insert any module into the I/O Chassis while controller power to the chassis is ON. Failure to observe this rule may result in damage to the module circuitry.

The Thermocouple Input Expander Module may be placed in any I/O

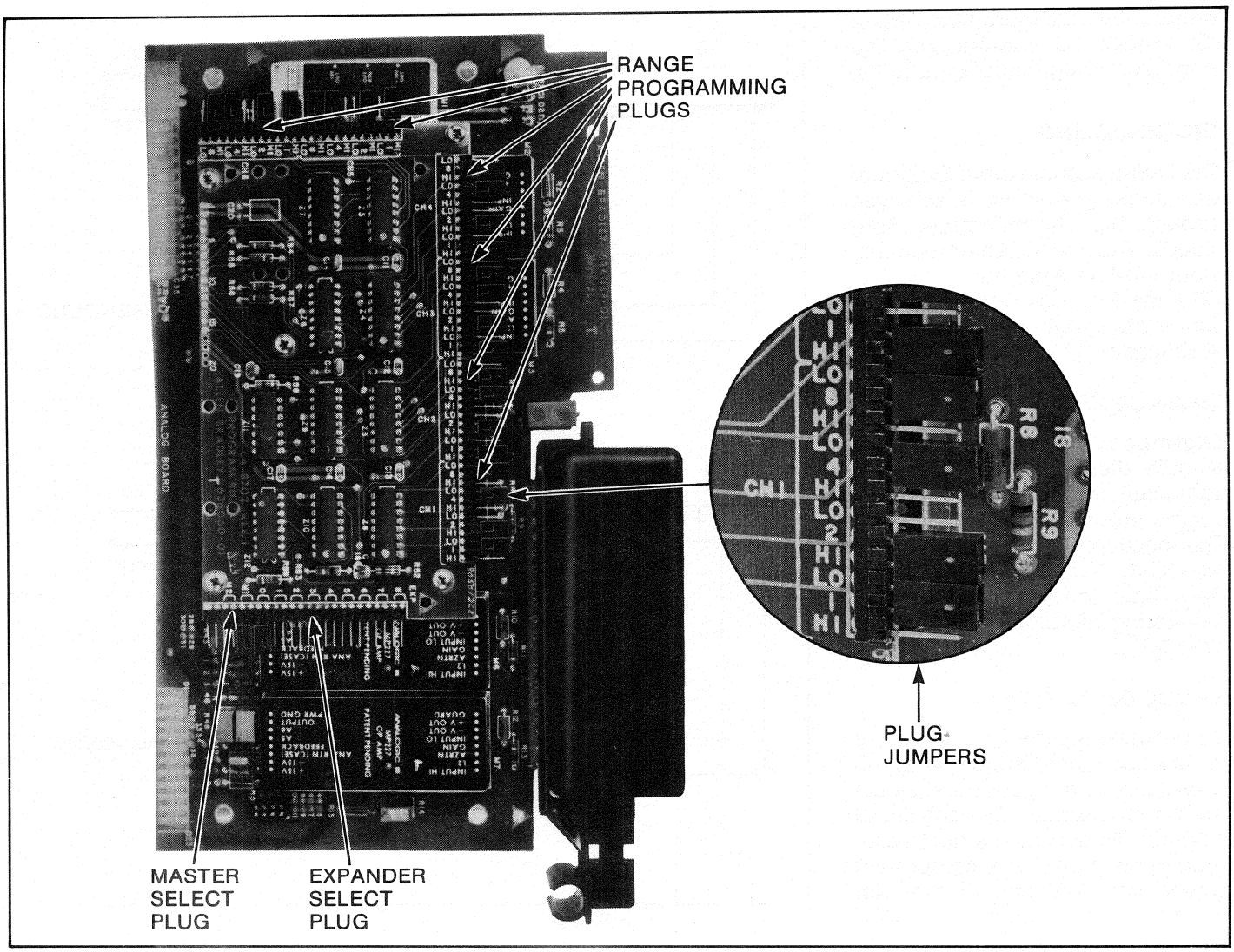



**FIGURE 2 — Positioning of Range Programming Plugs**

**TABLE D — Range Programming Plug Positions**

| RANGE/TYPE | | PROGRAM CODE | | | |
|---|---|---|---|---|---|
| | | 8 | 4 | 2 | 1 |
| Thermocouple Type | Type E | LO | LO | LO | LO |
| | Type J | LO | LO | LO | HI |
| | Type K | LO | LO | HI | LO |
| | Type T | LO | LO | HI | HI |
| | Type B | LO | HI | LO | LO |
| | Type R | LO | HI | LO | HI |
| | Type S | LO | HI | HI | LO |
| Linear Range | ±100mV | HI | LO | LO | LO |
| | ±50mV | HI | LO | LO | HI |
| | ±25mV | HI | LO | HI | LO |
| | ±12.5mV | HI | LO | HI | HI |
| Channel not present | | HI | HI | HI | HI |

Chassis slot. However, to minimize noise and temperature effects, group Thermocouple and Analog Input Modules together within an I/O chassis whenever possible.

## KEYING

In initial design stages, the Thermocouple Input Expander Module may be inserted into any I/O chassis slot. However, once specified slots have been designated for a module, care should be taken so that other types of modules will not be mistakenly placed into these slots. Plastic keying bands, shipped with each I/O chassis, provide an easy method for the user to key an I/O slot to accept only one type of module. Use of these keying bands is strongly recommended.

Each type of I/O module is slotted at its rear edge. The position of the keying bands on the backplane connectors must correspond to these slots to allow insertion of the module. Any I/O Chassis slot may be keyed solely to receive the Thermocouple Input Expander Module.

For the Thermocouple Input Expander Module, position the keying bands on the upper backplane connectors between these numbers printed on the backplane.

- Between 8 and 10
- Between 20 and 22

Refer to Figure 3.

NOTE: Keying slots are not present on initial production units. Therefore caution must be exercised when changing modules in an I/O Rack.

The position of these bands may be changed by the user if subsequent system design and rewiring makes insertion of a different type of module necessary. Needle nose pliers may be used to insert or remove keying bands.

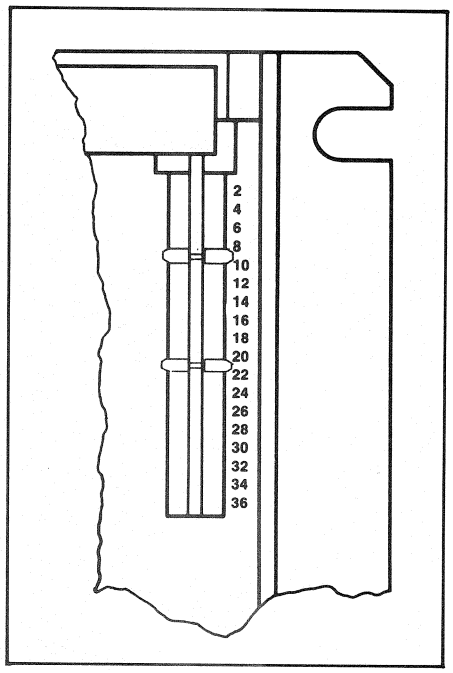
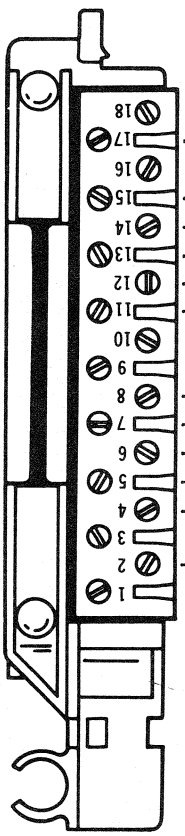



**FIGURE 3 — Keying Diagram**

**CONNECTION DIAGRAM**
(SEE APPLICABLE CODES AND LAWS)




NO CONNECTION
THERMOCOUPLE #1 HI
NO CONNECTION
THERMOCOUPLE #1 LO
THERMOCOUPLE #2 HI
THERMOCOUPLE #3 HI
THERMOCOUPLE #2 LO
THERMOCOUPLE #3 LO
NO CONNECTION
NO CONNECTION
THERMOCOUPLE #4 HI
THERMOCOUPLE #5 HI
THERMOCOUPLE #4 LO
THERMOCOUPLE #5 LO
THERMOCOUPLE #6 HI
NO CONNECTION
THERMOCOUPLE #6 LO
NO CONNECTION

NOTE 1: THERMAL SHROUD MUST BE INSTALLED ON FIELD WIRING ARM TO ACHIEVE MAXIMUM ERROR SPECIFICATIONS.

NOTE 2: IT IS ESSENTIAL THAT STANDARD THERMOCOUPLE WIRING TECHNIQUES BE USED TO INSURE PROPER AND ACCURATE MODULE OPERATION. SEE THERMOCOUPLE MANUFACTURER'S WIRING RECOMMENDATIONS.

1771-WE THERMOCOUPLE
FIELD WIRING ARM

**FIGURE 4 — Connection Diagram**



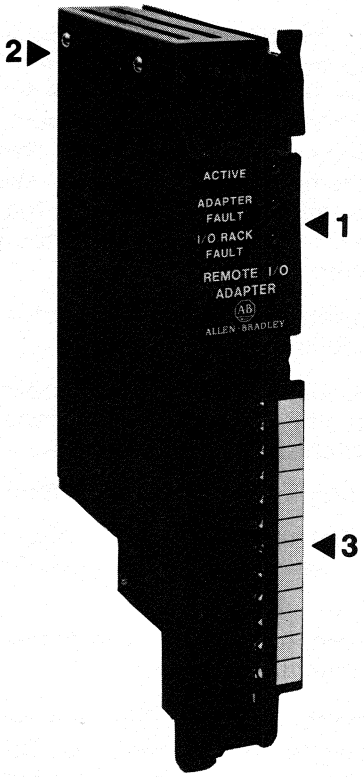

ALLEN-BRADLEY

Systems Division-PC Business
747 Alpha Drive, Cleveland, Ohio 44143

P/N 955090-96A

# ALLEN-BRADLEY REMOTE I/O ADAPTER MODULE ASSEMBLY

## Cat. No. 1771-AS




1. Diagnostic indicators
2. Rack Address Switch Assembly cover plate
3. Field Wiring Arm connects here

### SPECIFICATIONS

**Function**
Transmit input status data to the I/O Scanner
Receive output status data from the I/O Scanner
Verify data validity and provide fault detection

**Module Location**
Bulletin 1771 I/O Rack Adapter Slot

**Type of Communication**
Serial

**Maximum I/O Rack Distance**
10,000 feet (57.6K Baud)
5,000 feet (115.2K Baud)

**Typical 5V Power Supply Current Requirement**
1.2 A.

**Ambient Temperature Rating**
Operational 0° C to + 60° C
Storage -40° C to +85° C

**Relative Humidity**
5 to 95%
(without condensation)

**Keying**
Top Connector —
Between pins 44 and 46
Bottom Connector —
Between pins 20 and 22

**Interconnect Cable**
Allen-Bradley Cat. No. 1770-CD
Belden Cable 9463, or equivalent

### DESCRIPTION

The Remote I/O Adapter Module Assembly (Cat. No. 1771-AS) directs the transmission of data between the Processor and the I/O modules.

Remote I/O Adapter Module Assembly (Cat. No. 1771-AS) includes the following units:

- Remote I/O Adapter Module (Cat. No. 1771-ASC)
- One 12-Terminal Field Wiring Arm (Cat. No. 1771-WB)
- Module Group Label Set (Cat. No. 1771-XL)

Specific functions of the Remote I/O Adapter Module are:

- Receive data and information from the I/O Scanner in serial form before transmitting it in parallel form to update the I/O modules.
- Read data and information from the I/O modules in parallel form before transmitting it in serial form to the I/O Scanner.

The Remote I/O Adapter Module may be installed up to 10,000 cable feet from the I/O Scanner.

Block Transfer and Single Transfer programming may be used with the Remote I/O Adapter Module.

The Remote I/O Adapter Module is compatible with Bulletin 1771 I/O Modules. Refer to Table A for Processor/Scanner Compatibility.

**TABLE A — Processor/Scanner Compatibility**

| PROCESSOR | SCANNER |
|---|---|
| PLC-2 Family | 1772-SD |
| PLC-3 | 1775-S4A<br>1775-S4B |

### STATUS INDICATORS

Three indicators are located on the front of the Module (Figure 1). These indicators are:

ACTIVE — This green indicator provides three indications:

- ON — A proper communication link has been established between the I/O Scanner and the Remote I/O Adapter Module.

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Publication 1771-938 — October, 1981
Supersedes Publication 1771-938 — Dated September, 1981

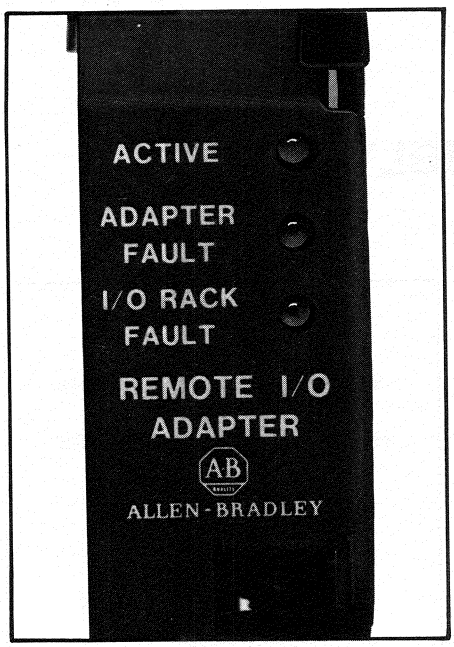



**FIGURE 1 — Status Indicators**

When illuminated, it also indicates that DC power is properly supplied to the I/O Rack and the I/O Adapter is actively controlling the I/O modules. The ACTIVE indicator is normally ON.

- OFF — A proper communication link has not been established between the I/O Scanner and the Remote I/O Adapter Module. A fault has been detected and the I/O Rack has responded in the manner selected by the Last State Switch.
- FLASHING — Proper communication has been established between the I/O Scanner and the Remote I/O Adapter. The Remote I/O Adapter is not actively controlling the I/O modules. This indicator will also flash if the processor is in the Program or Test Mode.

ADAPTER FAULT — This red indicator provides two indications:

- ON — The Module is not operating properly. A fault has been detected and the I/O Rack has responded in the manner selected by the Last State Switch. When this indicator is ON, the other indicators are no longer valid. The ADAPTER FAULT indicator is normally OFF.
- FLASHING — The ADAPTER FAULT and ACTIVE indicators will flash alternately. Flashing will only occur if the Processor Restart Lockout Switch on the I/O Rack Backplane Switch Assembly has been selected. The I/O Rack Restart pushbutton must be depressed to clear the Restart Lockout.

I/O RACK FAULT — This red indicator provides the following indication:

- ON — A fault has been detected at the Remote I/O Adapter, the I/O Chassis on the logic side of the I/O modules. The I/O RACK FAULT indicator is normally OFF.

A detailed Fault Diagnostics table (Table E) is included in this data sheet. Fault diagnostics provided by the indicators are explained in greater detail.

## SWITCH SETTINGS

### I/O Rack Backplane Switch

On the backplane of the I/O Chassis, near the adapter slot, is a switch assembly containing 8 switches. Refer to Figure 2. These switches must be set by the user in proper combinations (Figure 3) to allow communication between Bulletin 1771 I/O Racks and the Processors. Switches may be set ON or OFF with the tip of a ball-point pen.

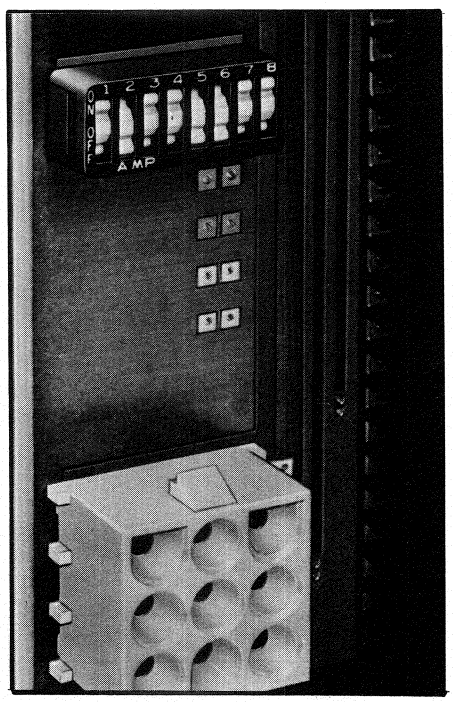



**FIGURE 2 — I/O Rack Backplane Switch Location**

### PLC-2 Family

The Module requires addressing and maximum rack distance selection through the Rack Address Switch Assembly (SW-1) and the Maximum Rack Distance Switch Assembly (SW-2). These switch assemblies are located on the PC board underneath the component cover.

To select a configuration, proceed as follows:

1. Loosen two screws and move the left side cover plate to expose the switches. Refer to Figure 4.
2. Identify the switch assemblies.
3. Set the Switches according to the selected configuration (Figure 4).
4. Replace the cover plate and tighten the screws.

The tip of a ball-point pen can be used to set the switches. Do not use a pencil because the tip can break off and jam the switch.

### PLC-3

A Rack Address Switch Assembly and a table for the I/O Rack Number switch settings are shown in Figure 4 and Table D, respectively.

## POWER REQUIREMENTS

Circuitry of the Remote I/O Adapter Module is driven by a Power Supply which connects to the I/O Chassis backplane. The Module requires a current of 1.2A from the 5V DC output of this Supply. This amount should be totalled with the current requirements of other modules in the I/O Rack to avoid overloading the Supply.

Power Supplies suitable for use are:

- System Power Supply (Cat. No. 1771-P1)

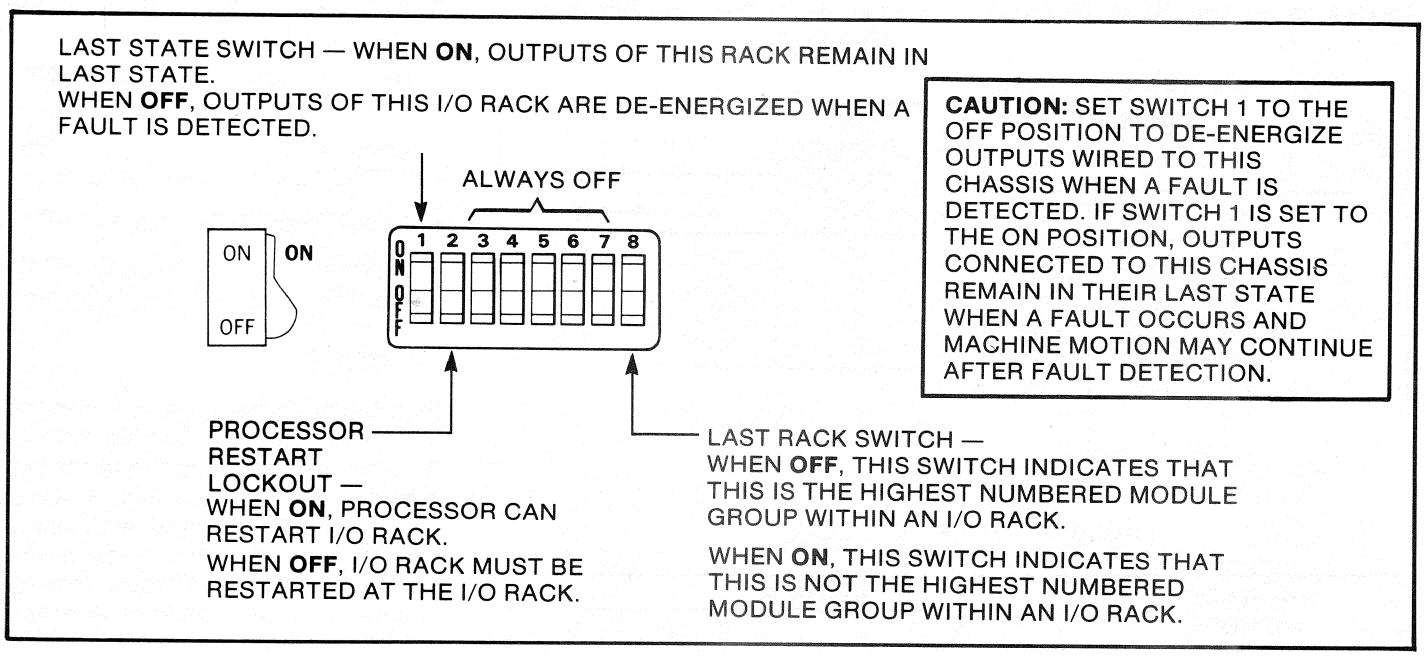



**FIGURE 3 — I/O Rack Backplane Switch Assembly**

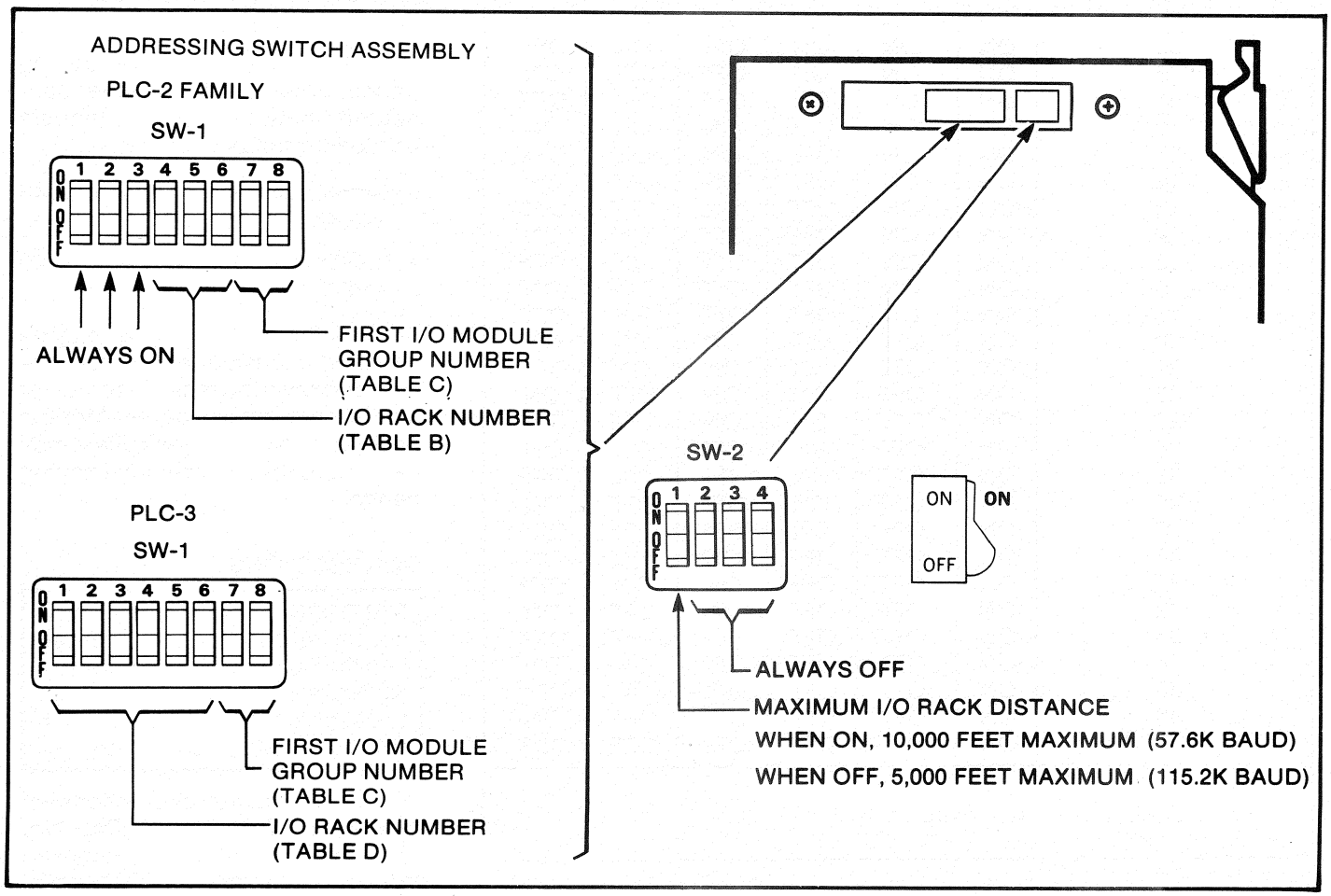



**FIGURE 4 — Remote I/O Adapter Module Switch Assemblies**

**TABLE B — I/O Rack Number (PLC-2)**

| I/O RACK NO. | SWITCH | | |
|---|---|---|---|
| | 4 | 5 | 6 |
| 1 | ON | ON | ON |
| 2 | ON | ON | OFF |
| 3 | ON | OFF | ON |
| 4 | ON | OFF | OFF |
| 5 | OFF | ON | ON |
| 6 | OFF | ON | OFF |
| 7 | OFF | OFF | ON |

**TABLE C — First Module Group Number**

| FIRST MODULE GROUP NO. | SWITCH | |
|---|---|---|
| | 7 | 8 |
| 0 | ON | ON |
| 2 | ON | OFF |
| 4 | OFF | ON |
| 6 | OFF | OFF |

**TABLE D — I/O Rack (PLC-3)**

| I/O RACK NUMBER | SWITCH | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 00 | ON | ON | ON | ON | ON | ON |
| 01 | ON | ON | ON | ON | ON | OFF |
| 02 | ON | ON | ON | ON | OFF | ON |
| 03 | ON | ON | ON | ON | OFF | OFF |
| 04 | ON | ON | ON | OFF | ON | ON |
| 05 | ON | ON | ON | OFF | ON | OFF |
| 06 | ON | ON | ON | OFF | OFF | ON |
| 07 | ON | ON | ON | OFF | OFF | OFF |
| 10 | ON | ON | OFF | ON | ON | ON |
| 11 | ON | ON | OFF | ON | ON | OFF |
| 12 | ON | ON | OFF | ON | OFF | ON |
| 13 | ON | ON | OFF | ON | OFF | OFF |
| 14 | ON | ON | OFF | OFF | ON | ON |
| 15 | ON | ON | OFF | OFF | ON | OFF |
| 16 | ON | ON | OFF | OFF | OFF | ON |
| 17 | ON | ON | OFF | OFF | OFF | OFF |
| 20 | ON | OFF | ON | ON | ON | ON |
| 21 | ON | OFF | ON | ON | ON | OFF |
| 22 | ON | OFF | ON | ON | OFF | ON |
| 23 | ON | OFF | ON | ON | OFF | OFF |
| 24 | ON | OFF | ON | OFF | ON | ON |
| 25 | ON | OFF | ON | OFF | ON | OFF |
| 26 | ON | OFF | ON | OFF | OFF | ON |
| 27 | ON | OFF | ON | OFF | OFF | OFF |
| 30 | ON | OFF | OFF | ON | ON | ON |
| 31 | ON | OFF | OFF | ON | ON | OFF |
| 32 | ON | OFF | OFF | ON | OFF | ON |
| 33 | ON | OFF | OFF | ON | OFF | OFF |
| 34 | ON | OFF | OFF | OFF | ON | ON |
| 35 | ON | OFF | OFF | OFF | ON | OFF |
| 36 | ON | OFF | OFF | OFF | OFF | ON |
| 37 | ON | OFF | OFF | OFF | OFF | OFF |

NOTE: Do not use other switch positions.

- Auxiliary Power Supply (Cat. No. 1771-P2)
- System Power Supply (Cat. No. 1772-P1) — Series B or later
- Local Power Supply (Cat. No. 1774-P1) — Series C or later
- Power Supply (Cat. No. 1775-P1)
- Auxiliary Power Supply (Cat. No. 1777-P2) — Series B or later

## KEYING

In initial design stages, the Remote I/O Adapter Module (Cat. No. 1771—ASC) is inserted into the left most slot of the I/O Chassis. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for keying the adapter slot to accept only one type of adapter module. Use of these keying bands is strongly recommended. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module.

Refer to Figure 5. Insert the keying bands onto the backplane connectors between these numbers printed on the backplane:

- Upper Connector — Between 44 and 46
- Lower Connector — Between 20 and 22

The position of these bands may be changed if subsequent system design and rewiring make insertion of a different type of Adapter Module necessary. Needle-nose pliers may be used to insert or remove keying bands.

## CONNECTIONS

**CAUTION:** The Module must not be removed from or inserted into the Bulletin 1771 I/O Chassis while system power is ON. Failure to observe this rule may result in damage to Module circuitry.

I/O communication cables connect to a Field Wiring Arm (Cat. No. 1771-WB) which can be removed from the Bulletin 1771 I/O Chassis. Refer to Figure 6. The Field Wiring Arm pivots on the front of the

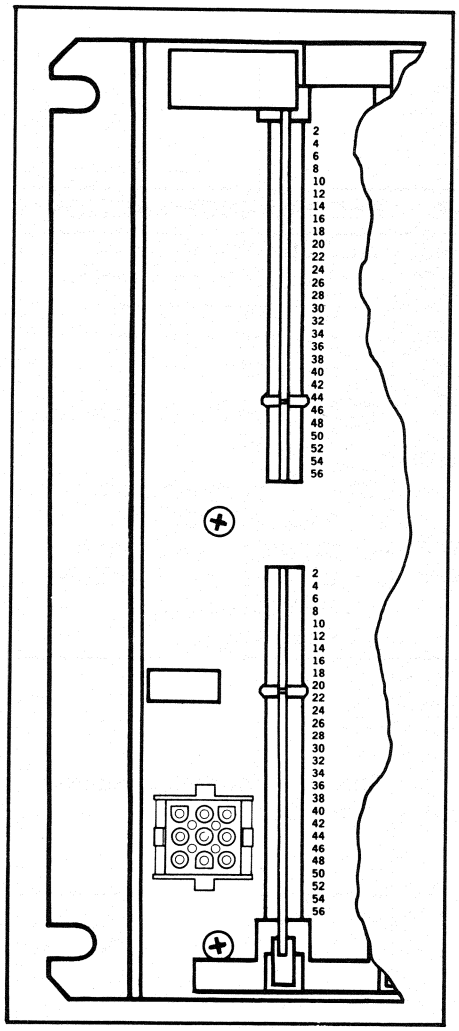


**FIGURE 5 — Adapter Module Keying Diagram**

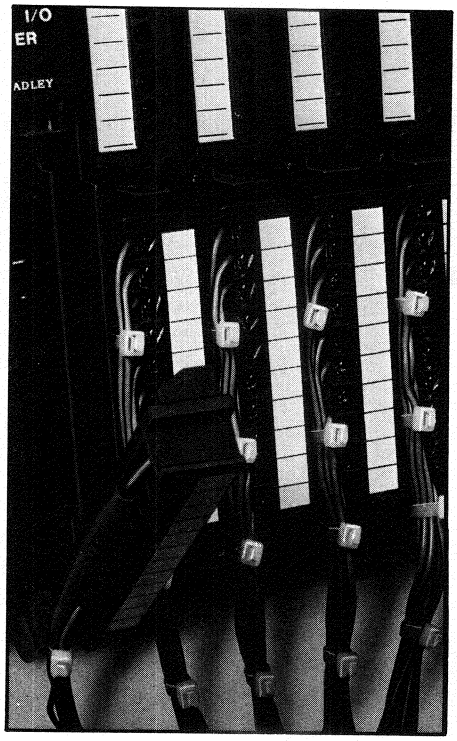



**FIGURE 6 — Field Wiring Arm**

Chassis to connect with the Module printed circuit board. Because wiring connections are made on the Wiring Arm, a module can be removed from the I/O Chassis without the need to disconnect the wiring.

The Connection Diagram (Figure 7) illustrates the Remote I/O Adapter Module (Cat. No. 1771-ASC) connections. A label on the side cover also identifies the Field Wiring Arm terminal connections to the Module. Additional space for user labeling is provided on the front of the Module and on the Wiring Arm itself.

The Field Wiring Arm terminals labeled RESET have significance when the Processor Restart Lockout feature is used. This feature is selected at a switch assembly on the Bulletin 1771 I/O Chassis backplane. A normally open/momentary contact pushbutton may be wired across the Terminals. Once a fault at an I/O Rack has been cleared, the user can reset the lockout at the I/O Rack by pressing the pushbutton.

**TABLE E — Fault Diagnostics [1]**

LEGEND: ⊗ ON  O OFF  ⊗ EITHER ON OR OFF  ⊗ FLASHING

| INDICATION | MODE | DESCRIPTION | PROBABLE CAUSE | RECOMMENDED ACTION |
|---|---|---|---|---|
| ⊗ Active<br>O Adapter Fault<br>O I/O Rack Fault | 1 | Adapter is fully operational; controlling I/O. This is a NORMAL indication. | | |
| ⊗ Active<br>⊗ Adapter Fault<br>⊗ I/O Rack Fault | 2 | An Adapter fault exists [2] | The Remote I/O Adapter itself is not operating properly and will remain in this fault mode until corrective action occurs. | A) Cycle power to the Chassis in an attempt to clear the Adapter Fault. [3]<br>B) If the Adapter Fault will not clear, replace the Remote I/O Adapter. |

**TABLE E — Fault Diagnostics [1] (Cont.)**

| INDICATION | MODE | DESCRIPTION | PROBABLE CAUSE | RECOMMENDED ACTION |
|---|---|---|---|---|
| ⊗ Active<br>O Adapter Fault<br>● I/O Rack Fault | 3 | An I/O Rack fault exists. [2] | A problem has occurred between the Remote I/O Adapter Module and other Modules within the rack, i.e. high noise on the backplane, shorted printed circuit board runs on the backplane or other I/O Module hardware fault. The Remote I/O Adapter will remain in this fault mode until corrective action occurs. | A) Cycle power to the Chassis in an attempt to clear a problem resulting from high noise. [3]<br>B) Replace the Remote I/O Adapter.<br>C) If the problem does not clear, a hardware problem exists in the Chassis or I/O Module. Replace faulty equipment. |
| Ⓟ Active<br>O Adapter Fault<br>O I/O Rack Fault | 4 | Scanner/Adapter communication link is good. The Remote I/O Adapter is not actively controlling I/O. [4] | A) The Processor is in the Program or Test Mode.<br>B) The Scanner is holding the Remote I/O Adapter in a fault mode. | The fault should be cleared by the Scanner. |
| Ⓕ Active<br>Ⓕ Adapter Fault<br>O I/O Rack Fault | 5 | The two lights alternately flash (toggle). The Scanner/Adapter communication link is good. The Adapter is not actively controlling I/O. [2] The Remote I/O Adapter is in the Processor Restart Lockout Mode. | A fault has occurred. The Remote I/O Adapter Module cannot be restarted by the Processor/Scanner until the reset pushbutton is depressed. | A) Depress the Reset pushbutton to clear the lockout feature. The Adapter Fault indicator should stop flashing. The Remote I/O Adapter should return to Mode Number 1 or 4.<br>B) If after repeated attempts to depress the Reset pushbutton the alternate flashing does not stop, either:<br>1) The pushbutton is not wired properly the wiring arm is down.<br>or 2) The Remote I/O Adapter has been reset by the Processor/Scanner and was immediately faulted. The fault is re-occurring and must be eliminated. |

**TABLE E — Fault Diagnostics [1] (Cont.)**

| INDICATION | MODE | DESCRIPTION | PROBABLE CAUSE | RECOMMENDED ACTION |
|---|---|---|---|---|
| O Active<br>O Adapter Fault<br>O I/O Rack Fault | 6 | All indicators off. Any of a number of problems are present. (If the Remote I/O Module is wired to a Remote I/O Scanner Distribution Panel (Cat. No. 1772-SD) which is in the DISABLE SEARCH mode, proceed to item 5 first.) | Checklist:<br>1) No power to I/O Chassis. | Check the power supply to be sure it is functional. Check cable connection. Make sure the Adapter Module is fully inserted into Chassis. |
| | | | 2) The Twinaxial Cable (Cat. No. 1770-CD) is not connected, improperly connected or the wiring arm is not connected to the module. | Correct difficulties. |
| | | | 3) Check the Scanner to make sure it is functional and configured properly. | If the Scanner is not operational, the indicator on the Remote I/O Adapter should be off. |
| | | | 4) Check the link from the Scanner | If the Scanner is operational and the Adapter is powered and wired correctly, it is possible that the wiring between the Scanner and the Adapter has been disrupted. Fix cables. |
| | | | 5) If the Remote I/O Adapter is connected to a Scanner/Distribution Panel which is in the DISABLE SEARCH Mode, all indicators off is a legal state. [2] | In the DISABLE SEARCH mode,one faulted chassis within a Rack Group Address will cause the Scanner/Distribution Panel to fault **all** chassis with that Rack Address Group. The Scanner/Distribution Panel will establish a communication link with chassis whose first slot address is numbered lower than the rack which is faulted. This chassis whose first slot addresses are numbered greater than the faulted rack may be operating perfectly: however, since the Scanner/Distribution Panel is not actively scanning the Adapter, all indicators OFF may be a legal state.<br><br>To clear the problem, check sequentially from the first through to the last to determine where the fault exists. Clear up any difficulties, and proceed to the next chassis. |

## TABLE E — Fault Diagnostics [1] (Cont.)

NOTES:

[1] The operating mode of the Remote I/O Adapter must be selected in accordance with the guidelines established in the documentation for the Remote I/O Scanner/Distribution Panel or the Remote I/O Scanner-Program Interface or Message Handling — whichever Scanner the Remote I/O Adapter is connected to. (Particular attention should be paid to the DISABLE SEARCH Mode in the 1772-SD.)

[2] The I/O Chassis is in the fault response mode selected by the Last State Switch on the backplane.

[3] Cycling power will clear the Block Transfer Request queue. All pending Block Transfers would be lost. The user program must repeat the request for Block Transfers from this Chassis.

[4] If a fault occurs and the Processor is in the RUN mode and operating in the dependent mode, the chassis fault response mode is selected by the Last State Switch on the backplane.

When connected to an I/O Scanner/Distribution Panel select to:

| | |
|---|---|
| PLC-2 Mode | If the Processor is in PROGRAM or TEST keyswitch position, chassis is in the fault response mode selected by the Last State Switch. |
| PLC-2/20 Mode | If the Processor is in the PROGRAM or TEST keyswitch position, all outputs are de-energized. |

When connected to the Remote I/O Scanner-Program Interface or Message Handling, see PLC-3 documentation to determine the state of the outputs.

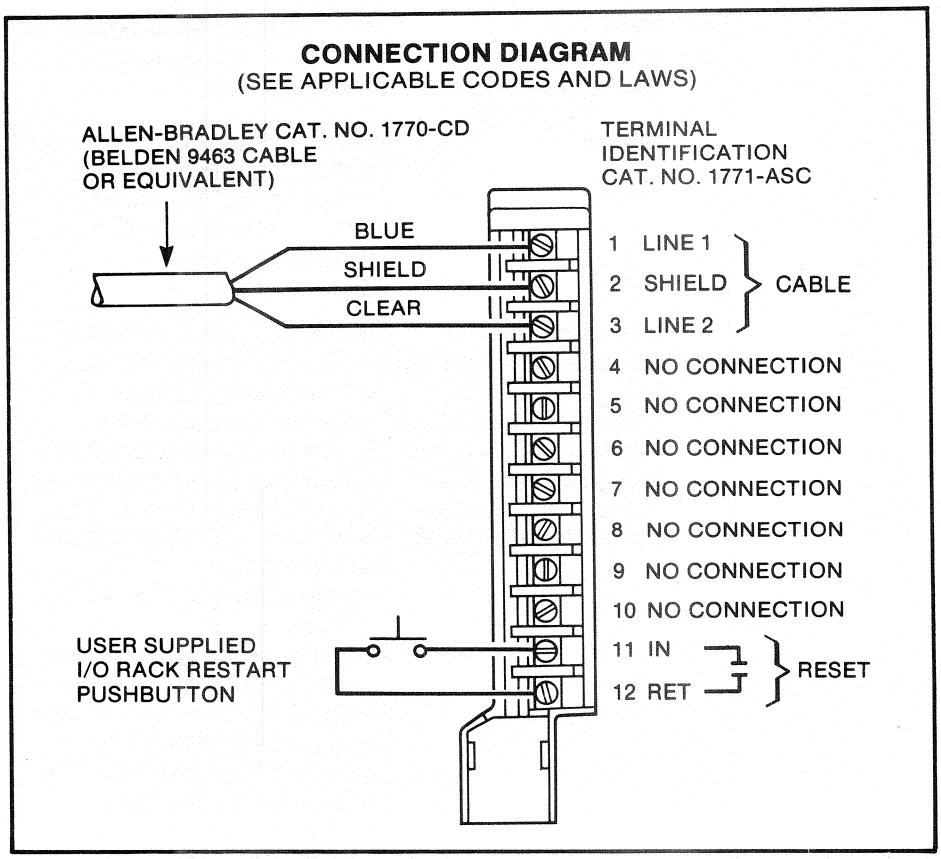
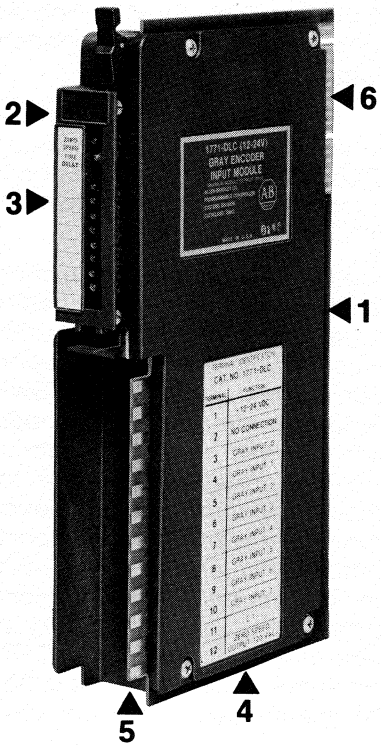



**FIGURE 7 — Connection Diagram**

ALLEN-BRADLEY

# ALLEN-BRADLEY GRAY ENCODER (12-24V DC) INPUT MODULE (8-BIT) ASSEMBLY

## Cat. No. 1771-DL




1. Protective cover
2. Brown identification label
3. Status indicators
4. Label identifies user output connections.
5. Field Wiring Arm connects here.
6. Slotted for I/O slot insertion only.

### DESCRIPTION

The Gray Encoder (12-24V DC) Input Module (8-Bit) Assembly (Cat. No. 1771-DL) accepts an 8-bit Gray Code from an absolute encoder and converts the code to an eight bit natural binary number that can be used by an Allen-Bradley Programmable Controller. If this module is used with a PLC-2 Family processor, the GET BYTE-LIMIT TEST instructions may be used.

The Module also provides a 120V AC Zero Speed Switch Function which is energized while the Gray Encoder is in motion. As a result of encoder motion failure, this output is de-energized.

The time delay between encoder motion failure and output de-energization is customer adjustable between 0.3 and 6 seconds.

The Gray Encoder (12-24V DC) Input Module (8-Bit) Assembly (Cat. No. 1771-DL) includes:

- 1 Gray Encoder (12-24V DC) Input Module (8-Bit)(Cat. No. 1771-DLC)
- 1 12-terminal gold-plated Field Wiring Arm (Cat. No. 1771-WB)

### STATUS INDICATORS

There are nine red LED status indicators on the front of the Gray Encoder Input Module.

The top LED on the front of the Module (Figure 1) turns ON when the Zero Speed Switch function is energized.

Each of the eight lower LEDs corresponds to a single Gray Code bit input terminal. When the logic state is OFF, its corresponding status indicating LED illuminates.

### SPECIFICATIONS

**Interface Capability**

**Input**
One 8-Bit Absolute Gray Encoder Input per Module

**Digital Resolution**
1 part in 256

**High True Logic**
(from a 7406, 7407 or equivalent TTL circuit with an open collector output)
Module sources current to user device

**Logic State**
Logic "1" State - $V_{IN} \geq 10$ volts
Logic "0" State - $V_{IN} \leq 2$ volts

**Input Voltage Range** [1]
Nominal: 12 to 24V DC
(will operate over the range of 10 to 27V DC)

**Input Sourcing Current**
6 mA per bit at 10V DC
15 mA per bit at 27V DC

**Input Filter Time Delay**
1 millisecond (max)

**I/O Rack Power Requirement**

**Voltage**
5V DC

**Current**
120 mA maximum

**Operational Ambient Temperature Range**
0° to +60° C (+32° F to + 140° F)

**Storage Temperature Range**
-40° to +85° C (-40° F to +185 ° F)

[1] This voltage is sufficient to power the Gray Encoder (12-24V DC) Input Module assembly (Cat. No. 1771-DL) together with certain Encoders. Some Encoders may require an additional 5V DC power supply. The user must check the power requirements of his Encoder to ensure proper operation.

(continued)

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## SPECIFICATIONS
**(continued)**

**Relative Humidity**
5% to 95% (without condensation)

**Keying**
4 and 6, 24 and 26

**Maximum Wire Size**
14 gauge stranded

**Cable**
Belden 8761, or equivalent
Maximum cable distance to the module from the Encoder is 50 cable feet.

**Zero Speed Switch Function**

**Output Voltage**
Nominal: 120V AC (will operate over the range of 92-138V AC)

**Output Frequency Range**
47 to 63 Hz

**Continuous Output Current**
0.5 amperes (max)

**Maximum Surge Current**
2 amperes for 10 milliseconds

**Minimum Load Current**
50 MA

**"ON State" Voltage Drop**
2V at 100 mA load current

**"OFF State" Leakage Current**
5 mA, (max)

**Output Fuse**
8AG 1 Amp Normal Blow

**Zero Speed Output Time Delay Range**
Customer adjustable from 0.3 to 6 seconds. Unless specified otherwise, factory set at 6 seconds

## SYSTEM POWER

System power is supplied through the I/O chassis backplane from the I/O Rack Power Supply. The Module requires a current of 120 mA from the 5V DC output of this supply. This amount must be totaled with the current requirements of other modules in the rack to avoid overloading the supply.

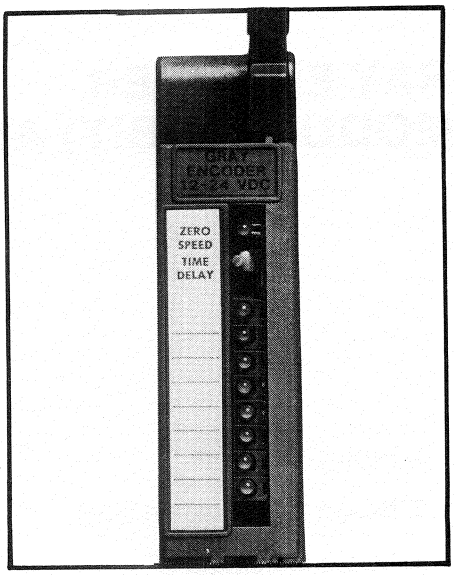



**FIGURE 1 — LED Status Indicators**

## EXTERNAL POWER

The Gray Encoder Module (Cat. No. 1771-DL) requires a 12 to 24 volt DC power supply which is connected to the Field Wiring Arm and the Absolute Encoder (Figure 3). The Encoder driving circuit must be able to sink 15 mA at 24V DC or 6 mA at 12V DC per Gray Code input. This is the power requirement for the outputs of the Encoder to the Module only. The current requirement of the Absolute Encoder must be added to the power requirements of other modules in the rack to avoid overloading the power supply.

NOTE: Some Absolute Encoders may require an additional 5V DC power supply.

In addition, the Gray Encoder Module provides a Zero Speed Switch Function. This circuit is energized while the Encoder is in motion and is rated at 0.5 amp at 120 volts AC, 47 to 63 Hz.

## WIRING

**CAUTION:** Do not remove the Module from or insert the Module into the Chassis while the I/O rack power is ON. Failure to observe this rule may result in damage to the Module's circuitry.

The Gray Encoder Module may be placed in any 1771 I/O rack and slot. Group low voltage input modules together within a single I/O chassis whenever possible.

Use Belden 8761 (or equivalent) cable to connect the input devices to the Module's Field Wiring Arm. Follow the appropriate Connection Diagram (Figure 3).

The Zero Speed Switch must only be used to interrupt a "sealed-in" circuit (see connection diagram). It must not be used to initate a "seal-in" circuit.

A load with large inductive characteristics can generate substantial voltage transients which could exceed the internal surge suppression of the Zero Speed Switch Output. Additional surge suppression devices may be needed to provide protection for the logic circuitry. Since switching frequency and load impedance are important factors in selecting a suppression device, it is not possible to specify a particular device for every possible Module load. Refer to Table A for some possible starting points for selecting a suppression device.

**TABLE A — Suppressors**

| ALLEN-BRADLEY EQUIPMENT | SUPPRESSOR A-B CAT. NO. |
|---|---|
| Motor Starter Bulletin 509 | 599-K04 |
| Relay Bulletin 700N | 700N5<br>700N9 |
| Motor Starter Bulletin 709 | 1401-N10 |
| General Purpose: [1] | Electro Cube RG 1676-14 |

[1] Electro Cube, Inc.
1710 South Delmar Avenue
San Gabriel, CA 91776

## COMPATIBLE ENCODERS

A list of Absolute Encoders which are compatible with the Gray Encoder Input Module is shown in Table B. Equivalent Encoders may be used.

**TABLE B — List of Compatible Encoders**

| DIRECTION OF ROTATION | BEI ELECTRONICS INC. MODEL NO. |
|---|---|
| Counterclockwise | H25G-F2-CCW-8GC-7406-EM20-S |
| Clockwise | H25G-F2-CW-8GC-7407-EM20-S |

## KEYING

In initial design stages, the Gray Encoder (12-24V DC) Input Module (8-Bit) (Cat. No. 1771-DLC) may be inserted into any I/O slot in the I/O chassis. However, once a group has been designated for a module, care should be taken so that other types of modules will not be placed into this slot. Plastic keying bands, shipped with each I/O Chassis, provide an easy method for keying an I/O slot to accept only one type of module. Use of these keying bands is strongly recommended.

The Module is slotted in two places on its rear edge. The position of the keying bands on the backplane connector must correspond to these slots to allow insertion of the module. The I/O rack backplane connectors of any module group can be keyed to accept the Gray Encoder Input Module.

Refer to Figure 2. Snap the keying bands on the upper backplane connectors between these numbers printed on the backplane.

- Between 4 and 6
- Between 24 and 26

The position of these keying bands may be changed if subsequent system design and rewiring makes insertion of a different type of module necessary.

Needle-nose pliers may be used to insert or remove keying bands.

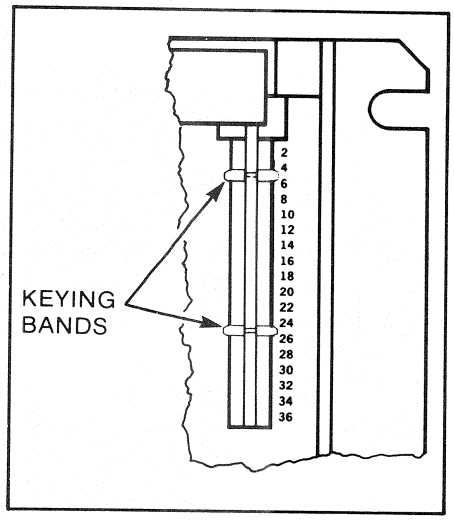



**FIGURE 2 — Keying Bands**

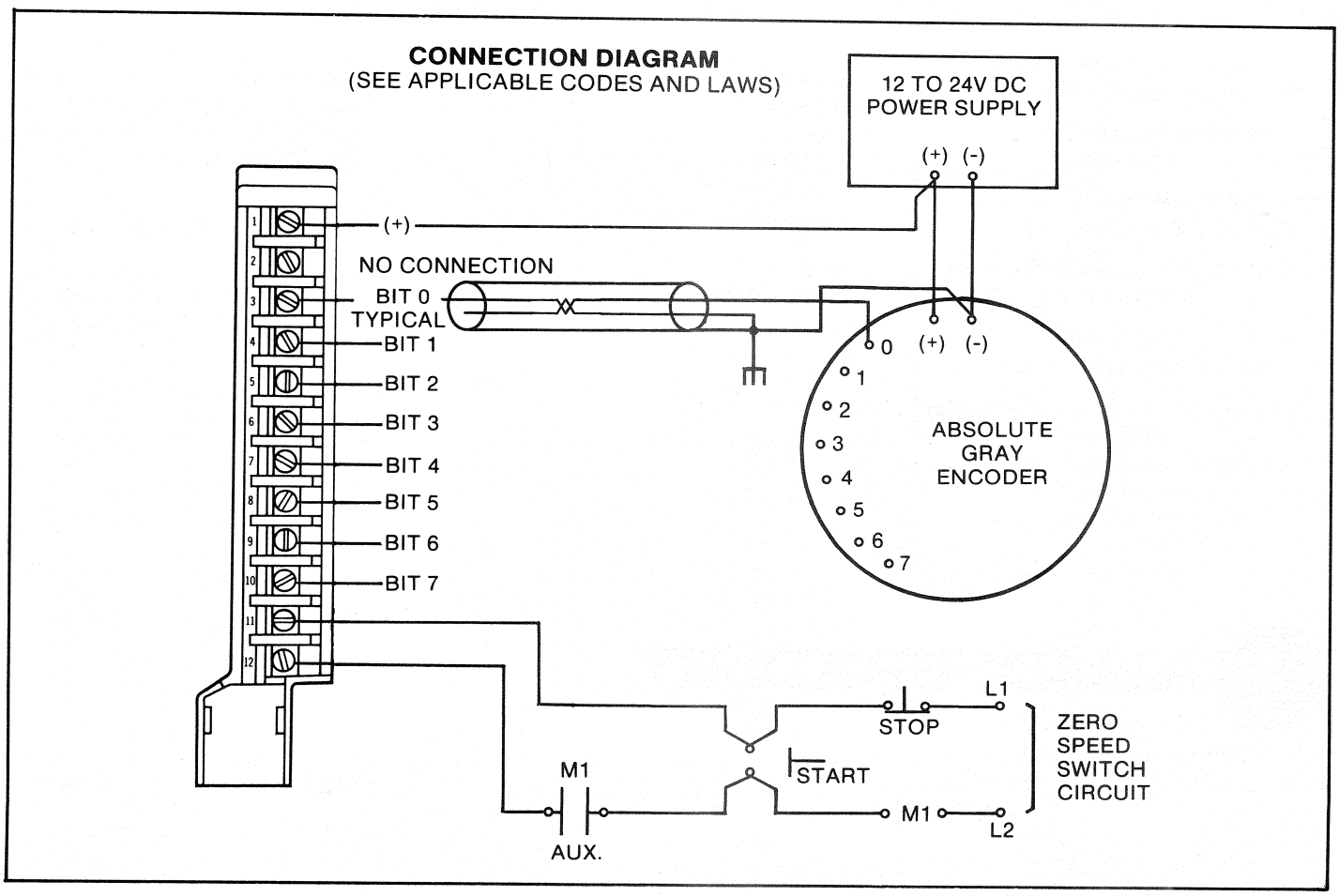



**FIGURE 3 — Connection Diagram**




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