POWER CIRCUIT BREAKER DIAGRAMS

INTRODUCTION

It is the object of this publication to provide a practical guide which will enable those who install, operate, or maintain General Electric power circuit breakers, to make the best use of the electrical diagrams which are customarily supplied with such equipment.

Two types of electrical diagrams, which are supplied with each G-E power circuit breaker are defined and explained herein:

"Elementary Diagrams"
"Connection Diagrams"

ELEMENTARY DIAGRAMS (SEE FIG. 1)

DEFINITION

An elementary diagram is one which shows, in straight-line form without regard for physical relationships, all circuits and device elements of an equipment and its associated apparatus or any clearly defined portion thereof, such as contacts, coils, resistors, etc. Where the circuits' functions are inherently in a definite sequence, they are so arranged on the diagram. The elementary diagram of a G-E power circuit breaker shows every device element and all circuits of the equipment.

The following characteristics of this diagram should be noted:

Each circuit is drawn in the so-called "straight-line" form; that is, in the most direct line from one polarity of its source of power to the other.

In order to produce the foregoing characteristic, the coils and contacts of devices are entirely disassociated; that is, the physical relationship of elements is disregarded, as, for instance, the coils and contacts of device 51 in Fig. 1.

The electrical details of the connections of the devices are definitely defined by cross reference between the device function numbers on the device element symbols in the elementary diagram. For example, the fact that the contacts of 51 are connected in the trip circuit is established by this means, as is the fact that the operating coils of 51 are connected in the current transformer secondary circuit.

1. The following conventions are used in the preparation of elementary diagrams.

The ampere ratings of fuses, the total ohmic values of resistors and the microfarad values of capacitors are placed below the abbreviations, as shown in Figs. a, b and c, respectively.

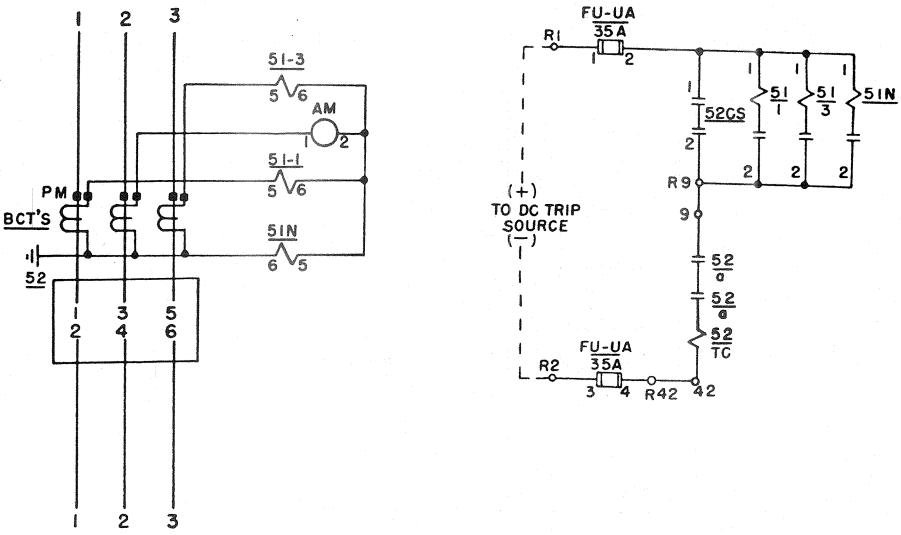


Fig. 1 Elementary Diagram

FIG.a FIG.b FIG.c

2. Wherever applicable, devices are designated by American Standard Device Function Numbers and the elements are identified by these numbers.

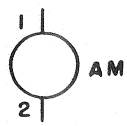
51 A-C Time Overcurrent Relay (From list of American Standard Device Function Numbers)

Descriptions of auxiliary devices with suffixes X, Y and Z indicate the nature of the auxiliary function if a few words suffice for such a description; otherwise, the term "auxiliary" is used. For example:

52X	Closing relay for 52
52Y	Cutoff relay for 52
52a	Auxiliary switch
	Open when 52 is open
52b	Auxiliary switch
	Closed when 52 is open
52CS	Control switch for 52
27X	Auxiliary relay for 27

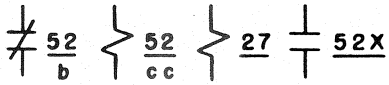
In order to prevent any possible conflict, one letter or combination of letters has only one meaning on an individual equipment. Furthermore, its meaning is clearly designated in the device function number list and/or the diagram abbreviations. All other words beginning with the same letter are written out in full each time or some other distinctive abbreviation is used.

3. Devices to which function numbers are not applicable, such as meters and instruments, are given abbreviations; i.e., AM for ammeter. The element is indicated thus:



4. Device function numbers are underscored to distinguish them from device terminal or device element numbers.

5. Distinguishing features of device elements are frequently placed beneath the function number thus:



These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Fig. 1 (0153B5802 Rev. 0)

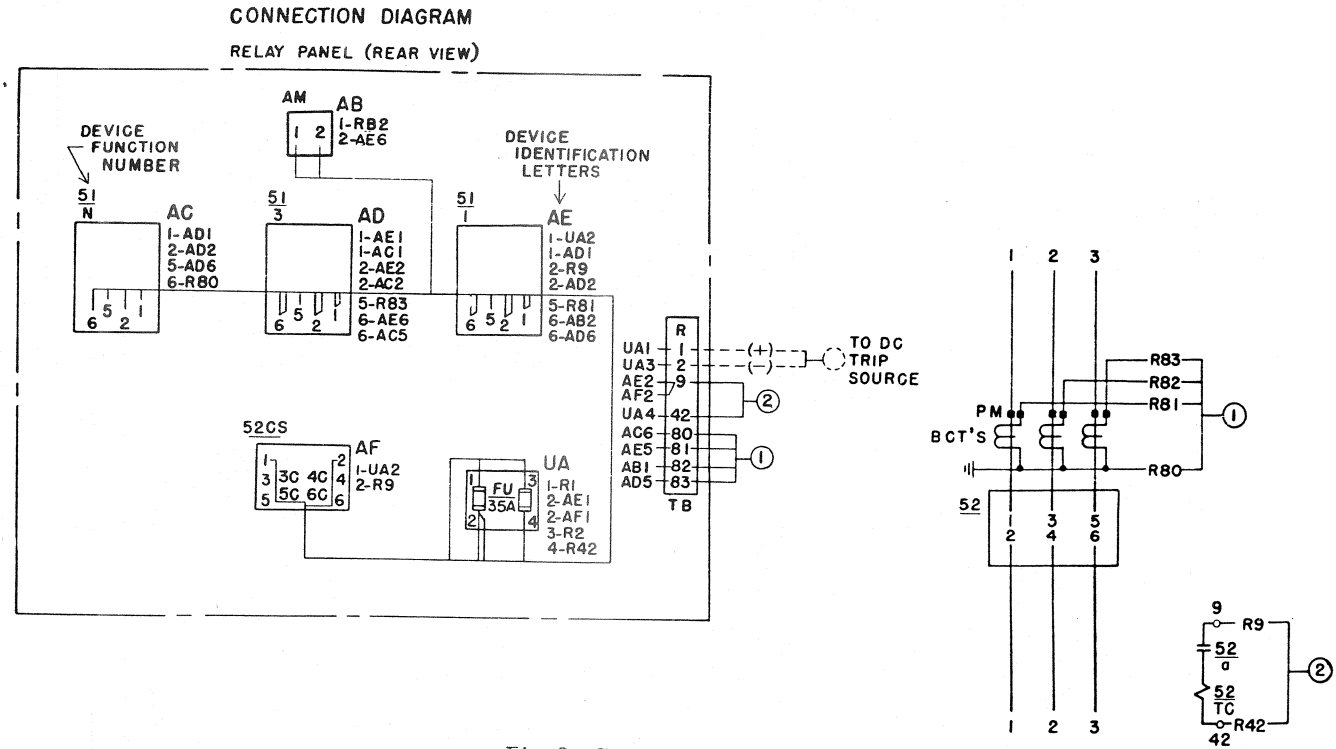
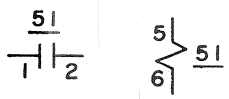


Fig. 2 Connection Diagrams

The abbreviations are descriptive of the feature indicated as:

A	Automatic
RC	Restraining Coil
TC	Trip coil
TDC	Time delay closing

6. Device terminal or element numbers derived from the internal device diagram, are usually placed at the left of, or below the element symbol thus:



7. Main power circuits, and their component device elements, are usually drawn separate from control circuits.

8. The contacts of all devices are shown in their de-energized or non-operated positions, including those that operate in response to other than electrical quantities, such as temperature, speed, pressure, flow, level and vibration. The contacts of these devices are shown in the position they assume when the quantities to which they respond are at their lowest level. The contacts of those devices which have no de-energized or non-operated positions, such as manually operated switches, are shown normally open with sufficient identifying information present on the diagram to indicate when the contacts open and close.

CONNECTION DIAGRAMS (SEE FIG. 2)

DEFINITION

A connection diagram is one which shows the connections of an installation or its component devices and equipment.

Power circuit breaker connection diagrams show the general physical arrangement of devices, and accessory items such as terminal boards, fuse blocks, resistors, etc.

It will be noted that Fig. 2 shows the relative location of the devices on the panel, the origin and destination of the actual wires used in making the connections between devices, and the terminal board provided for the purpose of joining the connections on the panel to those leading from the panel to the external apparatus.

The connection diagram is primarily an instrument of manufacture. While it has some value to the user of power circuit breakers as a record of the general physical arrangement of the connections of a breaker, including such accessory items as terminal boards, fuse blocks, resistors, etc., it is not intended nor adaptable as a means of tracing circuits through various device elements. Such tracing of circuits is accomplished better from the elementary diagram.

There are however, a number of conventions which promote uniformity and facilitate reading the connection diagram.

1. Devices on power circuit breakers are assigned an arbitrary identification letter or a pair of letters. Fuse blocks that are not part of device assemblies are identified by a pair of letters, the first being "U" and the second being arbitrary. Similarly, resistors are always identified by the letter "R" plus an arbitrary letter. Terminal boards located in breaker mechanism houses are identified by terminal numbers only according to ASA Standard C37.11-1957. Terminal boards mounted in relay equipment houses are identified by a combination of the ASA Standard numbers prefixed by the letter "R". Indicating lamps (when supplied) associated with a control switch are designated by the switch letters followed by a letter representing the lamp's color; for example, if the switch letter is AF the green lamp is AF-G. Lamps not associated with a switch may be given separate letters.

2. Each stud on a device, indicating instrument or meter is assigned a number.

3. Connections are indicated by designations which are derived from the identification letters of the devices and their stud or terminal numbers. A lead connecting Point #1 on terminal board "R" to stud #1 Fuse "UA", is designated on the terminal board as connecting to UA1 and on Fuse UA in the stud number assignment as connecting to R1.

Short jumpers such as connections between terminals on the same device are usually shown in full and do not bear any lead identification.

The method outlined for tracing out a circuit on the simple diagram of Fig. 2 also holds for more complicated diagrams. With the aid of the respective elementary diagram while tracing through circuits of the connection diagram, a marked proficiency in reading the diagrams will result and a better knowledge of circuits will follow.

AMERICAN STANDARD DEVICE FUNCTION NUMBERS

1. Master Element
2. Time-delay Starting or Closing, Relay
3. Checking or Interlocking Relay
4. Master Contactor
5. Stopping Device
6. Starting Circuit Breaker
7. Anode Circuit Breaker
8. Control Power Disconnecting Device
9. Reversing Device
10. Unit Sequence Switch
11. Reserved for future application
12. Over-Speed Device
13. Synchronous-Speed Device
14. Under-Speed Device
15. Speed or Frequency Matching Device
16. Reserved for future application
17. Shunting or Discharge Switch
18. Accelerating or Decelerating Device
19. Starting-to-Running Transition Contactor
20. Valve
21. Distance Relay
22. Equalizer Circuit Breaker
23. Temperature Control Device
24. Reserved for future application
25. Synchronizing or Synchronism-Check Device
26. Apparatus Thermal Device
27. Undervoltage Relay
28. Flame Detector
29. Isolating Contactor
30. Annunciator Relay
31. Separate Excitation Device
32. Directional Power Relay
33. Position Switch
34. Master Sequence Device
35. Brush-Operating or Slip-Ring Short-Circuiting Device
36. Polarity or Polarizing Voltage Device
37. Undercurrent or Underpower Relay
38. Bearing Protective Device
39. Mechanical Condition Monitor
40. Field Relay
41. Field Circuit Breaker
42. Running Circuit Breaker
43. Manual Transfer or Selector Device
44. Unit Sequence Starting Relay
45. Atmospheric Condition Monitor
46. Reverse-Phase or Phase-Balance Current Relay
47. Phase-Sequence Voltage Relay
48. Incomplete Sequence Relay
49. Machine or Transformer Thermal Relay
50. Instantaneous Overcurrent or Rate-of-Rise Relay
51. A-C Time Overcurrent Relay
52. A-C Circuit Breaker
53. Exciter or D-C Generator Relay
54. Reserved for future application (Use 72HS)
55. Power Factor Relay
56. Field Application Relay
57. Short-Circuiting or Grounding Device
58. Rectification Failure Relay
59. Overvoltage Relay
60. Voltage or Current Balance Relay
61. Reserved for future application (Use 60C when 60V is also present.)
62. Time-Delay Stopping, or Opening, Relay
63. Liquid or Gas Pressure or Vacuum Relay
64. Ground Protective Relay
65. Governor
66. Notching or Jogging Device
67. A-C Directional Overcurrent Relay
68. Blocking Relay
69. Permissive Control Device
70. Rheostat
71. Liquid or Gas-Level Relay
72. D-C Circuit Breaker
73. Load-Resistor Contactor
74. Alarm Relay
75. Position Changing Mechanism
76. D-C Overcurrent Relay
77. Pulse Transmitter
78. Phase Angle Measuring or Out-of-Step Protective Relay
79. A-C Reclosing Relay
80. Liquid or Gas Flow Relay
81. Frequency Relay
82. D-C Reclosing Relay
83. Automatic Selective Control or Transfer Relay
84. Operating Mechanism
85. Carrier or Pilot-Wire Receiver Relay
86. Locking-Out Relay
87. Differential Protective Relay
88. Auxiliary Motor or Motor Generator
89. Line Switch
90. Regulating Device
91. Voltage Directional Relay
92. Voltage and Power Directional Relay
93. Field Changing Contactor
94. Tripping or Trip-Free Relay
95. Used only for specific applications on individual installation where none of the assigned numbered functions from 1 to 94 are suitable.
96.
97.
98.
99.

NOTE: Alternate names such as relay, contactor, circuit breaker, switch or device may be used for any function where applicable.

NOTE: Suffix letters are used with device function numbers for various purposes; for instance, suffix N is generally used if the device is connected in the secondary neutral of current transformers, and suffixes X, Y and Z are used to denote separate auxiliary devices.

STANDARD DEVICE DESCRIPTIONS

(Used on wiring and elementary diagrams for power circuit breaker mechanisms of the type indicated)

PNEUMATIC OPERATED MECHANISMS (For Oil Circuit Breakers)

aa1	Cutoff Switch Operated by Piston
aa2	Cutoff Switch Operated by Prop
ac	Normally Open Auxiliary Switch Capable of Fine Adjustment
ae	High Speed Auxiliary Switch (Normally Open)
bd	Reclosing Switch Capable of Fine Adjustment
be	High Speed Auxiliary Switch (Normally Closed)
VC	Control Valve Closing Coil
VCO	Control Valve Cutoff Coil
VSI	Control Valve Seal-in Switch
VTF	Control Valve Trip-free Coil
VX	Auxiliary Control Valve Coil Opens Air Valve Over Piston On Trip-free Operation
X	Closing Relay
Y	Closing Cutoff Relay (Anti-pump)
63A	Pressure Alarm Closes on Low Pressure
63C	Pressure Cut-out Opens on Low Pressure
63G	Pressure Governor Controls Compressor Motor
33T	Pressure Transfer Switch
38T	Compressor Motor Timer

ATB MECHANISMS

Va	Auxiliary Switch on Control Valve Open When Valve is in Reset or Breaker Open Position
Vb	Auxiliary Switch on Control Valve Closed When Valve is in Reset or Breaker Open Position
VC	Control Valve Closing Coil
V-T	Control Valve Trip Coil
X	Closing Relay
Y	Closing Cutoff Relay (Anti-pump)
Z	Transfer Relay for Trip-free Operation
63AH	Pressure Alarm Switch, Closes on Low Pressure of 2000 Pound Pressure System
63AL	Pressure Alarm Switch, Closes on Low Pressure of 500 Pound Pressure System
63CT	Close and Trip Pressure Indicating Switch
63CTX	Auxiliary Relay for Close and Trip Cutoff

SPRING OPERATED MECHANISMS

CCX	Closing Coil Auxiliary Contact
SCO	Spring Cutoff Switch
CL/MS	Closing Latch Monitoring Switch Closed When Latch is Capable of Blocking Fully-charged Closing Springs
SM/LS	Spring Motor Limit Switch

MOTOR OPERATED MECHANISM

bb	Mechanism Motor Cutoff Switch
aa	Cutoff Switch, Cam Actuated Momentarily After Closing Stroke of Breaker
LC/69	Combination Latch Checking and Permissive Switch, Open When Latch is Out of Normal Position. Manual Trip Device Holds Contact Open Until Hand Reset

DIAGRAM ABBREVIATIONS

AC	ALTERNATING CURRENT
ACB	AIR CIRCUIT BREAKER
AIL	AMBER INDICATING LAMP
AM	AMMETER
AMP	AMPERE
ANN	ANNUNCIATOR
ARM	ARMATURE
AS	AMMETER SWITCH
AUTO	AUTOMATIC
AUTO TR	AUTO-TRANSFORMER
AUX	AUXILIARY
BASW	BELL ALARM SWITCH
BAT	BATTERY
BAT CHG	BATTERY CHARGER
BB	BENCHBOARD
BC	BACK CONNECTED
BCT	BUSHING CURRENT TRANSFORMER
BD	BOARD
BE	BREAKER END
BKR	BREAKER
BPD	BUSHING POTENTIAL DEVICE
BRKT	BRACKET
BV	BACK VIEW
CAB	CABINET
CAP	CAPACITOR; CAPACITY
CAT	CATALOG
CC	CLOSING COIL
CIL	CLEAR INDICATING LAMP
CKT	CIRCUIT
CNTOR	CONTACTOR
CO	CUT OUT
COMPT	COMPARTMENT
CONN	CONNECT
CONT	CONTINUED; CONTROL
CPT	CONTROL POWER TRANSFORMER
CS	CONTROL SWITCH
CT	CURRENT TRANSFORMER
CY	CYCLE
DC	DIRECT CURRENT
DD	DISCONNECTING DEVICE
DEV	DEVICE
DIAG	DIAGRAM
DIFF	DIFFERENTIAL
DIR	DIRECTION
DISC	DISCONNECT
DISCH	DISCHARGE
DM	DEMAND METER
DO	DRAWOUT
DPDT	DOUBLE POLE DOUBLE THROW
DPST	DOUBLE POLE SINGLE THROW
DS	DISCONNECTING SWITCH
DSCT	DOUBLE SECONDARY CURRENT TRANSFORMER
DWG	DRAWING
DX	DUPLEX
ELEM	ELEMENTARY
EMER	EMERGENCY
ENCL	ENCLOSURE
EQ	EQUALIZER
EQUIP	EQUIPMENT
EXC	EXCITATION: EXCITER
EXIST	EXISTING
FB	FUSE BLOCK
FC	FRONT CONNECTION
FDR	FEEDER
FLD	FIELD
FLEX	FLEXIBLE
FM	FREQUENCY METER
FRWK	FRAMEWORK
FU	FUSE
FUT	FUTURE
FV	FRONT VIEW
FWD	FORWARD
GD	GROUND DETECTOR
GEN	GENERATOR
GIL	GREEN INDICATING LAMP
GOV	GOVERNOR
GRD	GROUND
HC	HOLDING COIL
HP	HORSEPOWER
HR	HAND RESET
HTR	HEATER
IMPR	IMPEDOR
INC	INCOMING
INST	INSTANTANEOUS; INSTRUMENT
INT CON	INTERNAL CONNECTION
IT	INSULATING TRANSFORMER
KV	KILOVOLT
KVA	KILOVOLT-AMPERE
KVAH	KILOVOLT-AMPERE-HOUR
KVAHM	KILOVOLT-AMPERE-HOURMETER
KVAM	KILOVOLT-AMPERE-METER
KVAR	KILOVAR; REACTIVE KILOVOLT-AMPERE
KVAR HR	KILOVAR-HOUR
KW	KILOWATT
KWH	KILOWATT-HOUR
KWHM	KILOWATT-HOURMETER
L	LAMP; LOWERING
LA	LIGHTNING ARRESTER
LC	LATCH CHECKING SWITCH
LH	LEFT HAND
LIR	LOAD INDICATING RESISTOR
LRC	LOAD RATIO CONTROL
LS	LIMIT SWITCH
LSS	LEFT SIDE SHEET
LT	LIGHT
LTG	LIGHTING
MAM	MILLIAMMETER
MAN	MANUAL
MAN OP	MANUALLY OPERATED
MC	METAL-CLAD
MECH	MECHANICAL; MECHANISM
MFR	MANUFACTURE
MG	MOTOR GENERATOR
MISC	MISCELLANEOUS
MOT	MOTOR
MTD	MOUNTED
MV	MILLIVOLT
UF	MICROFARAD
NC	NORMALLY CLOSED
NEG	NEGATIVE
NEUT	NEUTRAL
NO	NORMALLY OPEN; NUMBER
NOR	NORMAL
NP	NAMEPLATE
OC	OVERCURRENT
OCB	OIL CIRCUIT BREAKER
OPR	OPERATE
PB	PUSH BUTTON
PB STA	PUSH-BUTTON STATION
PCB	POWER CIRCUIT BREAKER
PE	PANEL END
PF	POWER FACTOR
PFD	PREFERRED
PFM	POWER FACTOR METER
PH	PHASE
PM	POLARITY MARK
PNEU	PNEUMATIC
PNL	PANEL
POS	POSITION; POSITIVE
POT	POTENTIAL
PRI	PRIMARY
PT	POTENTIAL TRANSFORMER
PU	PICK UP
PWR	POWER
RB	RELAY BLOCK
RCD	REVERSE CURRENT DEVICE
RE	RECEPTACLE
REAC	REACTOR
REC	RECORDING
RECL	RECLOSING
RECT	RECTIFIER
REG	REGULATOR
REQ	REQUISITION
RES	RESISTANCE; RESISTOR
REV	REVERSE; REVISE
RH	RIGHT HAND
RHEO	RHEOSTAT
RIL	RED INDICATING LAMP
RSS	RIGHT SIDE SHEET
RTD	RESISTANCE TEMPERATURE DETECTOR
SEC	SECONDARY
SECT	SECTION
SEQ	SEQUENCE
SER	SERIES
SH	SHEET; SHUNT
SI	SEAL-IN DEVICE
SOL	SOLENOID
SP	SPARE
SPDT	SINGLE POLE DOUBLE THROW
SPST	SINGLE POLE SINGLE THROW
STA	STATION; STATIONARY
STAB	STABILIZER
STD	STANDARD
STR	STRUCTURE
SUB STA	SUBSTATION
SUM	SUMMARY
SUPV	SUPERVISORY
SW	SWITCH
SWBD	SWITCHBOARD
SWG BKT	SWINGING BRACKET
SWGR	SWITCHGEAR
SYM	SYMBOL
SYN	SYNCHRONISM - IZING; SYNCHRONOUS; SYNCHROSCOPE
SYN CONV	SYNCHRONOUS CONVERTER
SS	SYNCHRONIZING SWITCH
TB	TERMINAL BOARD
TC	TRIP COIL
TD	TESTING DEVICE; TIME DELAY
TDC	TIME DELAY CLOSING
TDO	TIME DELAY OPENING
TEL	TELEPHONE
TLM	TELEMETER
TEMP	TEMPERATURE
TM	TEMPERATURE METER
TPST	TRIPLE POLE SINGLE THROW
TRANS	TRANSFORMER
UVD	UNDERVOLTAGE DEVICE
V	VOLT
VA	VOLT-AMPERE
VAC	VACUUM
VAR	VOLTAGE ADJUSTING RHEOSTAT; REACTIVE VOLT-AMPERE
VARHR	VAR-HOUR
VARM	VARMETER
VM	VOLTMETER
VS	VOLTMETER SWITCH
VT	VACUUM TUBE
W	WATT; WIRE
WHDM	WATTHOUR DEMAND METER
WHM	WATTHOUR METER
WIL	WHITE INDICATING LAMP
WM	WATTMETER
YIL	YELLOW INDICATING LAMP