INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

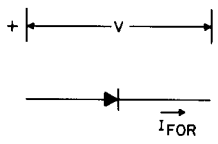
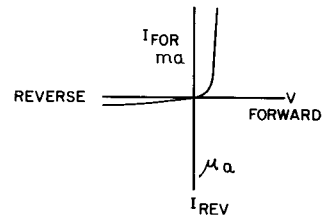
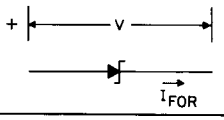
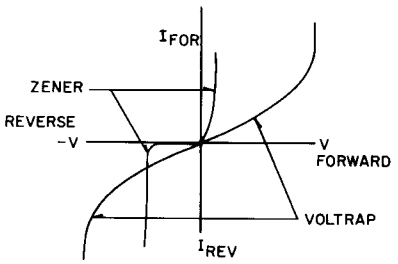
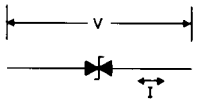
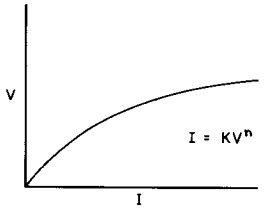
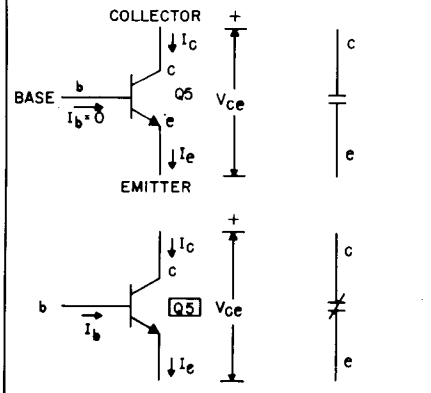
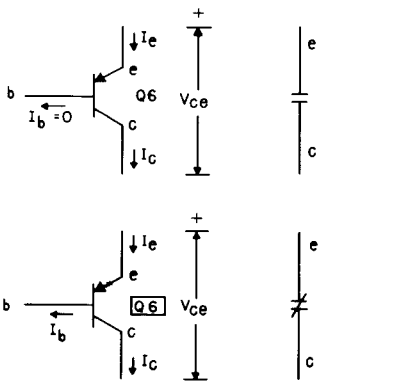
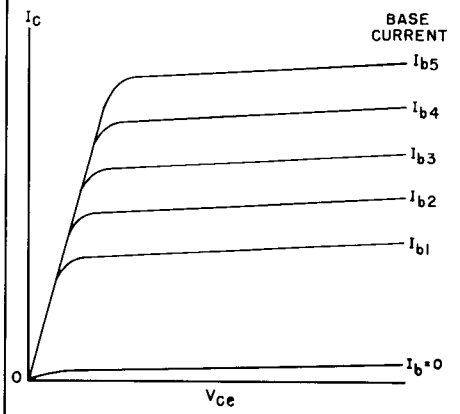
SYMBOLS FOR SOLID STATE PROTECTIVE RELAYING

The following are standard for Westinghouse solid state protective relaying and consists of three sections: (1) Device Symbols, (2) Logic Circuits and (3) Static Relay Diagram terminology. Typical basic characteristics, equivalent circuits, electromechanical contact equivalents are shown where applicable to aid in understanding.

The symbols and terminology are in line with ASA Y32.14-1962 (Graphic Symbols for Logic Diagrams).

The current and voltage nomenclature is the same as used previously. The current arrows show the direction of current flow. All voltages are voltage drops with the (+) mark indicating the point of relative positive potential.

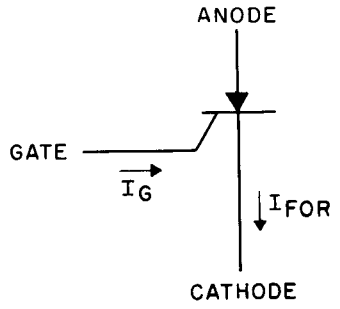
SYMBOLS FOR SOLID STATE PROTECTIVE RELAYING

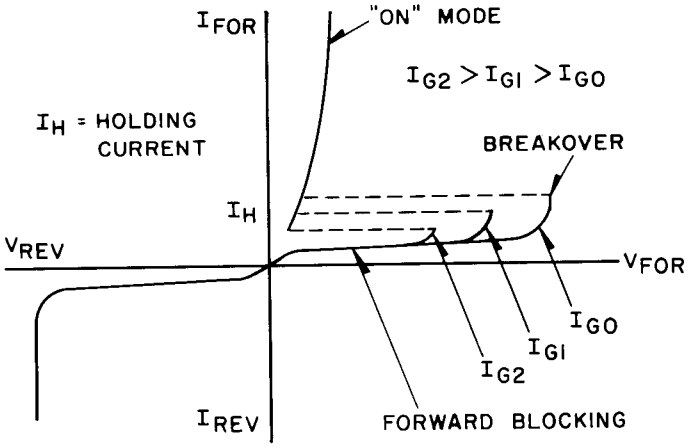
DEVICE	SYMBOL	BASIC CHARACTERISTIC
DIODE		
ZENER DIODE		
SURGE SUPPRESSOR (VOLTRAP, THYRECTOR)		
VARISTOR		
TRANSISTOR NPN TYPE SOLID STATE / EQUIVALENT ELECTROMECHANICAL		
PNP TYPE SOLID STATE / EQUIVALENT ELECTROMECHANICAL		
		 BASE CURRENT I_b IS VERY MUCH SMALLER THAN THE COLLECTOR CURRENT I_c

Q5 RECTANGLE AROUND TRANSISTOR DESIGNATION DENOTES CONDUCTION IN QUIESCENT (AT REST) STATE

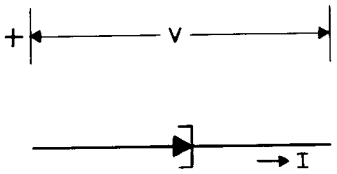
THYRISTOR

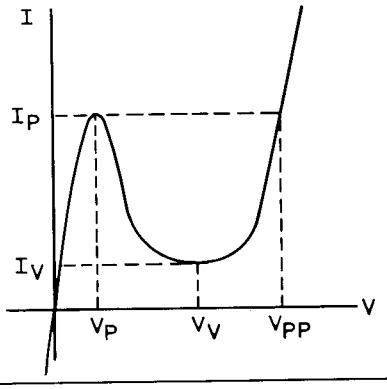
(TRINISTOR CONTROLLED RECTIFIER, SCR)



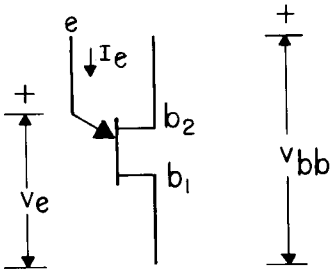


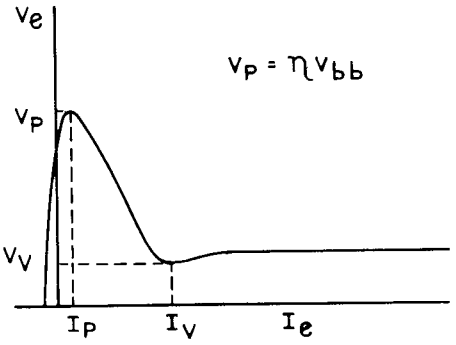
TUNNEL DIODE



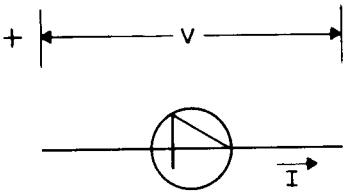


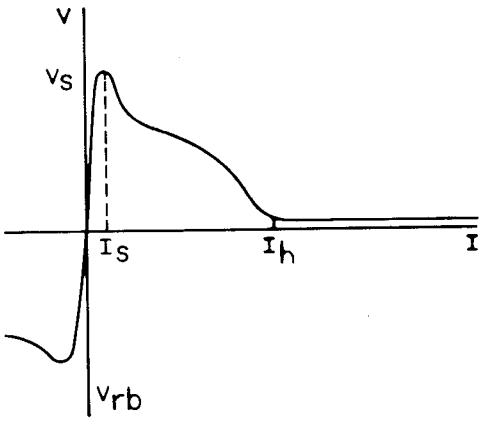
UNIJUNCTION

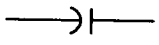
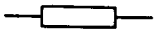
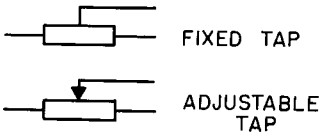




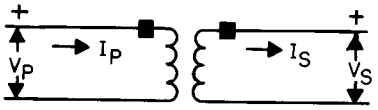
4 LAYER DIODE



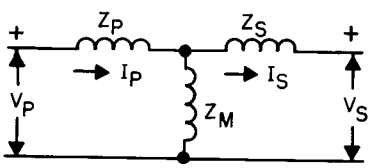


DEVICE	FIXED	VARIABLE	TAPPED
CAPACITOR			
RESISTOR RHEOSTATS POTENTIOMETERS			
REACTOR			

TRANSFORMER, COMPENSATORS

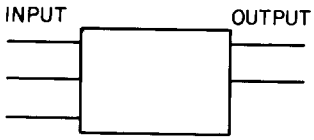


EQUIVALENT CIRCUIT



TRANSFORMER Z_M VERY HIGH,
COMPENSATOR OR AIR-GAP TRANSFORMER
Z_M IS LOW, AIR-GAP LIMITS SATURATION

COMPOSITE NETWORKS - SEQUENCE FILTERS



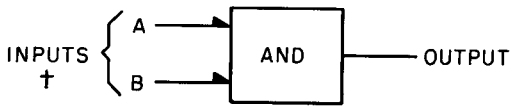
THREE PHASE
A-C CURRENT
OR VOLTAGE

SINGLE PHASE VOLTAGE PROPORTIONAL TO:
I_1, I_2, $3I_0$ OR I_0, E_1, E_2, $3E_0$ OR E_0
AND COMBINATIONS $K_1 I_1 + K_2 I_2 + K_0 I_0$

THESE STATIC NETWORKS PROVIDE LESS COMPLEX FAULT SENSING THAN IS AVAILABLE DIRECTLY FROM THE THREE PHASE POWER SYSTEM.

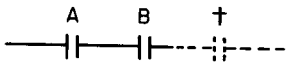
LOGIC CIRCUITS

AND



INPUTS		OUTPUT
A	B	
0	0	0
0	1	0
1	0	0
1	1	1

ELECTROMECHANICAL CONTACT EQUIVALENT

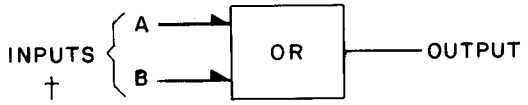


SIGNAL ON ALL INPUTS REQUIRED TO PROVIDE AN OUTPUT

NOTES : 1 - ACTIVE STATE OF A SIGNAL (MAY BE DEFINED AS POSITIVE OR NEGATIVE VOLTAGE OR CURRENT)
0 - INACTIVE STATE OF A SIGNAL (REFERENCE)
† - CAN HAVE MORE THAN TWO INPUTS

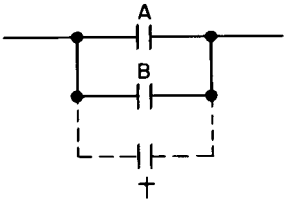
LOGIC CIRCUITS - CONTINUED

INCLUSIVE OR



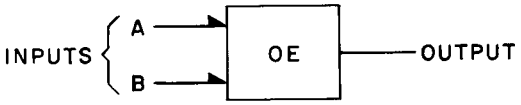
INPUTS		OUTPUT
A	B	
0	0	0
0	1	1
1	0	1
1	1	1

ELECTROMECHANICAL CONTACT EQUIVALENT



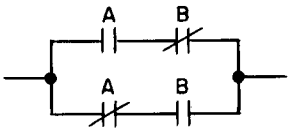
SINGLE INPUT WILL PRODUCE AN OUTPUT
ALL INPUTS PRODUCE AN OUTPUT

EXCLUSIVE OR



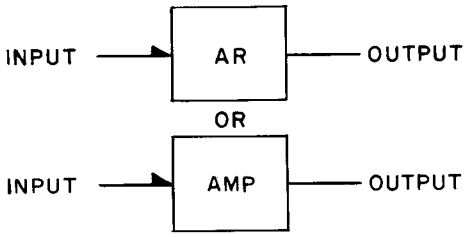
INPUTS		OUTPUT
A	B	
0	0	0
0	1	1
1	0	1
1	1	0

ELECTROMECHANICAL CONTACT EQUIVALENT



SINGLE INPUT WILL PRODUCE AN OUTPUT
ALL INPUTS SIMULTANEOUSLY PRODUCE NO OUTPUT

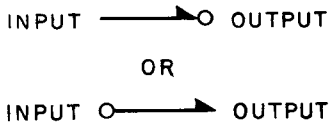
AMPLIFIER



INPUT	OUTPUT
0	0
1	1

INPUT SIGNAL PRODUCES OUTPUT

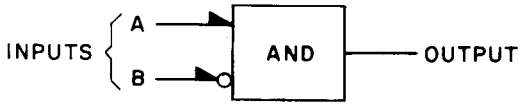
NEGATION (NOT)



INPUT	OUTPUT
0	1
1	0

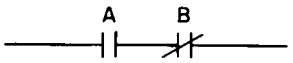
ABSENCE OF INPUT SIGNAL PRODUCES OUTPUT

EXAMPLE OF LOGIC NEGATION



INPUTS		OUTPUT
A	B	
0	0	0
0	1	0
1	0	1
1	1	0

ELECTROMECHANICAL CONTACT EQUIVALENT



SIGNAL AT A AND NOT AT B PRODUCES OUTPUT

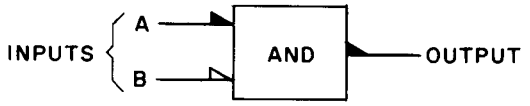
MIXED LOGIC

WHERE IT IS DESIRED TO REPRESENT SIGNAL POLARITY, USE OPEN AND CLOSED ARROWS.

A ONE INPUT (OR OUTPUT) TO A CLOSED ARROW IS MORE POSITIVE THAN A CORRESPONDING 0 INPUT (OR OUTPUT)

A ONE INPUT (OR OUTPUT) TO AN OPEN ARROW IS MORE NEGATIVE THAN A CORRESPONDING 0 INPUT (OR OUTPUT)

AS AN EXAMPLE :



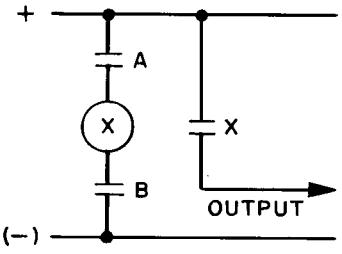
1 INPUT AT A IS MORE POSITIVE THAN 0 INPUT

1 INPUT AT B IS MORE NEGATIVE THAN 0 INPUT

1 OUTPUT IS MORE POSITIVE THAN 0 OUTPUT

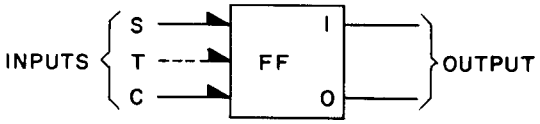
INPUTS		OUTPUT
A	B	
0	0	0
0	1	0
1	0	0
1	1	1

ELECTROMECHANICAL CONTACT EQUIVALENT



INPUTS AT A AND B PRODUCE OUTPUT

FLIP FLOP



S = SET

C = CLEAR (RESET)

T = TRIGGER

SET SIGNAL YIELDS 1 AT 1, 0 AT 0 OUTPUT

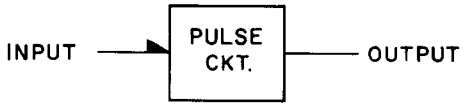
CLEAR SIGNAL YIELDS 1 AT 0, 0 AT 1 OUTPUT

SIMULTANEOUS SET AND CLEAR SIGNALS YIELD UNDEFINED OUTPUT

FF RETAINS PREVIOUS STATE FOLLOWING REMOVAL OF BOTH INPUTS SIMILAR TO LATCHING RELAY

WHERE T (TRIGGER) IS USED, T INPUT CHANGES OUTPUT STATE

PULSE CIRCUIT

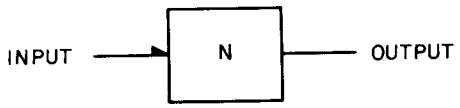


INPUT	OUTPUT
0	0
1	Δ

Δ - OUTPUT PULSES AT OSCILLATOR RATE AS LONG AS "1" INPUT EXISTS

LOGIC CIRCUITS – CONTINUED

INVERSION

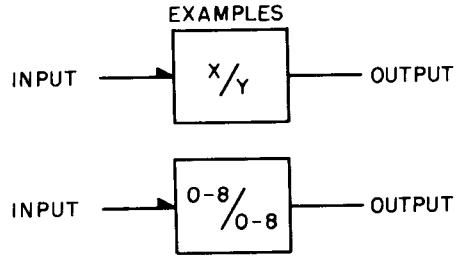


INPUT	OUTPUT
1	1
0	0

PRODUCES POLARITY INVERSION, BUT NO LOGIC NEGATION

TIME DELAY

EXAMPLES

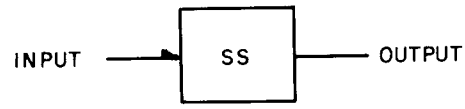


X = OPERATE TIME IN MILLISECONDS
(TIME FOR OUTPUT TO APPEAR FOLLOWING INPUT SIGNAL)

Y = RESET TIME IN MILLISECONDS
(TIME FOR OUTPUT TO BE REMOVED FOLLOWING REMOVAL OF INPUT SIGNAL)

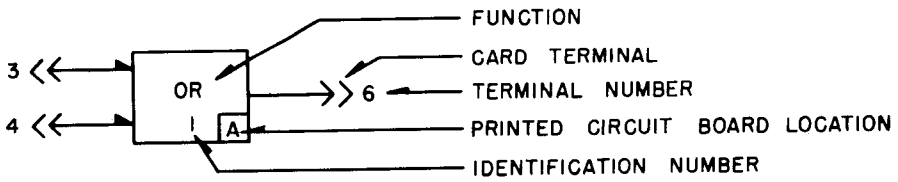
X & Y MAY BE ADJUSTABLE AS INDICATED FOR EXAMPLE BY 0-8

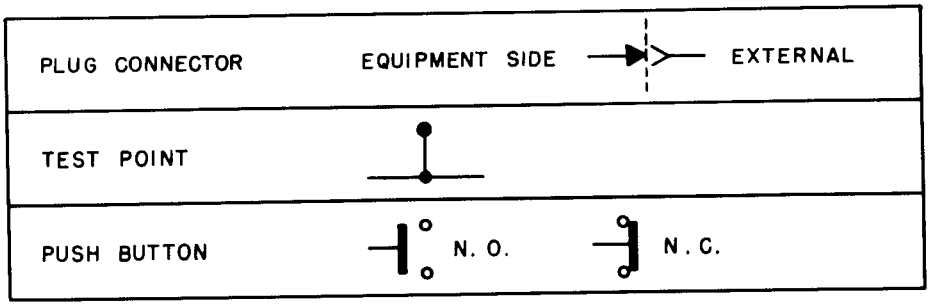
SINGLE SHOT



FOLLOWING APPLICATION OF SUSTAINED INPUT, SINGLE PULSE OUTPUT APPEARS

STATIC RELAY DIAGRAMS





STATIC RELAY DIAGRAMS - CONTINUED

RELAY TERMINAL BLOCK

CABINET OR PANEL TERMINAL BLOCK

FT-1 SWITCH (CURRENT TYPE)

FT-1 SWITCH (VOLTAGE TYPE)

WESTINGHOUSE ELECTRIC CORPORATION
RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**
Printed in U.S.A.

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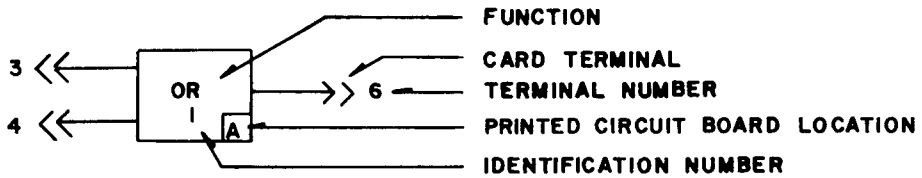
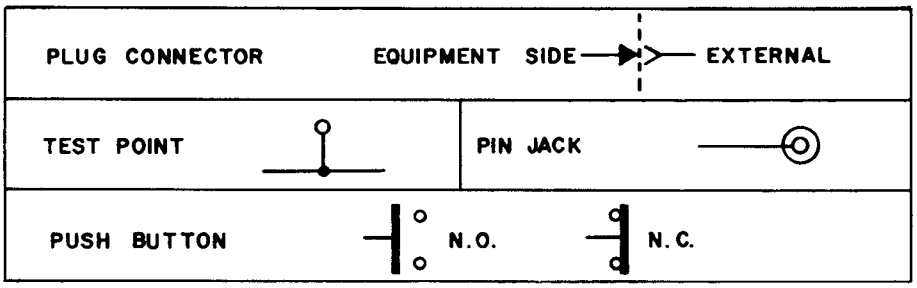
SUPERSEDES I.L. 41-000.1A
*Denotes change from superseded issue.

EFFECTIVE FEBRUARY 1971

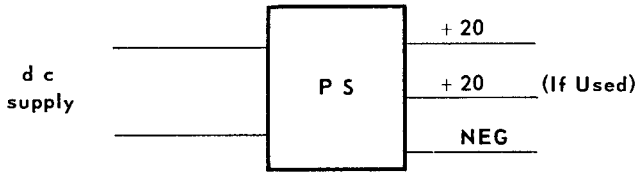
SOLID STATE RELAY DIAGRAM, CONTINUED

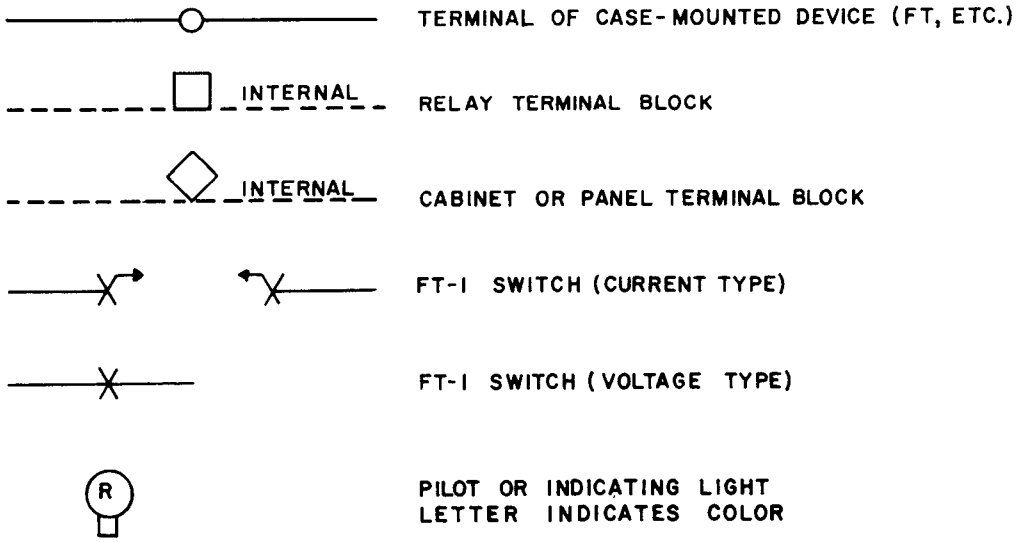




*

POWER SUPPLY





WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

PROTECTIVE RELAY SCHEMATIC DIAGRAM NOMENCLATURE AND SYMBOLS

RELAY TYPE DESIGNATION

Symbol	Description
HZ	Impedance Phase Relay
HZM	Distance Phase Relay
HKB	Phase Comparison Carrier Relay
HRK	Carrier Ground Directional Over-Current Relay, Current Polarized
HRP	Carrier Ground Directional Over-Current Relay, Potential Polarized
RS	Carrier Auxiliary Relay
RSN	Carrier Auxiliary Relay With Out-of-Step Blocking
HQS	Carrier Single Pole Tripping Phase Selector Relay
TS	Selective Pole Auxiliary Relay
CO	Phase or Ground Back-Up Over Current Relay
CR	Phase or Ground Back-Up Directional Over-Current Relay, Potential Polarized
CRC	Ground Back-Up Directional Over-Current Relay, Current Polarized
CWP	Ground Back-Up Directional Product Type Relay, Potential Polarized
CWC	Ground Back-Up Directional Product Type Relay, Current Polarized
TV	Telemetering Auxiliary Relay
TSO-3	Out-of-step blocking
TR	Auxiliary Tripping Relay
MG	Auxiliary Relay - Multi-contact Clapper Type
SG	Auxiliary Relay - Clapper Type
TT-1	Auxiliary Relay - Carrier Alarm
SX	Selective Reclosing Toggle Relay

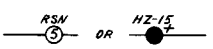
RELAY & CIRCUIT ELEMENT DESIGNATION

Symbol	Description
Dash or Sub P or G	Phase or Ground Circuits
I_p	Ground Relay Polarizing Current
E_o	Ground Relay Polarizing Voltage
D_o	Ground Relay Directional Element
I_o	Ground Relay Overcurrent Element
D	Phase Relay Directional Element
Z_1	HZ or HZM Relay-First Zone Impedance or Distance Element.
Z_2	HZ or HZM Relay-Second Zone Impedance or Distance Element.
Z_3	HZ or HZM Relay-Third Zone Impedance or Distance Element.
T	HZ or HZM Relay-Timer Motor Contacts are T_2 & T_3.
T_2	HZ or HZM Relay-Second Zone Time Element Contact.
T_3	HZ or HZM Relay-Third Zone Time Element Contact
RRG	RS or RSN Relay-Carrier Ground Trip Contact-Coils are RRT and RRH
RRP	RS or RSN Relay-Carrier Phase Trip Contact-Coils are RRT and RRH
RRB	RSN Relay-Carrier Out-of-Step Blocking Contact Coils are RRT and RRH
RRH	RS or RSN Relay-Carrier Holding Coil-Contacts are RRG, RRP and RRB
RRT	RS or RSN Relay-Carrier Operating Coil-Contacts are RRG, RRP and RRB
CSP	RS or RSN Relay-Phase Auxiliary Element
CSG	RS or RSN Relay-Ground Auxiliary Element
AL	RS or RSN Relay-Alarm Element
X2 & P	Out-of-Step Blocking Element. X2 is Telephone Type Relay With Time Delay drop-out. P is Telephone Type Pendulum Relay. Pick-up of Combination is 4 cycles, drop-out Adjustable from 20 cycles to 15 seconds
A,B,C	Out-of-Step Blocking Elements -- Voltage Type Contactor Switches
S_A,S_B,S_C	HQS Relay-Phase Selector Elements-A,B,C Refer to Phases

NOMENCLATURE AND SYMBOLS

FD_A, FD_B, FD_C	HCS Relay-Zero Sequence Fault Detector Contactor Switch Element-A, B,C Refer to Phases
X_3	Telephone Type Relay Element-Fast Pick-Up, Slow Drop-Out
CSA, CSB, CSC, CS, CS1, CS2	Auxiliary Contactor Switch
MA	Milliammeter
X & Y	A-C. Supply
P & N	D-C. Supply usually Station Battery
101	Control Switch
52	Circuit Breaker Control Elements
79	Reclosing Relay Elements
43	Recloser Cut-out Switch

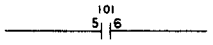
DIAGRAM SYMBOLS



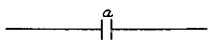
Relay or Device Terminal - Number indicates Terminal and Relay Type. + indicates Relative Instantaneous Polarity Mark.

Normally Open Contact (De-energized).

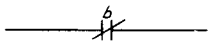
Normally Closed Contact (De-energized).



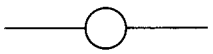
Manually Operated Switch - Contact numbers on base shown by contacts.



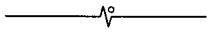
Circuit Breaker Auxiliary Switch - Open when Breaker Contacts are Open.



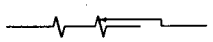
Circuit Breaker Auxiliary Switch - Closed when Breaker Contacts are Open.



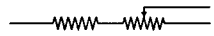
D.C. Device or Element Coil.



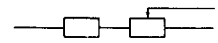
Operation Indicator.



A.C. Current Coil (Fixed and Variable).

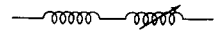


A.C. Voltage Coil (Fixed and Variable).

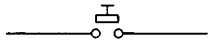


Resistor (Fixed and Variable).

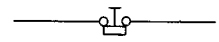
Condenser (Fixed and Variable).



Reactor (Fixed and Variable).

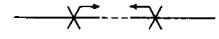


Manually Operated Push Button - Normally Open.

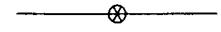


Manually Operated Push Button - Normally Closed.

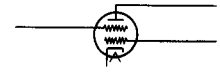
Test Switch Location.



Test Switch Location with Current Transformer Short Circuiting Device.

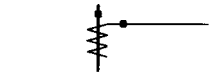


Detachable Type Relays - Trip Circuit Interlock or Safety Switch Location.

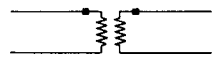


Vacuum Tube - In Carrier Transmitter and Receiver Type 6L6 or 25L6, etc.

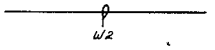
Protective Gap.



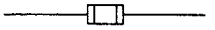
Current Transformer (C.T.) with Squares Designating Polarity Marks.



Potential (P.T.) or Auxiliary Current Transformer with Squares Designating Polarity Marks.

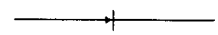


Switchboard Panel Wire Designations. Block around number indicates Switchboard Terminal Block.



Fuse and Fuse Block.

Ground.



Rectox. Arrow indicates Direction of Current Flow.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION

NEWARK, N.J.

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