INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE STU-12 TRANSFER TRIP RELAY

Caution: It is recommended that the user of this equipment become acquainted with the information in this instruction leaflet before energizing the equipment. Failure to observe this precaution may result in damage to the equipment.

If the equipment is mounted in a cabinet, the cabinet must be bolted down to the floor or otherwise secured before swinging out the equipment rack to prevent its tipping over.

APPLICATION

The type STU-12 relay is a static auxiliary relay used in a directional comparison tripping scheme (over-reaching transfer trip). The STU-12 relay provides circuits for:

a. high speed tripping for all faults

b. alarm and trip circuit lockout upon channel failure

c. supplying necessary coordination during a sudden reversal in power flow for an external fault.

d. check-back test

e. blown fuse detection.

The STU-12 relay can be applied to two or three terminal lines.

The STU-12 relay works with audio tone channels or with any comparable equipment that produces a voltage output for trip, loss of signal, and noise.

CONSTRUCTION

The type STU-12 relay consists of printed circuit boards, power supply, fuses, a pilot light, power switch, and channel trip light mounted on a standard 19-inch wide panel 8 3/4 inches high (5 rack units). Edge slots are provided for mounting the rack on a standard relay rack. The components are connected as shown in Fig. 1.

SUPERSEDES I. L. 41-958.7
*Denotes change from superseded issue.

EFFECTIVE AUGUST 1968

The style numbers of the different boards with reference to the assemblies are as follows:

Style Number	Description
898C286G01	Includes circuit for switchboard light.
898C286G02	Does not include circuit for switchboard light.

Power Supply

The STU-12 relay operates from a regulated 45 v.d.c. supply. This voltage is taken from a zener diode mounted on a heat sink. Variation of the resistance value between the positive side of the unregulated d.c. supply and the 45 volt zener diode adapts the receiver for operation on 48 or 125 volts d.c.

Card Extender

A board extender (Style No. 644B315G01) is available for facilitating circuit voltage measurements or major adjustments. After withdrawing any one of the circuit boards, the extender is inserted in that compartment. The board then is inserted into the terminal block on the front of the extender. This restores all circuit connections, and all components and test points on the board are readily accessible.

OPERATION

The type STU-12 relay is used with a pilot-wire tone channel in a directional transfer trip relay scheme for power line protection. High-speed tripping is obtained for two-terminal or multi-terminal line applications for faults anywhere on the protected line.

The protective relays and relay settings used in the STU-12 scheme are the same as used in directional comparison carrier schemes with the relay set to reach beyond the remote line terminals, so that end zone faults will appear well within the relay characteristic for fast relay operation.

The STU-12 scheme, however, uses a tripping signal rather than a blocking signal, because the pilot-wire tone channel is separate from the conductors of the protected power line. This avoids having to send the signal on the conductors through a fault.

The signals to which the STU-12 relay responds is received from the receiver of the tone equipment and the output of the protective relays. For the STU-12 relay to operate, the channel receiver must receive a trip signal from the remote terminal and the local protective relay must operate.

With a non-trip condition on the STU-12 relay, the signals to the STU-12 relay are as shown in the logic diagram of Fig. 1. The

number "1" indicates that a voltage is obtained at that point while a "0" indicates that the voltage is approximate zero. As seen in Fig. 1, the inputs from the tone receiver are a "1" from the low signal clamp, a "0" from the noise clamp, and a "0" from the trip. The STU-12 relay receives a "0" from the protective relays.

For the conditions shown, the alarm relay of the STU-12 is picked up and the tone trip amber light is off.

A. Sequence with Protective Relay Operation Only

If a protective relay operates, the output from the relay puts a "1" into the OR circuit of the protective relay interface board. The output of the OR changes to a "1" and energizes the blown fuse detector, and AND circuit, and an OR circuit. The output from the OR removes negative potential from one input of the NAND circuit of the channel interface logic. However, tripping will not occur because the NAND is held at negative potential due to "0" input from the tone trip.

With a second input to the AND circuit of the protective relay interface logic, a "1" output is obtained. This output is applied to the keying circuit through an OR circuit of the timing and keying logic. The output voltage from the keying circuit shifts the local transmitter from a guard condition to a trip condition.

2.5 seconds after the protective relay has operated, the blown fuse detector picks up to change its output to a "0". This "0" output is sealed in through an external pushbutton and will remain in this condition until the reset pushbutton is opened. The "0" output of the blown fuse detector de-energizes the AND circuit to the keying lead and the local transmitter shifts back to a guard frequency. Also the input to the NAND of the channel interface logic is shorted to negative and the STU-12 is clamped to a non-operative dondition.

A third output from the blown fuse detector is applied to an external alarm relay which drops out to close its contacts. The alarm relay will remain closed until the protective relay resets and the fuse lockout reset is open momentarily.

B. Tone Trip Sequence Only

Upon receipt of a tone trip, the "0" input into the channel interface logic changes to a "1". This "1" removes negative potential from the tone trip input to the NAND. However, tripping will not occur because the NAND is held at negative potential by the protective relay input. The change to "1" from the tone trip will energize the amber light which will turn on to indicate that a trip frequency is being transmitted from the remote terminal.

The output from the tone trip is also applied to a NOT circuit

which changes its output from a "1" to a "0". This change removes one input from a two input AND circuit of the timing and keying logic (through an OR) and causes the output of the AND to change to a "0". If this "0" is maintained for 25 milliseconds, the X unit will drop out and clamp the NAND to negative through the X lead. This input will remain in a zero state for 25 milliseconds after the tone trip is removed.

C. Loss of Signal

If a channel failure occurs, the low signal output from the tone equipment changes to a "0". This energizes a NOR circuit, whose output goes to "0" after a 150 millisecond time delay. This causes the alarm relay of the trip logic to drop out and close its contacts to indicate a channel failure.

The loss of the lockout voltage also removes one input of the two input AND circuit of the timing and keying logic. The output of the AND changes to a "0", and 25 milliseconds later the X unit is de-energized. This clamps the NAND circuit into a non-operative state. The loss of X and lockout (Lo) is seen by the X_1 unit, and 2.5 seconds later the output of the X_1 unit changes to a "1" and puts an input into the keying AND. However, the X unit input to the AND had previously dropped to zero, and the AND is not energized. The local transmitter remains in a non-keyed state.

D. Noise

If an output is obtained from the noise clamp of the channel equipment, the input to the noise interface changes to a "1" and energizes a NOT and a NOR circuit. The output of the NOT changes to a "0" and shorts the input to the channel trip NAND to negative. This puts the NAND in a non-operating condition. If the noise condition exists for 150 milliseconds, the STU-12 relay will recognize the condition as a loss of channel and lock the STU-12 trip NAND to a non-trip state.

E. Check-Back

A check-back test of the transfer trip received signal is obtained without the necessity of having an operator at remote terminals and without danger of tripping on external faults.

The operating sequence is as follows:

1. The operator at any line terminal moves the test switch to the "OFF" position. This places the transfer trip scheme temporarily out-of-service and stops transmission of a tone signal from the local station to the remote station. The remote tone receiver recognizes the condition as a loss of channel and the following occurs at the remote terminal:

The low-signal output of the tone receiver changes to a "0" output. After 150 milliseconds, the lockout unit of the remote STU-12 drops out. The dropout of lockout (Lo) de-energizes the X unit through the AND of the keying and timing logic. This clamps the NAND of the remote STU-12 to a non-operative state.

The loss of both X and Lo causes the X_1 unit to pickup to provide a "1" input to the keying AND of the timing and keying logic. The keying AND has a "1" input from the X_1 unit, and a "0" from the X unit, and the remote terminal is transmitting a guard frequency.

2. After holding the test switch in the "OFF" position for a few seconds, the operator next moves the test switch to the "RECEIVE" position. This re-establishes the transmission of the guard signal, and the following occurs at the remote terminal:

   The low-signal output of the tone receiver changes to a "1" and the lockout (Lo) picks up. This energizes the X unit through the AND circuit of the timing and keying logic; and 25 milliseconds later, a "1" output is obtained from the X unit. An input is also applied to the NOR of the X_1 unit, however, the dropout time for this unit is 2.5 seconds. Hence for 2.5 seconds, the keying AND has two "1" inputs and an output is obtained. This output keys the remote transmitter to a trip frequency until the X_1 unit resets. The operator at the local terminal should see the "Blue" and "Amber" test lights for approximately 2.5 seconds. On 3 terminal lines, both sets of lights should be on if all channels are operative.

3. This completes the check-back test, and the test switch should be moved to "normal" position as soon as the test lamps go dark. This restores the equipment to the operative position at all line terminals.

CHARACTERISTICS

The type STU-12 relay is available for application to 2 or 3 terminal lines where frequency shift tone channels are utilized. The logic diagram for the STU-12 relay is shown in Figure 1, and the transistor circuit of the relay for a two terminal line is shown in Figure 2.

Lockout Unit Time	150 milliseconds
X Unit Time	25 millisecond pickup 25 millisecond dropout
X_1 Unit Time	2.5 seconds

Blown Fuse Detector Time	2.5 seconds
Operating Time	0.75 microsecond to obtain voltage output
Voltage Output Relay (when used) Maximum Output	60 milliamperes, 45 v.d.c.
Keying Voltage to Tone Transmitter	-45 volts, d.c.
Battery Voltage Variations	
Rated Voltage	Allowable Variation
48 v.d.c.	42-56 v.d.c.
125 v.d.c.	105-140 v.d.c.
Ambient Temperature Range	-20°C. to +60°C
Battery Drain	235 milliamperes, 48 v.d.c. 275 milliamperes, 125 v.d.c.
Dimensions	Panel Height 8-3/4 inches or 5 rack units
	Panel Width 19-inches

SETTING

No setting is required on the STU-12 relay.

INSTALLATION

The STU-12 relay is generally supplied in a cabinet or on a relay rack as part of a complete assembly. The location must be free from dust, excessive humidity, vibration, corrosive fumes or heat. The maximum temperature around the chassis must not exceed 60°C.

Routine Maintenance

Periodic checks of the relaying system as described in the assembly instructions are desirable to indicate impending failure so that the equipment can be taken out of service for correction. At regular maintenance intervals, any accumulated dust should be removed.

Trouble-Shooting

The components of the STU-12 are operated well within their ratings, and under normal conditions should give long trouble-free service. However, if a relay has given an indication of trouble in service or during routine checks, the voltages tabulated in TABLE I should be checked to determine the faulty circuit. The test point and component location on the boards are given in Figures 6, 7, 8 and 9.

TABLE I

Test point voltages to negative except where specified to positive 45 volts, d.c.

Board	Test Point	Normal Channel	With Noise Only	Low Signal Only	PR Trip Only	Tone Trip Only	System Trip
PR INTER-FACE	Term. 15	0.3	0.3	0.3	20	0.3	20
	Term. 16	0.3	0.3	0.3	20	0.3	20
	Term. 17	0.3	0.3	0.3	20	0.3	20
	TP 51	15.5	15.5	15.5	0.4	15.5	0.4
	TP 52	0.3	0.3	0.3	15	0.3	15
	TP 53	15.5	15.5	15.5	0.4	15.5	0.4
	Term. 1	0.1	0.1	0.1	11.6	0.1	11.6
	TP 54	0.1	0.1	0.1	42	0.1	42
	Term. 8	15	15	15	0.3	15	0.3
	Term. 4	0.3	0.3	0.3	45	0.3	45
	Term. 3	0.3	0.3	0.3	45	0.3	45
	TP 55	15	15	15	0.1	15	0.1
	Term. 5	0.02	0.02	0.02	16.7	0.02	16.7
TIMING AND KEYING LOGIC	Term. 19	12.8	0.11	0.11	12.8	12.8	12.8
	Term. 11	9.5	9.5	9.5	9.5	0.03	0.03
	Term. 1	0.1	0.1	0.1	11.6	0.1	11.6
	Term. 5	0.02	0.02	0.02	16.7	0.1	16.7
	TP 101	0.1	0.1	0.1	0.1	17	0.1
	TP 102	14.7	14.7	14.7	14.7	0.2	14.7
	TP 103	13.5	0.9	0.9	13.5	0.9	13.5
	TP 104	0.2	33	33	0.2	33	0.2
	Term. 18	15.5	0.05	0.05	15.5	0.05	15.5
	TP 105	0.10	20	20	0.10	0.10	0.10
	TP 106	42	0.10	0.10	42	42	42
	TP 107	0.10	15.5	15.5	0.10	0.10	0.10
	TP 108	16.5	16.5	16.5	16.5	16.5	16.5
	TP 109	0.05	0.05	0.05	0.05	0.05	0.05
	Term 17 to pos	0.1	0.1	0.1	-45	0.1	-45

CONTINUED ON PAGE 10

TABLE I (CONTINUED)

Test point voltages to negative except where specified to positive 45 volts, d.c.

Board	Test Point	Normal Channel	With Noise Only	Low Signal Only	PR Trip Only	Tone Trip Only	System Trip
CHANNEL INTER-FACE	Term 16 to pos	-16	-16	-2	-16	-16	-16
	TP 151	0.05	0.05	15	0.05	0.05	0.05
	Term 17 to	0	-16	0	0	0	0
	TP 153	15	0.05	15	15	15	15
	TP 154	0.05	15	0.05	0.05	0.05	0.05
	TP 155	15	0.05	0.05	15	15	15
	TP 156	0.05	21	21	0.05	0.05	0.05
	Term. 19	10	0.10	0.10	10	10	10
	Term. 12	0.05	45	45	0.05	0.05	0.05
	Term 15 to pos	0	0	0	0	-16	-16
	Term. 11	9.5	9.5	9.5	9.5	0.03	0.03
	Term. 10	0.1	0.1	0.1	0.1	10	10
	Term. 1	0.1	0.1	0.1	11.6	0.1	11.6
	Term. 8	15	15	15	0.3	15	0.3
	Term. 18	15.5	0.05	0.05	15.5	0.05	15.5
	Term. 6	15	15	15	15	15	0.2
TRIP	Term. 12	0.3	45	45	0.3	0.3	0.3
	Term. 10	0.1	0.1	0.1	0.1	10.0	10.0
	Term. 16	45	45	45	45	0.6	0.6
	Term. 6	15	15	15	15	15	0.2
	Term. 18	0.05	0.05	0.05	0.05	0.05	43
	TP 201	15.3	15.3	15.3	15.3	15.3	0.3
	TP 202	0.1	0.1	0.1	0.1	0.1	10.3
	Term. 7	45	45	45	45	45	0.8

Renewal Parts

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing the repair work. When ordering parts, always give the complete nameplate data.

ELECTRICAL PARTS LIST

Panel Mounted Components

Circuit Symbol	Description	Westinghouse Style Number
	POWER SUPPLY	
SW1	Switch	183A856H01
PL	Pilot Light 125V DC	183A825G01
	Pilot light 48V DC	183A825G04
F1 - F2	1.5 Ampere Fuse	11D9195H26
R1	26.5 Ohm, 40W, 48V DC	04D1299H44
R1 - R2	150 Ohm, 40W, 125V DC	1202499
VR1	Zener Diode, IN2828B, 50W	184A854H06
	ALARM	
A	Amber Light	183A825G08
R3 - R4	330 Ohm, 3W	185A207H15

Protective Relay Interface Board

	CAPACITOR	
C51	68 MFD, 35V DC	187A508H02
	DIODES	
D51 to D62	IN457A	184A855H07
	TRANSISTORS	
Q51-Q52-Q53-Q57	2N696	762A585H01
Q54-Q55	2N697	184A638H18
Q56-Q58	2N699	184A638H19
	RESISTORS	
R51-R54-R56-R57-R60 R66-R69-R71-R74	10K Ohm - 1/2 W	184A763H51
R52-R55-R61-R63-R75	33K Ohm - 1/2 W	184A763H63
R53-R58-R59-R62-R67 R73-R76	68K Ohm - 1/2 W	184A763H71
R64	1K Ohm - 1/2 W	184A763H27
R65 (Typical Value)	56K Ohm - 1/2 W	
R68	12K Ohm - 1/2 W	184A763H53
R70	3.3K Ohm - 1/2 W	184A763H39
R72	100K Ohm - 1/2 W	184A763H75
	ZENER DIODES	
Z51	IN3686B, 20V	185A212H06

ELECTRICAL PARTS LIST

Timing and Keying Board

Circuit Symbol	Description	Westinghouse Style Number
	CAPACITORS	
C101-C102	1 MFD	187A624H04
C103	68 MFD, 35V DC	187A508H02
	DIODES	
D101 to D114	1N457A	184A855H07
	TRANSISTORS	
Q110 to Q110	2N696	762A585H01
	RESISTORS	
R101-R103-R106-R108 R112-R121-R129-R134 R136-R137 (Typical Value)	33K Ohm - 1/2 W	184A763H63
R102-R105-R111-R115 R119-R122-R124-R126 R130-R133-R138	10K Ohm - 1/2 W	184A763H51
R104-R107-R117-R128 R131-R132-R135-R140	68K Ohm - 1/2 W	184A763H71
R109-R114-R125	1K Ohm - 1/2 W	184A763H27
R110-R113	20K Ohm - 1/2 W	184A763H58
R116-R123 (Typical Value)	27K Ohm - 1/2 W	184A763H51
R118-R120	39K Ohm - 1/2 W	184A763H65
R127 (Typical Value)	56K Ohm - 1/2 W	
	ZENER DIODES	
Z101	1N957B, 68V	186A797H06
Z102-Z103	1N3686B, 20V	185A212H06

Channel Interface Board

	CAPACITOR	
C151	6.8 MFD, 35V, DC	184A661H25
	DIODES	
D151 to D161	1N457A	184A855H07
	TRANSISTORS	
Q151-Q154-Q161	2N2043	184A638H21
Q152-Q155-Q156-Q157 Q158-Q162-Q163	2N696	762A585H01
Q159	2N697	184A638H18
Q160-Q164	2N699	184A638H19

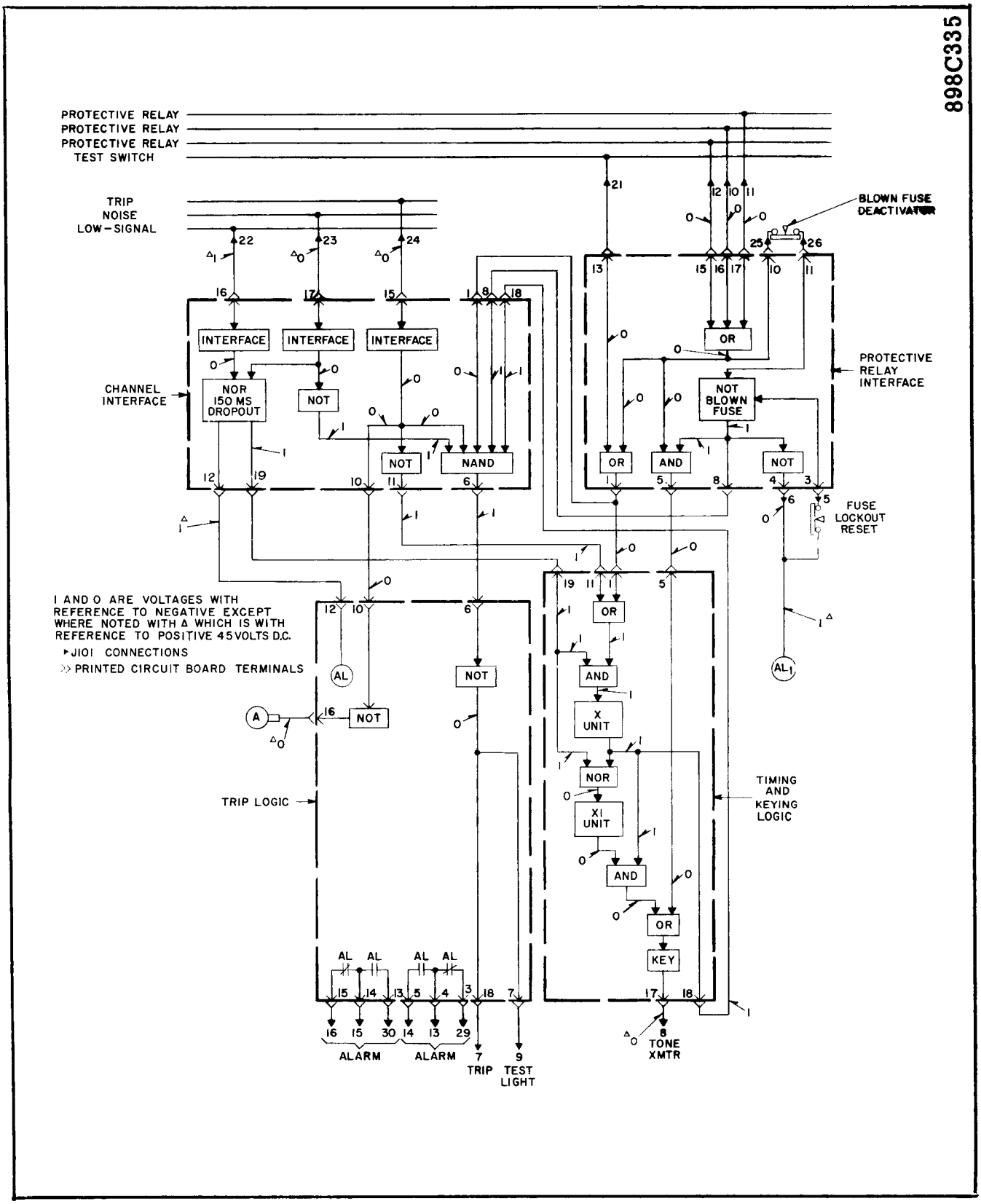
ELECTRICAL PARTS LIST

Channel Interface Board (Continued)

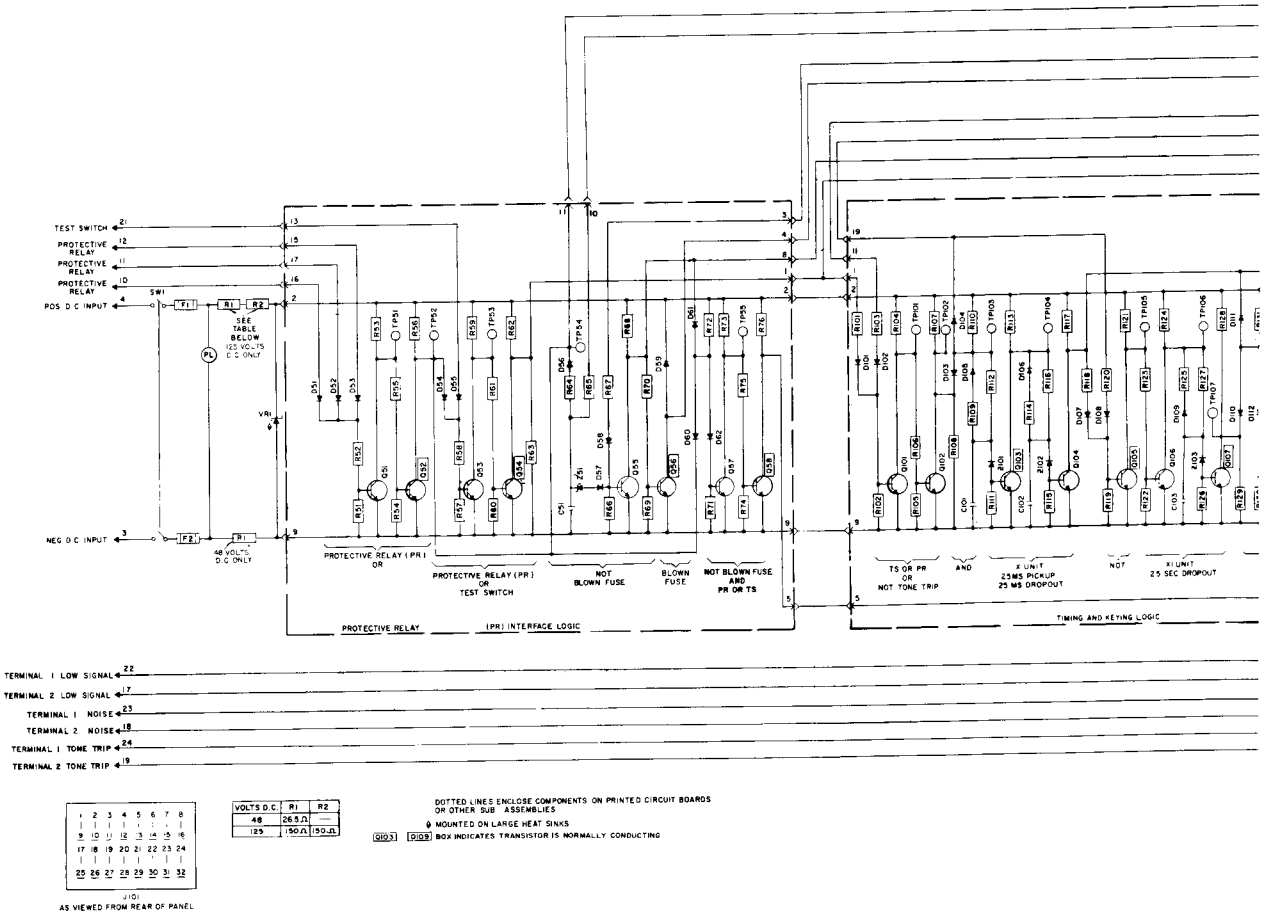
Circuit Symbol	Description	Westinghouse Style Number
	RESISTORS	
R151-R159-R179	6.8K Ohm - 1/2 W	184A763H47
R152-R160-R174-R180	1K Ohm - 1/2 W	184A763H27
R153-R161-R164-R167 R171-R175-R177-R181 R183-R188-	10K Ohm - 1/2 W	184A763H51
R154-R162-R182	100K Ohm - 1/2 W	184A763H75
R155-R163-R166-R170 R185	68K Ohm - 1/2 W	184A763H71
R165-R168-R169-R172 R184-R187	33K Ohm - 1/2 W	184A763H63
R173	39K Ohm - 1/2 W	184A763H65
R176-R186	12K Ohm - 1/2 W	184A763H53
R178	3.3K Ohm - 1/2 W	184A763H39
	ZENER DIODES	
Z151	1N3686B, 20V	185A212H06
Z152	1N957B, 6.8V	186A797H06

Trip Board

	CAPACITORS	
C201	.25	187A624H02
	DIODES	
D201	1N475A	184A855H07
	TRANSISTORS	
Q202	2N2043	184A638H21
Q203	2N696	762A585H01
Q204	2N697	184A638H18
Q201-Q205	2N699	184A638H19
	RESISTORS	
R201-R207-R210-R213	10K Ohm - 1/2 W	184A763H51
R202-R214	3.3K Ohm - 1/2 W	184A763H39
R211	33K Ohm - 1/2 W	184A763H63
R205-R209	68K Ohm - 1/2 W	184A763H71
R206	10K Ohm - 1 W	187A643H51
R208	100K Ohm - 1/2 W	184A763H75
R212	12K Ohm - 1/2 W	184A763H53
R204	1K - 1/2 W	184A763H27
R203	20K - 1/2 W	184A763H58
	ALARM UNIT	
AL	Telephone Relay	408C062H07



* Fig. 1 Logic Diagram of Type STU-12 Relay for Two Terminal Lines



VOLTS D.C.	R1	R2
48	265 Ω	—
125	150 Ω	150 Ω

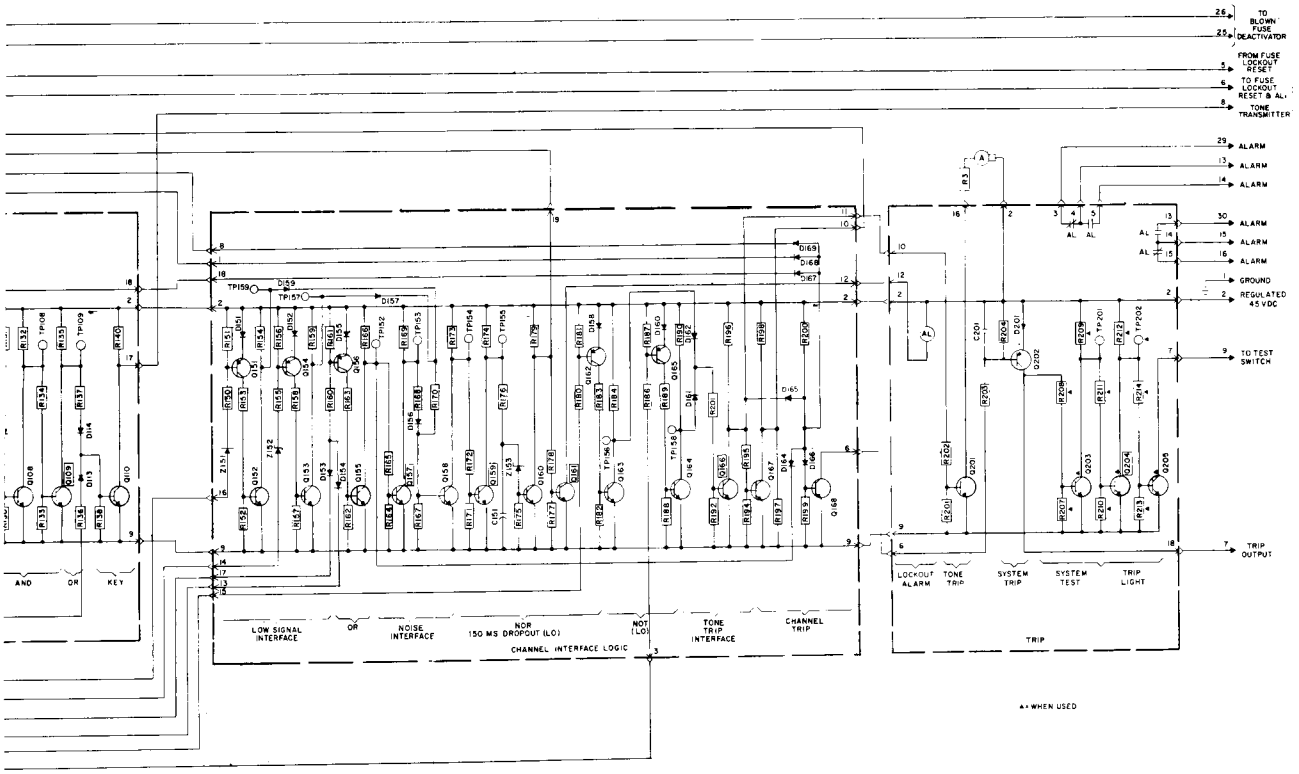
J101
AS VIEWED FROM REAR OF PANEL

DOTTED LINES ENCLOSE COMPONENTS ON PRINTED CIRCUIT BOARDS OR OTHER SUB ASSEMBLIES

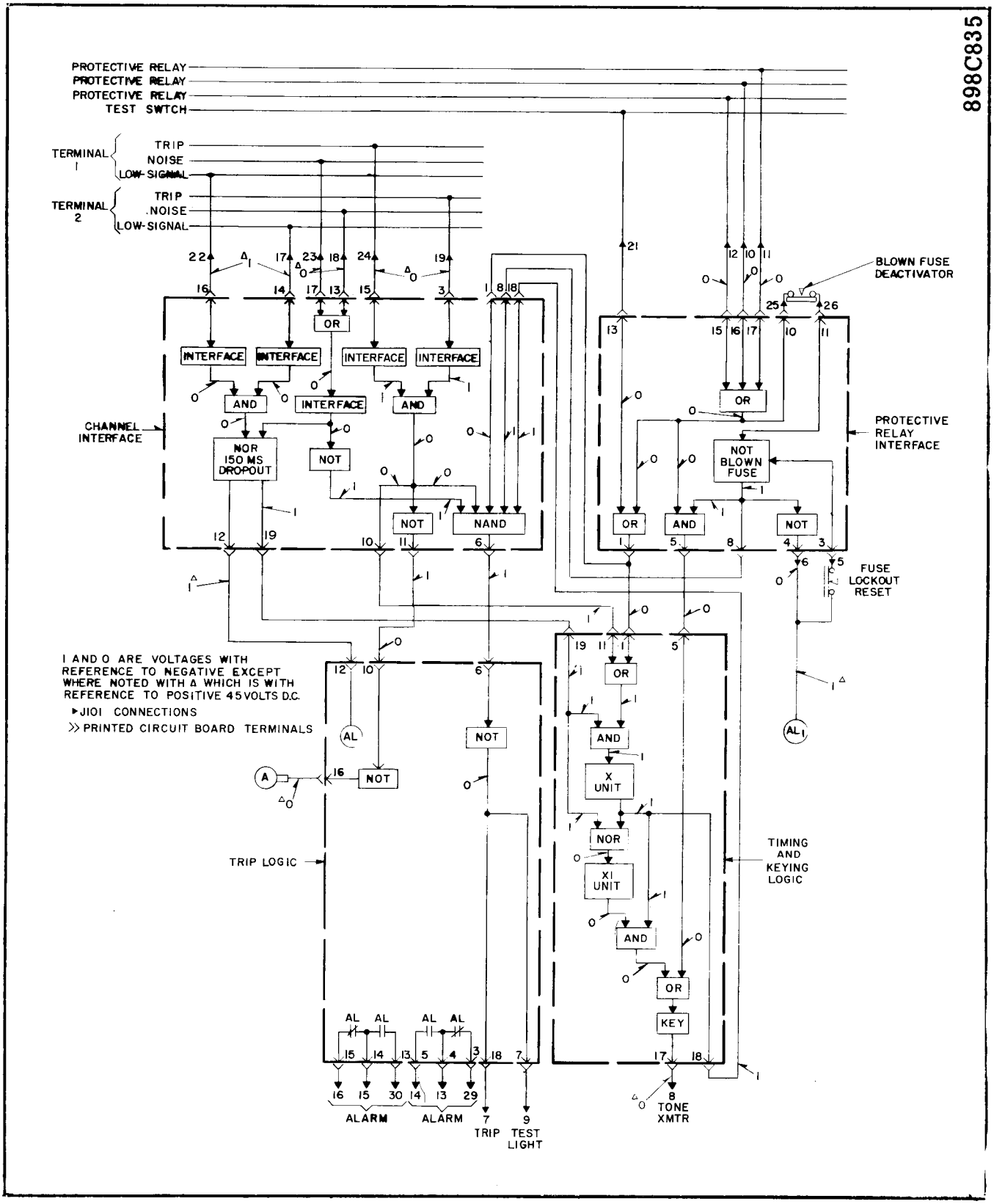
Ψ MOUNTED ON LARGE HEAT SINKS

Q103 D109 BOX INDICATES TRANSISTOR IS NORMALLY CONDUCTING

* *Fig. 3 Internal Schematic of Typ*


TO BLOWN FUSE DEACTIVATOR
FROM FUSE LOCKOUT RESET
TO FUSE LOCKOUT RESET & AL
TONE TRANSMITTER
ALARM
ALARM
ALARM
ALARM
ALARM
ALARM
GROUND
REGULATED 45 VDC
TO TEST SWITCH
TRIP OUTPUT
AND
OR
KEY
LOW SIGNAL INTERFACE
OR
NOISE INTERFACE
NOR
150 MS DROPOUT (LO)
NOT (LO)
TONE TRIP INTERFACE
CHANNEL TRIP
CHANNEL INTERFACE LOGIC
LOCKOUT ALARM
TONE TRIP
SYSTEM TRIP
SYSTEM TEST
TRIP LIGHT
TRIP
** WHEN USED

756J689



* Fig. 4 Logic Diagram of STU-12 for Three Terminal Lines

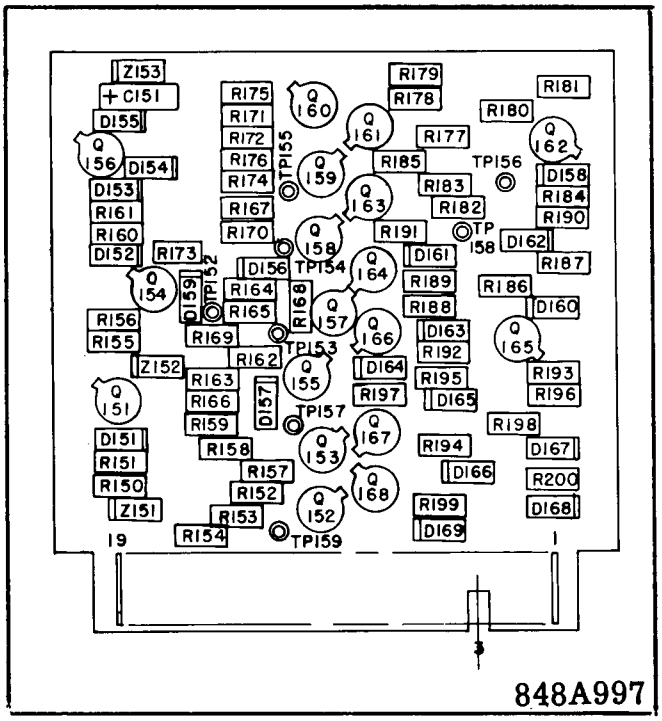


Fig. 5 Component Location on Channel Interface Board for Three Terminal Lines

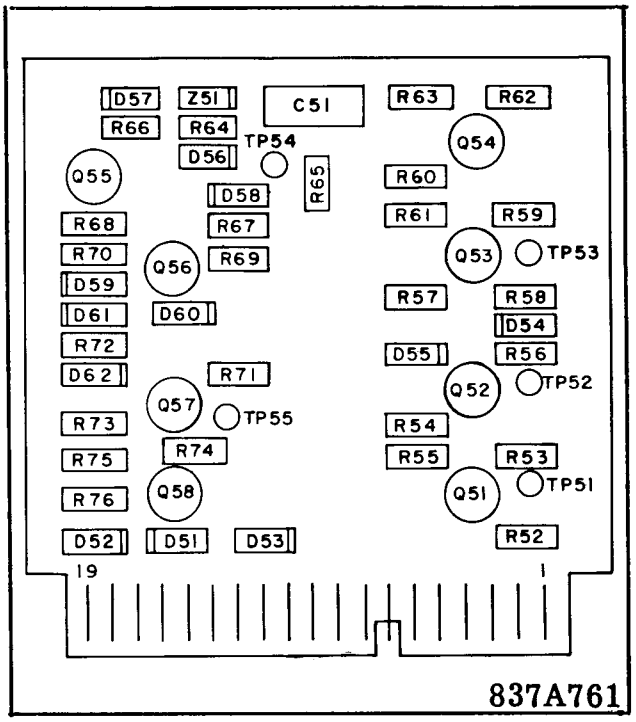


Fig. 6 Component Location on the Protective Relay Interface Board

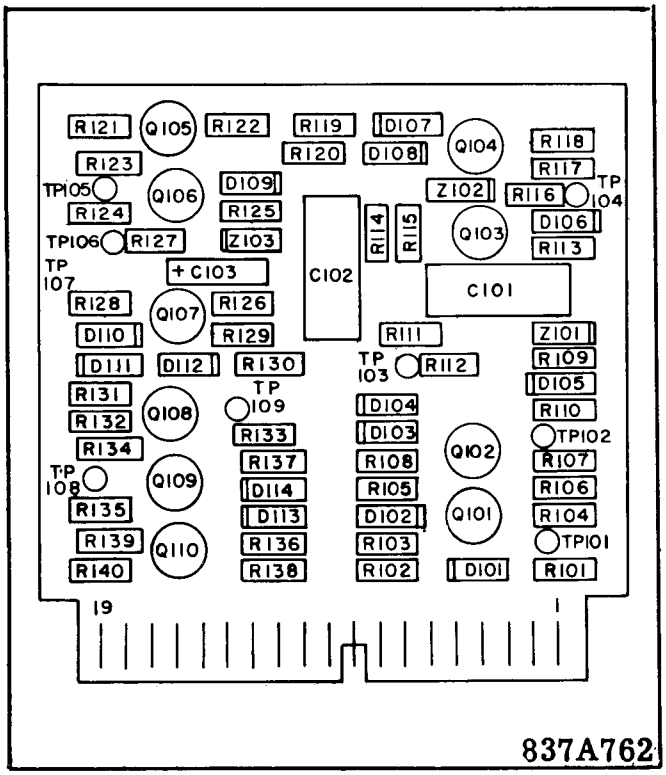


Fig. 7 Component Location on the Timing and Keying Board

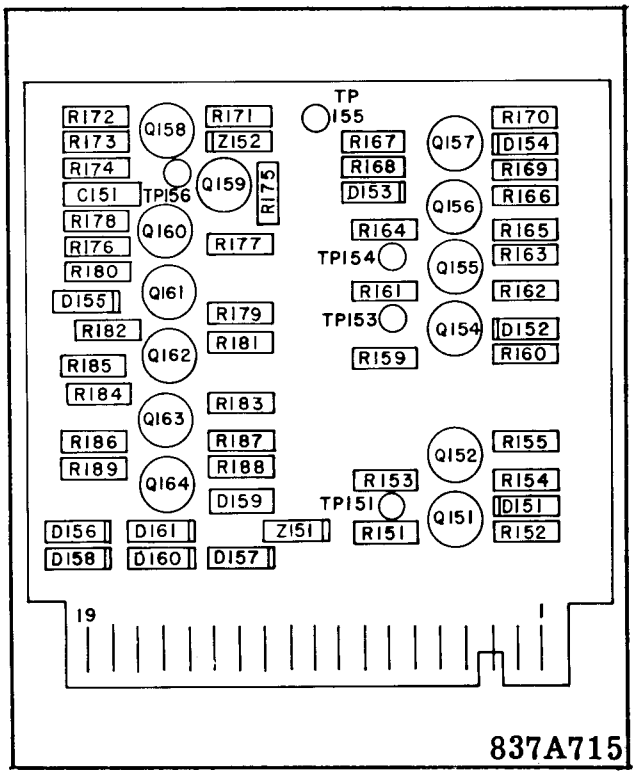


Fig. 8 Component Location on the Channel Interface Board

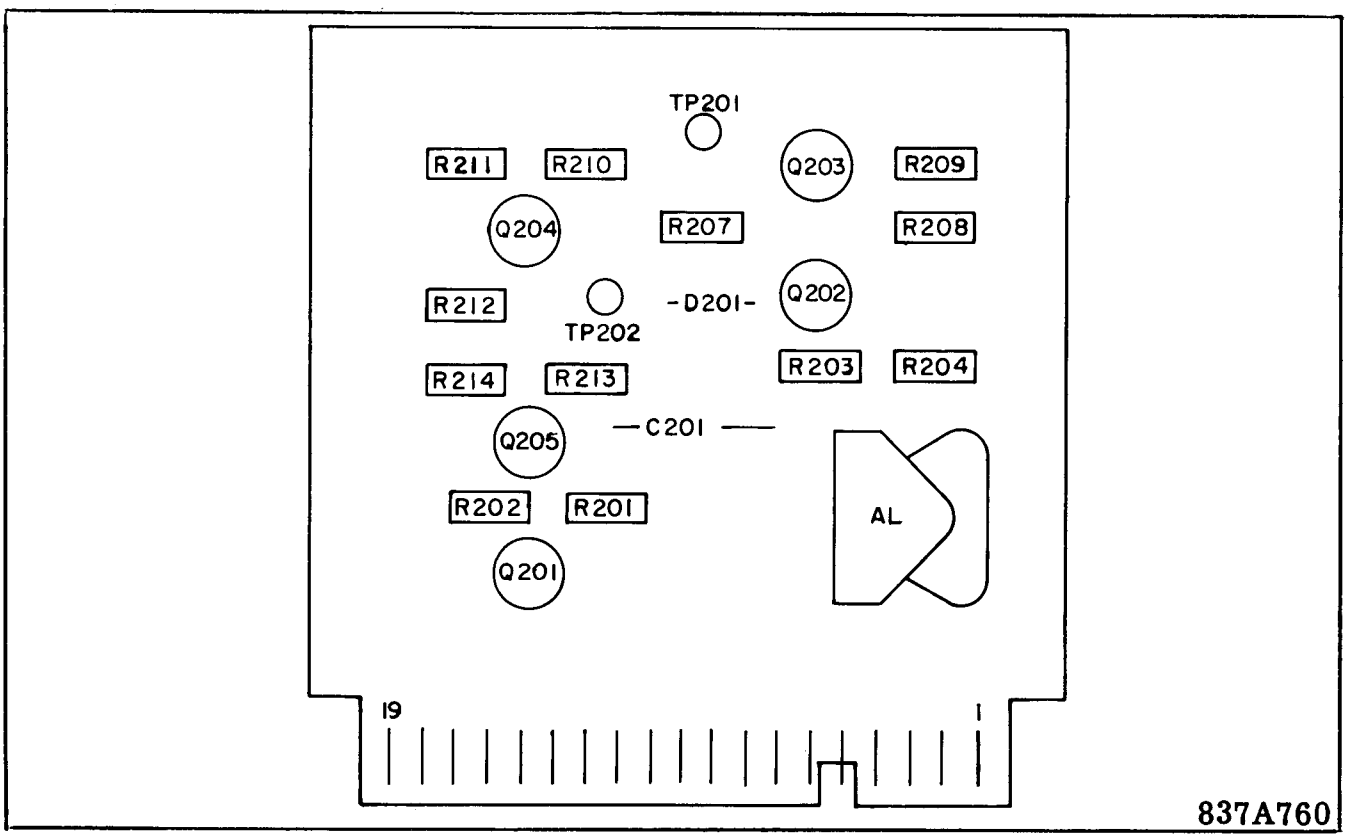


Fig. 9 Component Location on the Trip Board

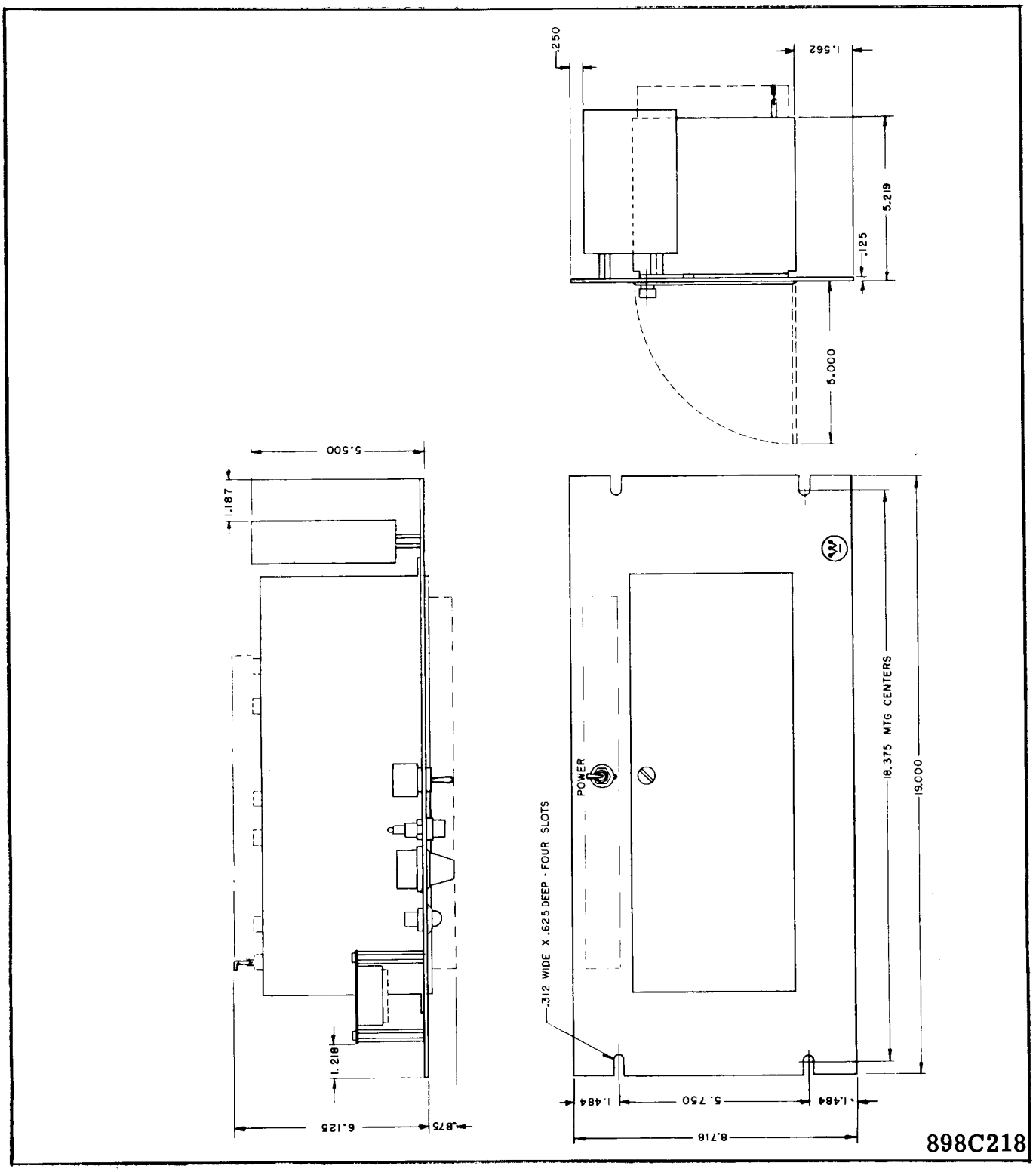


Fig. 10 Outline and Drilling Plan for the Type STU-12 Relay

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE STU-12 TRANSFER TRIP RELAY

Caution: It is recommended that the user of this equipment become acquainted with the information in this instruction leaflet before energizing the equipment. Failure to observe this precaution may result in damage to the equipment.

If the equipment is mounted in a cabinet, the cabinet must be bolted down to the floor or otherwise secured before swinging out the equipment rack to prevent its tipping over.

APPLICATION

The type STU-12 relay is a static auxiliary relay used in a directional comparison tripping scheme (over-reaching transfer trip). The STU-12 relay provides circuits for:

a. high speed tripping for all faults

b. alarm and trip circuit lockout upon channel failure

c. supplying necessary coordination during a sudden reversal in power flow for an external fault.

d. check-back test

e. blown fuse detection.

The STU-12 relay can be applied to two or three terminal lines.

The STU-12 relay works with audio tone channels or with any comparable equipment that produces a voltage output for trip, loss of signal, and noise.

CONSTRUCTION

The type STU-12 relay consists of printed circuit boards, power supply, fuses, a pilot light, power switch, and channel trip light mounted on a standard 19-inch wide panel 8 3/4 inches high (5 rack units). Edge slots are provided for mounting the rack on a standard relay rack. The components are connected as shown in Fig. 1.

PRINTED CIRCUIT BOARDS

The STU-12 relay contains 4 printed circuit boards; protective relay interface board, timing and keying board, channel interface board and a trip board.

All of the circuitry that is suitable for mounting on printed circuit boards is contained in an enclosure that projects from the rear of the panel and is accessible by opening a hinged door on the front of the panel. The printed circuit boards slide into position in slotted guides at the top and bottom of each compartment, and the board terminals engage a terminal block at the rear of the compartment. Each board and terminal block is keyed so that if a board is placed in the wrong compartment, it cannot be inserted into the terminal block. A handle on the front of each board is labeled to identify its function in the circuit.

1. Protective Relay Interface Board

   The protective relay interface board is the connecting link between output of the protective relays and the STU-12 circuits. This board contains the circuits associated with the protective relays and consists of a blown fuse detector, interface circuits for a test switch and three separate protective relay inputs.

   The blown fuse detector is a timing circuit whose output shorts to negative 2.5 seconds after operation of a protective relay. This shorts the input to the keying circuit to prevent keying of the tone transmitter and also shorts the input to the channel trip NAND to prevent tripping of the system. An external mounted alarm relay is also de-energized to close its contacts to sound an alarm. (Telephone relay style 408C062H07 should be used for this function.) A seal-in circuit is provided to maintain the blown fuse condition until it is reset by an externally connected pushbutton.

   For maintenance purposes circuits are provided to de-activate the blown fuse detector by means of an external connected switch.

2. Timing and Keying Board

   This module contains the necessary circuits to key the tone transmitter, to supply necessary co-ordination on reversal of fault current for an external fault (X), and to provide checkback (X_1).

   The keying circuit provides a voltage for shifting the tone transmitter from a guard condition to a trip condition. This circuit is energized by operation of either the protective relays or the checkback unit (X_1) through an OR circuit.

   The X_1 unit is a 2.5 second timer which provides a means to key the transmitter from the remote terminal as described under operation. The unit operates on a loss of signal from the

channel equipment.

The X unit is a timer unit which picks up in 25 milliseconds and drops out in 25 milliseconds. It is energized by the protective relay and the lockout unit of the associated tone receiver. Upon operation of the X unit, the STU-12 relay is clamped to a non-operative state.

3. Channel Interface Board

The channel interface board is the connecting link between the tone channel, the protective relay, and the trip board and consists of interface circuits, a lockout circuit, and the channel trip NAND. Each of the circuits perform designated functions with reference to the channel equipment. The interface circuits connect the lockout circuit and the channel trip NAND to the tone channel. In the normal state, the trip NAND produces an output voltage due to the tone trip input and the protective relay input being held at negative potential. This prevents base current from flowing into the transistor of the NAND and keeps the transistor turned off. As long as one of the five inputs is held at negative potential, a voltage output is obtained from the NAND. This voltage will exist until all inputs into the NAND are positive. Base current will then be applied to the NAND transistor and the transistor will turn on. This shorts the output of the NAND to negative potential. If the channel is lost or if noise exists for extended periods of time, after 150 milliseconds, the lockout input will short the input of the NAND and hold the output in a non-operative condition. Also noise output from the tone channel will short the input of the NAND and hold the output in a non-operative condition.

This board will vary depending upon the make of frequency shift equipment used as the channel.

4. Trip Board

The trip board contains the final output of the STU-12 relay and consists of an output transistor to convert the output of the channel trip NAND to the proper polarity and an alarm relay. Under non-trip conditions, a voltage output is obtained from the channel trip NAND and the output transistor is not conducting. As a result, the output of the STU-12 relay is zero volts. In order for a voltage to be obtained, all inputs to the channel trip NAND must be at positive potential to turn the output transistor on. The voltage output obtained from the STU-12 relay is used as one input to a SRU output package.

Additional circuits can be included in the trip module for the connection of an externally-mounted switchboard light. The light can be used to monitor the trip of the STU-12 relay, and should be connected between the regulated 45 volts d.c. (terminal 2) and terminal 9. The style switchboard light to use is either style 1589193 or 1589181 with bulb style 1124156.

The style numbers of the different boards with reference to the assemblies are as follows:

Style Number	Description
898C286G01	Includes circuit for switchboard light.
898C286G02	Does not include circuit for switchboard light.

Power Supply

The STU-12 relay operates from a regulated 45 v.d.c. supply. This voltage is taken from a zener diode mounted on a heat sink. Variation of the resistance value between the positive side of the unregulated d.c. supply and the 45 volt zener diode adapts the receiver for operation on 48 or 125 volts d.c.

Card Extender

A board extender (Style No. 644B315G01) is available for facilitating circuit voltage measurements or major adjustments. After withdrawing any one of the circuit boards, the extender is inserted in that compartment. The board then is inserted into the terminal block on the front of the extender. This restores all circuit connections, and all components and test points on the board are readily accessible.

OPERATION

The type STU-12 relay is used with a pilot-wire tone channel in a directional transfer trip relay scheme for power line protection. High-speed tripping is obtained for two-terminal or multi-terminal line applications for faults anywhere on the protected line.

The protective relays and relay settings used in the STU-12 scheme are the same as used in directional comparison carrier schemes with the relay set to reach beyond the remote line terminals, so that end zone faults will appear well within the relay characteristic for fast relay operation.

The STU-12 scheme, however, uses a tripping signal rather than a blocking signal, because the pilot-wire tone channel is separate from the conductors of the protected power line. This avoids having to send the signal on the conductors through a fault.

The signals to which the STU-12 relay responds is received from the receiver of the tone equipment and the output of the protective relays. For the STU-12 relay to operate, the channel receiver must receive a trip signal from the remote terminal and the local protective relay must operate.

With a non-trip condition on the STU-12 relay, the signals to the STU-12 relay are as shown in the logic diagram of Fig. 1. The

number "1" indicates that a voltage is obtained at that point while a "0" indicates that the voltage is approximate zero. As seen in Fig. 1, the inputs from the tone receiver are a "1" from the low signal clamp, a "0" from the noise clamp, and a "0" from the trip. The STU-12 relay receives a "0" from the protective relays.

For the conditions shown, the alarm relay of the STU-12 is picked up and the tone trip amber light is off.

A. Sequence with Protective Relay Operation Only

If a protective relay operates, the output from the relay puts a "1" into the OR circuit of the protective relay interface board. The output of the OR changes to a "1" and energizes the blown fuse detector, and AND circuit, and an OR circuit. The output from the OR removes negative potential from one input of the NAND circuit of the channel interface logic. However, tripping will not occur because the NAND is held at negative potential due to "0" input from the tone trip.

With a second input to the AND circuit of the protective relay interface logic, a "1" output is obtained. This output is applied to the keying circuit through an OR circuit of the timing and keying logic. The output voltage from the keying circuit shifts the local transmitter from a guard condition to a trip condition.

2.5 seconds after the protective relay has operated, the blown fuse detector picks up to change its output to a "0". This "0" output is sealed in through an external pushbutton and will remain in this condition until the reset pushbutton is opened. The "0" output of the blown fuse detector de-energizes the AND circuit to the keying lead and the local transmitter shifts back to a guard frequency. Also the input to the NAND of the channel interface logic is shorted to negative and the STU-12 is clamped to a non-operative dondition.

A third output from the blown fuse detector is applied to an external alarm relay which drops out to close its contacts. The alarm relay will remain closed until the protective relay resets and the fuse lockout reset is open momentarily.

B. Tone Trip Sequence Only

Upon receipt of a tone trip, the "0" input into the channel interface logic changes to a "1". This "1" removes negative potential from the tone trip input to the NAND. However, tripping will not occur because the NAND is held at negative potential by the protective relay input. The change to "1" from the tone trip will energize the amber light which will turn on to indicate that a trip frequency is being transmitted from the remote terminal.

The output from the tone trip is also applied to a NOT circuit

which changes its output from a "1" to a "0". This change removes one input from a two input AND circuit of the timing and keying logic (through an OR) and causes the output of the AND to change to a "0". If this "0" is maintained for 25 milliseconds, the X unit will drop out and clamp the NAND to negative through the X lead. This input will remain in a zero state for 25 milliseconds after the tone trip is removed.

C. Loss of Signal

If a channel failure occurs, the low signal output from the tone equipment changes to a "0". This energizes a NOR circuit, whose output goes to "0" after a 150 millisecond time delay. This causes the alarm relay of the trip logic to drop out and close its contacts to indicate a channel failure.

The loss of the lockout voltage also removes one input of the two input AND circuit of the timing and keying logic. The output of the AND changes to a "0", and 25 milliseconds later the X unit is de-energized. This clamps the NAND circuit into a non-operative state. The loss of X and lockout (Lo) is seen by the X_1 unit, and 2.5 seconds later the output of the X_1 unit changes to a "1" and puts an input into the keying AND. However, the X unit input to the AND had previously dropped to zero, and the AND is not energized. The local transmitter remains in a non-keyed state.

D. Noise

If an output is obtained from the noise clamp of the channel equipment, the input to the noise interface changes to a "1" and energizes a NOT and a NOR circuit. The output of the NOT changes to a "0" and shorts the input to the channel trip NAND to negative. This puts the NAND in a non-operating condition. If the noise condition exists for 150 milliseconds, the STU-12 relay will recognize the condition as a loss of channel and lock the STU-12 trip NAND to a non-trip state.

E. Check-Back

A check-back test of the transfer trip received signal is obtained without the necessity of having an operator at remote terminals and without danger of tripping on external faults.

The operating sequence is as follows:

1. The operator at any line terminal moves the test switch to the "OFF" position. This places the transfer trip scheme temporarily out-of-service and stops transmission of a tone signal from the local station to the remote station. The remote tone receiver recognizes the condition as a loss of channel and the following occurs at the remote terminal:

The low-signal output of the tone receiver changes to a "0" output. After 150 milliseconds, the lockout unit of the remote STU-12 drops out. The dropout of lockout (Lo) de-energizes the X unit through the AND of the keying and timing logic. This clamps the NAND of the remote STU-12 to a non-operative state.

The loss of both X and Lo causes the X_1 unit to pickup to provide a "1" input to the keying AND of the timing and keying logic. The keying AND has a "1" input from the X_1 unit, and a "0" from the X unit, and the remote terminal is transmitting a guard frequency.

2. After holding the test switch in the "OFF" position for a few seconds, the operator next moves the test switch to the "RECEIVE" position. This re-establishes the transmission of the guard signal, and the following occurs at the remote terminal:

   The low-signal output of the tone receiver changes to a "1" and the lockout (Lo) picks up. This energizes the X unit through the AND circuit of the timing and keying logic; and 25 milliseconds later, a "1" output is obtained from the X unit. An input is also applied to the NOR of the X_1 unit, however, the dropout time for this unit is 2.5 seconds. Hence for 2.5 seconds, the keying AND has two "1" inputs and an output is obtained. This output keys the remote transmitter to a trip frequency until the X_1 unit resets. The operator at the local terminal should see the "Blue" and "Amber" test lights for approximately 2.5 seconds. On 3 terminal lines, both sets of lights should be on if all channels are operative.

3. This completes the check-back test, and the test switch should be moved to "normal" position as soon as the test lamps go dark. This restores the equipment to the operative position at all line terminals.

CHARACTERISTICS

The type STU-12 relay is available for application to 2 or 3 terminal lines where frequency shift tone channels are utilized. The logic diagram for the STU-12 relay is shown in Figure 1, and the transistor circuit of the relay for a two terminal line is shown in Figure 2.

Lockout Unit Time	150 milliseconds
X Unit Time	25 millisecond pickup 25 millisecond dropout
X_1 Unit Time	2.5 seconds

Blown Fuse Detector Time	2.5 seconds
Operating Time	0.75 microsecond to obtain voltage output
Voltage Output Relay (when used) Maximum Output	60 milliamperes, 45 v.d.c.
Keying Voltage to Tone Transmitter	-45 volts, d.c.
Battery Voltage Variations Rated Voltage 48 v.d.c. 125 v.d.c.	 Allowable Variation 42-56 v.d.c. 105-140 v.d.c.
Ambient Temperature Range	-20°C. to +60°C
Battery Drain	235 milliamperes, 48 v.d.c. 275 milliamperes, 125 v.d.c.
Dimensions	Panel Height 8-3/4 inches or 5 rack units Panel Width 19-inches

SETTING

No setting is required on the STU-12 relay.

INSTALLATION

The STU-12 relay is generally supplied in a cabinet or on a relay rack as part of a complete assembly. The location must be free from dust, excessive humidity, vibration, corrosive fumes or heat. The maximum temperature around the chassis must not exceed 60°C.

Routine Maintenance

Periodic checks of the relaying system as described in the assembly instructions are desirable to indicate impending failure so that the equipment can be taken out of service for correction. At regular maintenance intervals, any accumulated dust should be removed.

Trouble-Shooting

The components of the STU-12 are operated well within their ratings, and under normal conditions should give long trouble-free service. However, if a relay has given an indication of trouble in service or during routine checks, the voltages tabulated in TABLE I should be checked to determine the faulty circuit. The test point and component location on the boards are given in Figures 6, 7, 8 and 9.

TABLE I

Test point voltages to negative except where specified to positive 45 volts, d.c.

Board	Test Point	Normal Channel	With Noise Only	Low Signal Only	PR Trip Only	Tone Trip Only	System Trip
PR INTER-FACE	Term. 15	0.3	0.3	0.3	20	0.3	20
	Term. 16	0.3	0.3	0.3	20	0.3	20
	Term. 17	0.3	0.3	0.3	20	0.3	20
	TP 51	15.5	15.5	15.5	0.4	15.5	0.4
	TP 52	0.3	0.3	0.3	15	0.3	15
	TP 53	15.5	15.5	15.5	0.4	15.5	0.4
	Term. 1	0.1	0.1	0.1	11.6	0.1	11.6
	TP 54	0.1	0.1	0.1	42	0.1	42
	Term. 8	15	15	15	0.3	15	0.3
	Term. 4	0.3	0.3	0.3	45	0.3	45
	Term. 3	0.3	0.3	0.3	45	0.3	45
	TP 55	15	15	15	0.1	15	0.1
	Term. 5	0.02	0.02	0.02	16.7	0.02	16.7
TIMING AND KEYING LOGIC	Term. 19	12.8	0.11	0.11	12.8	12.8	12.8
	Term. 11	9.5	9.5	9.5	9.5	0.03	0.03
	Term. 1	0.1	0.1	0.1	11.6	0.1	11.6
	Term. 5	0.02	0.02	0.02	16.7	0.1	16.7
	TP 101	0.1	0.1	0.1	0.1	17	0.1
	TP 102	14.7	14.7	14.7	14.7	0.2	14.7
	TP 103	13.5	0.9	0.9	13.5	0.9	13.5
	TP 104	0.2	33	33	0.2	33	0.2
	Term. 18	15.5	0.05	0.05	15.5	0.05	15.5
	TP 105	0.10	20	20	0.10	0.10	0.10
	TP 106	42	0.10	0.10	42	42	42
	TP 107	0.10	15.5	15.5	0.10	0.10	0.10
	TP 108	16.5	16.5	16.5	16.5	16.5	16.5
	TP 109	0.05	0.05	0.05	0.05	0.05	0.05
	Term 17 to pos	0.1	0.1	0.1	-45	0.1	-45

CONTINUED ON PAGE 10

TABLE I (CONTINUED)

Test point voltages to negative except where specified to positive 45 volts, d.c.

Board	Test Point	Normal Channel	With Noise Only	Low Signal Only	PR Trip Only	Tone Trip Only	System Trip
CHANNEL INTER-FACE	Term 16 to pos	-16	-16	-2	-16	-16	-16
	TP 151	0.05	0.05	15	0.05	0.05	0.05
	Term 17 to	0	-16	0	0	0	0
	TP 153	15	0.05	15	15	15	15
	TP 154	0.05	15	0.05	0.05	0.05	0.05
	TP 155	15	0.05	0.05	15	15	15
	TP 156	0.05	21	21	0.05	0.05	0.05
	Term. 19	10	0.10	0.10	10	10	10
	Term. 12	0.05	45	45	0.05	0.05	0.05
	Term 15 to pos	0	0	0	0	-16	-16
	Term. 11	9.5	9.5	9.5	9.5	0.03	0.03
	Term. 10	0.1	0.1	0.1	0.1	10	10
	Term. 1	0.1	0.1	0.1	11.6	0.1	11.6
	Term. 8	15	15	15	0.3	15	0.3
	Term. 18	15.5	0.05	0.05	15.5	0.05	15.5
	Term. 6	15	15	15	15	15	0.2
TRIP	Term. 12	0.3	45	45	0.3	0.3	0.3
	Term. 10	0.1	0.1	0.1	0.1	10.0	10.0
	Term. 16	45	45	45	45	0.6	0.6
	Term. 6	15	15	15	15	15	0.2
	Term. 18	0.05	0.05	0.05	0.05	0.05	43
	TP 201	15.3	15.3	15.3	15.3	15.3	0.3
	TP 202	0.1	0.1	0.1	0.1	0.1	10.3
	Term. 7	45	45	45	45	45	0.8

Renewal Parts

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing the repair work. When ordering parts, always give the complete nameplate data.

ELECTRICAL PARTS LIST

Panel Mounted Components

Circuit Symbol	Description	Westinghouse Style Number
	POWER SUPPLY	
SW1	Switch	183A856H01
PL	Pilot Light 125V DC	183A825G01
	Pilot light 48V DC	183A825G04
F1 - F2	1.5 Ampere Fuse	11D9195H26
R1	26.5 Ohm, 40W, 48V DC	04D1299H44
R1 - R2	150 Ohm, 40W, 125V DC	1202499
VR1	Zener Diode, IN2828B, 50W	184A854H06
	ALARM	
A	Amber Light	183A825G08
R3 - R4	330 Ohm, 3W	185A207H15

Protective Relay Interface Board

	CAPACITOR	
C51	68 MFD, 35V DC	187A508H02
	DIODES	
D51 to D62	IN457A	184A855H07
	TRANSISTORS	
Q51-Q52-Q53-Q57	2N696	762A585H01
Q54-Q55	2N697	184A638H18
Q56-Q58	2N699	184A638H19
	RESISTORS	
R51-R54-R56-R57-R60 R66-R69-R71-R74	10K Ohm - 1/2 W	184A763H51
R52-R55-R61-R63-R75	33K Ohm - 1/2 W	184A763H63
R53-R58-R59-R62-R67 R73-R76	68K Ohm - 1/2 W	184A763H71
R64	1K Ohm - 1/2 W	184A763H27
R65 (Typical Value)	56K Ohm - 1/2 W	
R68	12K Ohm - 1/2 W	184A763H53
R70	3.3K Ohm - 1/2 W	184A763H39
R72	100K Ohm - 1/2 W	184A763H75
	ZENER DIODES	
Z51	IN3686B, 20V	185A212H06

ELECTRICAL PARTS LIST

Timing and Keying Board

Circuit Symbol	Description	Westinghouse Style Number
	CAPACITORS	
C101-C102	1 MFD	187A624H04
C103	68 MFD, 35V DC	187A508H02
	DIODES	
D101 to D114	1N457A	184A855H07
	TRANSISTORS	
Q110 to Q110	2N696	762A585H01
	RESISTORS	
R101-R103-R106-R108 R112-R121-R129-R134 R136-R137 (Typical Value)	33K Ohm - 1/2 W	184A763H63
R102-R105-R111-R115 R119-R122-R124-R126 R130-R133-R138	10K Ohm - 1/2 W	184A763H51
R104-R107-R117-R128 R131-R132-R135-R140	68K Ohm - 1/2 W	184A763H71
R109-R114-R125	1K Ohm - 1/2 W	184A763H27
R110-R113	20K Ohm - 1/2 W	184A763H58
R116-R123 (Typical Value)	27K Ohm - 1/2 W	184A763H51
R118-R120	39K Ohm - 1/2 W	184A763H65
R127 (Typical Value)	56K Ohm - 1/2 W	
	ZENER DIODES	
Z101	1N957B, 68V	186A797H06
Z102-Z103	1N3686B, 20V	185A212H06

Channel Interface Board

	CAPACITOR	
C151	6.8 MFD, 35V, DC	184A661H25
	DIODES	
D151 to D161	1N457A	184A855H07
	TRANSISTORS	
Q151-Q154-Q161	2N2043	184A638H21
Q152-Q155-Q156-Q157 Q158-Q162-Q163	2N696	762A585H01
Q159	2N697	184A638H18
Q160-Q164	2N699	184A638H19

ELECTRICAL PARTS LIST

Channel Interface Board (Continued)

Circuit Symbol	Description	Westinghouse Style Number
	RESISTORS	
R151-R159-R179	6.8K Ohm - 1/2 W	184A763H47
R152-R160-R174-R180	1K Ohm - 1/2 W	184A763H27
R153-R161-R164-R167 R171-R175-R177-R181 R183-R188-	10K Ohm - 1/2 W	184A763H51
R154-R162-R182	100K Ohm - 1/2 W	184A763H75
R155-R163-R166-R170 R185	68K Ohm - 1/2 W	184A763H71
R165-R168-R169-R172 R184-R187	33K Ohm - 1/2 W	184A763H63
R173	39K Ohm - 1/2 W	184A763H65
R176-R186	12K Ohm - 1/2 W	184A763H53
R178	3.3K Ohm - 1/2 W	184A763H39
	ZENER DIODES	
Z151	1N3686B, 20V	185A212H06
Z152	1N957B, 6.8V	186A797H06

Trip Board

	CAPACITORS	
C201	.25	187A624H02
	DIODES	
D201	1N475A	184A855H07
	TRANSISTORS	
Q202	2N2043	184A638H21
Q203	2N696	762A585H01
Q204	2N697	184A638H18
Q201-Q205	2N699	184A638H19
	RESISTORS	
R201-R207-R210-R213	10K Ohm - 1/2 W	184A763H51
R202-R214	3.3K Ohm - 1/2 W	184A763H39
R211	33K Ohm - 1/2 W	184A763H63
R205-R209	68K Ohm - 1/2 W	184A763H71
R206	10K Ohm - 1 W	187A643H51
R208	100K Ohm - 1/2 W	184A763H75
R212	12K Ohm - 1/2 W	184A763H53
R204	1K - 1/2 W	184A763H27
R203	20K - 1/2 W	184A763H58
	ALARM UNIT	
AL	Telephone Relay	408C062H07

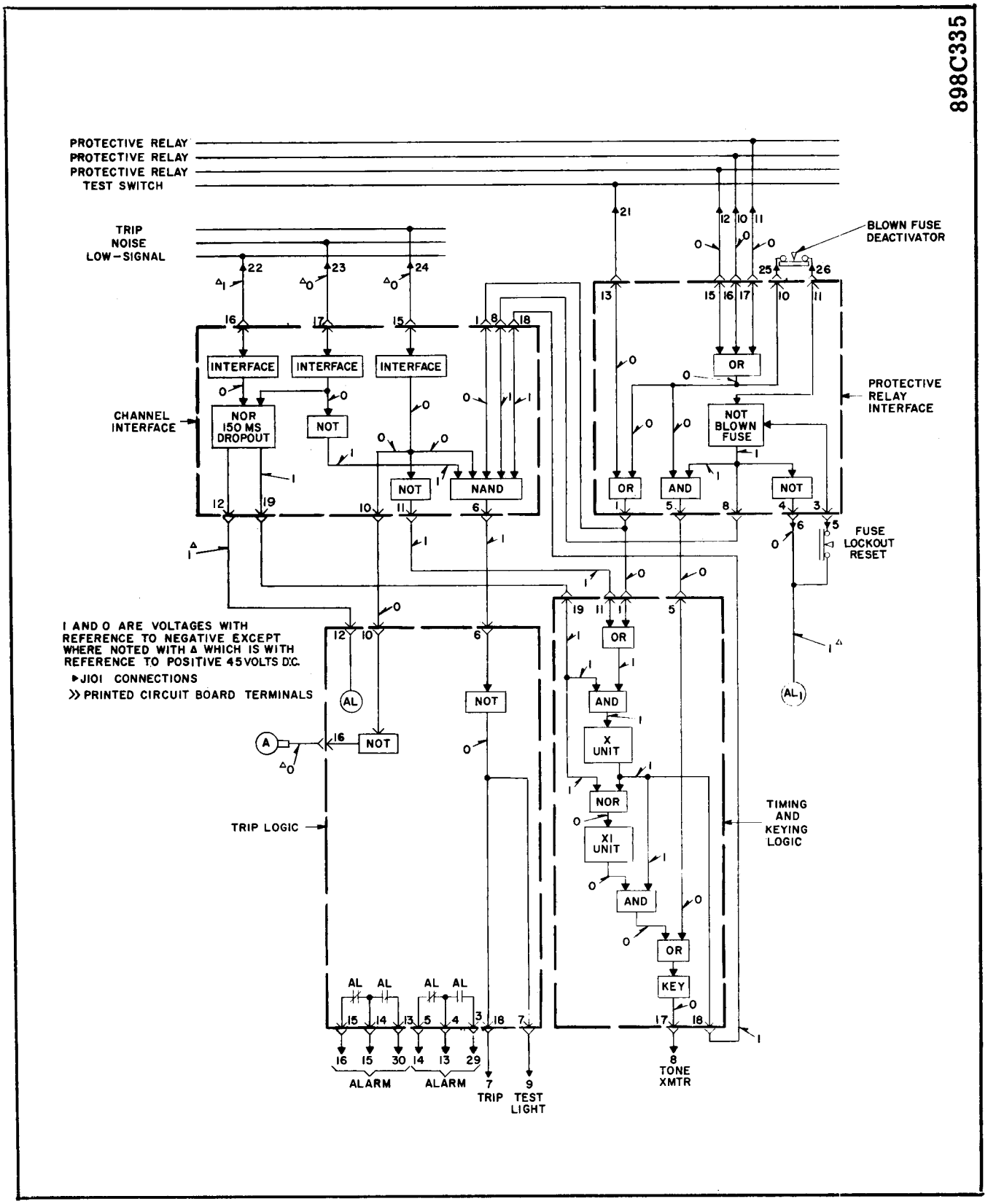
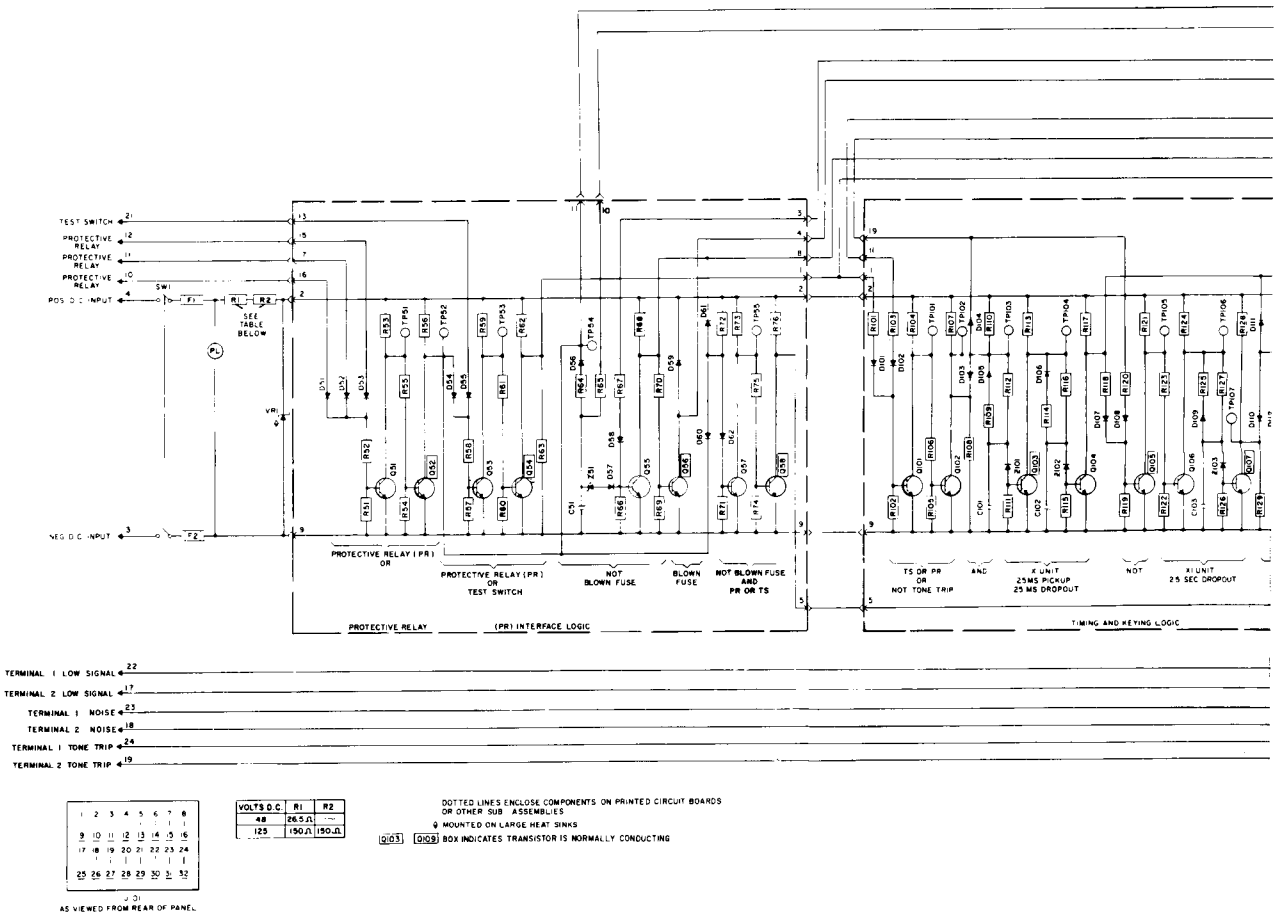


Fig. 1 Logic Diagram of Type STU-12 Relay for Two Terminal Lines



AS VIEWED FROM REAR OF PANEL

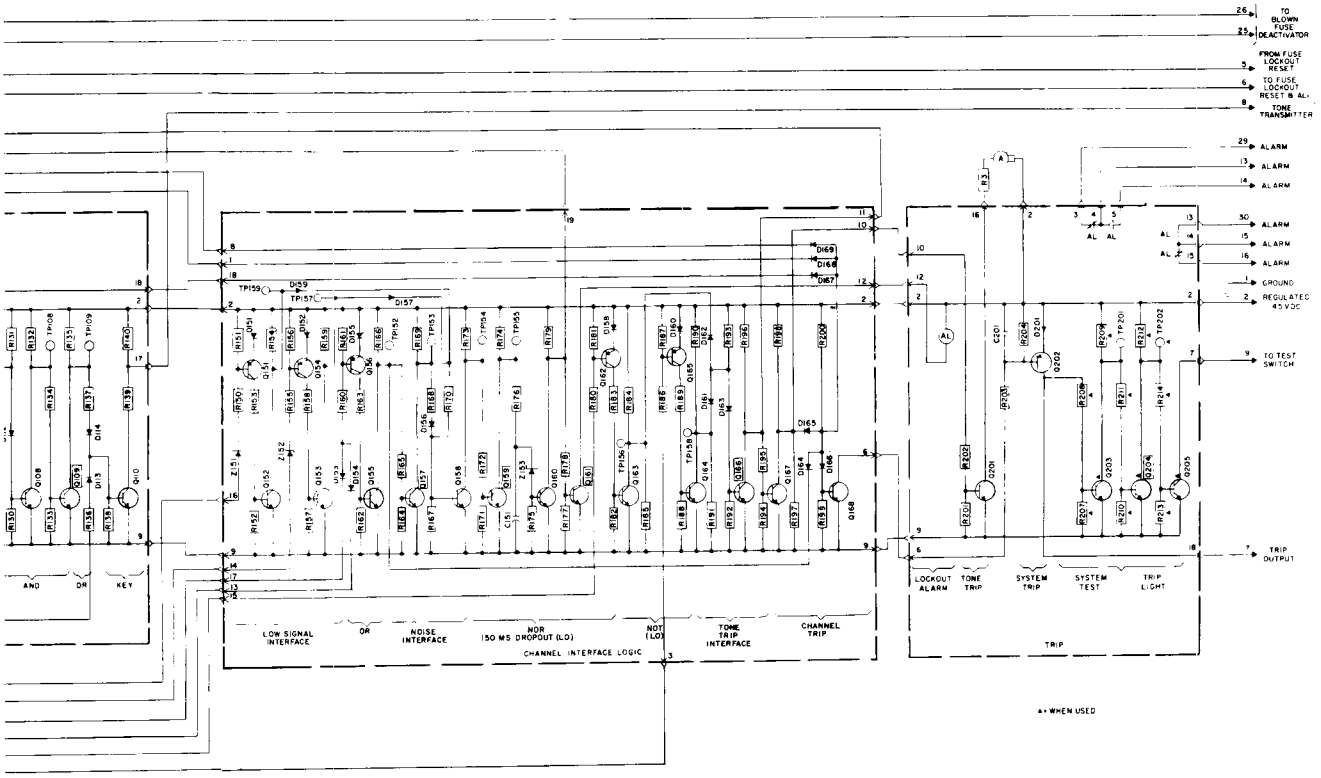
VOLTS D.C	R1	R2
48	26.5Ω	—
125	150Ω	150Ω

DOTTED LINES ENCLOSE COMPONENTS ON PRINTED CIRCUIT BOARDS OR OTHER SUB ASSEMBLIES

♀ MOUNTED ON LARGE HEAT SINKS

Q103 Q109 BOX INDICATES TRANSISTOR IS NORMALLY CONDUCTING

Fig. 3 Internal Schematic of Type



756J689

STU-12 Relay for Three Terminal Lines

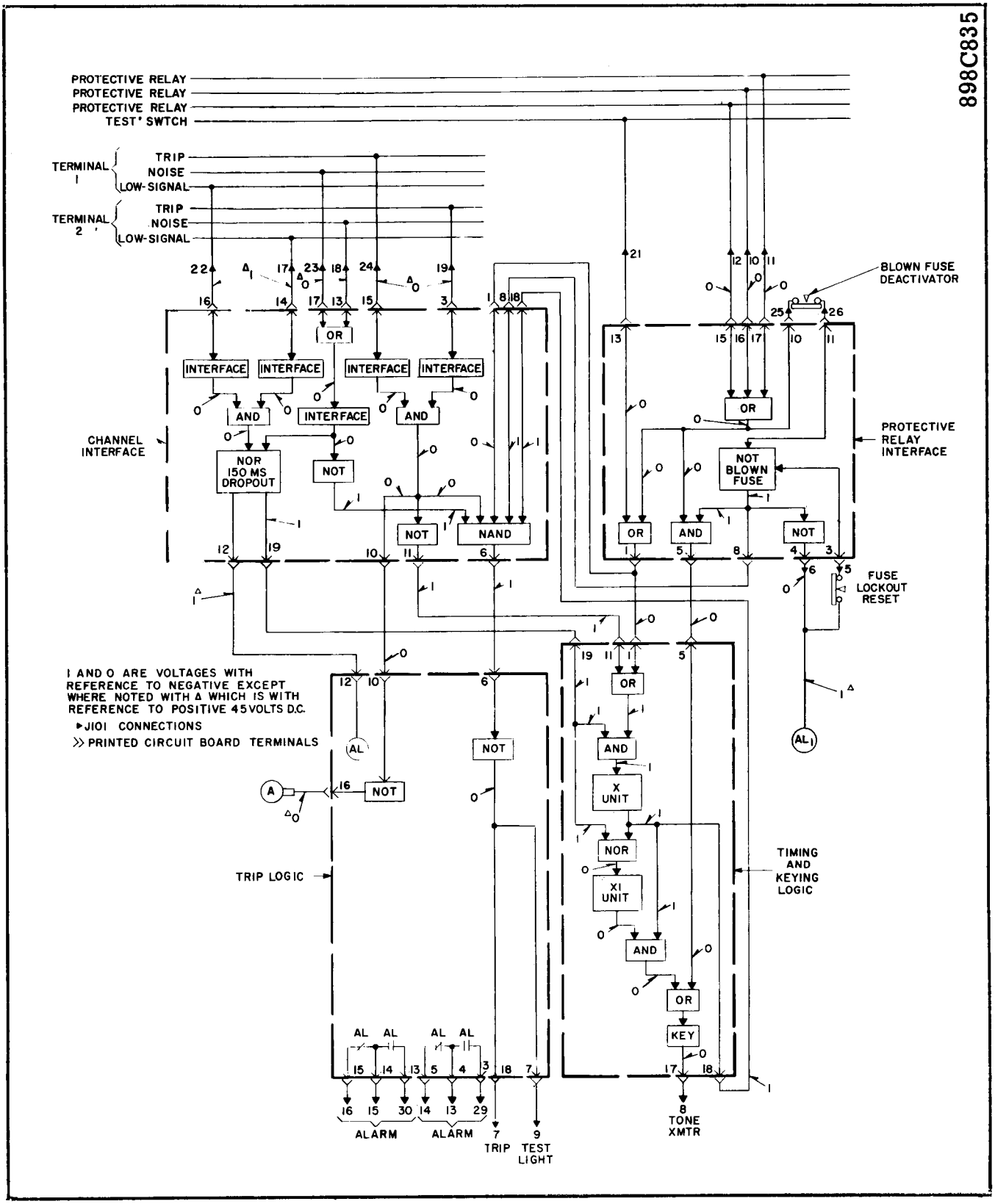


Fig. 4 Logic Diagram of STU-12 for Three Terminal Lines

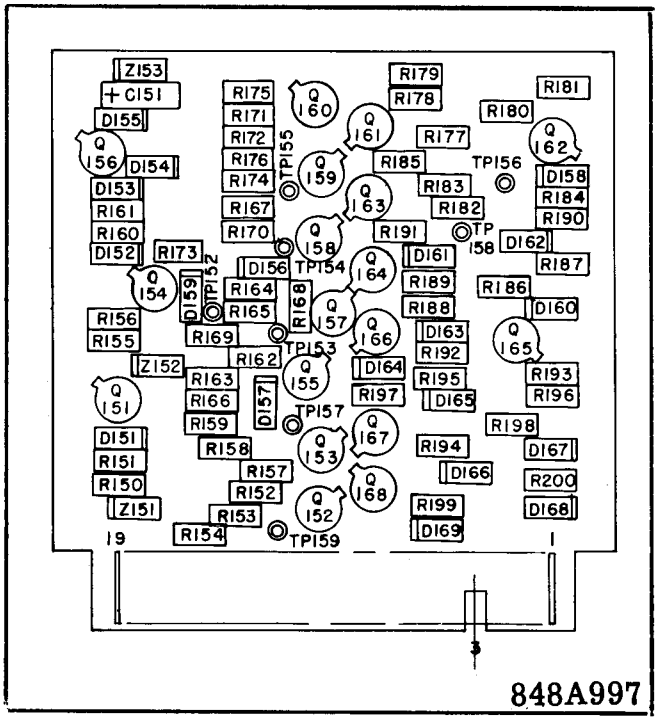


Fig. 5 Component Location on Channel Interface Board for Three Terminal Lines

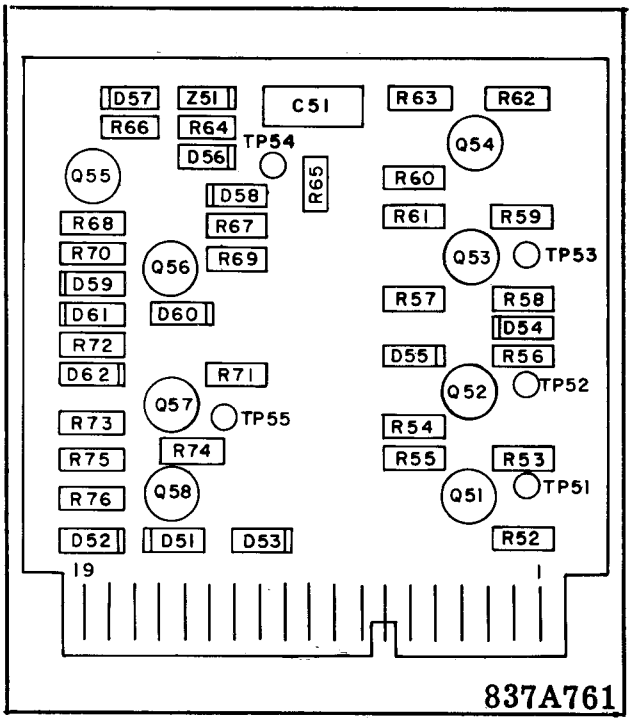


Fig. 6 Component Location on the Protective Relay Interface Board

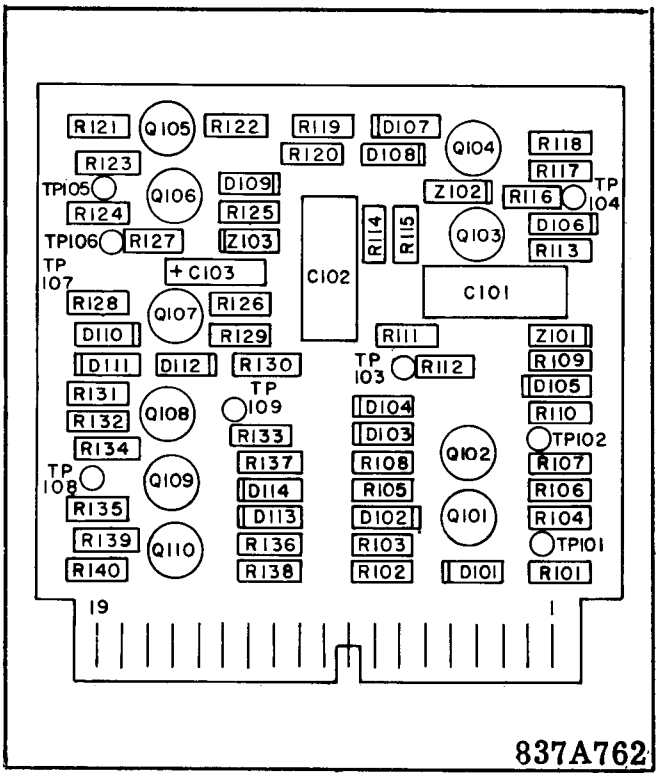


Fig. 7 Component Location on the Timing and Keying Board

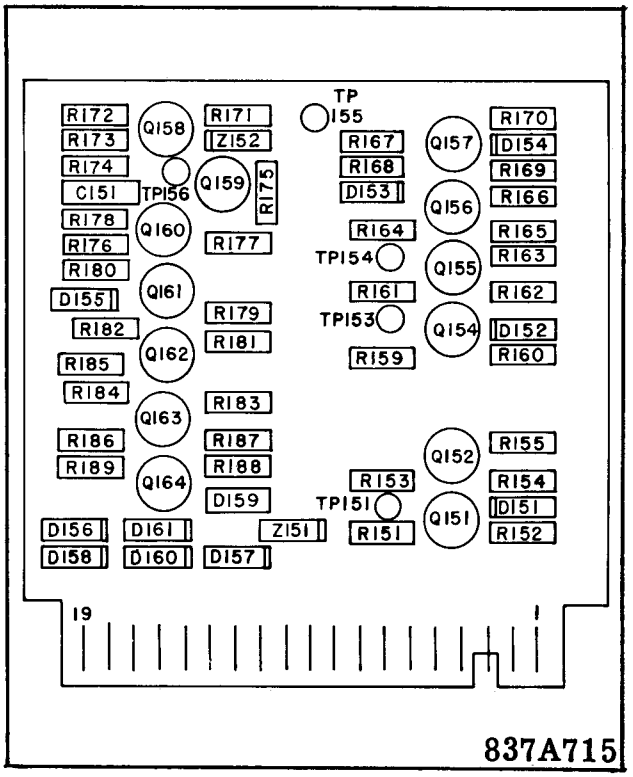


Fig. 8 Component Location on the Channel Interface Board

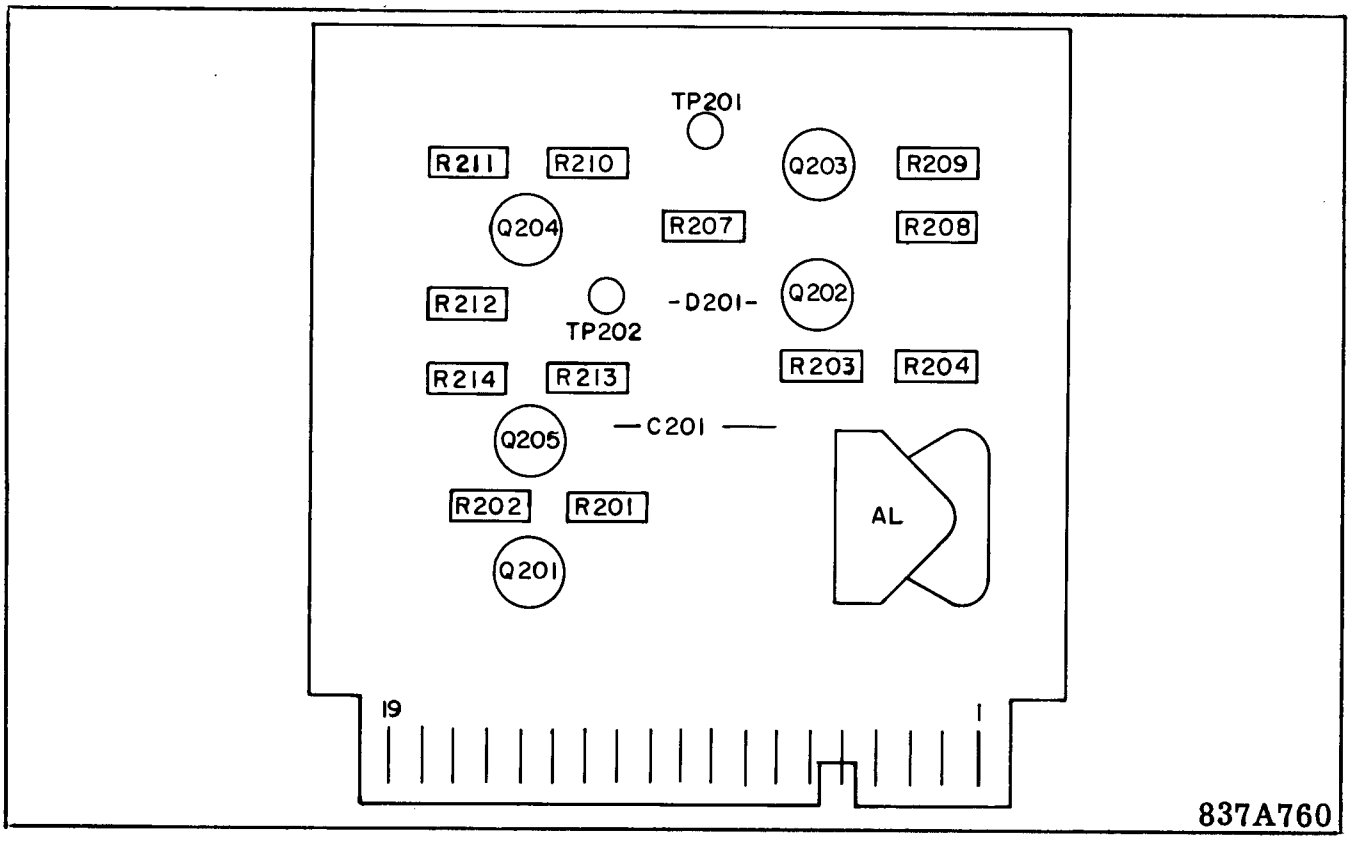


Fig. 9 Component Location on the Trip Board

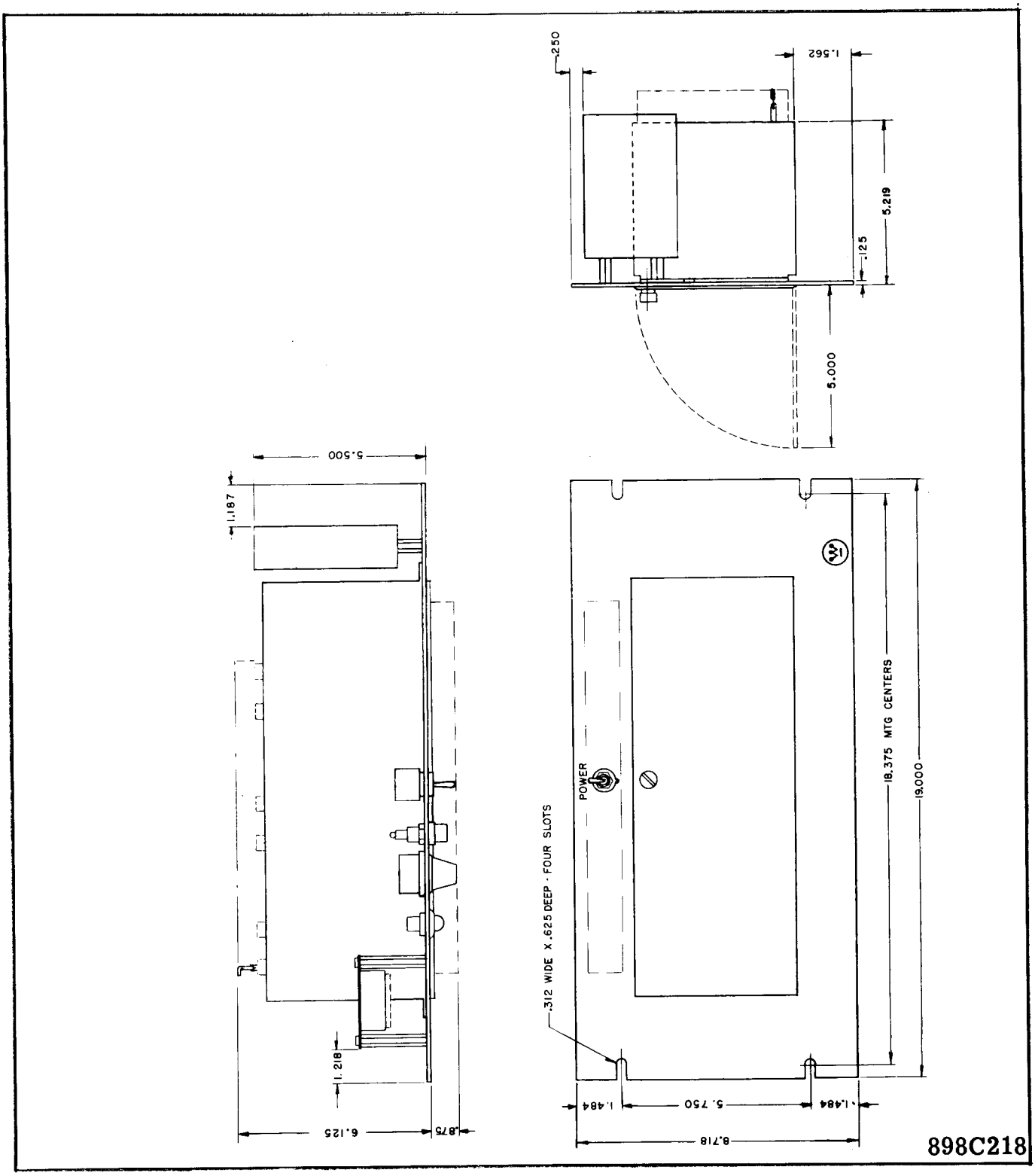


Fig. 10 Outline and Drilling Plan for the Type STU-12 Relay

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.