INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TT-8 AUXILIARY RELAY

CAUTION Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

The type TT-8 is an auxiliary relay used in the type KD directional comparison tripping system. The TT-8 relay provides a circuit for high speed tripping, controls the transfer tripping signal for the remote line terminals, and supplies necessary coordination during power reversal conditions.

CONSTRUCTION

The type TT-8 relay consists of three time-delay auxiliary relay units, two silicon zener diodes, and a tripping diode.

Auxiliary Units X, X1, and X2

The auxiliary units X, X1, and X2 are telephone-type relays. In these relays, an electromagnet attracts, a right-angle iron bracket which in turn operates a set of make or break contacts.

All units are of slow-release type. The delay in release is obtained by a copper slug located at the end opposite from the armature. When the coil becomes deenergized, the change in flux through the slug results in an electromotive force and associated current in it.

This current produces a flux which aids the main flux and delays the release of the armature. When the coil is energized, the operation of the relay is not appreciably delayed because the armature is operated by flux not linking the slug.

Tripping Diode D1

Tripping diode D1 has 300V rating (JEDEC No. 1N1203 for 125 volts relay).

Blocking Diodes D2, D3

Blocking diodes D2 and D3 are zener type diodes having a one watt, 200 volt rating (JEDEC No. 1N-3051).

OPERATION

Microwave or tone relaying makes use of a channel separate from the protected line. Therefore, either a blocking or a tripping signal can be utilized for relaying. The tripping signal is preferable, since it effects high-speed tripping particularly in cases where a tapped line terminal has weak source of fault current. In the event of channel failure, undesirable tripping cannot take place since the microwave signal must be received over the channel to initiate high-speed tripping.

K-Dar Overreaching Trip Scheme

In this scheme, the tripping relays, as in the directional comparison carrier scheme, are set to operate for a fault anywhere on the protected line, and they reach beyond the line at the remote line terminals. Fast relay operation is obtained since all faults will be within the relay characteristic. For short lines there is no problem in setting the tripping relays to see faults in the protected zone.

A ''trip request'' is transmitted when the local fault-detecting relays operate; this signal closes the remote receiver relay contact. However, the receiver relay cannot initiate tripping unless the fault-detecting relays also operate. For external fault relay set in the direction of the fault, hereafter called Station I, will operate and send a trip request for the breaker at the other station, hereafter called Station II. However, since the relays at station II do not operate for this fault, neither breaker is tripped. At station II the fault detecting relays do not permit tripping. At station I the receiver relay contacts remain open in the absence of a trip request from station II. In contrast for internal fault 2, the fault detectors operate at both

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breakers and both initiate a trip request. Therefore, both breaker trip circuits are energized through the fault-detector contacts and the receiver-relay contact, to clear this fault. For detailed operation of this scheme refer to Fig. 2.

The following relays are used in this scheme.

1 - Type KD Directional Distance Phase Relay
1 - Type KRC, KRP, KRD, or KRQ Directional Overcurrent Ground Relay
1 - Type TT-8 Transfer-Trip Auxiliary Relay

For internal faults the fault-detecting relays (Z2 or $D_O + I_O$) operate at both stations, keying a trip request by applying battery positive to the transmitter keying circuit. Receiver-relay contact 94 closes at both stations to permit tripping through Z2 or $D_O + I_O$, X, 94, and TS contacts.

In order to test for successful receipt of a trip-request signal the test cutout switch TS is turned to the "REC" position. In this position, the trip circuit is open and the fault-detecting relay contacts are bypassed to provide a path for indicator-light current. This light is lit when the 94 contact closes, completing a successful test. To transmit, TS is turned to the "SEND" position. Contact 5-6 applies positive potential to the transmitter keying circuit.

Auxiliary Unit X

The X unit provides a coordinating delay to allow contact 94 to open, if a sudden reversal occurs in the direction of fault-power flow in the protected line. For an internal fault the X unit is energized at about the same time that the remote transmitter is being keyed, so that receiver relay 94 and X unit operate in parallel. Accordingly, the actual delay in tripping caused by the X unit is less than the total pickup time of X.

The Auxiliary Unit X1

The unit X1 delays the transmission of a trip-signal when the breaker in question is being tripped for other than a fault in the protected line. Suppose a bus fault occurs. If it were not for the X1 unit, the 52b contact would immediately initiate a trip request, before the remote fault-detecting relays had a chance to reset. A similar circumstance exists for an adjacent line fault where the breaker in question is common to the protected line as well. In either case, X1 prevents premature transmitter keying after the breaker opens.

The Auxiliary Unit X2

Relay unit X2 performs a signal-continuing function following tripping. This unit is energized along with the trip coil and continues the signal for about 8 cycles after the breaker opens. For example, this feature is needed where a 3 cycle and an 8 cycle breaker are mixed.

Tripping Diode D1

Rectifier D1 prevents the bus differential relay contacts, 87B, from keying the transmitter through rectifier D2.

Blocking Diodes D2, D3

Rectifier D2 blocks trip-current flow around contacts X and 94. Rectifier D3 also blocks trip-current flow. Without D3 the I_O contact would be bypassed and tripping would occur if D_O and not I_O operates.

A circuit is available through rectifier D2 to allow the line back-up relays to key a trip-request signal. This feature provides immediate tripping of the remote breaker for a line fault, even though the local primary relays fail to operate. Ordinarily, the D2 rectifier circuit is not required; it is needed only to handle the possibility of a primary relay failure.

CHARACTERISTICS

The characteristics of the various units of the relays are ar follows:

	125V Avg. Ohms
X Unit Coil	3,300
X Series Resistor	12,000 +
X 1 Unit Coil	3,300
X 1 Series Resistor	5,000 +
X 2 Unit Coil	3,300
X 2 Series Resistor	5,000 +

+ Adjusted Value

The pickup and operating values of these units are given under "Adjustments and Maintenance."

SETTINGS

Auxiliary Units

The auxiliary units X, X1 and X2 require a setting for the correct control voltage. For 48V d.c. voltage, the series resistors are by-passed by connecting

the lead to the rear terminal of the resistor. For 125V d.c. rated relays, the connection is made to the adjustable tap terminal on the series resistor.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments, other than those covered under ''SETTINGS,'' should be required.

Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

Auxiliary Units X, X1, X2'

Apply rated voltage to each auxiliary unit relay terminals and observe contact action. If desired, the timing of the operation can be checked as outlined under calibration procedure.

Routine Maintenance

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

NOTE When making a dielectric test on the relay, the high voltage may be applied at the relay terminals, from all circuits to ground, between coil and contact circuits, and between isolated coil circuits. However, the test voltage should not be applied across relay contacts and rectifier circuits.

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order.

Auxiliary Units X, X1, and X2

The operating time of units X, X1, and X2 should be checked with an electronic timer. When adjusting the series resistor, loosen the adjustments band to avoid damage to the resistance wire. The series resistor for each unit is located below the corresponding unit.

Auxiliary Unit X (Left-Hand Unit)

For 125 V.D.C. or 250 V.D.C. control voltage, the coil of the relay should be connected in series with the resistor. Adjust the resistance to measure:

12,000 ohms for 125 V.D.C.
20,000 ohms for 250 V.D.C.

With the armature closed, adjust the air gap to be .002'' - .003''. Contact gaps should measure from .020'' to .035''. The coil is energized across terminals 1 and 2.

Check for the specified 2-4 cycle dropout time across terminals 1 and 10. If necessary, the dropout time can be adjusted by changing the air gap. After final adjustment, the air gap should be a minimum of .002''. Check pickup time by applying first 80% and then 115% of rated voltage. It should fall within the specified limits of 0.6 to 1.5 cycles. If necessary, make further adjustment to achieve correct timing by slightly increasing or decreasing the series resistance.

Auxiliary Unit X1 (Middle Unit)

For 125 V.D.C. and 250 V.D.C. control voltage, the coil of the relay should be connected in series with the resistor. Adjust the resistance to measure:

5,000 ohms for 125 V.D.C. operation
13,000 ohms for 250 V.D.C. operation

With the armature closed, adjust the gap to the .002'' - .004''. Contact gaps should measure from

.020'' to .035''. Check for the specified 8 to 10 cycles dropout time by energizing the relay between terminals 2 & 3, and measuring the contact dropout time between terminals 5 and 7. If necessary, the dropout time can be adjusted by changing the air gap. After final adjustment the air gap should be a minimum of .002''. Check the pickup time first with 80% and then 115% of rated voltage. It should be below 1.0 cycle. If necessary, make further adjustment to achieve correct timing by slightly increasing or decreasing the series resistance.

Auxiliary Unit X2 (Right-Hand Unit)

For 125 V.D.C. or 250 V.D.C. control voltage, the coil of the relay should be connected in series with the resistor. Adjust the resistor to measure:

5,000 ohms for 125 V.D.C.
13,000 ohms for 250 V.D.C.

Adjust the armature air gap until the dropout time is between 6-8 cycles. Block X1 contact open. Energize the coil between terminals 2 and 9 and measuring time response across terminals 7 and 5. The final air-gap with the armature closed should be minimum .0015. Check the pickup time with 80% of rated voltage. It should be below 1.5 cycles. If necessary, make further adjustments to achieve correct timing by slightly increasing or decreasing series resistance.

D1 - (Tripping Diode Check)

A. Forward Voltage Drop

Pass 10 amperes d.c. in terminal 9 out terminal 8, with positive polarity on terminal 9, and using a high resistance voltmeter measure the voltage across terminals 8 and 9. It should be less than 1.5 volts.

B. Leakage Current

For 48/125 V d.c. Relays

Apply 250 V d.c. with 10,000 ohm resistor in series with terminals 8 and 9 and positive polarity on terminal 8. Measure the leakage current with a d.c. milliammeter. It should be less than 10 milliamperes.

Zener Blocking Diodes

A. Reverse Characteristic:

Breakdown voltage is the value of voltage at which the reverse current just exceeds 0.25 milliamperes and should be between 160 and 240 volts for each diode. The breakdown voltage is determined by slowly increasing the voltage until reverse current exceeds 0.25 milliamperes and starts to increase rapidly. Do not exceed 3 milliamperes reverse current.

B. Forward Characteristic:

With 200 milliamperes flowing in forward direction, the forward voltage across each diode should not exceed 1.5 volts.

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 repair work. When ordering parts, always give the complete nameplate data.

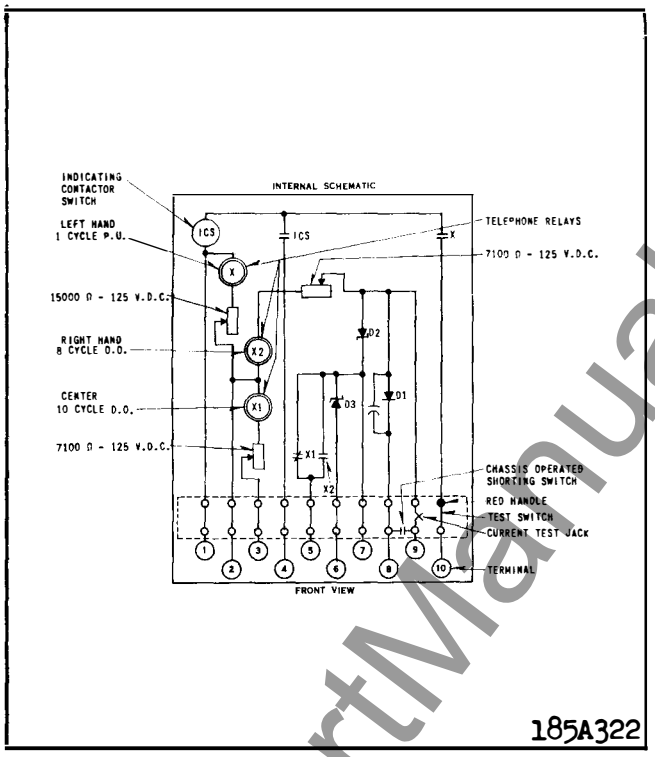

Fig. 1 - Internal Schematic of Type TT-8 Auxiliary Relay in FT-21 case.

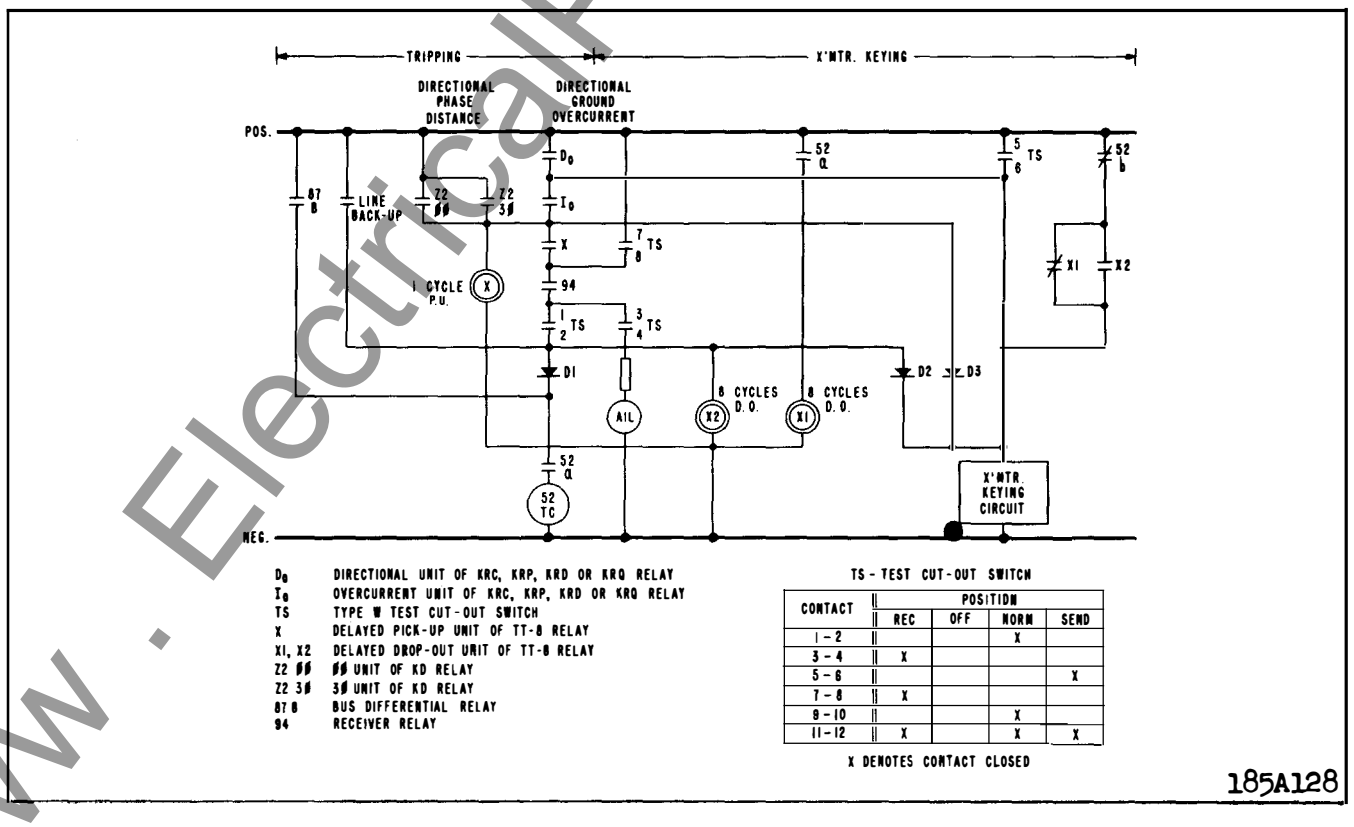

Fig. 2 - K-Dar/TT-8 overreaching transfer - Trip Scheme.

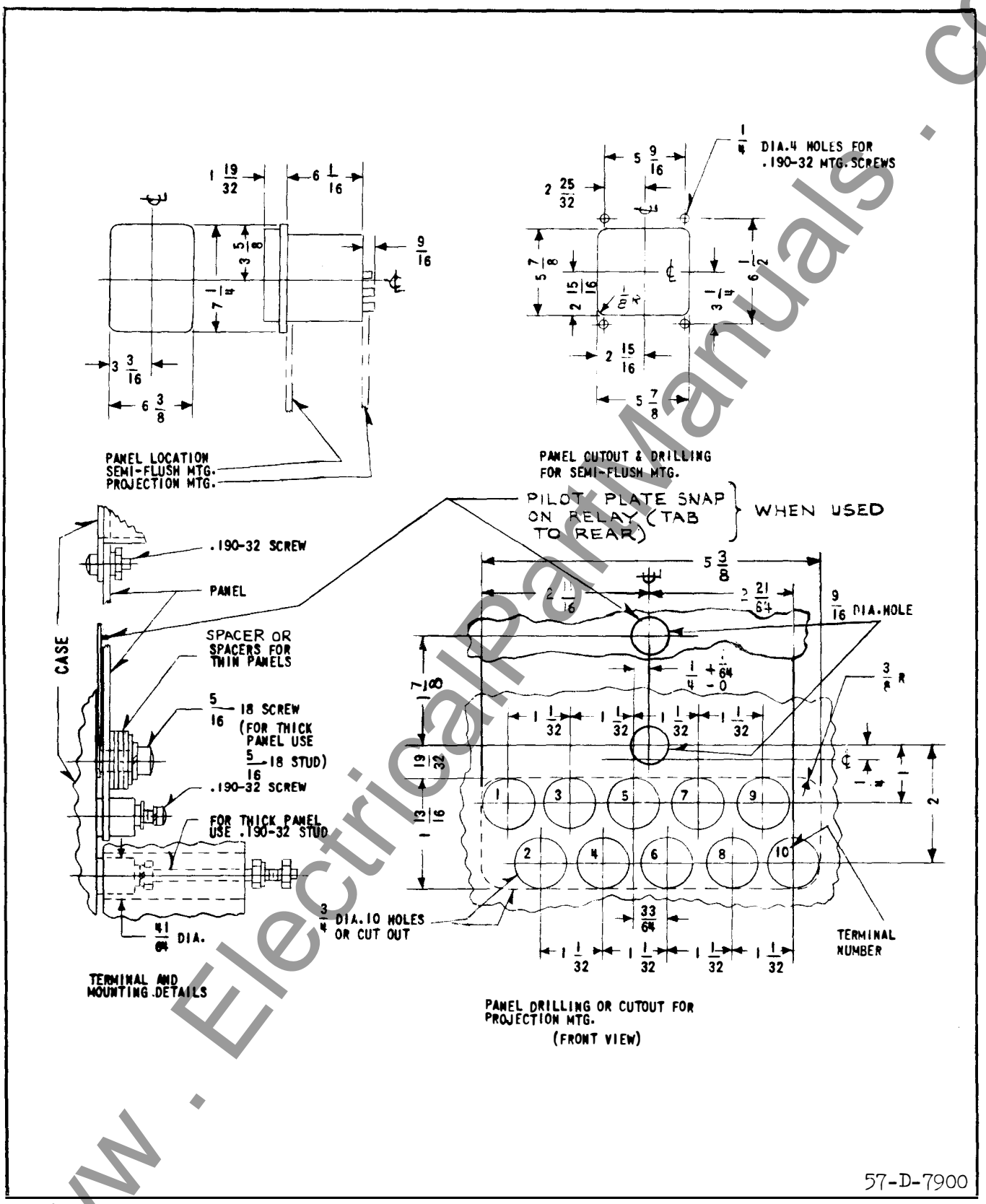

Fig. 3 - Outline and Drilling Plan for TT-8 Relay in FT-21 case.

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TT-12 UNIVERSAL CHANNEL TRANSFER-TRIP RELAY

CAUTION Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections;

APPLICATION

The type TT-12 is an auxiliary relay used in the K-DAR directional comparison permissive overreaching transfer trip system. The TT-12 relay provides a circuit 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.

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

The TT-12 relay may be applied with TA-3 or TA-1 audio tones or TCF power line carrier. Any comparable frequency shift channel equipment that contains receiver relay contacts as follows may also be used.

Guard relay: 1 form A or 1 form C

Trip relay: 2 form A and 1 form B or 3 form C contacts.

CONSTRUCTION

* The type TT-12 relay consists of a thermal type time delay relay, telephone type relays, silicon zener diodes, and an indicating contactor switch.

Auxiliary Unit X1

Auxiliary unit X1 is a thermostatic time delay relay that is actuated by a heater. The contacts are hermetically sealed.

Auxiliary Units X, Y and LO or ALX

The auxiliary units X, Y and LO or ALX are telephone type relays. In these relays an electromagnet attracts a right angle iron bracket which in turn operates a set of make or break contacts.

Tripping Diodes D1 and D2

Tripping diodes D1 and D2 are zener type diodes having a 50 watt, 200V rating (JEDEC No. 1N2846A for 125 volt and 48 volt relays). Two * diodes are used in series for 250 volt relays. (JEDEC NO. 1N2846A and 1N2846RA).

* Blocking Diodes D3 to D14

Blocking diodes D3 through D14 are zener type diodes having a one watt, 200 volt rating. Two are used in series for 250 volt relays. (Catalog No. 1.5KE-200)

Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attached to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit, Also, during this operation two fingers on armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

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*Denotes change from superseded issue.

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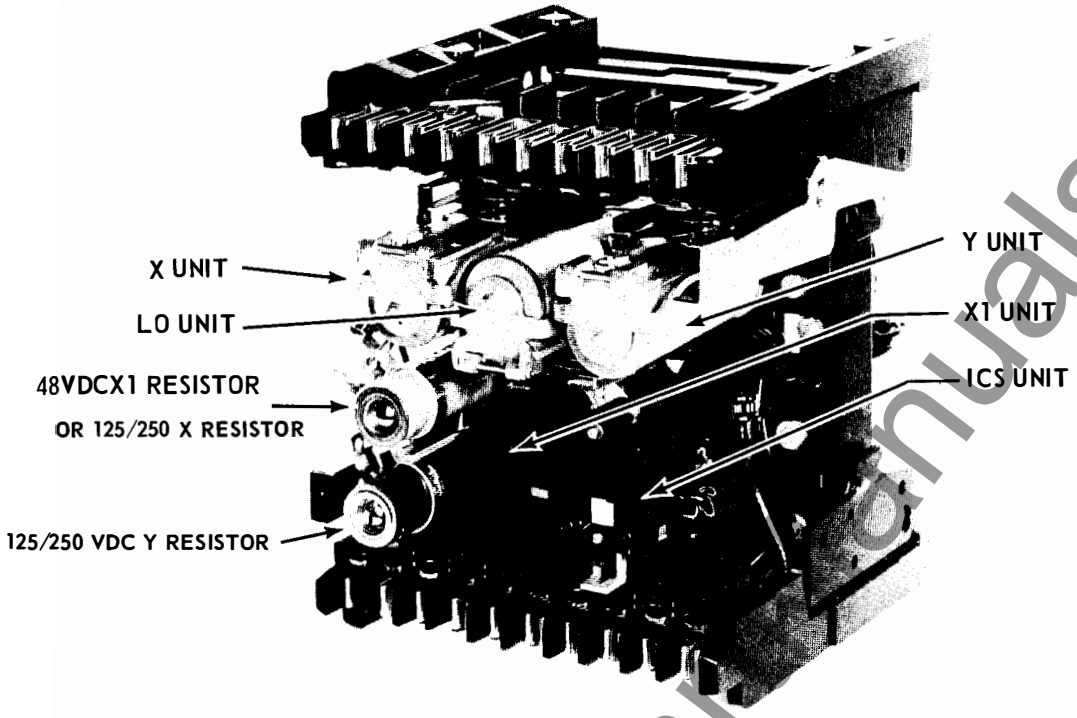

Fig. 1. Type TT-12 Relay without Case (Front View)

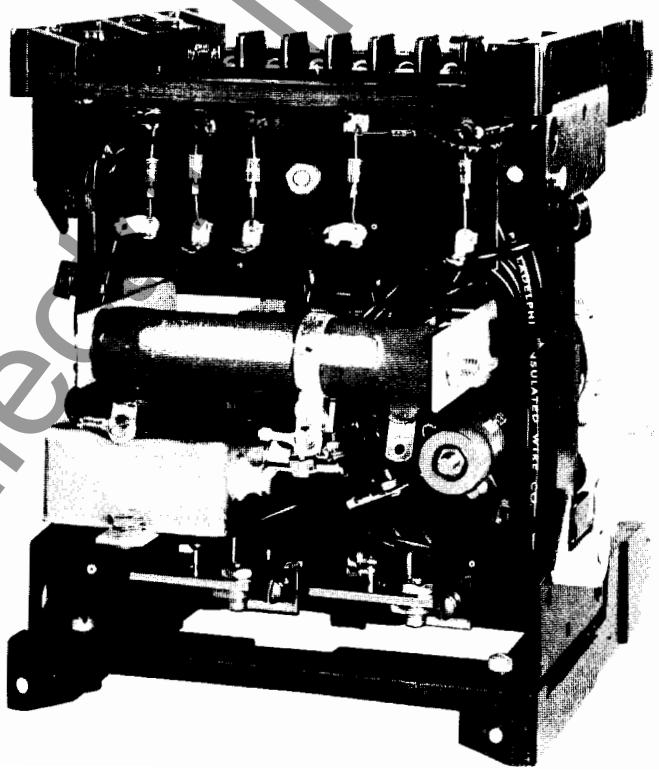

Fig. 2. Type TT-12 Relay without Case (Rear View)

OPERATION

The type TT-12 relay is used with a microwave, pilot-wire tone channel, or TCF power line carrier 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. See figs. 7, 8, 9, 10, 11 & 12.

The protective relays and the relay settings used in the TT-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 TT-12 scheme, however, uses a tripping signal rather than a blocking signal to provide improved security against undesired relay operation for external faults. Since the microwave or pilot wire tone channels are separated from the conductors of the protected power line, it is not necessary to use a blocking signal, as in the conventional directional comparison carrier scheme. This avoids having to send the signal on the conductors through a fault. The conventional directional comparison carrier scheme is arranged to trip on absence of the blocking signal, so that the channel failure will result in false tripping for external remote faults that are within reach of the protective relays. Since the TT-12 scheme requires reception of the trip signal as well as operation of the local protection relays, channel failure cannot result in undesired tripping.

Auxiliary Unit X

The X-unit is used to provide a coordinating delay, if a sudden reversal occurs in the direction of fault power flow in the protected line. For an internal fault, the X-relay is preclosed and is kept closed by fault detecting relays (PR). These consist of the KRD directional overcurrent ground relay and the KD zone 2 phase distance relay.

Auxiliary Unit Y and Anti-bounce Circuit

Auxiliary unit Y, in conjunction with capacitor and resistor provides for continuation of the audio tone tripping signal in case the protective relay (PR) contacts should have an initial bounce. The sequence of operation of this anti-bounce circuit is as follows:

As soon as a PR contact first closes, the capacitor charges almost instantaneously to the approximate value of the d-c control voltage through the resistor R and the normally closed Y contact, at the same time closing of the protective relay contact applies reverse bias to the keying transistor in the transmitter of the audio tone equipment, causing the transmitter to shift to the trip frequency. Should the PR contact bounce open, this reverse bias to "shift" is upheld by the capacitor voltage that is slowly discharged through a high resistance path in the transmitter circuit. When PR contact recloses the same sequence of events takes place. When finally PR closes "solid" or long enough for Y unit to operate, the anti-bounce circuit is cut off by the normally closed Y contact and the capacitor charge is dissipated through a normally open contact and its associated resistor.

Auxiliary Unit LO – Universal TT-12 Only

The LO unit is energized by the tone receiver 94-G guard relay contact as shown in Figs. 7, 8, 9, 10, 11 and 12. One contact of the LO relay energizes the X unit. This makes it possible, in case of channel failure, to lock out the transfer tripping at the local terminal. A second LO contact is in series with the tone receiver 94-T trip relay contact, as a second path to energize the LO unit coil, after the trip signal is received. A break contact is used, along with a break X relay contact, to supervise the X1 relay. The LO unit has prolonged dropout time, thus assuring that it will stay closed during a shift of frequency.

Auxiliary Unit X-1

The unit X-1 provides means for a check-back test. It is energized by a break contact of the X unit for all channels and the LO unit for tone channels or the AL in the TCF channel. Its contact energizes the keying circuit and is supervised by an X contact to avoid check-back keying during faults.

Auxiliary Unit ALX – TT-12 for TCF Only

The ALX unit is used as an alarm unit for these TT-12 relays used with a TCF carrier channel.

Operation of Test Facilities

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 the transmission of the guard signal from the local station to remote stations where the LO-unit (AL for TCF) drops out. The LO or AL and X unit break contacts energized to X-1 terminal unit which requires 2-3 seconds to pick-up.
2. After holding the test switch in the "OFF" position for approximately 10 seconds, the operator next moves the test switch to the "RECEIVE" position. This re-establishes the transmission of guard signal. The LO-unit (AL for TCF) and X-unit at remote line terminals pickup again. With the thermal unit X1 still picked up the trip signal is transmitted from remote line terminals until X1 unit resets. The operator should see the "BLUE AND AMBER" test light for approximately 2 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.

   The test switch in Figs. 7, 8, 9, 10, 11 and 12 provides a "send" position so that the transmitter may be shifted during periodic maintenance checks.

Tripping Diodes D1, D2

Tripping diode D1 provides isolation of the KD time circuit from the ground fault detector relay. Diode D2 prevents the keying circuit from being energized for operation of 86B contact for a bus fault behind the protected line. Otherwise, undesired tripping of remote terminals would result.

Blocking Diodes

D3 – blocks tripping current path through directional ground contact D_O and diode D5 and blocks tripping current path from battery positive thru X and X1 relay contacts during check-back tests.

D4 – blocks tripping current path through directional ground contact D_O, 94-T and X contacts.

D5 – blocks discharge of the anti-bounce capacitor through the Y unit.

D6 – prevents energizing one of the blue lights during check-back test on 3-terminal line arrangement with test switch in "RECEIVE" position. See Fig. 7.

D7 & D8 – are in series with the lockout relay coil and are used to clock the guard relay from energizing the amber light.

D9 – is needed when back contact of trip relay is not available.

D10 & D11 – blocks trip relay from picking up guard light when light is used.

D12 – blocks trip current flow through D4.

D13 – is needed to block the back contact of 94T from keying.

* D14 – blocks the pilot relays from energizing the X coil through D13 when the channel is lost and Lo is deenergized.

SETTING

There are no settings to be made on the relay.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The outline for the FT22 case is shown in Fig. 14.

The electrical connections may be made directly to the terminals by means of screws for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For 125 or 250 VDC TT-12 relays, an external X1 resistor is required. The outline drawing is shown in Fig. 13.

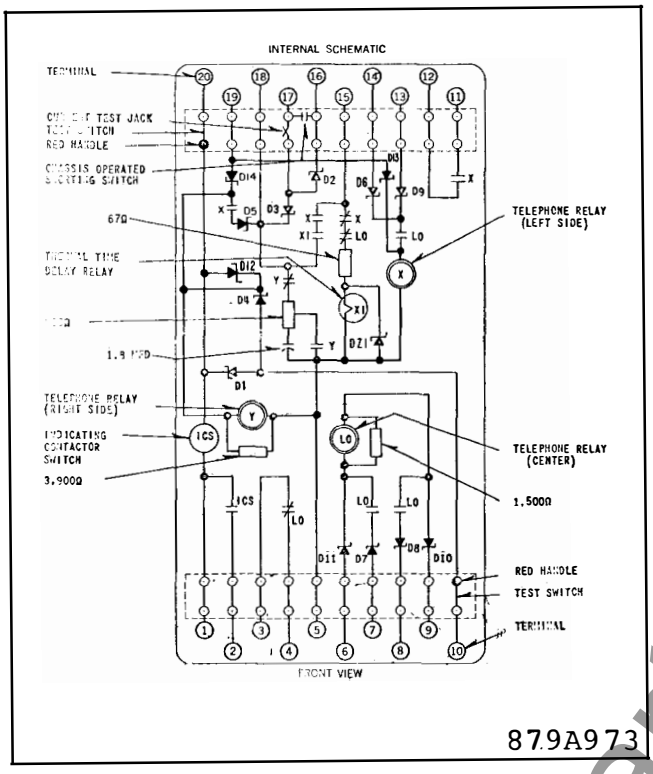

Fig. 3. Internal Schematic 48 VDC Universal TT-12 Relay in the Type FT22 Case

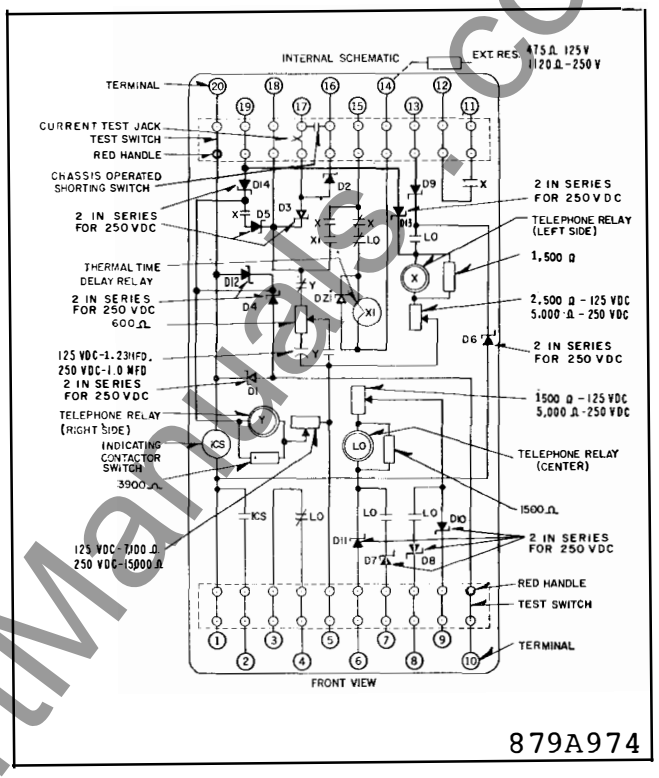

Fig. 4. Internal Schematic 125/250 VDC Universal TT-12 Relay in the Type FT22 Case

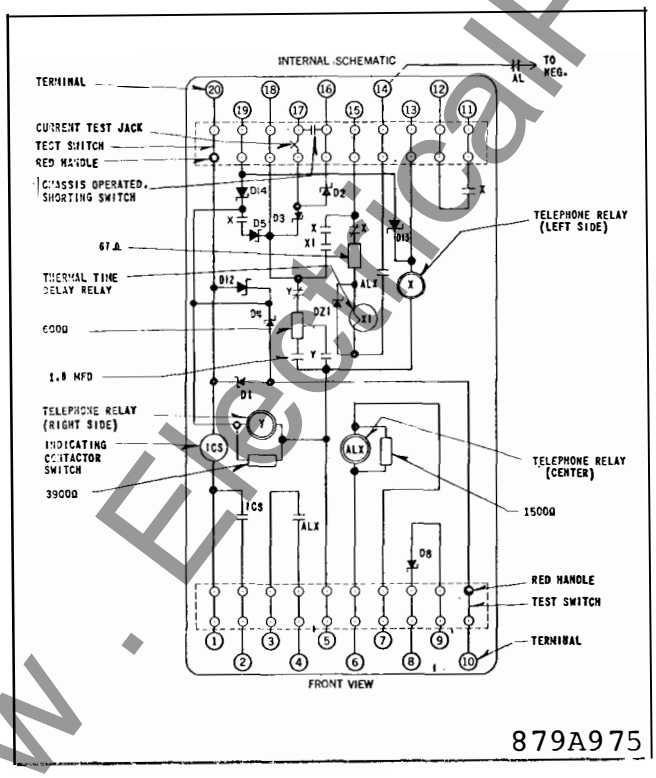

Fig. 5. Internal Schematic 48 VDC TT-12 Relay for TCF in the Type FT22 Case

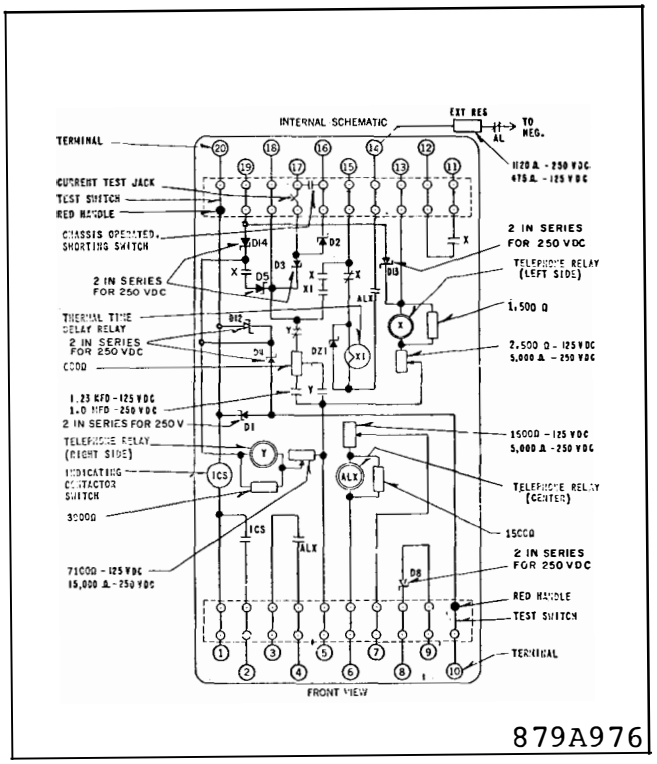

Fig. 6. Internal Schematic 125/250 VDC TT-12 Relay for TCF in the Type FT22 Case

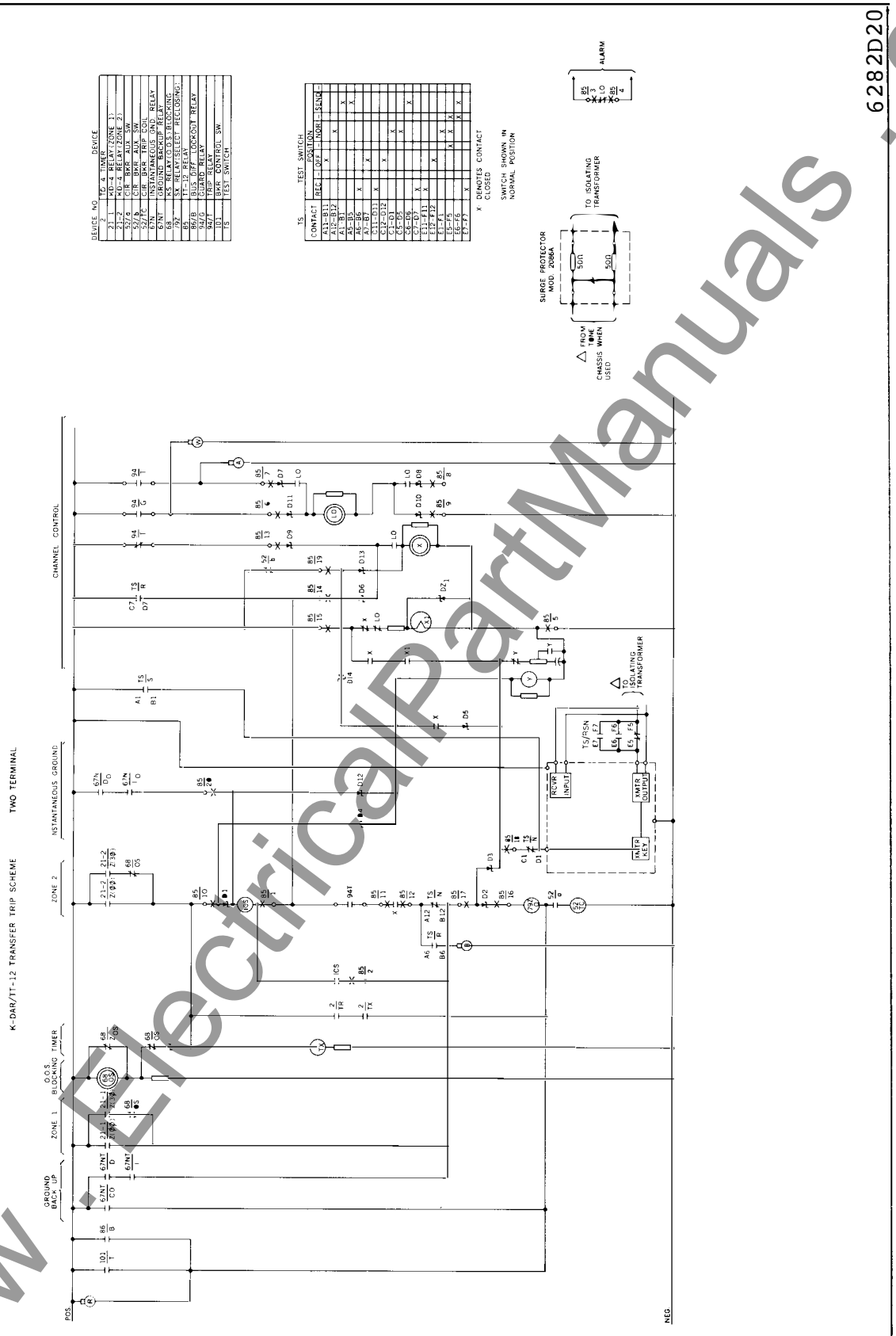

Fig. 7. K-Dar/TT12 Transfer Trip Scheme (Two Terminal Line) for 48 VDC Operation.

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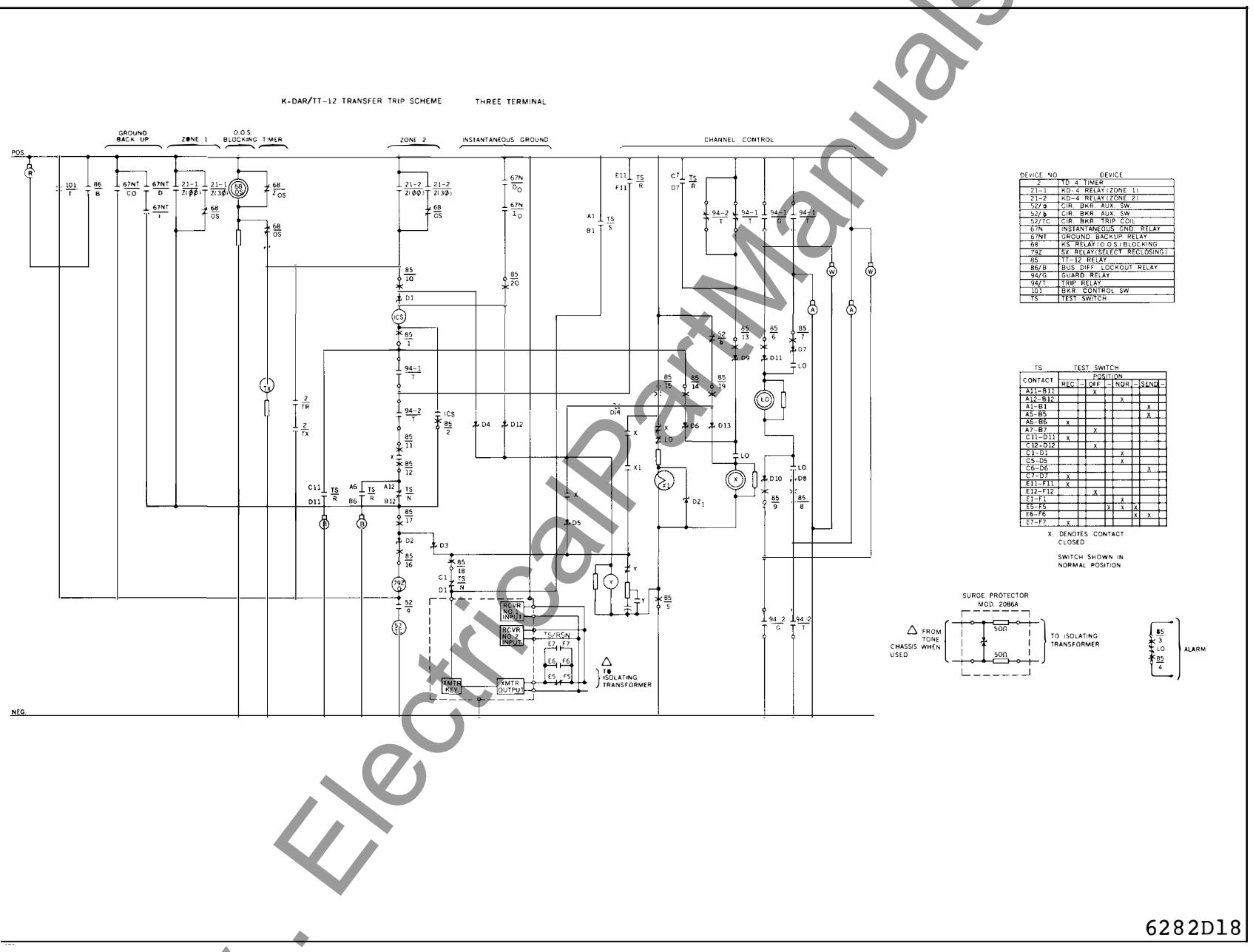


Fig. 8. K-Dar/TT12 Transfer Trip Scheme (Three Terminal Line) for 48 VDC Operation.

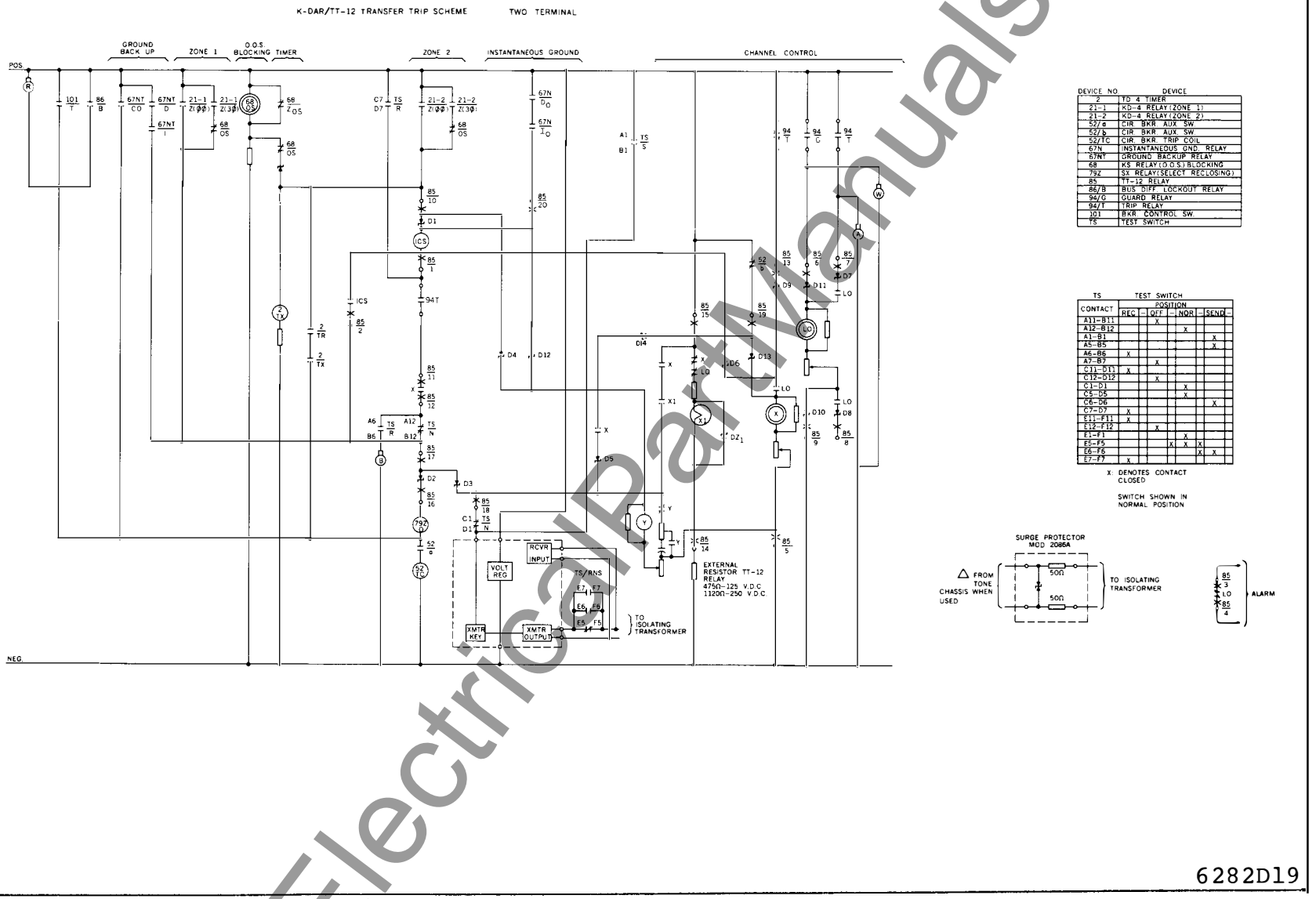
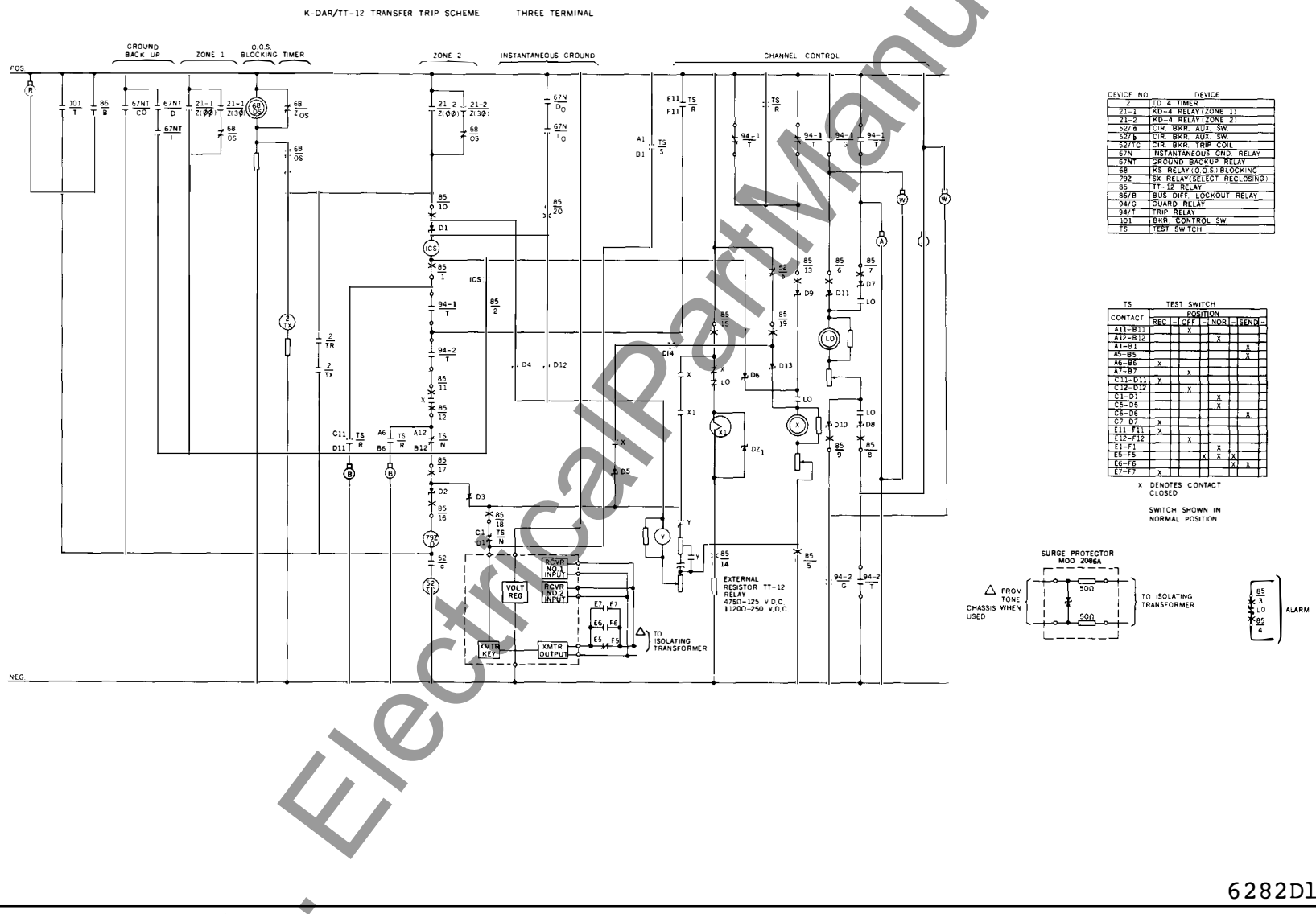


Fig. 9 K-Dat/TT12 Transfer Trip Scheme (Two Terminal Line) for 125 and 250 VDC Operation.



DEVICE NO.	DEVICE
Z	TD 4 TIMER
21-1	KD-4 RELAY (ZONE 1)
21-2	KD-4 RELAY (ZONE 2)
52/a	CIR. BKR. AUX. SW.
52/b	CIR. BKR. AUX. SW.
52/TC	CIR. BKR. TRIP COIL
67N	INSTANTANEOUS GND. RELAY
67NT	GROUND BACKUP RELAY
68	KS RELAY (O.O.S. BLOCKING
79Z	SX RELAY (SELECT RECLOSING)
85	TT-12 RELAY
86/B	BUS DIFF. LOCKOUT RELAY
94/G	GUARD RELAY
94/T	TRIP RELAY
101	BKR. CONTROL SW.
TS	TEST SWITCH

TS TEST SWITCH					
CONTACT	POSITION				
	REC.	OFF	NOR.	SEND	
A11-B11		X			
A12-B12			X		
A1-B1				X	
A5-B5				X	
A6-B6	X				
A7-B7		X			
C11-D11	X				
C12-D12		X			
C1-D1			X		
C5-D5			X		
C6-D6				X	
C7-D7	X				
E11-F11	X				
E12-F12		X			
E1-F1			X		
E5-F5			X	X	
E6-F6				X	X
E7-F7	X				

X DENOTES CONTACT CLOSED

SWITCH SHOWN IN NORMAL POSITION

Fig. 10 K-Dat/TT12 Transfer Trip Scheme (Three Terminal Line) for 125 and 250 VDC Operation.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments should be required.

Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

Auxiliary Units X, X1 and Y, and LO or ALX

Energize each auxiliary unit with rated voltage and check contact action. If desired, the timing of the operation can be checked as outlined under calibration procedure.

Zenner Tripping Diode

A. Reverse Characteristic:

Breakdown voltage is the value of voltage at which the reverse current just exceeds 5 milliamperes and should be between 160 to 240 volts for each diode. The breakdown voltage is determined by slowly increasing voltage until reverse current exceeds 5 milliamperes and starts to increase rapidly. **Do not** exceed 200 milliamperes reverse current.

B. Forward Characteristic:

With 10 amperes flowing in forward direction, the forward voltage across each diode should not exceed 1.5 volts.

Zener Blocking Diodes

A. Reverse Characteristic:

Breakdown voltage is the value of voltage at which the reverse current just exceeds 0.25 milliamperes and should be between 160 to 240 volts for each diode. The breakdown voltage is determined by slowly increasing the voltage until reverse current exceeds 0.25 milliamperes and starts to increase rapidly. **Do not** exceed 3 milliamperes reverse current.

B. Forward Characteristic:

With 200 milliamperes flowing in forward direction, the forward voltage across each diode should not exceed 1.5 volts.

Routine Maintenance

All relays should be operated periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

NOTE: When making a dielectric test on the relay, the high voltage may be applied at the relay terminal, from all circuits to ground, between coil and contact circuits, and between isolated coil circuits. However, the test voltage should **not** be applied across relay contacts, relay coils, or rectifier circuits.

CALIBRATION

Use the following procedure for calibrating the relay, if the relay has been taken apart for repairs or if the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order. Refer to figures 3, 4, 5 and 6.

Auxiliary Units X, X1, Y and LO or ALX

The operating time of units X, Y and LO should be checked with an electronic timer.

The residual air gap should not be less than .002'' and the contact gaps should be between .020'' to .035''.

Auxiliary Unit X

The X relay is located at the left (FV) and is energized between terminals 5 and 13, with the LO unit precosed. Its adjusting resistor is located at the upper front. Contact circuitry is between terminals 11 and 12. The approximate setting of the adjusting resistor is 2000 ohms for 125 volt relays and 4500 ohms for 250 volt relays. The 48 volt relays do not use a calibrating resistor.

The operating time for a variation of 85% and 115% of rated voltage is a minimum of 32 milli-
* seconds. If necessary, adjustment to achieve timing

may be made using the adjustment resistor. For 48 volt relays with no adjustable resistor, operate time must be 32 milliseconds or greater at 56 volts.

The dropout time should be less than 16 milliseconds. If necessary, the dropout time can be adjusted using the residual screw and changing the armature gap. After final adjustment, the gap should not be less than .002".

Auxiliary Unit Y

The Y unit is located at the right front and is energized between terminals 5 and 19. For contact circuitry, see Figure 3, 4, 5 and 6. The normally closed contact should open in 1.5 cycles at rated voltage. This adjustment is controlled by the Y unit resistor which is located at the lower left front. The approximate setting of the resistor is 5000 ohms for the 125 volt relays and 13,000 ohms for 250 volt relays. The 48 volt relays do not use a calibrating resistor.

The dropout time at rated voltage should be 40-60 milliseconds. If necessary, the dropout time can be adjusted by using the residual screw and changing the armature gap. After final adjustment, the armature gap should not be less than .002".

Auxiliary Unit LO or ALX

The LO unit is located at the upper center (FV) and is energized between terminals 6 and 9 for Fig. 3 & 4 or between terminals 6 & 7 for Fig. 5 and 6. Its adjusting resistor is located at the rear. See Figures 3, 4 and 5 for contact circuitry. The closing time should be approximately one cycle at rated voltage. The approximate setting of the adjusting resistor is 1300 ohms for the 125 volt relays and 3,400 ohms for 250 volt relays. The 48 volt relays do not use a calibrating resistor. The operating time for a variation of 85% and 115% or rated voltage is between 10 and 27 milliseconds. If necessary adjustment to achieve timing may be made using adjusting resistor.

The dropout time at rated voltage should be 40-60 milliseconds. If necessary, the dropout time can be adjusted using the residual screw and changing the armature gap. After final adjustment, the armature gap should not be less than .002".

Auxiliary Unit X1

The X1 unit is located at the lower center (FV) and is energized between terminals 5 and 15 for Fig. 3 with the X and LO units de-energized. The X1 unit should have a dropout time of 2.5 ± 1 second, after being energized for 10 seconds. This time is measured at terminals 15 and 18, keeping in mind that the break contact of the X unit will have to be jumpered. Adjust the timing if necessary, by means of adjusting a screw accessible from the top of the unit. To increase dropout time turn the screw slightly clockwise, and to decrease dropout time turn the screw slightly counterclockwise.

Indicating Contactor Switch (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than 1.0 ampere. To increase the pickup current, bend the springs out, or away from cover. To decrease the pickup, bend the springs in toward the cover. Make sure that the target drops freely when energized.

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 repair work. When ordering parts, always give the complete nameplate data.

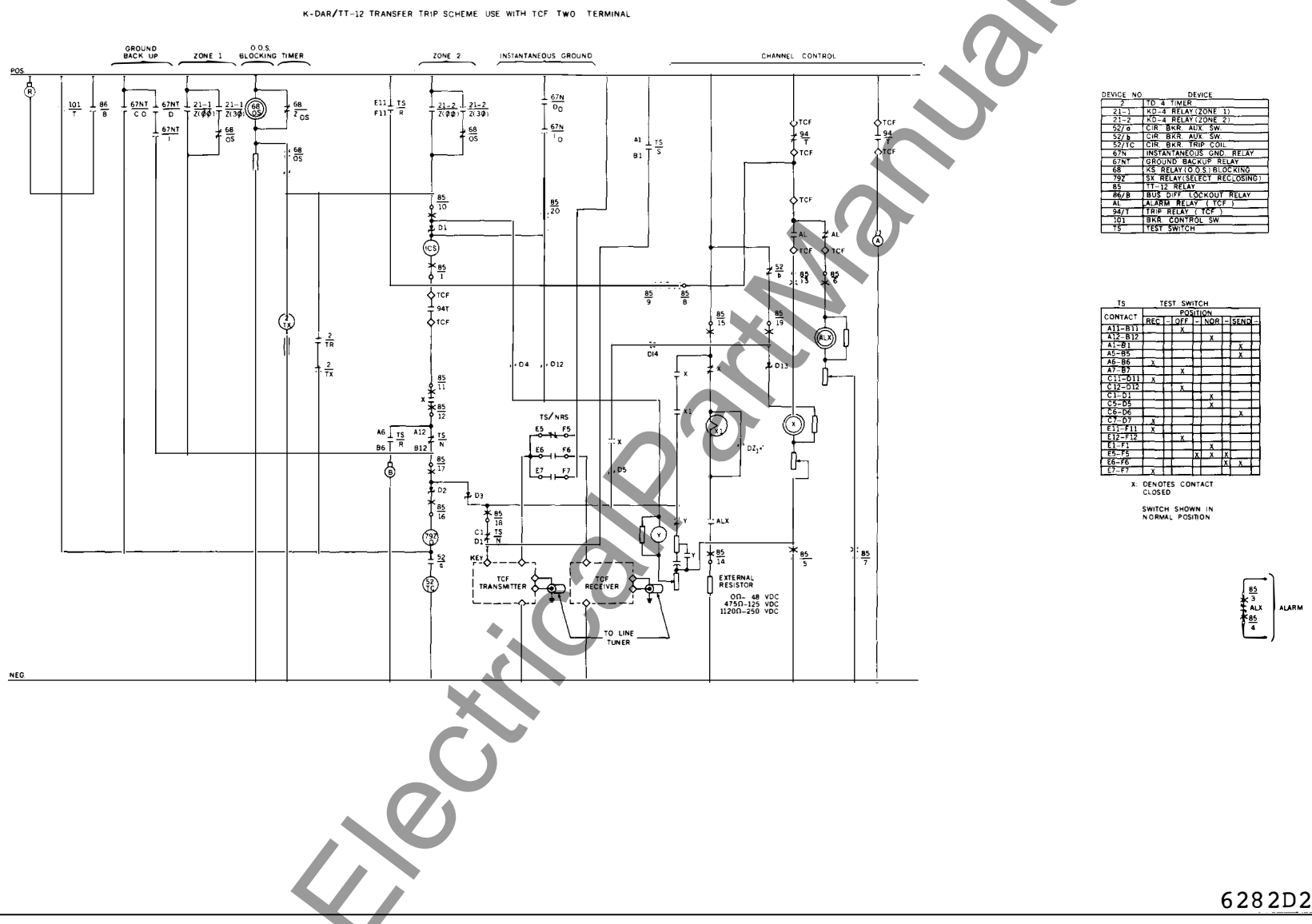
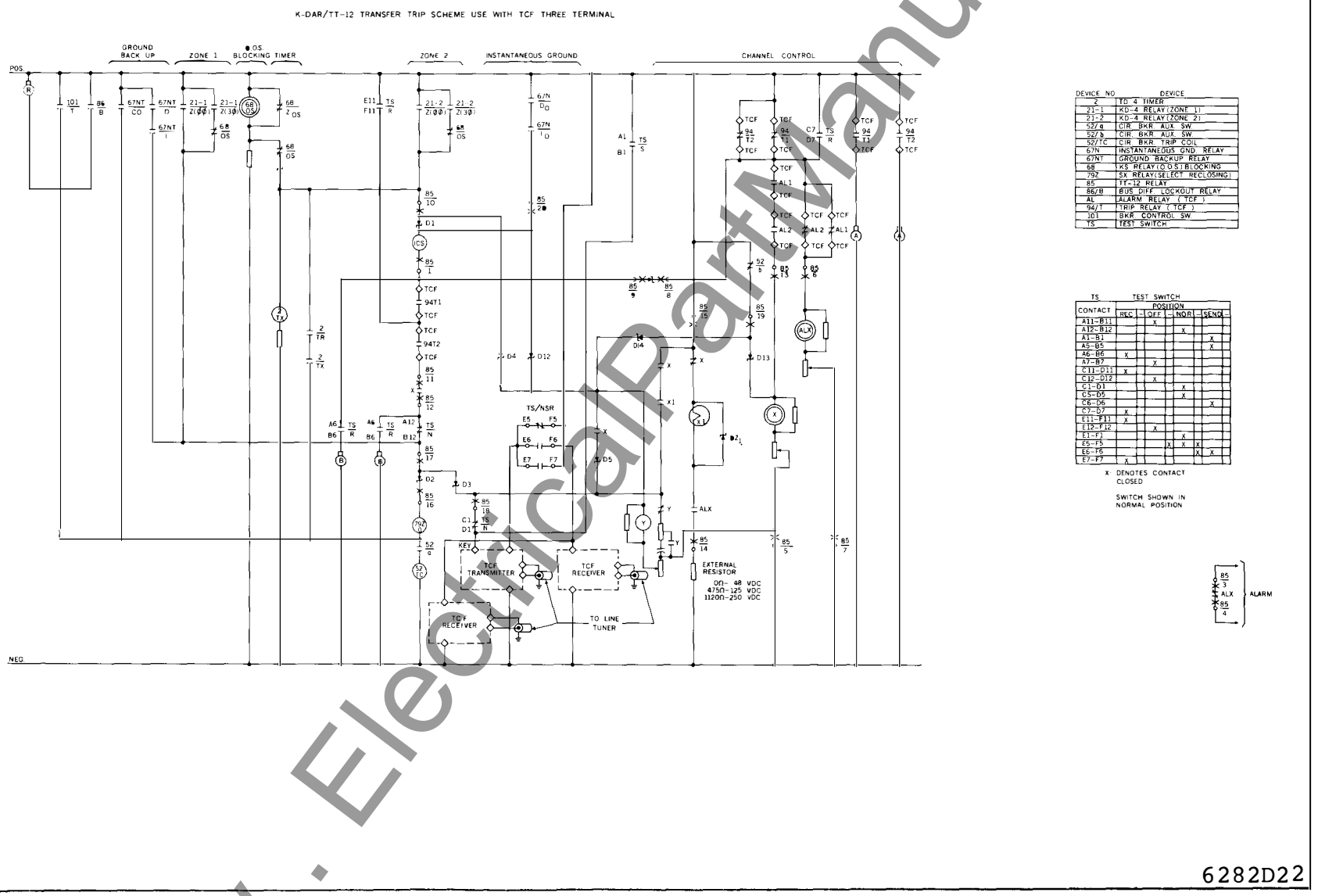


Fig. 11. Two Terminal 48 - 125-250 VDC TCF



DEVICE NO	DEVICE
2	TD 4 TIMER
21-1	KD-4 RELAY (ZONE 1)
21-2	KD-4 RELAY (ZONE 2)
52/a	CIR. BKR. AUX. SW.
52/b	CIR. BKR. AUX. SW.
52/TC	CIR. BKR. TRIP COIL
67N	INSTANTANEOUS GND. RELAY
67NT	GROUND BACKUP RELAY
68	KS RELAY (O.O.S.) BLOCKING
79Z	SX RELAY (SELECT RECLOSING)
85	TT-12 RELAY
86/B	BUS DIFF. LOCKOUT RELAY
AL	ALARM RELAY (TCF)
94/T	TRIP RELAY (TCF)
101	BKR. CONTROL SW.
TS	TEST SWITCH

TS CONTACT	TEST SWITCH POSITION			
	REC.	OFF	NOR.	SEND
A11-B11		X		
A12-B12			X	
A1-B1				X
A5-B5				X
A6-B6	X			
A7-B7		X		
C11-D11	X			
C12-D12		X		
C1-D1			X	
C5-D5			X	
C6-D6				X
C7-D7	X			
E11-F11	X			
E12-F12		X		
E1-F1			X	
E5-F5			X	X
E6-F6				X X
E7-F7	X			

X DENOTES CONTACT CLOSED

SWITCH SHOWN IN NORMAL POSITION

★ *Fig. 12. Three Terminal 48-125-250 VDC TCF*

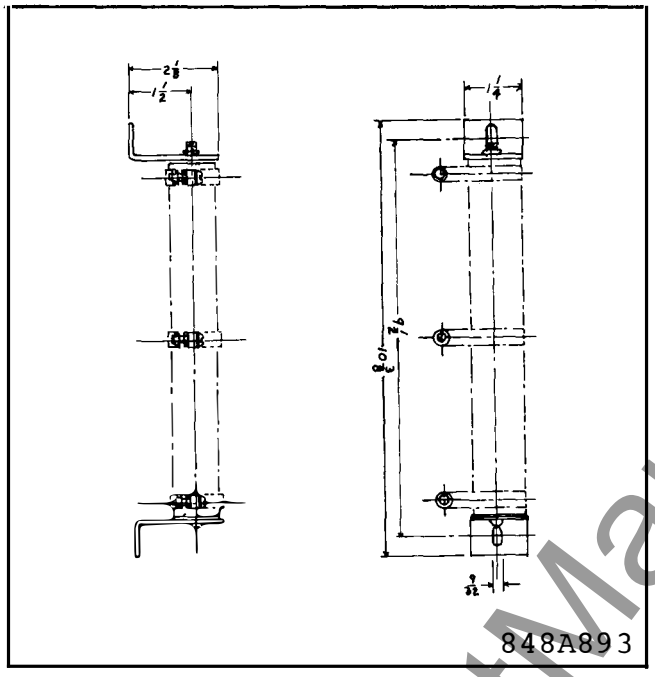


Fig. 13. Outline Dwg. for External Resistor for TT12 Relay

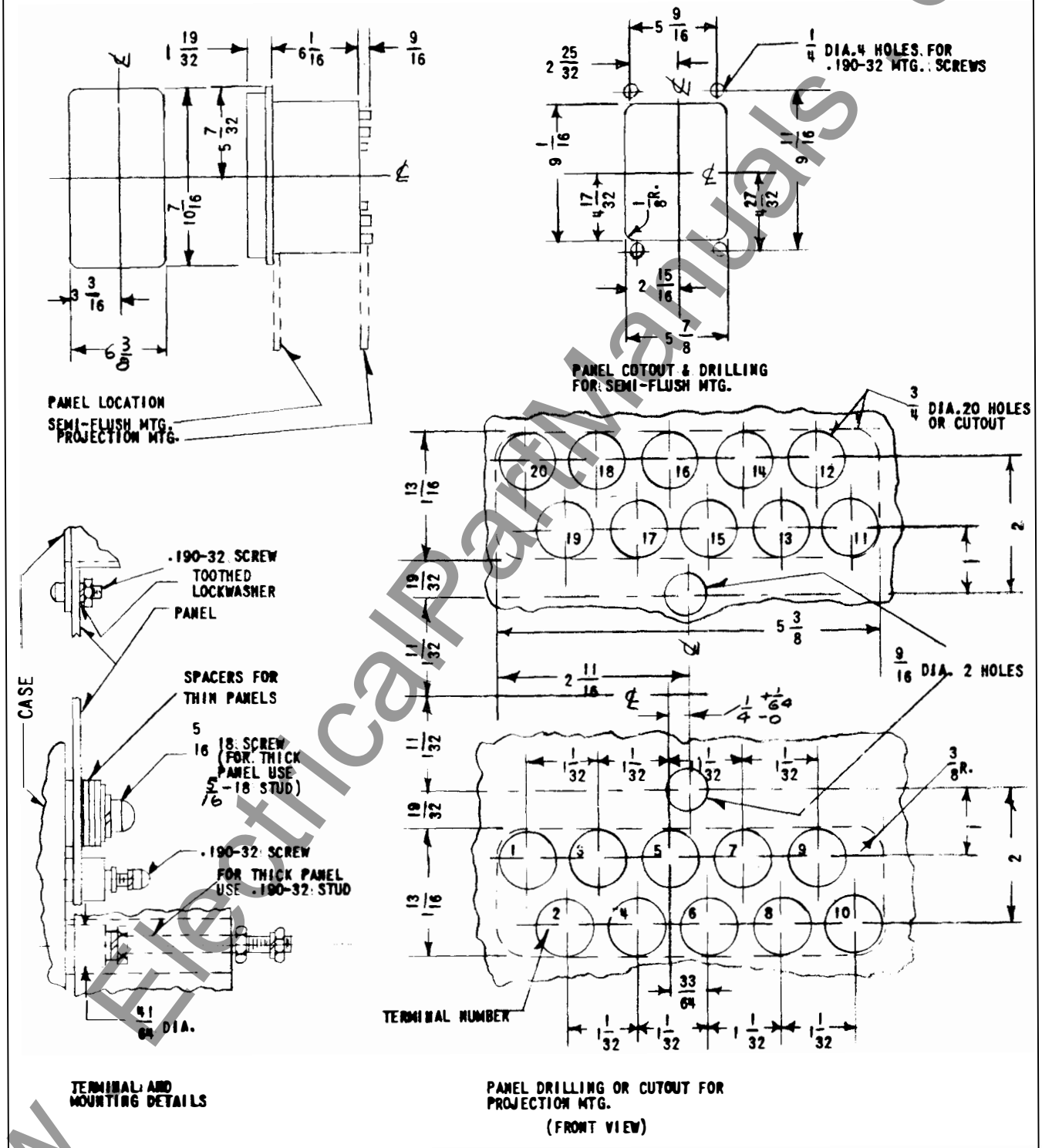


Fig. 14. Outline Drawing for FT22 Case

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TT-12 UNIVERSAL CHANNEL TRANSFER – TRIP RELAY

CAUTION Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections;

APPLICATION

The type TT-12 is an auxiliary relay used in the K-DAR directional comparison permissive overreaching transfer trip system. The TT-12 relay provides a circuit 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.

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

The TT-12 relay may be applied with TA-3 or TA-1 audio tones or TCF power line carrier. Any comparable frequency shift channel equipment that contains receiver relay contacts as follows may also be used.

Guard relay; 1 form A or 1 form C

Trip relay: 2 form A and 1 form B or 3 form C contacts.

CONSTRUCTION

The type TT-12 relay consists of a thermal type time delay relay, telephone type relays, silicon zener diodes, and an indicating contractor switch.

Auxiliary Unit X1

Auxiliary unit X1 is a thermostatic time delay relay that is actuated by a heater. The contacts are hermetically sealed.

Auxiliary Units X, Y and LO or ALX

The auxiliary units X, Y and LO or ALX are telephone type relays. In these relays an electromagnet attracts a right angle iron bracket which in turn operates a set of make or break contacts.

Tripping Diodes D1 and D2

Tripping diodes D1 and D2 are zener type diodes having a 50 watt, 200V rating (JEDEC No. 1N2846A for 125 volt and 48 volt relays). Two diodes are used in series for 250 volt relays.(JEDEC No. 1N2840A and 1N2846RA).

Blocking Diodes D3 to D13

Blocking diodes D3 through D13 are zener type diodes having a one watt, 200 volt rating (JEDEC No. 1N3051). Two are used in series for 250 volt relays.

Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attached to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit, Also, during this operation two fingers on armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

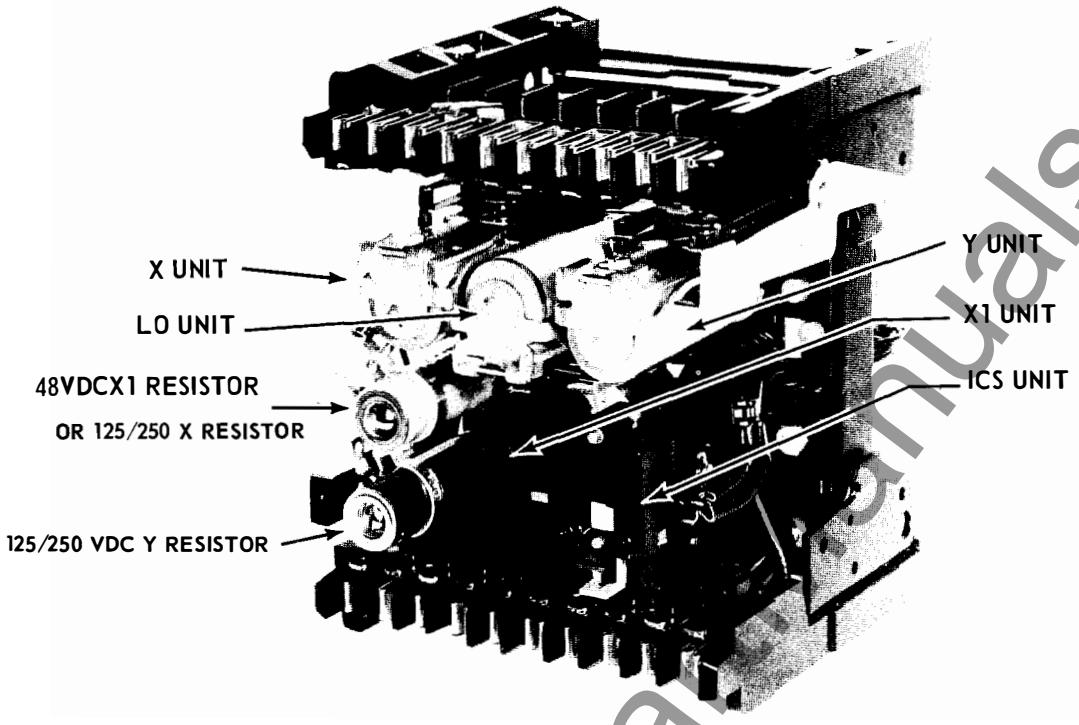


Fig. 1. Type TT-12 Relay without Case (Front View)

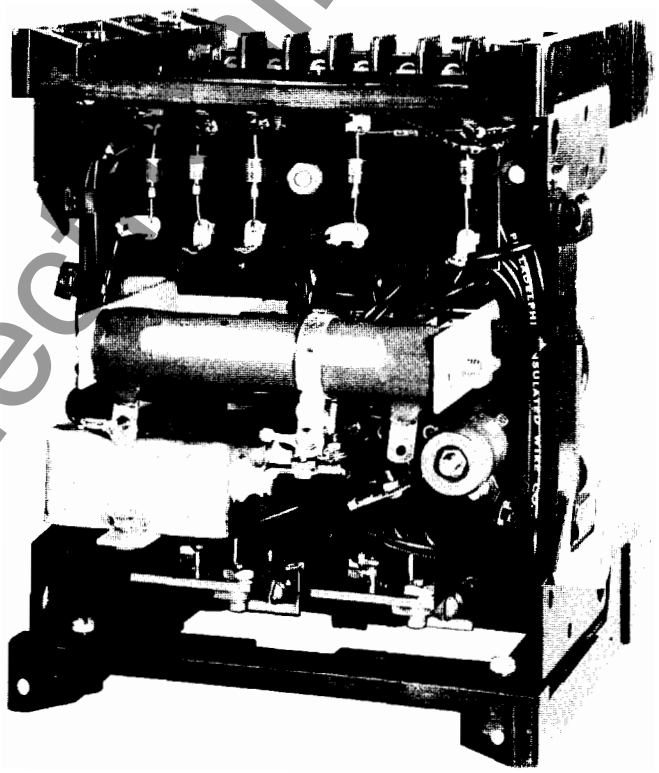


Fig. 2. Type TT-12 Relay without Case (Rear View)

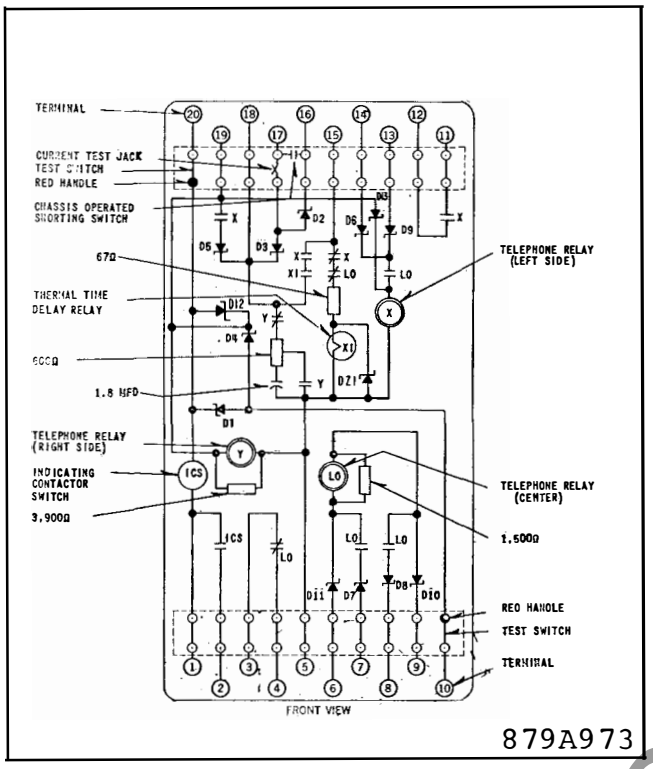


Fig. 3. Internal Schematic 48 VDC Universal TT-12 Relay in the Type FT22 Case

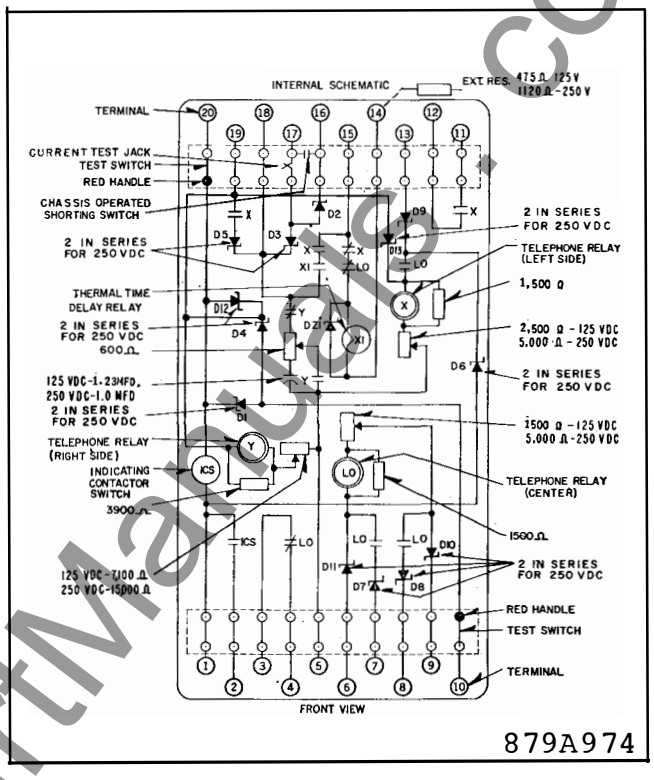


Fig. 4. Internal Schematic 125/250 VDC Universal TT-12 Relay in the Type FT22 Case

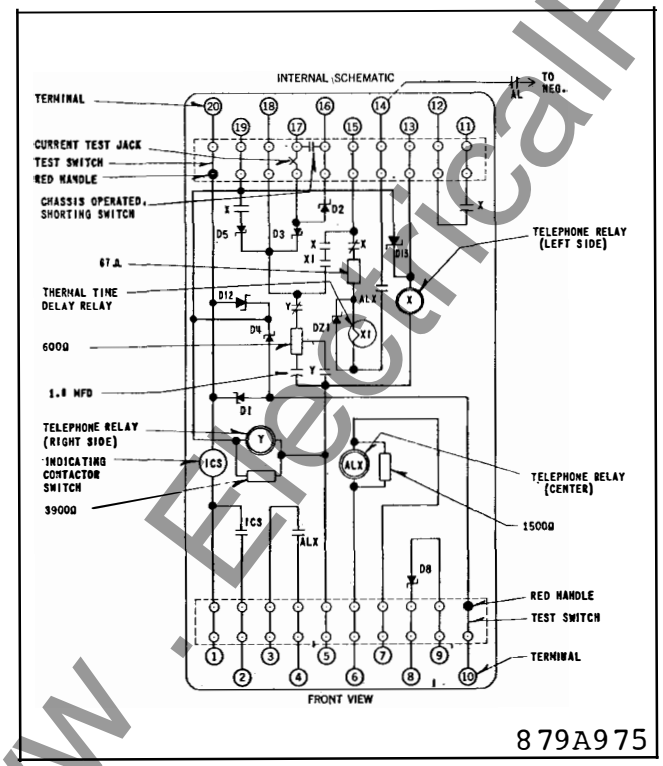


Fig. 5. Internal Schematic 48 VDC TT-12 Relay for TCF in the Type FT22 Case

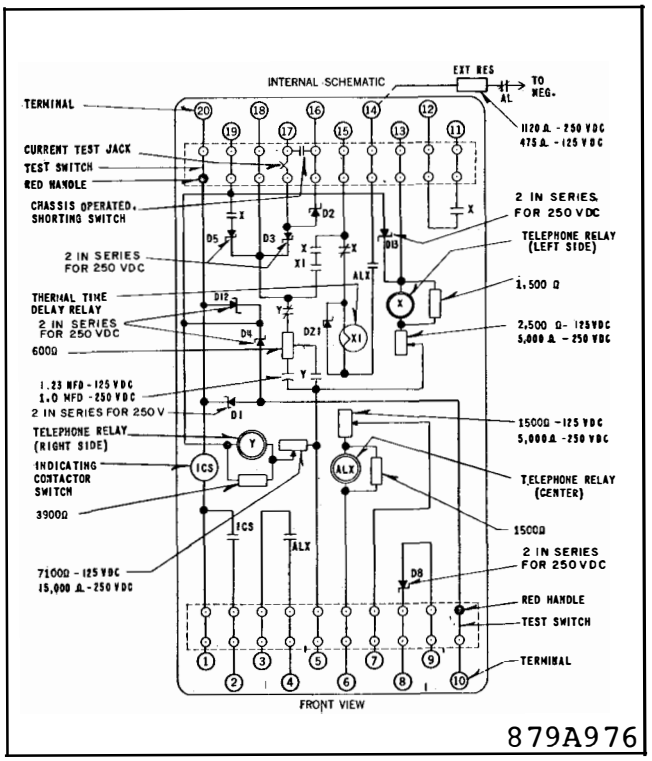


Fig. 6. Internal Schematic 125/250 VDC TT-12 Relay for TCF in the Type FT22 Case

OPERATION

The type TT-12 relay is used with a microwave, pilot-wire tone channel, or TCF power line carrier 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. See figs. 7, 8, 9, 10, 11 & 12.

The protective relays and the relay settings used in the TT-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 TT-12 scheme, however, uses a tripping signal rather than a blocking signal to provide improved security against undesired relay operation for external faults. Since the microwave or pilot wire tone channels are separated from the conductors of the protected power line, it is not necessary to use a blocking signal, as in the conventional directional comparison carrier scheme. This avoids having to send the signal on the conductors through a fault. The conventional directional comparison carrier scheme is arranged to trip on absence of the blocking signal, so that the channel failure will result in false tripping for external remote faults that are within reach of the protective relays. Since the TT-12 scheme requires reception of the trip signal as well as operation of the local protection relays, channel failure cannot result in undesired tripping.

Auxiliary Unit X

The X-unit is used to provide a coordinating delay, if a sudden reversal occurs in the direction of fault power flow in the protected line. For an internal fault, the X-relay is preclosed and is kept closed by fault detecting relays (PR). These consist of the KRD directional overcurrent ground relay and the KD zone 2 phase distance relay.

Auxiliary Unit Y and Anti-bounce Circuit

Auxiliary unit Y, in conjunction with capacitor and resistor provides for continuation of the audio tone tripping signal in case the protective relay (PR) contacts should have an initial bounce. The sequence of operation of this anti-bounce circuit is as follows:

As soon as a PR contact first closes, the capacitor charges almost instantaneously to the approximate value of the d-c control voltage through the resistor R and the normally closed Y contact, at the same time closing of the protective relay contact applies reverse bias to the keying transistor in the transmitter of the audio tone equipment, causing the transmitter to shift to the trip frequency. Should the PR contact bounce open, this reverse bias to "shift" is upheld by the capacitor voltage that is slowly discharged through a high resistance path in the transmitter circuit. When PR contact recloses the same sequence of events takes place. When finally PR closes "solid" or long enough for Y unit to operate, the anti-bounce circuit is cut off by the normally closed Y contact and the capacitor charge is dissipated through a normally open contact and its associated resistor.

Auxiliary Unit LO – Universal TT-12 Only

The LO unit is energized by the tone receiver 94-G guard relay contact as shown in Figs. 7, 8, 9, 10, 11 and 12. One contact of the LO relay energizes the X unit. This makes it possible, in case of channel failure, to lock out the transfer tripping at the local terminal. A second LO contact is in series with the tone receiver 94-T trip relay contact, as a second path to energize the LO unit coil, after the trip signal is received. A break contact is used, along with a break X relay contact, to supervise the X1 relay. The LO unit has prolonged dropout time, thus assuring that it will stay closed during a shift of frequency.

Auxiliary Unit X-1

The unit X-1 provides means for a check-back test. It is energized by a break contact of the X unit for all channels and the LO unit for tone channels or the AL in the TCF channel. Its contact energizes the keying circuit and is supervised by an X contact to avoid check-back keying during faults.

Auxiliary Unit ALX – TT-12 for TCF Only

The ALX unit is used as an alarm unit for these TT-12 relays used with a TCF carrier channel.

Operation of Test Facilities

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 the transmission of the guard signal from the local station to remote stations where the LO-unit (AL for TCF) drops out. The LO or AL and X unit break contacts energized to X-1 terminal unit which requires 2-3 seconds to pick-up.
2. After holding the test switch in the "OFF" position for approximately 10 seconds, the operator next moves the test switch to the "RECEIVE" position. This re-establishes the transmission of guard signal. The LO-unit (AL for TCF) and X-unit at remote line terminals pickup again. With the thermal unit X1 still picked up the trip signal is transmitted from remote line terminals until X1 unit resets. The operator should see the "BLUE AND AMBER" test light for approximately 2 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.

   The test switch in Figs. 7, 8, 9, 10, 11 and 12 provides a "send" position so that the transmitter may be shifted during periodic maintenance checks.

Tripping Diodes D1, D2

Tripping diode D1 provides isolation of the KD time circuit from the ground fault detector relay. Diode D2 prevents the keying circuit from being energized for operation of 86B contact for a bus fault behind the protected line. Otherwise, undesired tripping of remote terminals would result.

Blocking Diodes

D3 — blocks tripping current path through directional ground contact D_O and diode D5 and blocks tripping current path from battery positive thru X and X1 relay contacts during check-back tests.

D4 — blocks tripping current path through directional ground contact D_O, 94-T and X contacts.

D5 — blocks discharge of the anti-bounce capacitor through the Y unit.

D6 — prevents energizing one of the blue lights during check-back test on 3-terminal line arrangement with test switch in "RECEIVE" position. See Fig. 7.

D7 & D8 — are in series with the lockout relay coil and are used to clock the guard relay from energizing the amber light.

D9 — is needed when back contact of trip relay is not available.

D10 & D11 — blocks trip relay from picking up guard light when light is used.

D12 — blocks trip current flow through D4.

D13 — is needed to block the back contact of 94T from keying.

SETTING

There are no settings to be made on the relay.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The outline for the FT22 case is shown in Fig. 14.

The electrical connections may be made directly to the terminals by means of screws for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For 125 or 250 VDC TT-12 relays, an external X1 resistor is required. The outline drawing is shown in Fig. 13.

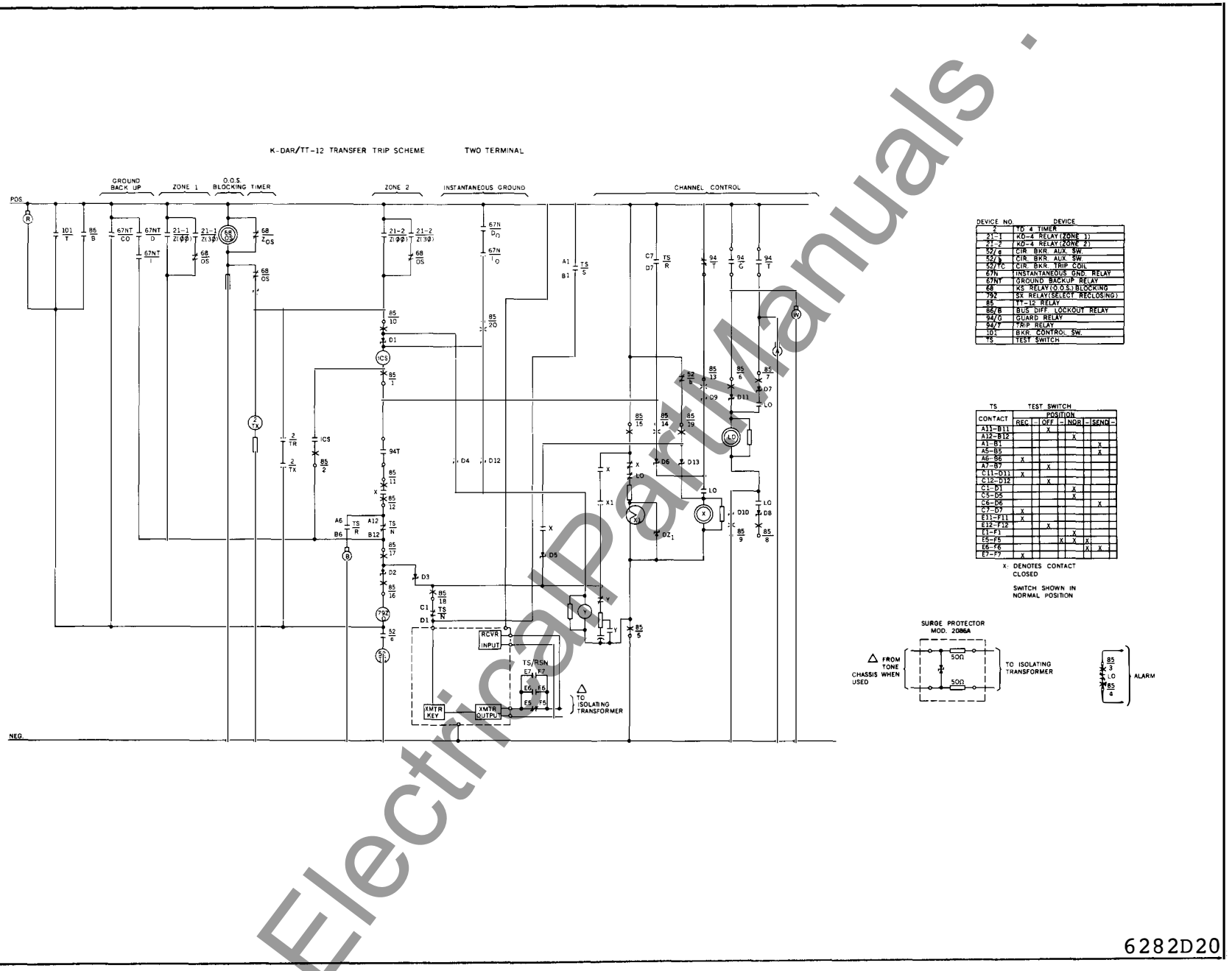


Fig. 7. K-Dar/TT12 Transfer Trip Scheme (Two Terminal Line) for 48 VDC Operation.

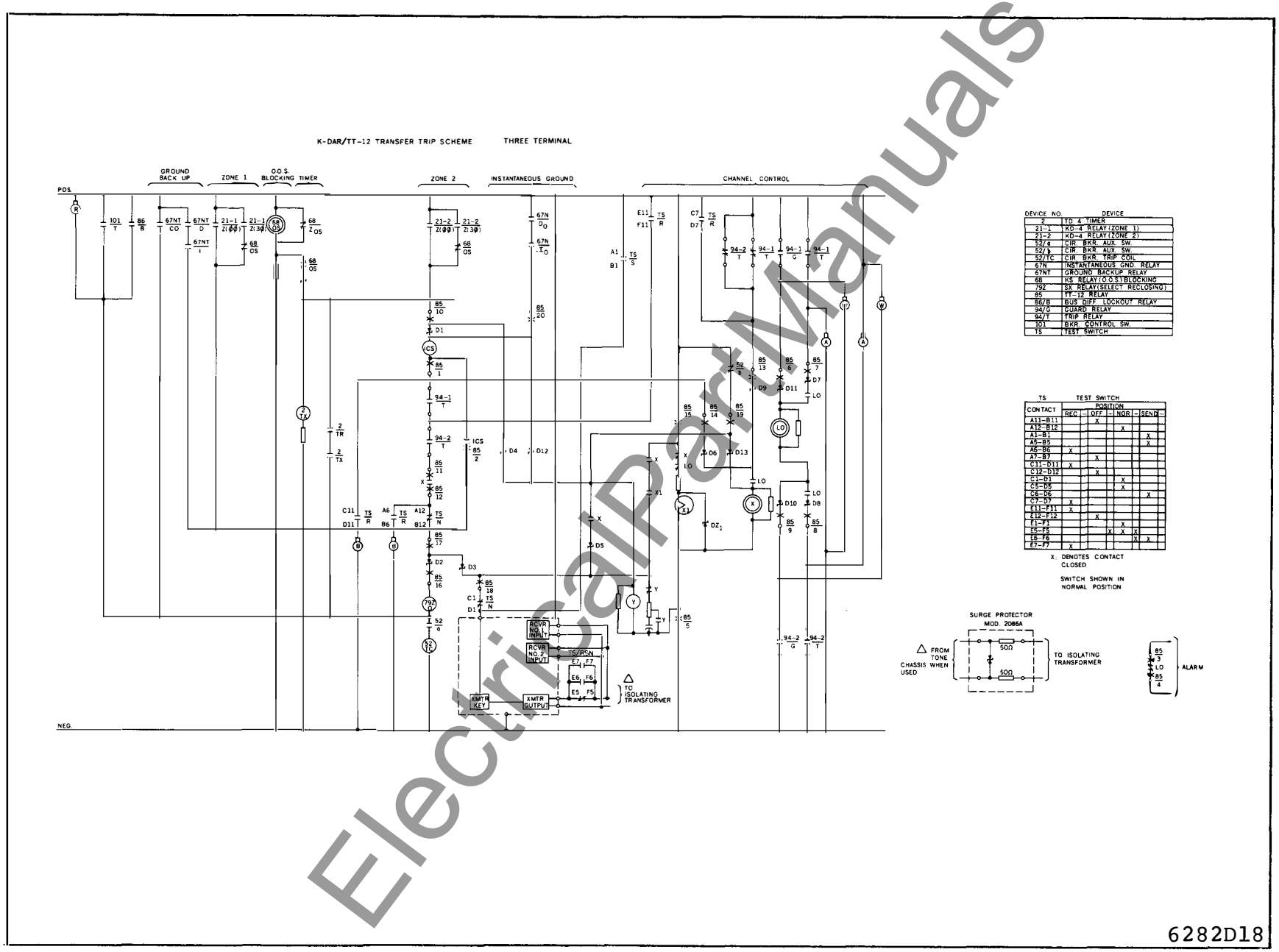


Fig. 8. K-Dar/TT12 Transfer Trip Scheme (Three Terminal Line) for 48 VDC Operation.

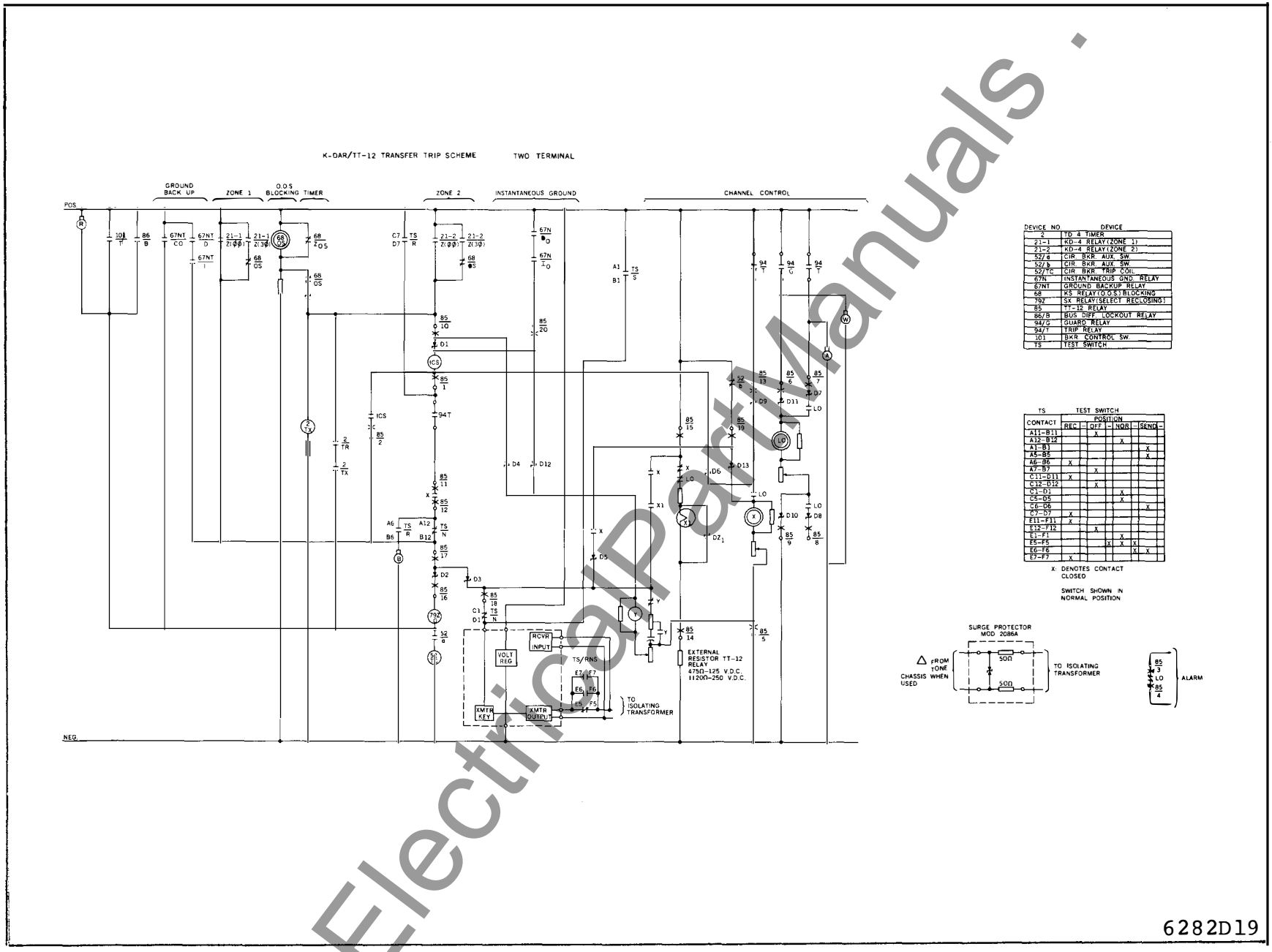


Fig. 9. K-Dat/TT12 Transfer Trip Scheme (Two Terminal Line) for 125 and 250 VDC Operation.

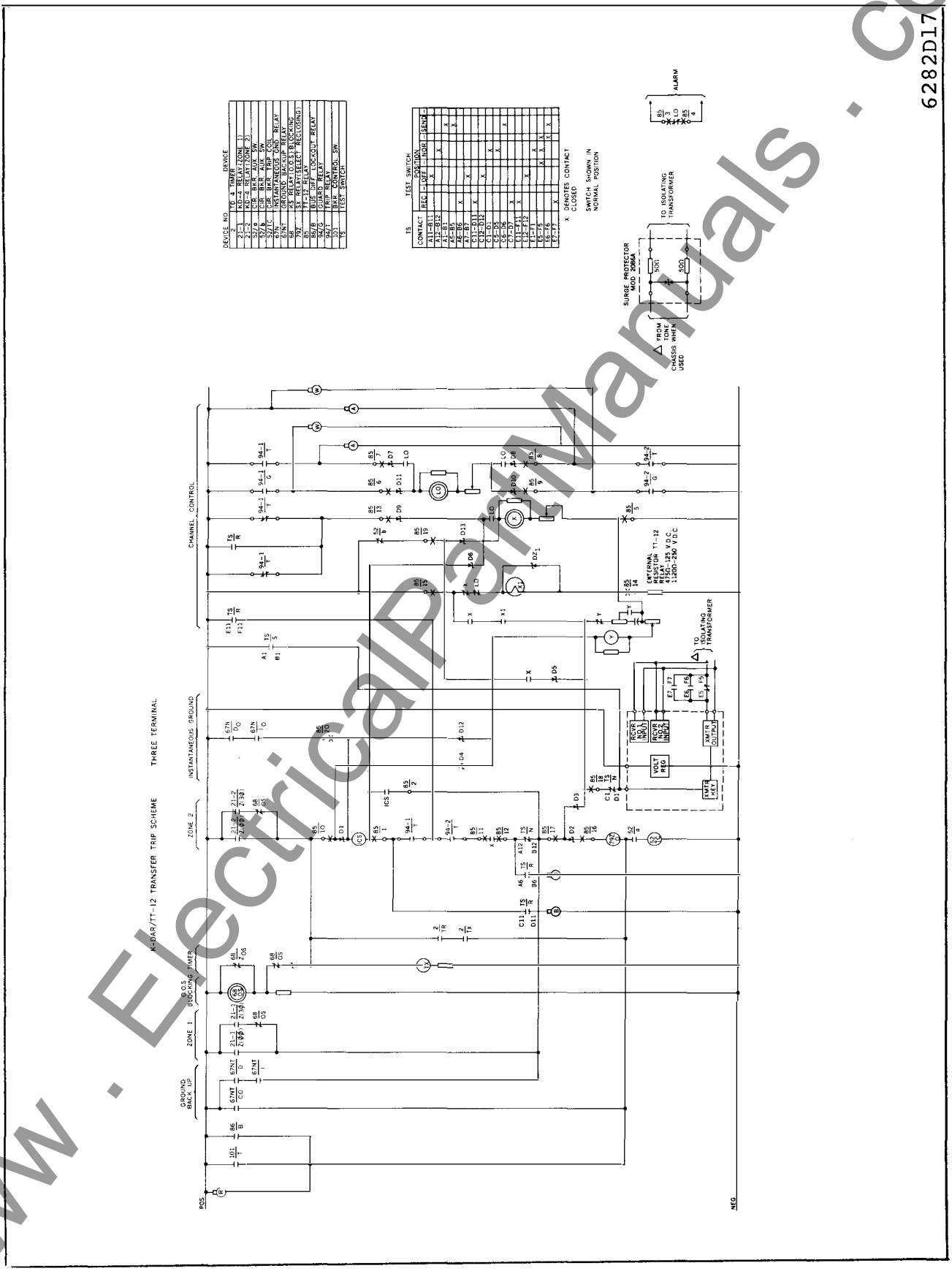


Fig. 10. K-Dar/TT12 Transfer Trip Scheme (Three Terminal Line) for 125 and 250 VDC Operation.

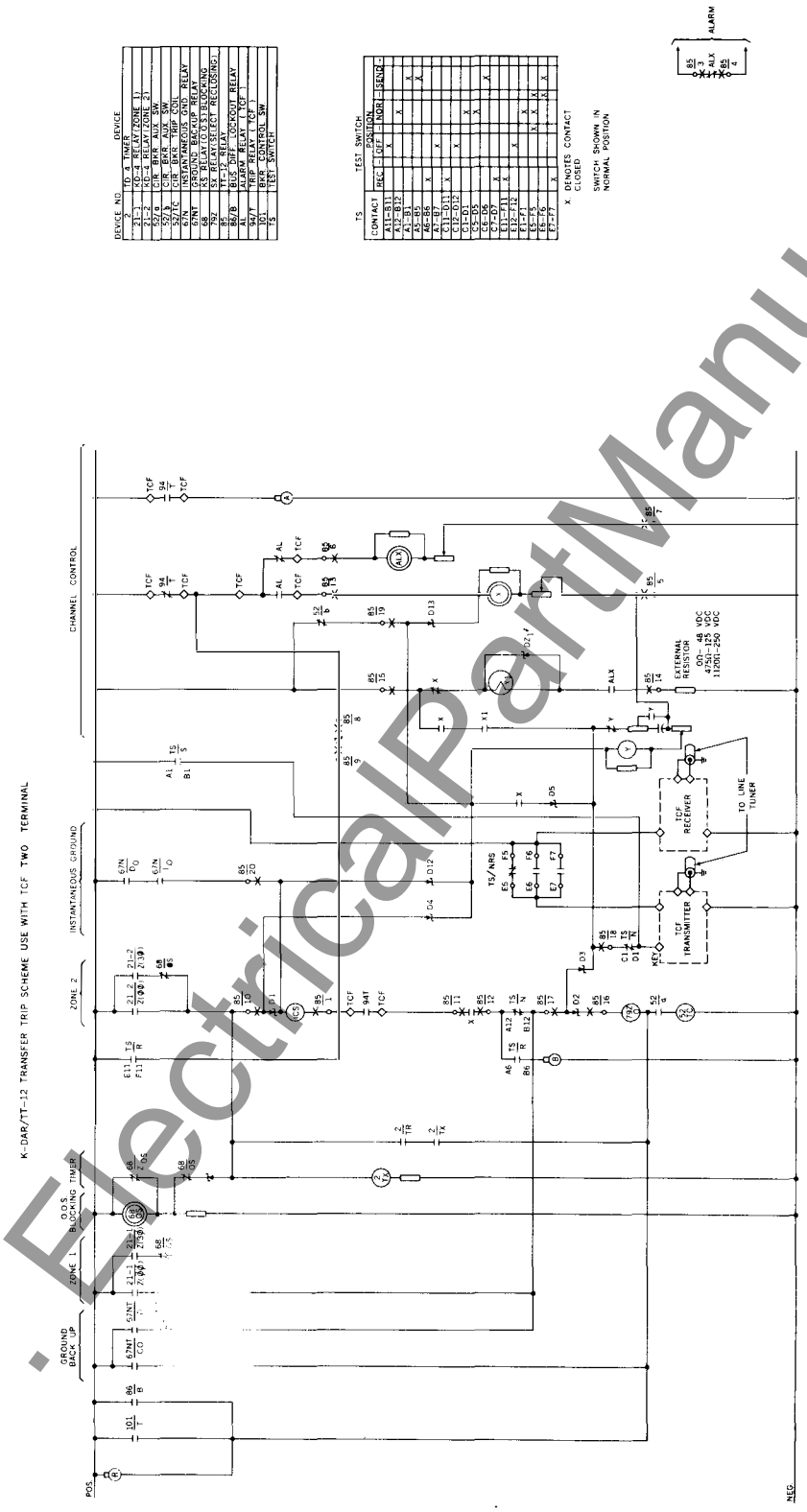


Fig. 11. Two Terminal 48 - 125-250 VDC TCF

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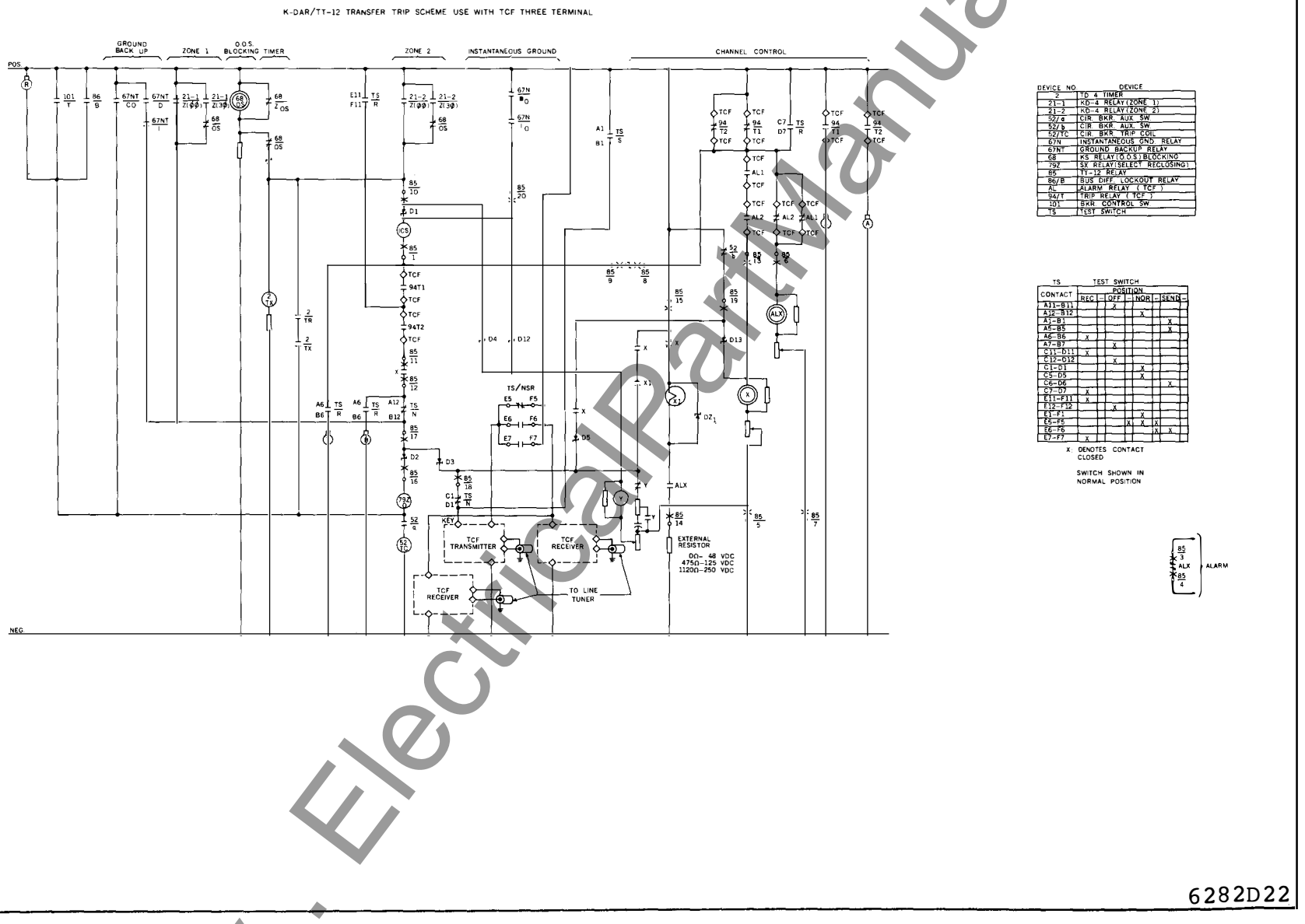

DEVICE NO.	DEVICE
2	TD 4 TIMER
21-1	KD-4 RELAY(ZONE 1)
21-2	KD-4 RELAY(ZONE 2)
52/a	CIR. BKR. AUX. SW.
52/b	CIR. BKR. AUX. SW.
52/TC	CIR. BKR. TRIP COIL
67N	INSTANTANEOUS GND. RELAY
67NT	GROUND BACKUP RELAY
68	KS RELAY(O.O.S.) BLOCKING
79Z	SX RELAY(SELECT RECLOSING)
85	TT-12 RELAY
86/B	BUS DIFF. LOCKOUT RELAY
AL	ALARM RELAY (TCF)
94/T	TRIP RELAY (TCF)
101	BKR. CONTROL SW.
TS	TEST SWITCH

TS CONTACT	TEST SWITCH POSITION			
	REC.	OFF	NOR.	SEN'D
A11-B11		X		
A12-B12			X	
A1-B1				X
A5-B5				X
A6-B6	X			
A7-B7		X		
C11-D11	X			
C12-D12		X		
C1-D1			X	
C5-D5			X	
C6-D6				X
C7-D7	X			
E11-F11	X			
E12-F12		X		
E1-F1			X	
E6-F5			X	X
E6-F6				X
E7-F7	X			

X DENOTES CONTACT CLOSED

SWITCH SHOWN IN NORMAL POSITION

Fig. 12. Three Terminal 48-125-250 VDC TCF

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

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INSTRUCTIONS

TYPE TT-12 UNIVERSAL CHANNEL TRANSFER – TRIP RELAY

CAUTION Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

The type TT-12 is an auxiliary relay used in the K-DAR directional comparison tripping scheme (over-reaching transfer trip). The TT-12 relay provides a circuit 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.

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

The TT-12 relay works with TA-1 audio tone channels or with any comparable equipment that contains receiver relay contacts as follows:

Guard relay: 1 form A or 1 form C
Trip relay: 2 form A and 1 form B or 3 form C contacts.

Use the TT-8 relay instead of the TT-12 where the channel receiver does not contain the necessary relay contact structure required for the TT-12 system. The TT-8 provides no monitoring facilities. Where monitoring is not integral with the receiver, use a TT-9 relay along with the TT-8.

CONSTRUCTOIN

The type TT-12 relay consists of a thermal type time delay relay, telephone type relays, silicon zener diodes, and an indicating contactor switch.

Auxiliary Unit X1

Auxiliary unit X1 is a thermostatic time delay relay that is actuated by a heater. The contacts are hermetically sealed.

Auxiliary Units X, Y and LO

The auxiliary units X, Y and LO are telephone type relays. In these relays, an electromagnet attracts a right angle iron bracket which in turn operates a set of make or break contacts.

Tripping Diodes D1 and D2

Tripping diodes D1 and D2 are zener type diodes having a 50 watt, 200 V rating (JEDEC No. 1N2846A for 125 volt and 48 volt relays). Two diodes are used in series for 250 volt relays. (JEDEC No. 1N2840A and 1N2846RA).

Blocking Diodes D3 to D11

Blocking diodes D3 through D8 are zener type diodes having a one watt, 200 volt rating (JEDEC No. 1N3051.) Two are used in series for 250 volt relays.

Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also, during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

The type TT-12 relay is used with a microwave

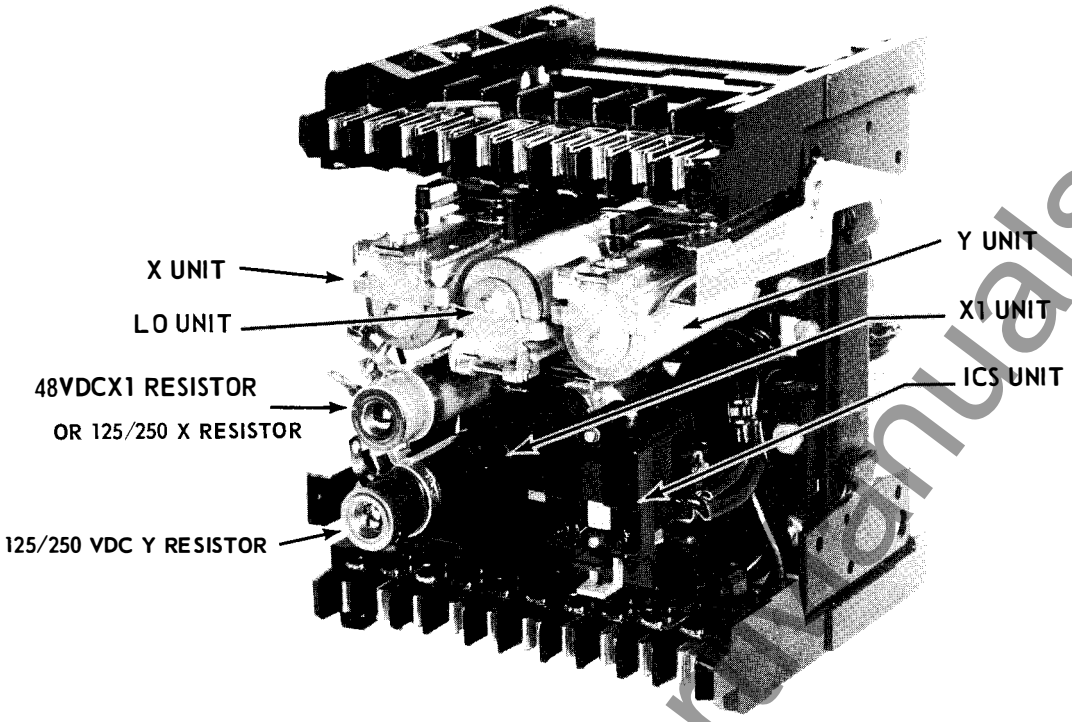


Fig. 1. Type TT-12 Relay without case (Front View)

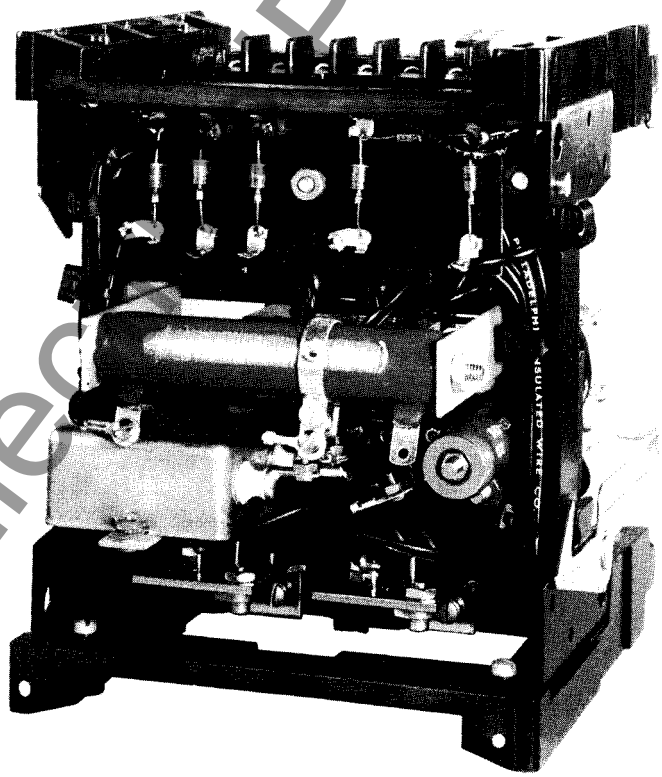


Fig. 2. Type TT-12 Relay without case (Rear View)

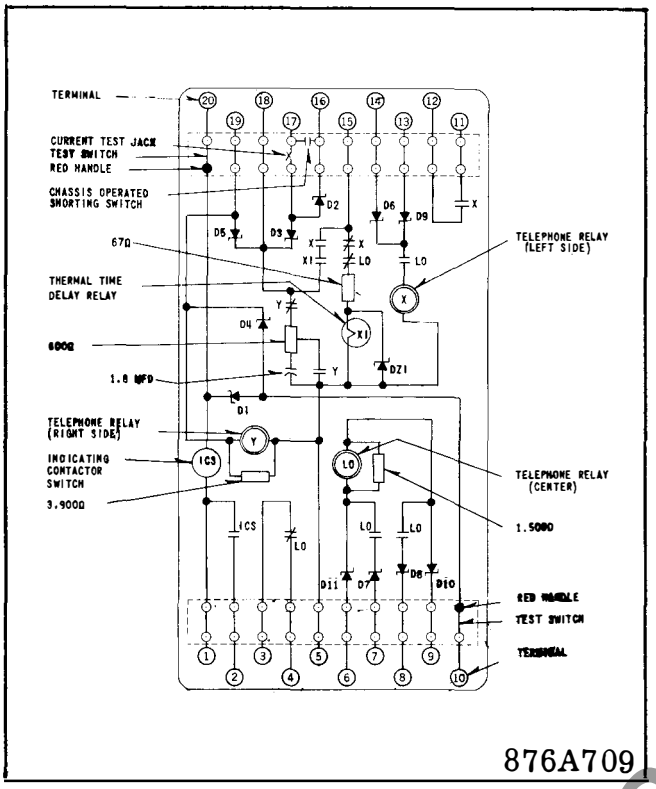


Fig. 3. Internal Schematic of the Type TT-12 Relay in the Type FT 22 case for 48 VDC Only.

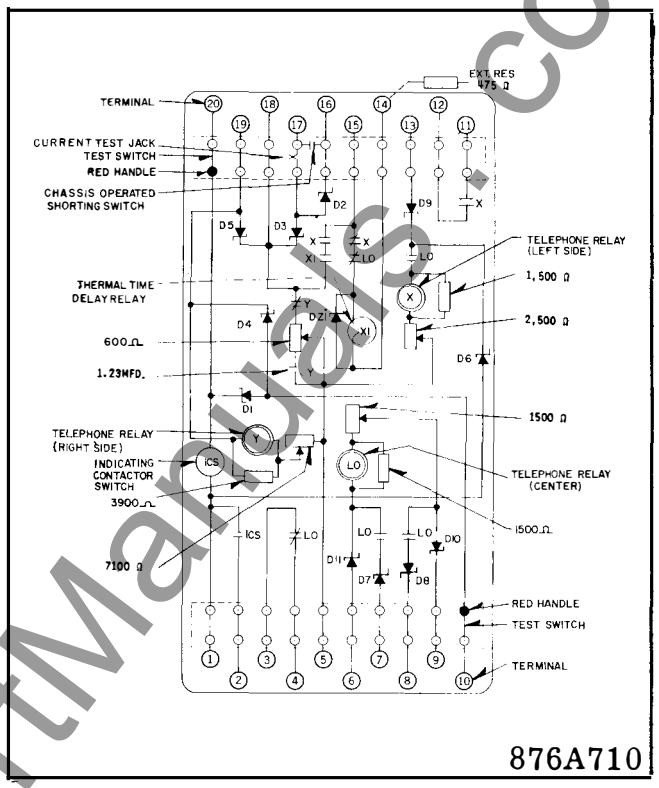


Fig. 4. Internal Schematic for the TT-12 Relay in the Type FT22 case for 125 VDC.

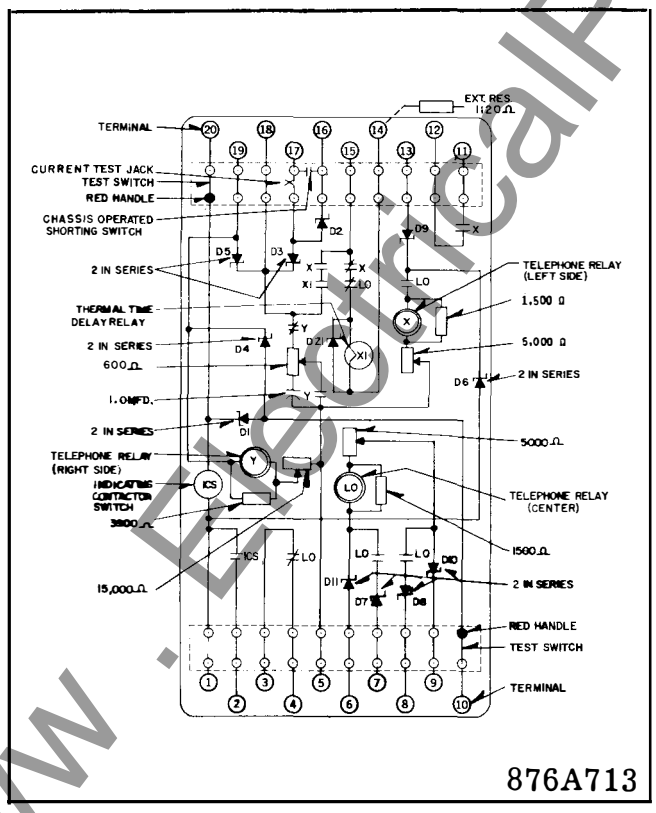


Fig. 5. Internal Schematic of the Type TT-12 Relay in the Type FT-22 case for 250 VDC.

or 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. See figs. 6, 7, 8, &9.

The protective relays and the relay settings used in the TT-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 TT-12 scheme, however, uses a tripping signal rather than a blocking signal to provide improved security against undesired relay operation for external faults. Since the microwave or pilot wire tone channels are separated from the conductors of the protected power line, it is not necessary to use a blocking signal, as in the conventional directional comparison carrier scheme. This avoids having to send the signal on the conductors through a fault. The conventional directional comparison carrier scheme is arranged to trip on absence of the blocking signal, so that the channel failure will result in false tripping for external remote faults that are within reach of the protective relays. Since the TT-12 scheme requires reception of the trip signal as well as operation of

the local protection relays, channel failure cannot result in undesired tripping.

Auxiliary Unit X

The X-unit is used to provide a coordinating delay, if a sudden reversal occurs in the direction of fault power flow in the protected line. For an internal fault, the X-relay is preclosed and is kept closed by fault detecting relays (PR). These consist of the KRD directional overcurrent ground relay and the KD zone 2 phase distance relay.

Auxiliary Unit Y and Anti-bounce Circuit

Auxiliary unit Y, in conjunction with capacitor and resistor provides for continuation of the audio tone tripping signal in case the protective relay (PR) contacts should have an initial bounce. The sequence of operation of this anti-bounce circuit is as follows:

As soon as a PR contact first closes, the capacitor charges almost instantaneously to the approximate value of the d-c control voltage through the resistor R and the normally closed Y contact, at the same time closing of the protective relay contact applies reverse bias to the keying transistor in the transmitter of the audio tone equipment, causing the transmitter to shift to the trip frequency. Should the PR contact bounce open, this reverse bias to "shift" is upheld by the capacitor voltage that is slowly discharged through a high resistance path in the transmitter circuit. When PR contact recloses the same sequence of events takes place. When finally PR closes "solid" or long enough for Y unit to operate, the anti-bounce circuit is cut off by the normally closed Y contact and the capacitor charge is dissipated through a normally open contact and its associated resistor.

Auxiliary Unit LO

The LO unit is energized by the tone receiver 94-G guard relay contact as shown in Figs. 6, 7, 8 & 9. One contact of the LO relay energizes the X unit. This makes it possible, in case of channel failure, to lock out the transfer tripping at the local terminal. A second LO contact is in series with the alarm circuit, and a third LO contact is in series with the tone receiver 94-T trip relay contact, as a second path to energize the LO unit coil, after the trip signal is received. A break contact is used, along with a break X relay contact, to supervise the X1 relay. The LO unit has prolonged dropout time, thus assuring that it will stay closed during a shift of frequency.

Auxiliary Unit X-1

The unit X-1 provides means for a check-back test. It is energized by a break contact of the X and LO units. Its contact energizes the keying circuit and is supervised by an X contact to avoid check-back keying during faults.

Operation of test facilities

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 the transmission of the guard signal from the local station to remote stations where the LO-unit drops out. The LO and X unit break contacts energized te X-1thermal unit which requires 2-3 seconds to pickup.

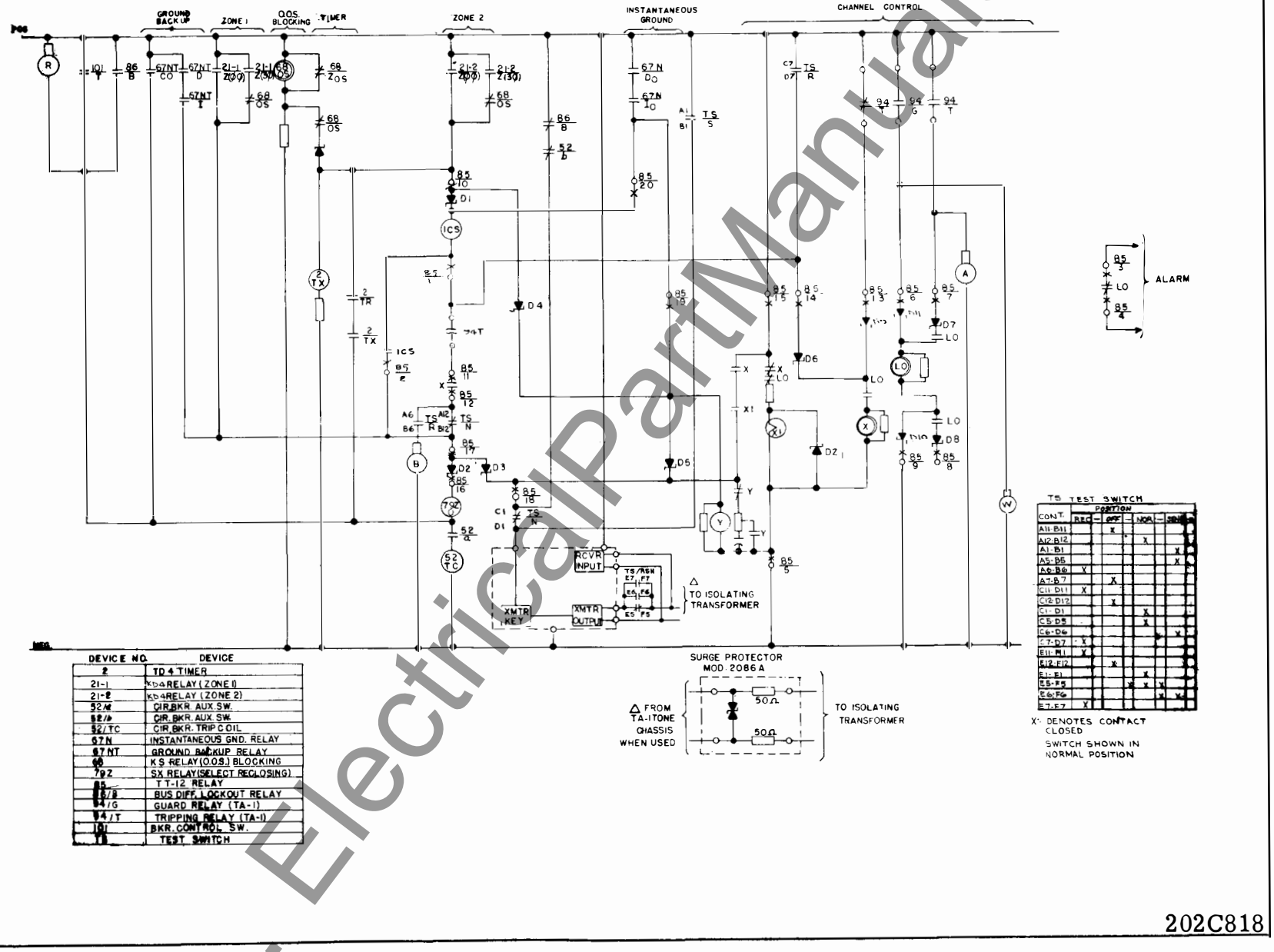
2. After holding the test switch in the "OFF" position for approximately 10 seconds, the operator next moves the test switch to the "RECEIVE" position. This re-establishes the transmission of guard signal. The LO-unit and X-unit at remote line terminals pickup again. With the thermal unit X1 still picked up the trip signal is transmitted from remote line terminals until X1 unit resets. The operator should see the "BLUE and AMBER" test light for approximately 2 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.

   The test switch in Figs. 6, 7, 8 & 9 provides a "send" position so that the transmitter may be shifted during periodic maintenance checks.

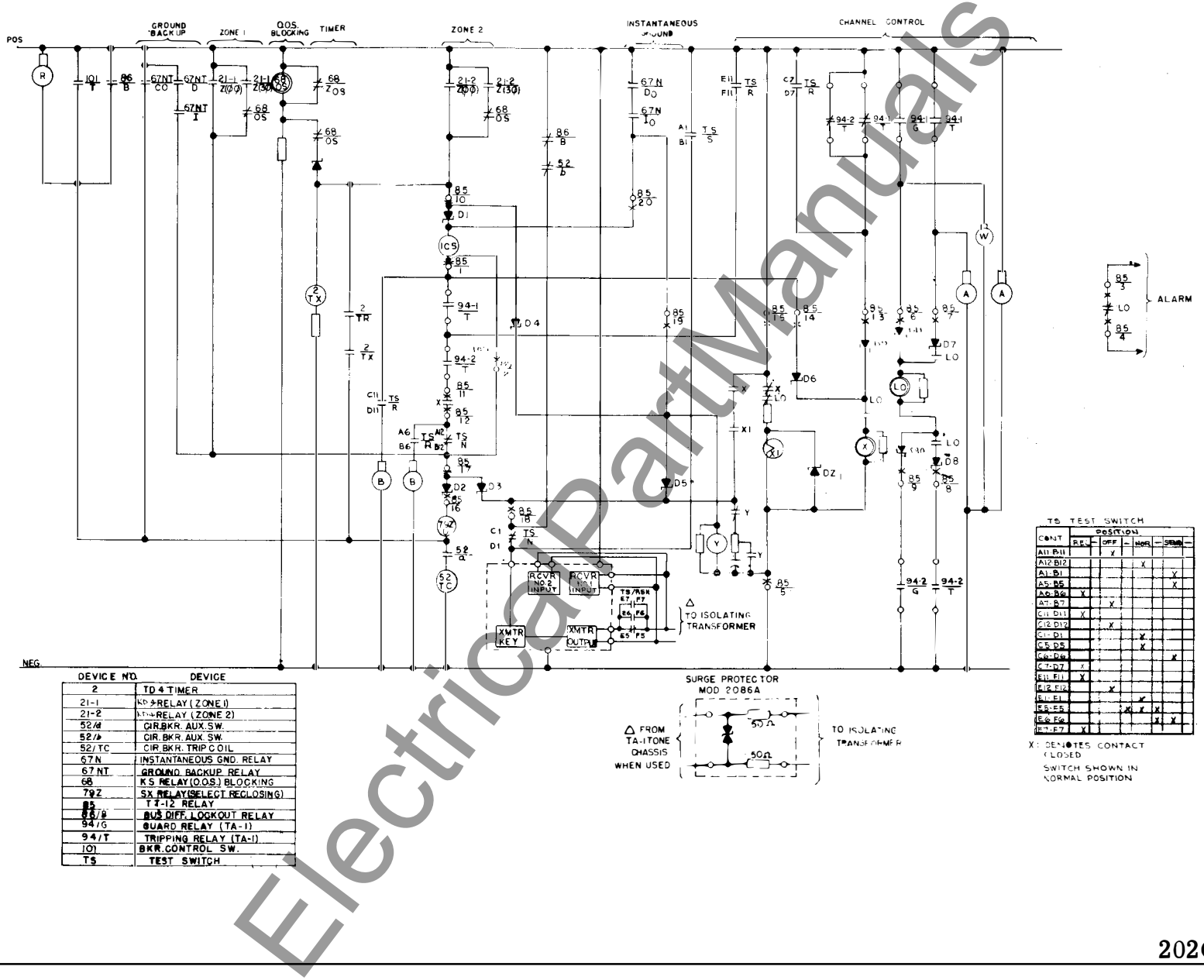
Tripping Diodes D1, D2

Tripping diode D1 provides isolation of the KD time circuit from the ground fault detector relay. Diode D2 prevents the keying circuit from being energized for operation of 86B contact for a bus fault behind the protected line. Otherwise, undesired tripping of remote terminals would result.



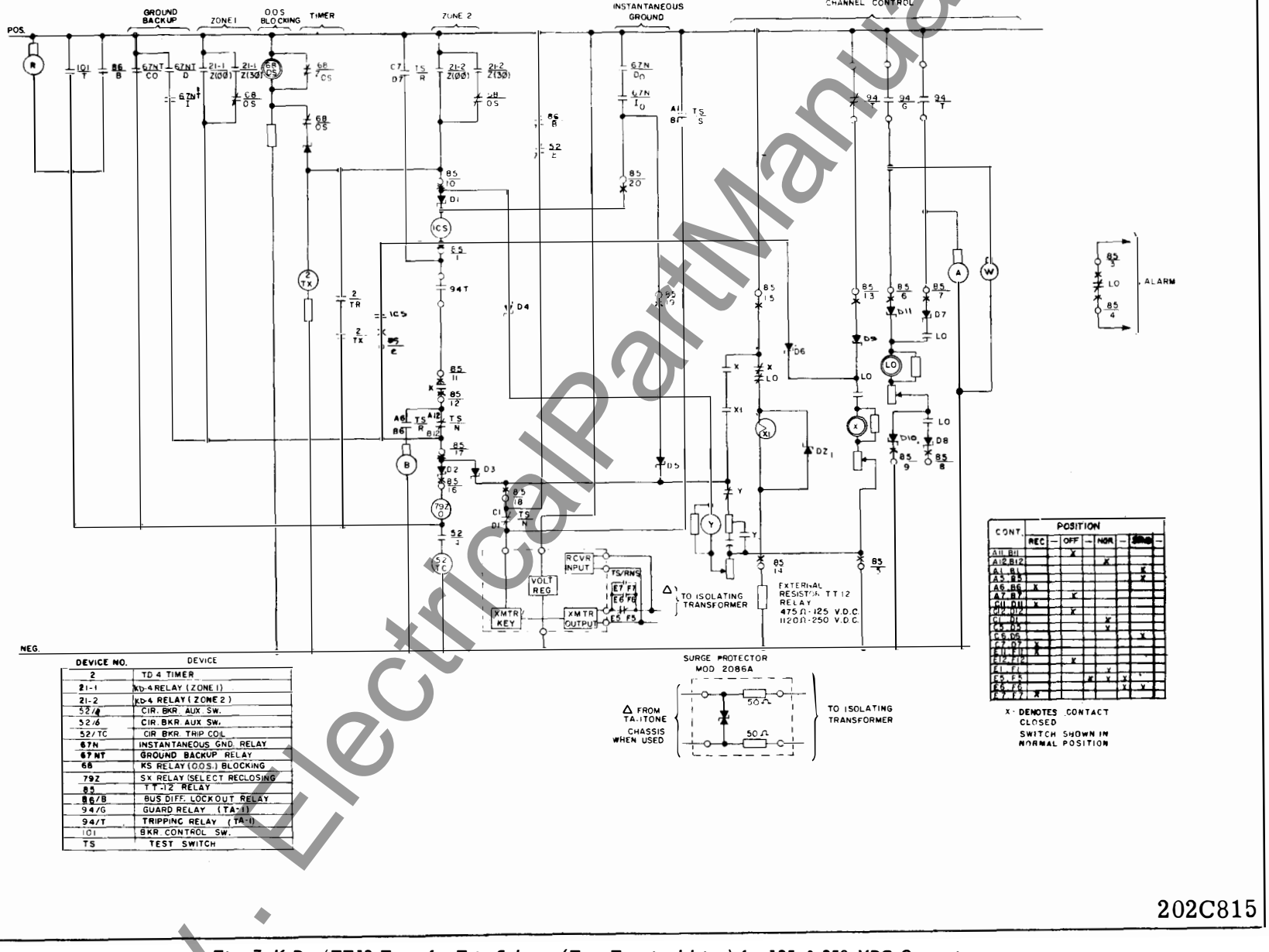
DEVICE NO.	DEVICE
2	TD 4 TIMER
21-1	KD4 RELAY (ZONE 1)
21-2	KD4 RELAY (ZONE 2)
52/a	CIR. BKR. AUX. SW.
52/b	CIR. BKR. AUX. SW.
52/TC	CIR. BKR. TRIP COIL
67N	INSTANTANEOUS GND. RELAY
67NT	GROUND BACKUP RELAY
68	KS RELAY (O.O.S.) BLOCKING
79Z	SX RELAY (SELECT RECLOSING)
85	TT-12 RELAY
86/B	BUS DIFF. LOCKOUT RELAY
94/G	GUARD RELAY (TA-1)
94/T	TRIPPING RELAY (TA-1)
101	BKR. CONTROL SW.
TS	TEST SWITCH

* *Fig. 5. K-Dar/TT12 Transfer Trip Scheme (Two Terminal Line) for 48 VDC Operation.*



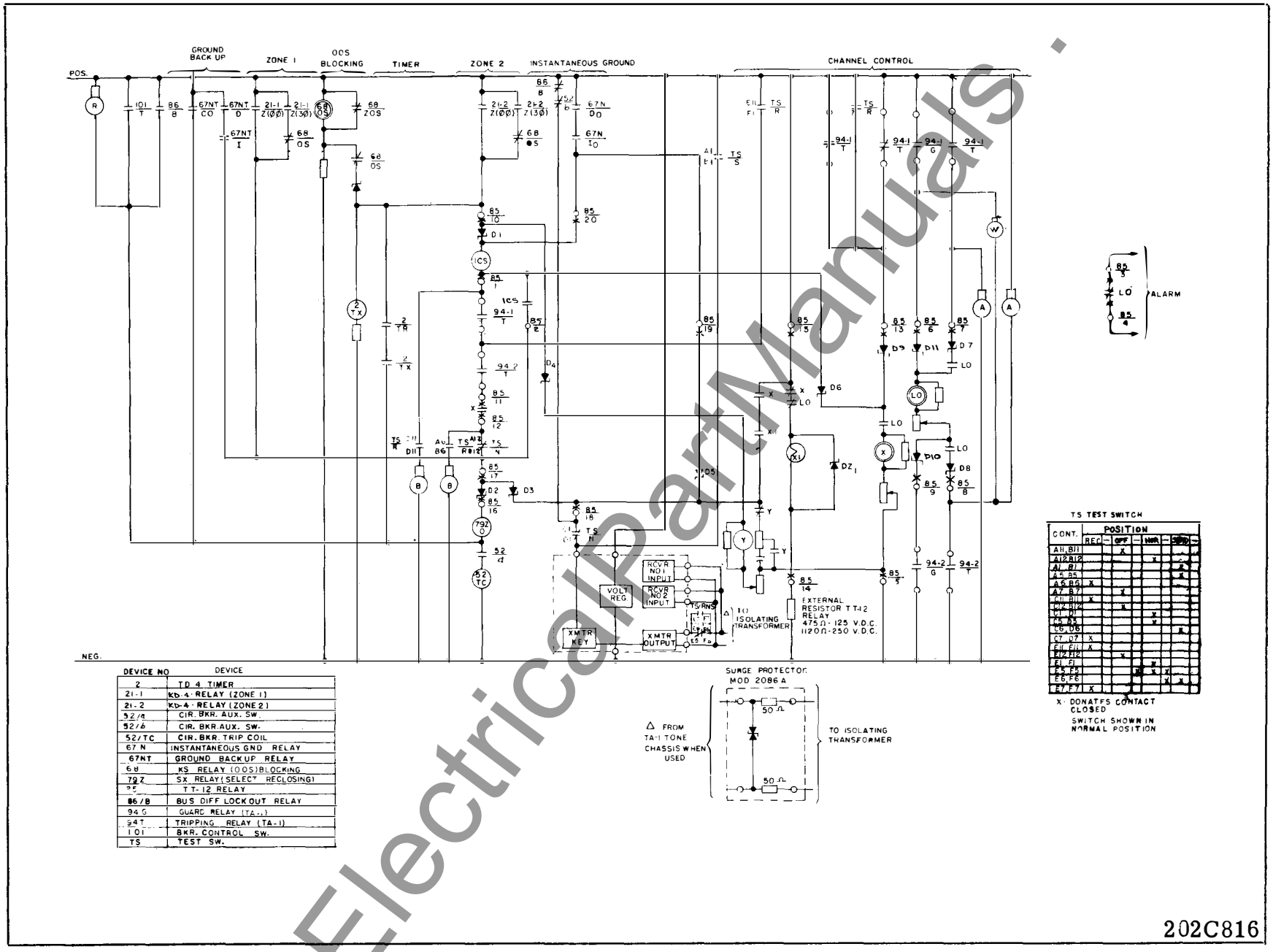
DEVICE NO.	DEVICE
2	TD-4 TIMER
21-1	KD-5 RELAY (ZONE 1)
21-2	KD-5 RELAY (ZONE 2)
52/a	CIR.BKR. AUX. SW.
52/b	CIR. BKR. AUX. SW.
52/TC	CIR. BKR. TRIP COIL
67N	INSTANTANEOUS GND. RELAY
67NT	GROUND BACKUP RELAY
68	K.S. RELAY (O.O.S.) BLOCKING
79Z	SX RELAY (SELECT RECLOSING)
85	TT-12 RELAY
86/B	BUS DIFF. LOCKOUT RELAY
94/G	GUARD RELAY (TA-1)
94/T	TRIPPING RELAY (TA-1)
101	BKR. CONTROL SW.
TS	TEST SWITCH

* *Fig. 6. K-Dar/TT12 Transfer Trip Scheme (Three Terminal Line) for 48 VDC Operation.*



DEVICE NO.	DEVICE
2	TD-4 TIMER
21-1	KD-4 RELAY (ZONE 1)
21-2	KD-4 RELAY (ZONE 2)
52/a	CIR. BKR. AUX. SW.
52/b	CIR. BKR. AUX SW.
52/TC	CIR. BKR. TRIP COIL
67N	INSTANTANEOUS GND. RELAY
67NT	GROUND BACKUP RELAY
68	KS RELAY (OOS.) BLOCKING
79Z	SX RELAY (SELECT RECLOSING
85	TT-12 RELAY
86/B	BUS DIFF. LOCKOUT RELAY
94/G	GUARD RELAY (TA-1)
94/T	TRIPPING RELAY (TA-1)
101	BKR. CONTROL SW.
TS	TEST SWITCH

Fig. 7. K-Dar/TT12 Transfer Trip Scheme (Two Terminal Line) for 125 & 250 VDC Operation.



DEVICE NO	DEVICE
2	TD 4 TIMER
21-1	KD-4 RELAY (ZONE 1)
21-2	KD-4 RELAY (ZONE 2)
52/a	CIR. BKR. AUX. SW.
52/b	CIR. BKR. AUX. SW.
52/TC	CIR. BKR. TRIP COIL
67 N	INSTANTANEOUS GND RELAY
67NT	GROUND BACK UP RELAY
68	KS RELAY (OOS) BLOCKING
79Z	SX RELAY (SELECT RECLOSING)
85	TT-12 RELAY
86/B	BUS DIFF LOCKOUT RELAY
94G	GUARD RELAY (TA-1)
94T	TRIPPING RELAY (TA-1)
101	BKR. CONTROL SW.
TS	TEST SW.

TS TEST SWITCH

CONT.	POSITION			
	REC	OFF	NOR	TRIP
A11,B11		X		
A12,B12			X	
A1, B1				
A5,B5				
A6,B6	X			
A7,B7		X		
C11,B11	X			
D12,B12		X		
C1, D1			X	
C5,D5				
C6,D6				
C7,D7	X			
F11,E11	X			
F12,E12		X		
F1, E1			X	
F5,E5				
F6,E6				
E7,F7	X			

X - DONOTES CONTACT CLOSED
SWITCH SHOWN IN NORMAL POSITION

SURGE PROTECTOR MOD 2086A
50Ω
50Ω
△ FROM TA-1 TONE CHASSIS WHEN USED
TO ISOLATING TRANSFORMER

* *Fig. 8. K-Dar/TT12 Transfer Trip Scheme (Three Terminal Line) for 125 & 250 VDC Operation.*

Blocking Diodes

D3— blocks tripping current path through directional ground contact D_O and diode D5 and blocks tripping current path from battery positive thru X and X1 relay contacts during check-back tests.

D4— blocks tripping current path through directional ground contact D_O, 94-T and X contacts.

D5— blocks discharge of the anti-bounce capacitor through the Y unit.

D6— prevents energizing one of the blue lights during check-back test on 3-terminal line arrangement with test switch in "RECEIVE" position. See Fig. 7.

D7&D8— are in series with the lockout relay coil and are used to block the guard relay from energizing the amber light.

D9— is needed when back contact of trip relay is not available.

D10&D11— blocks trip relay from picking up guard light when light is used.

SETTINGS

There are no settings to be made on the relay.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay.

The electrical connections may be made directly to the terminals by means of screws for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments should be required.

Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

Auxiliary Units X, X1, and Y, and LO

Energize each auxiliary unit with rated voltage and check contact action. If desired, the timing of the operation can be checked as outlined under calibration procedure.

Zenner Tripping Diode

a. Reverse Characteristic:

Breakdown voltage is the value of voltage at which the reverse current just exceeds 5 milliamperes and should be between 160 to 240 volts for each diode. The breakdown voltage is determined by slowly increasing voltage until reverse current exceeds 5 milliamperes nad starts to increase rapidly. Do not exceed 200 milliamperes reverse current.

b. Forward Characteristic:

With 10 amperes flowing in forward direction, the forward voltage across each diode should not exceed 1.5 volts.

Zener Blocking Diodes

a. Reverse Characteristic:

Breadkown voltage is the value of voltage at which the reverse current just exceeds 0.25 milliamperes and should be between 160 to 240 volts for each diode. The breakdown voltage is determined by slowly increasing the voltage until reverse current exceeds 0.25 milliamperes and starts to increase rapidly. Do not exceed 3 milliamperes reverse current.

b. Forward Characteristic:

With 200 milliamperes flowing in forward direction, the forward voltage across each diode should not exceed 1.5 volts.

Routine Maintenance

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended because of the danger of embedding small particles in the face of the soft silver and thus imparing the contact.

NOTE: When making a dielectric test on the relay, the high voltage maybe applied at the relay terminal, from all circuits to ground, between coil and contact circuits, and between isolated coil circuits. However, the test voltage should not be applied across relay contacts, relay coils, or rectifier circuits.

CALIBRATION

Use the following procedure for calibrating the relay, if the relay has been taken apart for repairs or if the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order. Refer to figures 3, 4 & 5.

Auxiliary Units X, X1, Y, and LO

The operating time of units X, Y and LO should be checked with an electronic timer.

The residual air gap should not be less than .002'' and the contact gaps should be between .020'' to .035''.

Auxiliary Unit X

The X relay is located at the left (FV) and is energized between terminals 5 and 13, with the LO unit preclosed. Its adjusting resistor is located at the upper front. Contact circuitry is between terminals 11 and 12. The approximate setting of the adjusting resistor is 2000 ohms for 125 volt relays and 4500 ohms for 250 volt relays. The 48 volt relays do not use a calibrating resistor.

The operating time for a variation of 85% and 115% of rated voltage is a minimum of 32 milliseconds. If necessary, adjustment to achieve timing may be made using the adjustment resistor. For 48 volt relays with no adjustable resistor, operate time must be 32 milliseconds or greater at 56 volts.

The dropout time should be less than 16 milliseconds. If necessary, the dropout time can be adjusted using the residual screw and changing the armature gap. After final adjustment, the gap should not be less than .002''

Auxiliary Unit Y

The Y unit is located at the right front and is energized between terminals 5 and 20. For contact circuitry, see Figures 3 & 4. The normally closed contact should open in 1.5 cycles at rated voltage. This adjustment is controlled by the Y unit resistor which is located at the lower left front. The approximate setting of the resistor is 5000 ohms for the 125 volt relays and 13,000 ohms for 250 volt relays. The 48 volt relays do not use a calibrating resistor.

The dropout time at rated voltage should be 40-60 milliseconds. If necessary, the dropout time can be adjusted by using the residual screw and changing the armature gap. After final adjustment, the armature gap should not be less than .002''.

Auxiliary Unit LO

The LO unit is located at the upper center (FV) and is energized between terminals 6 and 9. Its adjusting resistor is located at the rear. See Figures 3,4&5 for contact circuitry. The closing time should be approximately one cycle at rated voltage. The approximate setting of the adjusting resistor is 1300 ohms for the 125 volt relays and 3,400 ohms for 250 volt relays. The 48 volt relays do not use a calibrating resistor. The operating time for a variation of 85% and 115% or rated voltage is between 10 and 27 milliseconds. If necessary adjustment to achieve timing may be made using adjusting resistor.

The dropout time at rated voltage should be 40-60 milliseconds. If necessary, the dropout time can be adjusted using the residual screw and changing the armature gap. After final adjustment, the armature gap should not be less than .002''.

Auxiliary Unit X1

The X1 unit is located at the lower center (FV) and is energized between terminals 5 and 15 with the X and LO units de-energized. The X1 unit should have a dropout time of 2.5 ± 1 second, after being energized for 10 seconds. This time is measured at terminals 15 and 18, keeping in mind that the break contact of the X unit will have to be jumpered. Adjust the timing if necessary, by means of adjusting a screw accessible from the top of the unit. To increase dropout time turn the screw slightly clockwise, and to decrease dropout time turn the screw slightly counterclockwise.

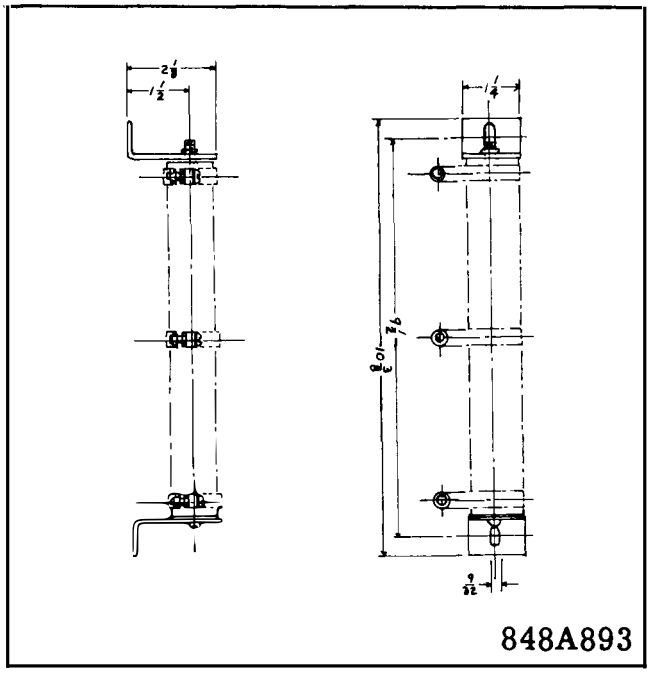


Fig. 9. Outline Dwg. for External Resistor for TT12 Relay

Indicating Contactor Switch (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than 1.0 ampere. To increase the pickup current, bend the springs out, or away from cover. To To decrease the pickup, bend the springs in toward the cover. Make sure that the target drops freely when energized.

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 repair work. When ordering parts, always give the complete nameplate data.

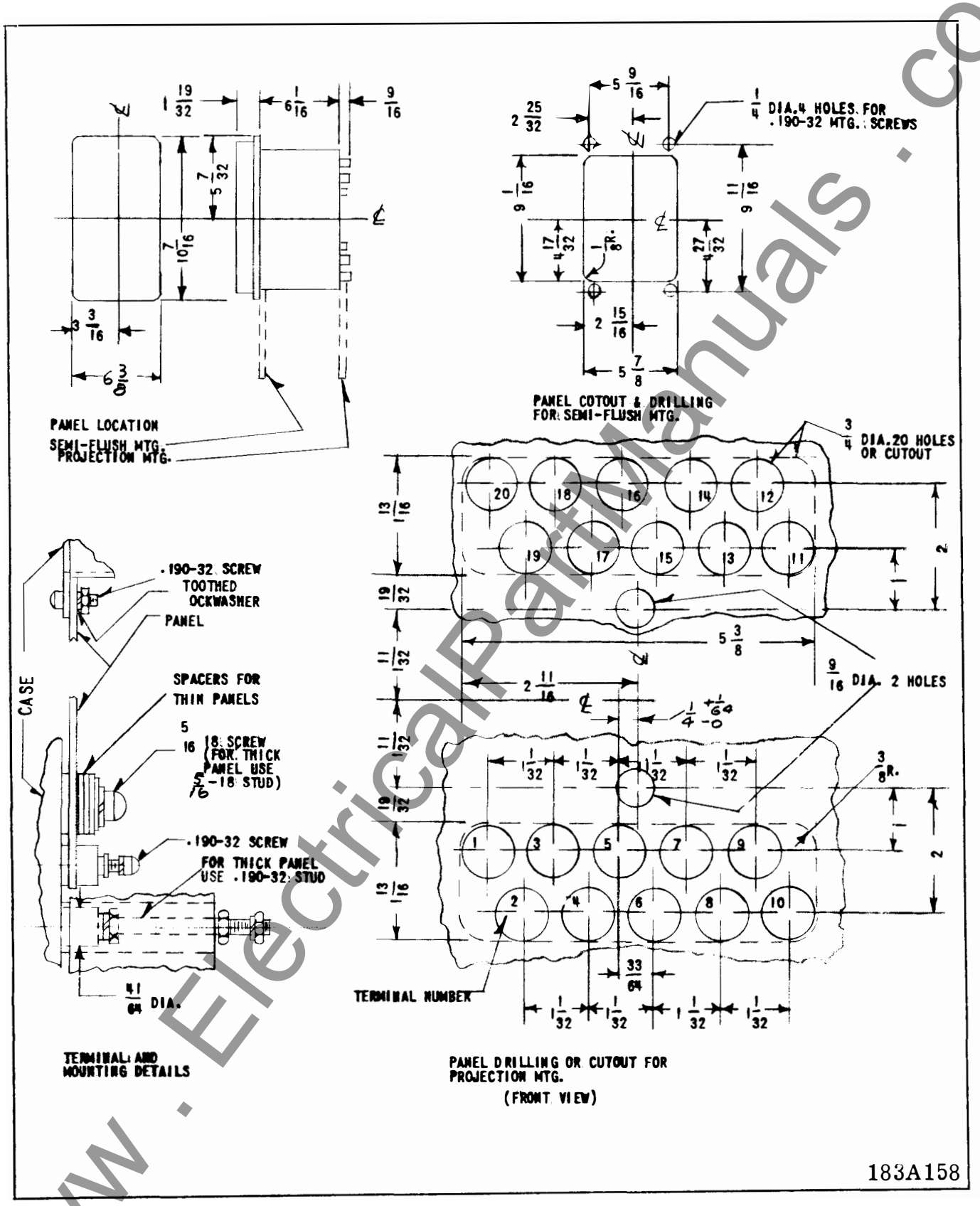


Fig. 10. Outline Dwg. for External Resistor for TT12 Relay.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TT-16 AUXILIARY RELAY WITH AVALANCHE DIODE

CAUTION: Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing parts during shipment, make sure that moving parts operate freely, inspect the contacts to see that they are clean and close properly and operate the relay to check the settings and electrical connections.

APPLICATION

The type TT-16 is an auxiliary relay used in the K-DAR directional comparison tripping scheme. The TT-16 relay provides a circuit for high speed tripping, controls the transfer signal for the remote line terminals and supplies necessary coordination during sudden reversal for external fault conditions. The TT-16 relay can be used on 2 or 3 terminal lines.

CONSTRUCTION

The type TT-16 relay consists of a mercury wetted contact relay, telephone type relays, avalanche diodes, and an indicating contactor switch.

Auxiliary Unit X

Auxiliary unit X is a mercury wetted relay.

Auxiliary Unit X2, Y and LO

Auxiliary units X2, Y and LO are telephone type relays.

Tripping Diode D9 and Blocking Diodes D3 to D8

These diodes are controlled avalanche type diodes with a 1000 volt, 12 ampere rating (JEDEC NO. 1N4529).

Indicating Contactor Switch Unit (ICS)

The indicating contactor switch is a small d-c operated clapper type device.

OPERATION

The type TT-16 relay is used with microwave or pilot wire tone channel in a directional transfer trip relay scheme for power transmission line protection. High-speed tripping is obtained for two-terminal or multi-terminal line applications for faults anywhere on the protected line.

SUPERSEDES 41-958.8
*Denotes change from superseded issue. EFFECTIVE SEPTEMBER 1967

The protective relays and the relay settings used in the TT-16 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 TT-16 scheme, however, uses a tripping signal rather than a blocking signal to provide improved security against undesired relay operation for external faults. Since the microwave or pilot wire tone channels are separate from the conductors of the protected power line, it is not necessary to use a blocking signal, as in the conventional directional comparison carrier scheme to avoid having to send the signal on the conductors through a fault. The conventional directional comparison carrier scheme is arranged to trip on absence of the blocking signal, so that the channel failure will result in false tripping for external remote faults that are within reach of the protective relays. Since the TT-16 scheme requires reception of the trip signal as well as operation of the local protection relays, channel failure cannot result in undesired tripping.

Auxiliary Unit X

The X-unit is used to provide a coordinating delay, if a sudden reversal occurs in the direction of fault power flow in the protected line. For an internal fault, the X-relay is preclosed and is kept closed by fault detecting relays.

Auxiliary Unit Y and Anti-bounce Circuit

Auxiliary unit Y, in conjunction with capacitor C and resistor R, provides for continuation of the audio tone tripping signal in case the protective relay (PR) contacts should have an initial bounce. The sequence of operation of this anti-bounce circuit is as follows:

> As soon as the PR contact first closes, the capacitor charges almost instantaneously to the approximate value of the d-c control voltage through the resistor R and the normally closed Y contact, at the same time closing of the protective relay contact applies reverse bias to transistors in the transmitter of the audio tone equipment, causing the transmitter to shift to the trip frequency. When the PR contact bounces open this reverse bias to "shift" is upheld by the capacitor voltage that is slowly discharged through a high resistance path in the transmitter circuit. When PR contact recloses the same sequence of events takes place. When finally PR closes "solid" or long enough for Y unit to operate, the anti-bounce circuit is cut off by the normally closed Y contact and the capacitor charge is dissipated through a normally open contact and resistor R.

Auxiliary Unit - LO

The LO unit is energized by the 94-G channel control contact. One contact of LO relay energizes the X unit. This makes it possible, in case of channel failure, to lockout the transfer tripping at the local terminal. The second LO contact is in series with alarm circuit, and the third LO contact is in series with the 94-T channel control contact, as a second path to energize LO unit coil, after trip signal is received. The LO unit has prolonged dropout time, thus assuring that it will stay closed long enough to transfer from guard to trip received signals without dropping out.

Auxiliary Unit - X2

The X2 unit is used to provide additional time delay in the transmitter initiate circuit, when desired. When used, it is connected in series with "b" contact of circuit breaker.

Tripping Diode D1

Tripping diode D1 provides isolation of the KD timer circuit from the ground fault detector relay.

Blocking Diodes D3 to D8

Blocking diodes D3 through D8 are utilized to prevent undesirable tripping or operation of associated equipment.

STYLE OF RELAYS

D.C. SUPPLY VOLTAGE	STYLE OF RELAY
48	*292B492A13
125	*292B492A12
250	292B492A14

SETTINGS

The only setting required is that if the X relay operating time. Operating times between 1.5 to 2.0 cycles can be obtained by utilizing slide wire resistor which is located at top front of TT-16 relay chassis. The X relay is set at the factory for a 1.5 cycle operate time.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay.

The electrical connections may be made directly to the terminals by means of screws for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments should be required.

Acceptance Check

The following check is recommended to insure that the relay is in proper working order.

Auxiliary Units X, X2, Y, and LO

Energize with rated voltage each auxiliary unit and check contact action. If desired, the timing of the operation can be checked as outlined under calibration procedure.

Avalanche Diode

Reverse Characteristic:

Breakdown voltage is the value of voltage at which the reverse current just exceeds 0.5 milliamperes and should be 600 volts for each diode. The breakdown voltage is determined by slowly increasing voltage until reverse current exceeds 0.5 milliamperes and starts to increase rapidly. A safety resistor should be used to prevent shorting the D.C. source.

Rountine Maintenance

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleared. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

NOTE: When making a dielectric test on the relay, the high voltage may be applied at the relay terminal, from all circuits to ground, between coil and contact circuits, and between isolated coil circuits. However, the test voltage should not be applied across relay contacts, relay coils, or rectifier circuits.

CALIBRATION

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or if the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order.

Auxiliary Units X, X1, Y, and LO

The operating time of units X and LO should be checked with an electronic timer.

Auxiliary Unit X

The X relay is located at the upper rear and is energized between terminals 5 and 13, with LO unit preclosed. Its adjusting resistor is mounted across the front and at the top of the TT-16 chassis. The operating range of the X unit is adjustable from 1.5 to 2.0 cycles and this is accomplished by adjusting its associated resistor.

The dropout time is 1.5 to 2.0 cycles at rated voltage.

NOTE: For the following telephone relay checks, the residual air gap should not be less than .002" and the contact gaps should be between .020" to .035".

Auxiliary Unit X2

The X2 unit is located at the upper right front of the TT-16 chassis and is energized between terminals 5 and 15, with the contact circuit being between terminals 15 and 18. The operating time of this unit at rated voltage is 6 to 8 cycles.

Auxiliary Unit Y

The Y unit is located at the left front of the TT-16 chassis and is energized between terminals 5 and 20. For contact circuitry, see Internal Schematic 848A729. The normally closed contact should open in 1.5 cycles at rated voltage. This adjustment is controlled by the Y unit resistor which is located at the lower left. The approximate setting of the resistor is 5000 ohms for the 125 volt relays or 13000 ohms for the 250 volt relays.

The dropout time should be 40-50 milliseconds. If necessary, the dropout time can be adjusted using the residual screw and changing the armature gap. After final adjustment, the armature gap should not be less than .002".

Auxiliary Unit LO

The LO unit is located at the lower right front of the TT-16 chassis and is energized between terminals 6 and 9. The closing time of a normally open contact should be approximately one cycle at rated voltage. This adjustment is controlled by the LO unit resistor which is located at the lower right front. The approximate setting of this resistor should 2000 ohms for 125 volt relays or 5000 ohms for 250 volt relays.

The dropout time should be 40-50 milliseconds. If necessary, the dropout time can be adjusted using residual screw and changing the armature gap. After final adjustment, the armature gap should not be less than .002".

Indicating Contactor Switch (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than 1.0 ampere.

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 repair work. When ordering parts, always give the complete nameplate data.

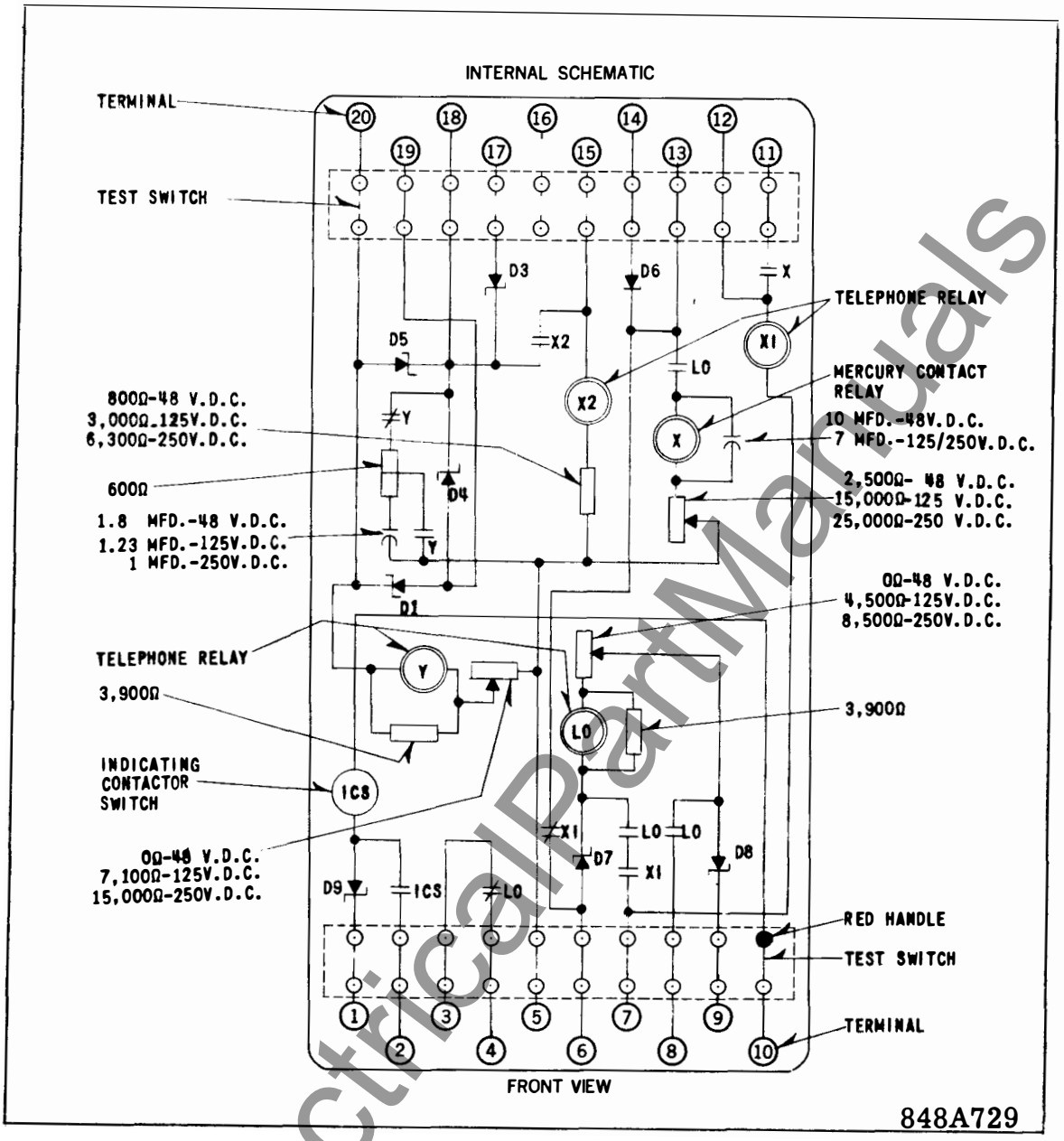


Fig. 1 Internal Schematic of the Type TT-16 Relay in the FT-32 Case.

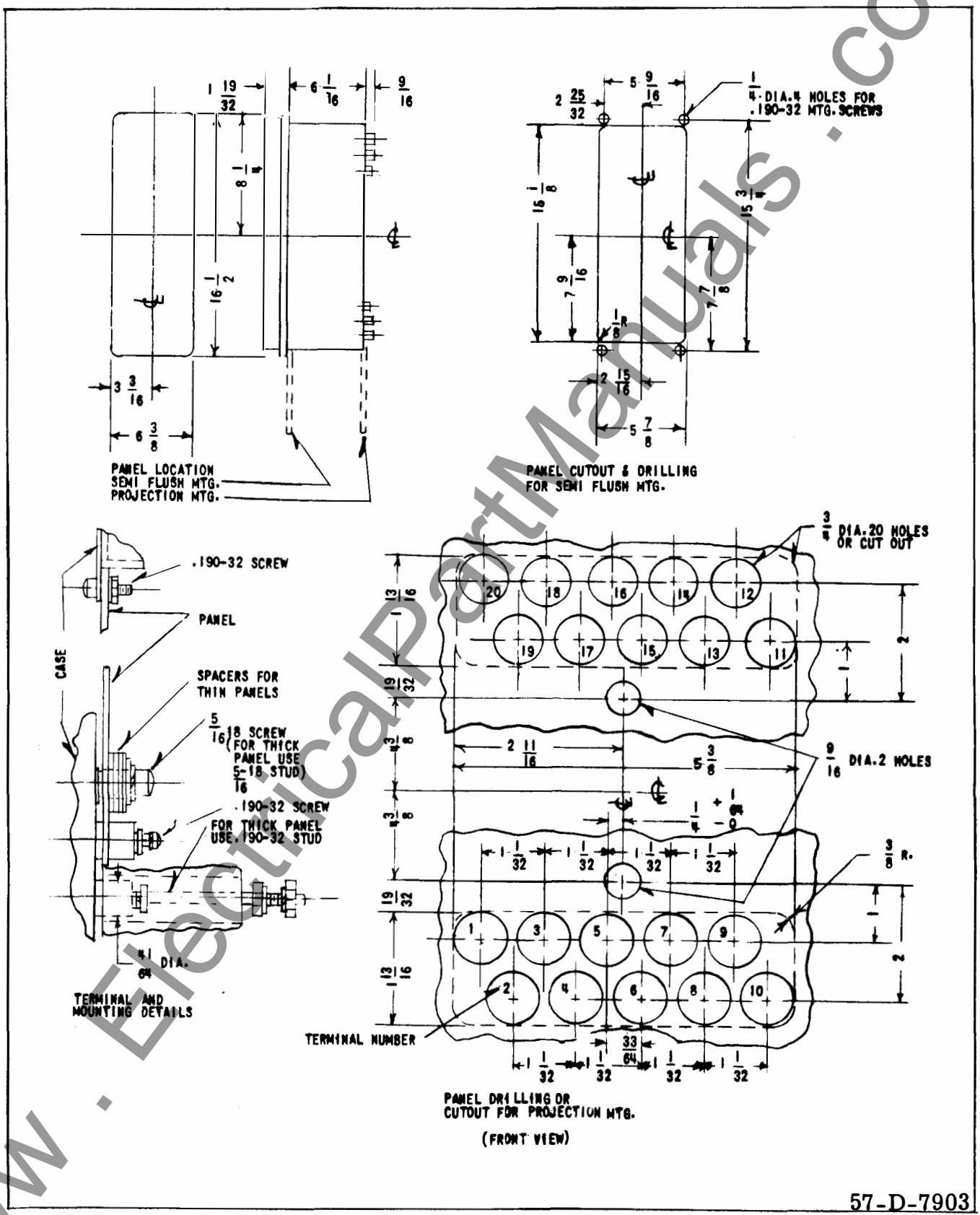


Fig. 2 Outline and Drilling Plan for the Type TT-16 Relay in the FT-32 Case.

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.

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

EFFECTIVE AUGUST 1968

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	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

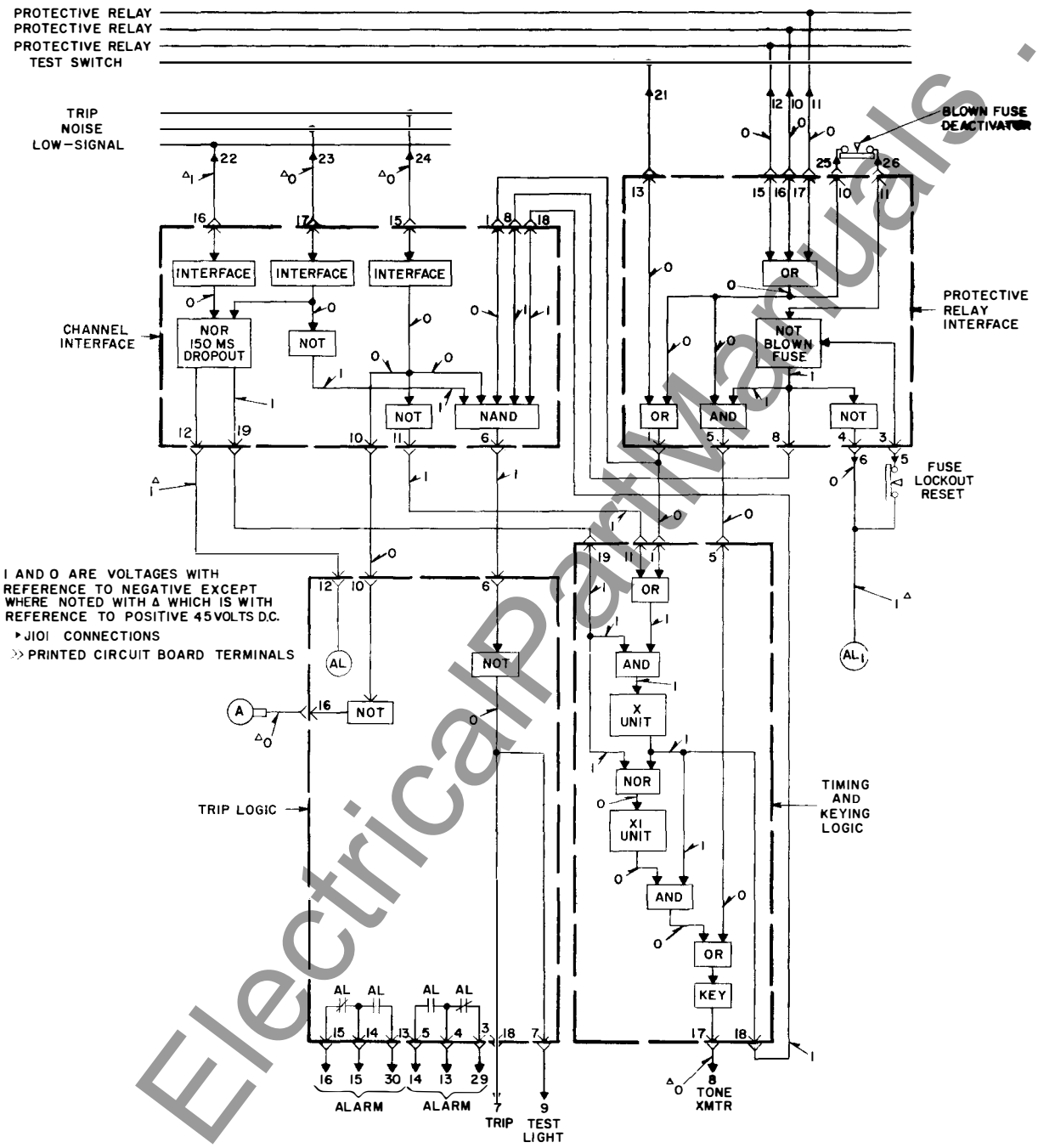
Channel Interface Board

	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

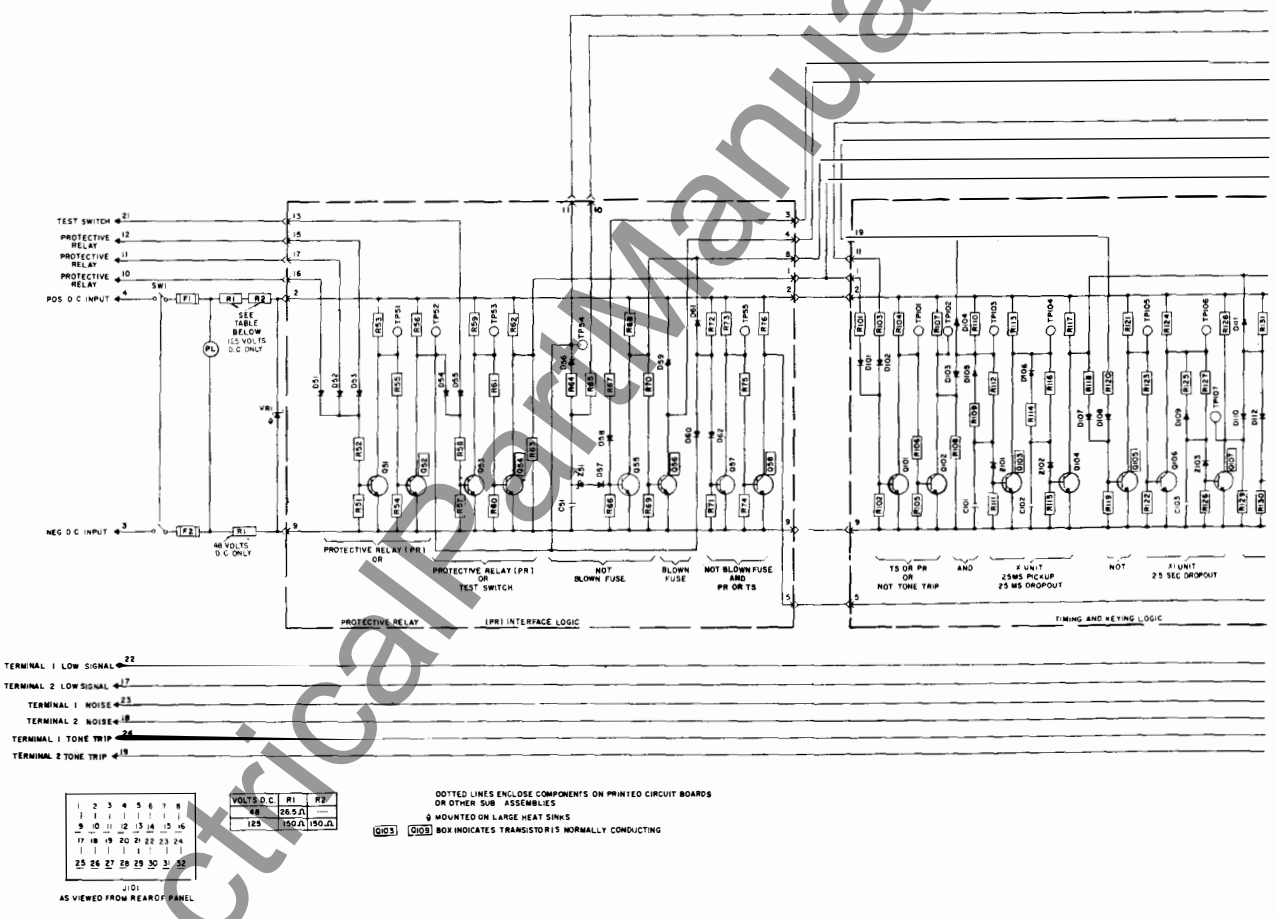
ELECTRICAL PARTS LIST

Channel Interface Board (Continued)

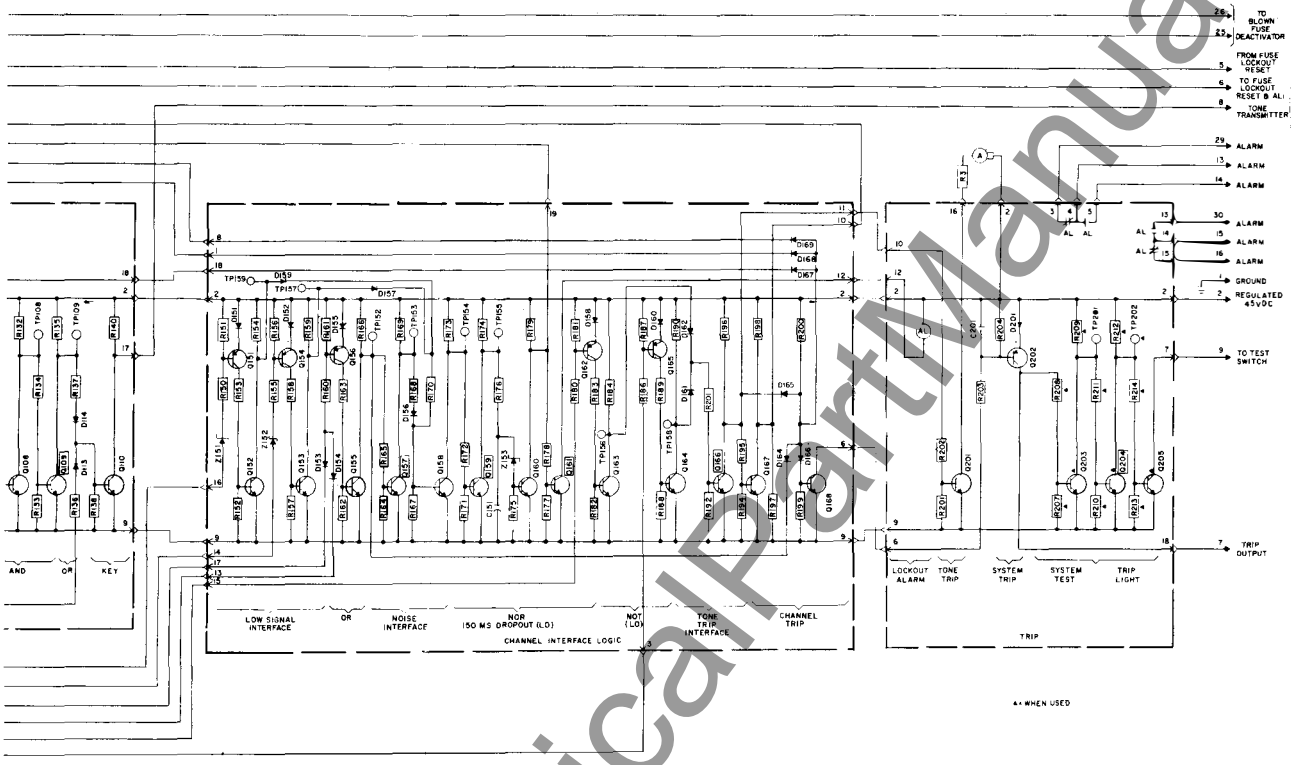
Circuit Symbol	Description	Westinghouse Style Number
	RESISTORS	
R151-R159-R179	6.8K Ohm - 1/2 W	184A763H47
R152-R160-R174-R180	1K Ohm - 1/2 W	184A763H27
R153-R161-R164-R167 R171-R175-R177-R181 R183-R188- R154-R162-R182	10K Ohm - 1/2 W	184A763H51
	100K Ohm - 1/2 W	184A763H75
R155-R163-R166-R170 R185	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**

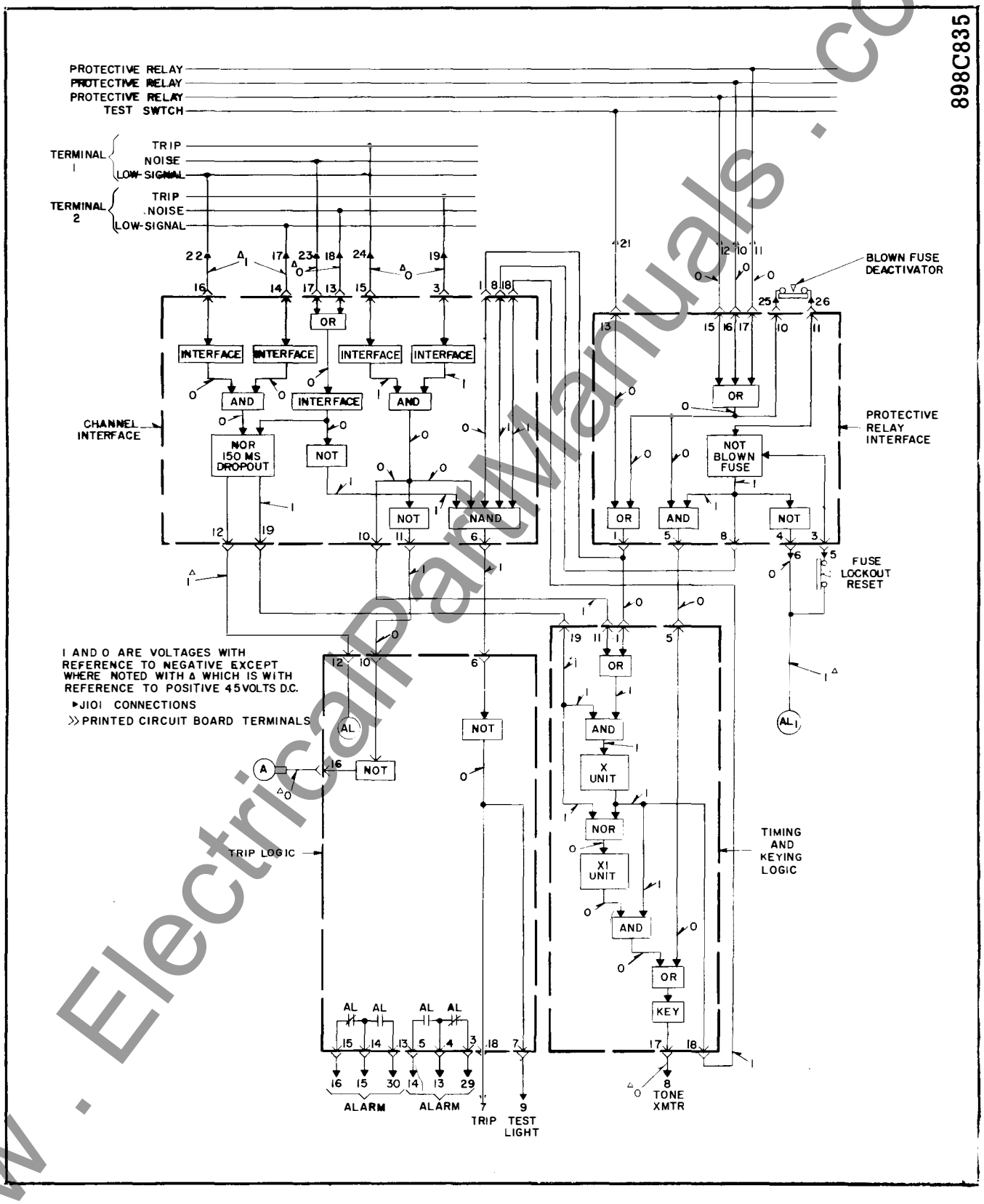


* *Fig. 3 Internal Schematic of Type*



756J689

STU-12 Relay for Three Terminal Lines



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

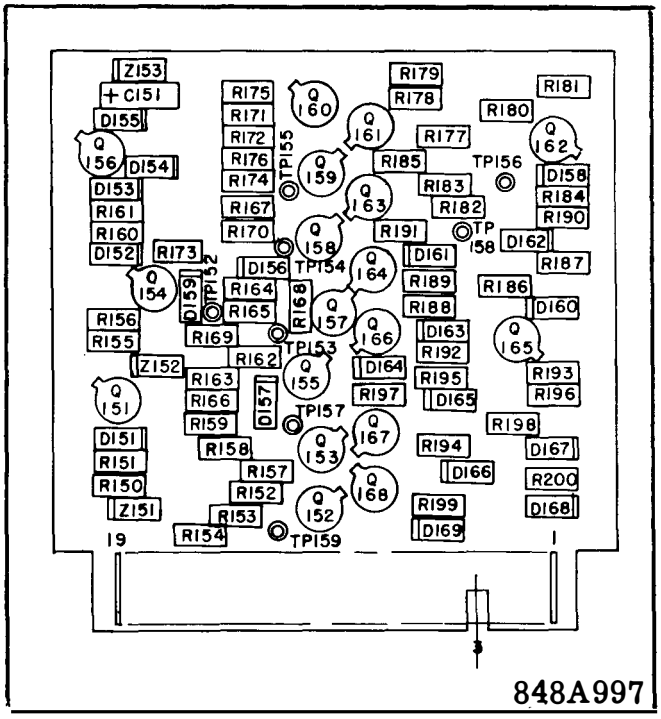


Fig. 5 Component Location on Channel Interface Board for Three Terminal Lines

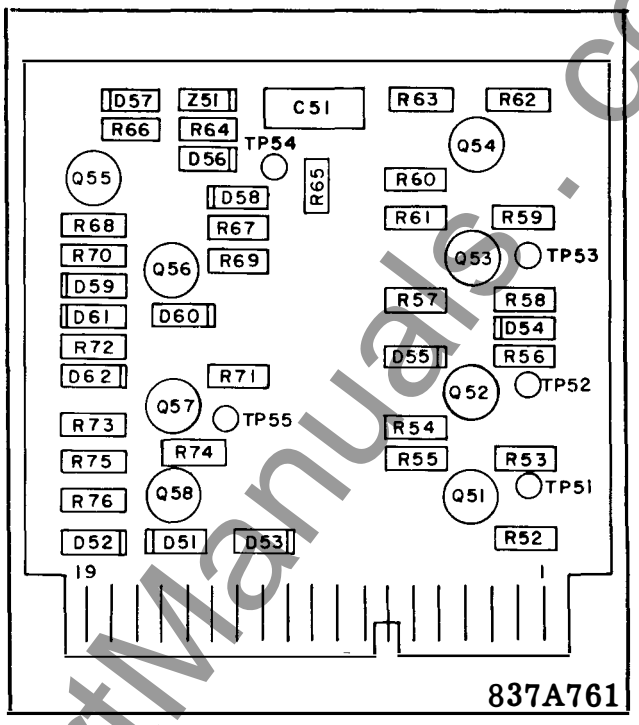


Fig. 6 Component Location on the Protective Relay Interface Board

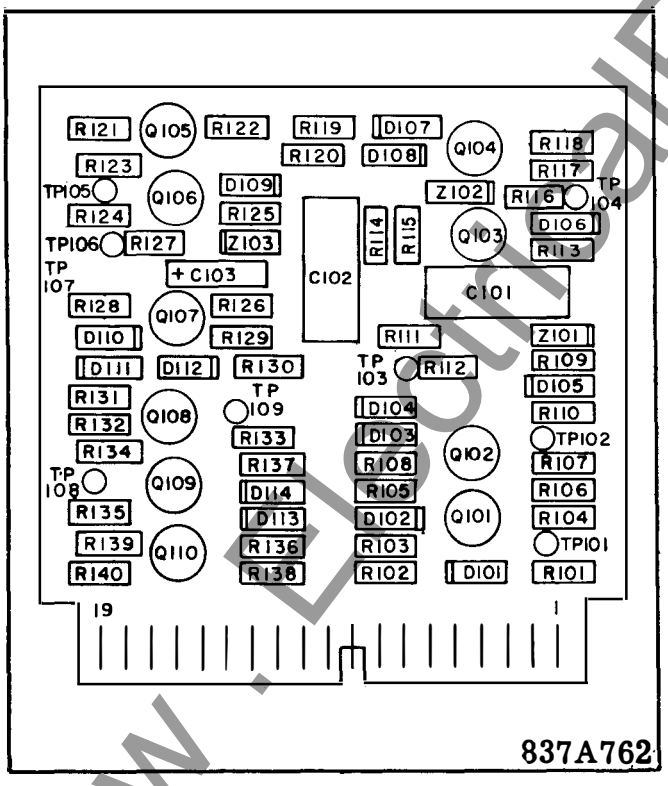


Fig. 7 Component Location on the Timing and Keying Board

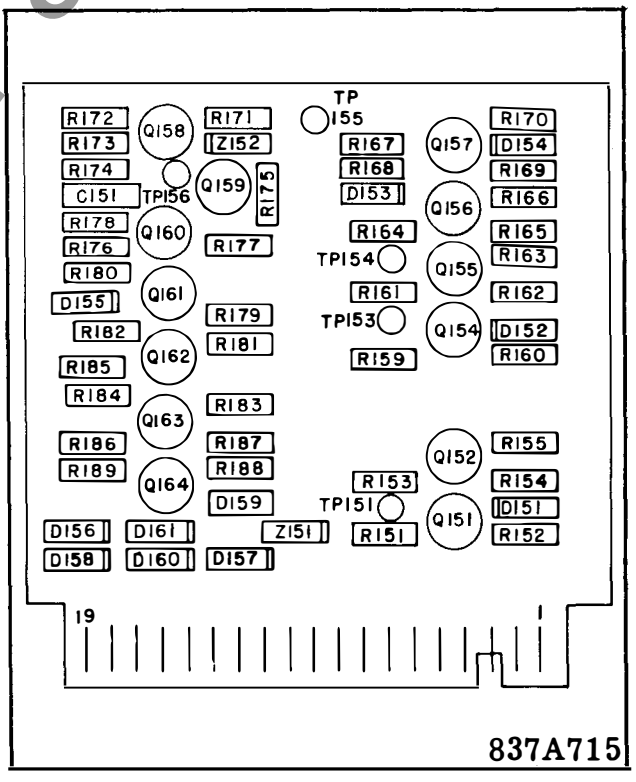


Fig. 8 Component Location on the Channel Interface Board

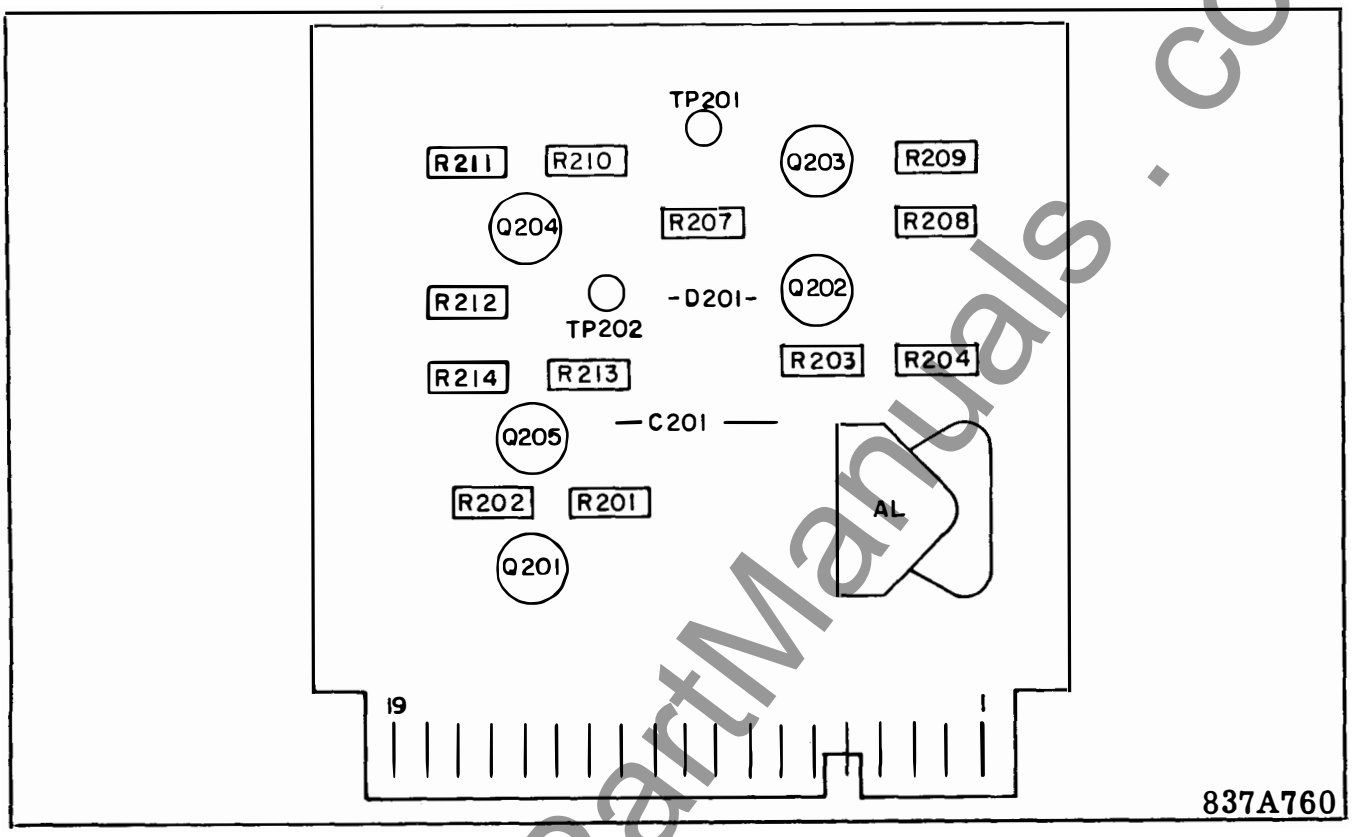


Fig. 9 Component Location on the Trip Board

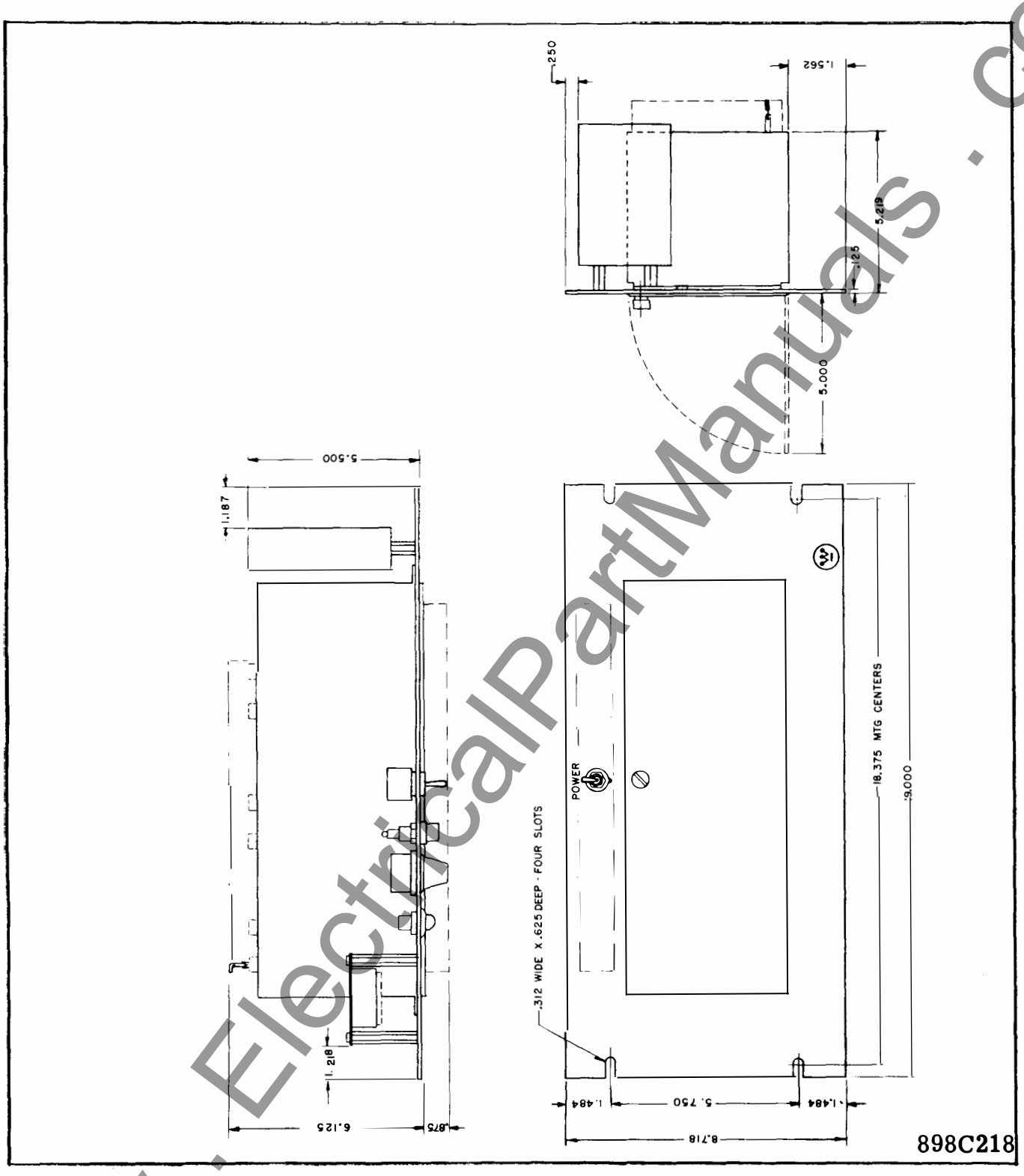


Fig. 10 Outline and Drilling Plan for the Type STU-12 Relay

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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TT-21 AUXILIARY RELAY

CAUTION: Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

The type TT-21 is an auxiliary relay used in the K-DAR directional comparison tripping scheme (overreaching transfer trip). The TT-21 relay provides a circuit for supplying necessary coordination during a sudden reversal in power flow for an external fault.

The TT-21 relay works with TCF carrier channels or with any comparable equipment that contains receiver trip relay contacts.

CONSTRUCTION

The type TT-21 relay consists of a telephone type relay, avalanche diodes, and an indicating contactor switch.

Auxiliary Unit X

The auxiliary unit X is a telephone type relay. In this relay, an electromagnet attracts a right angle iron bracket which in turn operates a set of make or break contacts.

Blocking Diodes D1 To D4 and Tripping Diodes D5 to D8.

These diodes are controlled avalanche type diodes with a 600 volt, 12 ampere rating (JEDEC No. IN4508).

Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also, during this operation, two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator to drop.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

The type TT-21 relay is used with a TCF carrier 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. See Fig. 3.

The protective relays and the relay settings used in the TT-21 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.

Auxiliary Unit X

The X-unit is used to provide a coordinating delay, if a sudden reversal occurs in the direction of fault power flow in the protected line. For an internal fault, the X-relay is preclosed and is kept closed by fault detecting relays (PR). These consist of the KRD directional overcurrent ground relay and the KD zone 2 phase distance relay.

SETTINGS

There are no settings to be made on the relay.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from

dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay.

The electrical connections may be made directly to the terminals by means of screws for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments should be required.

Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

Auxiliary Unit X

Energize the auxiliary unit with rated voltage and check contact action. If desired, the timing of the operation can be checked as outlined under calibration procedure.

Avalanche Diode

Reverse Characteristic:

Apply 600 volts D.C. The reverse current should be .5 milliamperes or less. The avalanche voltage is determined by slowly increasing the voltage until reverse current starts to increase rapidly. A safety resistor should be used to prevent shorting the D.C. source.

Routing Maintenance

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

NOTE: When making a dielectric test on the relay, the high voltage may be applied at the relay terminal, from all circuits to ground between coil and contact circuits, and between isolated coil circuits. However, the test voltage should not be applied across relay contacts, relay coils, or rectifier circuits.

CALIBRATION

Use the following procedure for calibrating the relay, if the relay has been taken apart for repairs or if the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order.

Auxiliary Unit X

The operating time of unit X should be checked with an electronic timer.

The residual air gap should not be less than .002'' and the contact gaps should be between .020'' to .035''.

The X relay is located at the left (FV) and is energized between terminals 5 and 13. The closing time should be set for approximately one cycle. The approximate setting of the adjusting resistor is 5000 ohms for the 125 volt relays. The 48 V relays do not use an adjusting resistor. The operating time for a variation of 85% and 115% of rated voltage is between 10 and 27 milliseconds. If necessary, adjustment to achieve timing may be made using adjustment resistor. Since there is no adjustment for the 48 volts relay, the 42 volts check limit is 32 m.s.

The dropout time should be approximately 25 milliseconds. If necessary, the dropout time can be adjusted using the residual screw and changing the armature gap. After final adjustment, the armature gap should not be less than .002''.

Indicating Contactor Switch (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than 1.0 ampere for the 1 ampere unit or .2/2 amperes for the tapped unit. To increase the pickup current, bend the springs out, or away from cover. Make sure that the target drops freely when energized.

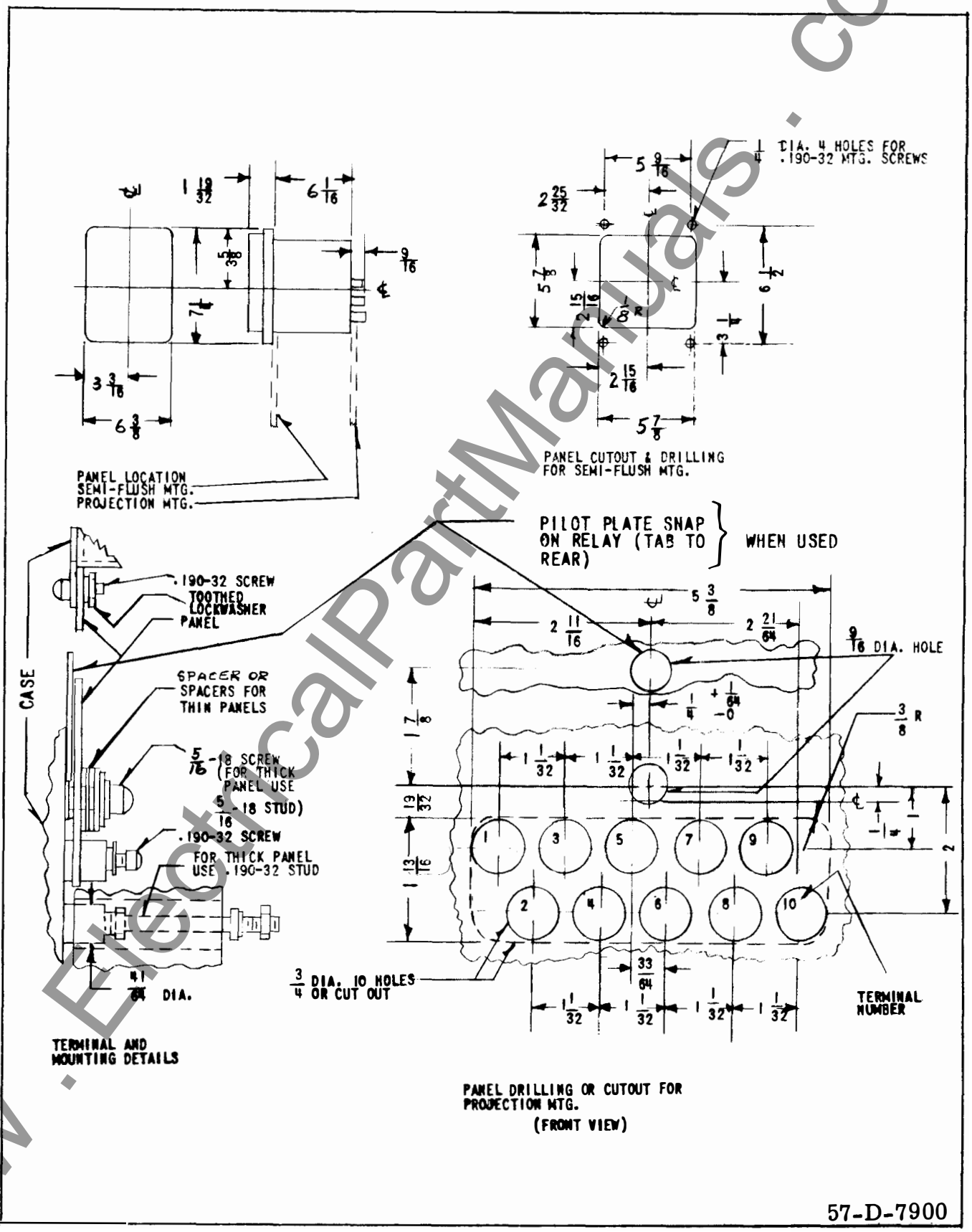
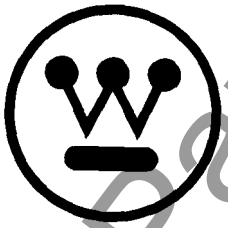


Fig. 4. Outline and Drilling Plan For The Type TT-21 Relay in the Type FT-11 Case.



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INSTRUCTIONS

TYPE TT-17 RELAY IN FT-22 CASE

CAUTION: Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

The type TT-17 relay is used in the K-DAR underreaching transfer trip system.

CONSTRUCTION

The type TT-17 relay consists of three telephone type relays and zener type blocking diodes, zener type tripping diodes, an indicating contactor switch (ICS) and an instantaneous trip (IT).

SETTINGS

There are no settings to be made on the relay except for setting desired pickup of IT unit.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay.

The electrical connections may be made directly to the terminals by means of screws for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments should be required.

1. Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

2. Auxiliary Units X, X1, and L0

Energize each auxiliary unit with rated voltage and check contact action, If desired, the timing of the operation can be checked as outlined under calibration procedure.

3. Zener Blocking Diodes D3 and D7

The zener type blocking diodes have a one watt, 200 volt rating (JEDEC No. 1N3051, two diodes in series used on 250 volt relays).

a. Reverse Characteristic:

Breakdown voltage is the value of voltage at which the current just exceeds 0.25 milliamperes and should be between 160 and 240 volts for each diode. The breakdown voltage is determined by slowly increasing voltage until reverse current exceeds 0.25 milliamperes and starts to increase rapidly. Do not exceed 3 milliamperes reverse current.

b. Forward Characteristic:

With 200 milliamperes flowing in forward direction, the forward voltage across each diode should not exceed 1.5 volts.

4. Zener Tripping Diodes D1 and D2

The zener type tripping diodes have a 50 watt, 200 volt rating (JEDEC No. 1N2846A for 125 volt and 48 volt relays, 1N2846A and 1N2846-RA for 250 volt relays).

a. Reverse Characteristic:

Breakdown voltage is the value of voltage at which the reverse current just exceeds 5 milliamperes and should be between 160 to 240

volts for each diode. The breakdown voltage is determined by slowly increasing voltage until reverse current exceeds 5 milliamperes and starts to increase rapidly. Do not exceed 200 milliamperes reverse current.

b. Forward Characteristic:

With 10 amperes flowing in forward direction, the forward voltage across each diode should not exceed 1.5 volts.

5. Routine Maintenance

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

NOTE: When making a dielectric test on the relay, the high voltage may be applied at the relay terminal, from all circuits to ground, between coil and contact circuits, and between isolated coil circuits. However, the test voltage should not be applied across relay contacts, relay coils, or rectifier circuits.

CALIBRATION

Use the following procedure for calibrating the relay, if the relay has been taken apart for repairs or if the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order.

Auxiliary Units X, X1 and L0

The operating time of units X, X1 and L0 should be checked with an electronic timer.

The residual air gap should not be less than .002'' and the contact gaps should be between .020'' to .035''.

The residual screw is used to control the dropout time.

Internal schematic Dwg. 188A526 shows coil and contact circuitry.

All required characteristics to be checked at rated voltage.

Auxiliary Unit X

The X unit is located at the left (FV). The operating time of the X unit is 10 to 20 milliseconds. The dropout time is 35 to 50 milliseconds.

Auxiliary Unit X1

The X1 unit is located at the center (FV). The operating time of the X1 unit is 65 to 120 milliseconds. The dropout time is 50 to 150 milliseconds.

Auxiliary Unit L0

The L0 unit is located at right (FV). Its adjusting resistor is located at the lower front. The approximate setting of the adjusting resistor is 1300 ohms for the 125 volt relays or 3400 ohms for the 250 volt relays. The 48 volt relays do not use a calibrating resistor. The operating time is 10 to 27 milliseconds. If necessary, adjustment to achieve timing may be made using adjusting resistor. The dropout time is 40 to 70 milliseconds.

Indicating Contactor Switch (ICS)

Close the L0 relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than 1.0 ampere. To increase the pickup current, bend the springs out, or away from cover. To decrease the pickup, bend the springs in toward the cover. Make sure that the target drops freely when energized.

Instantaneous Unit (IT)

The core screw which is adjustable from the top of the instantaneous unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The bridging moving contacts should touch both stationary contacts simultaneously.

The contact gap is a nominal .093''.

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 repair work. When ordering parts, always give the complete nameplate data.

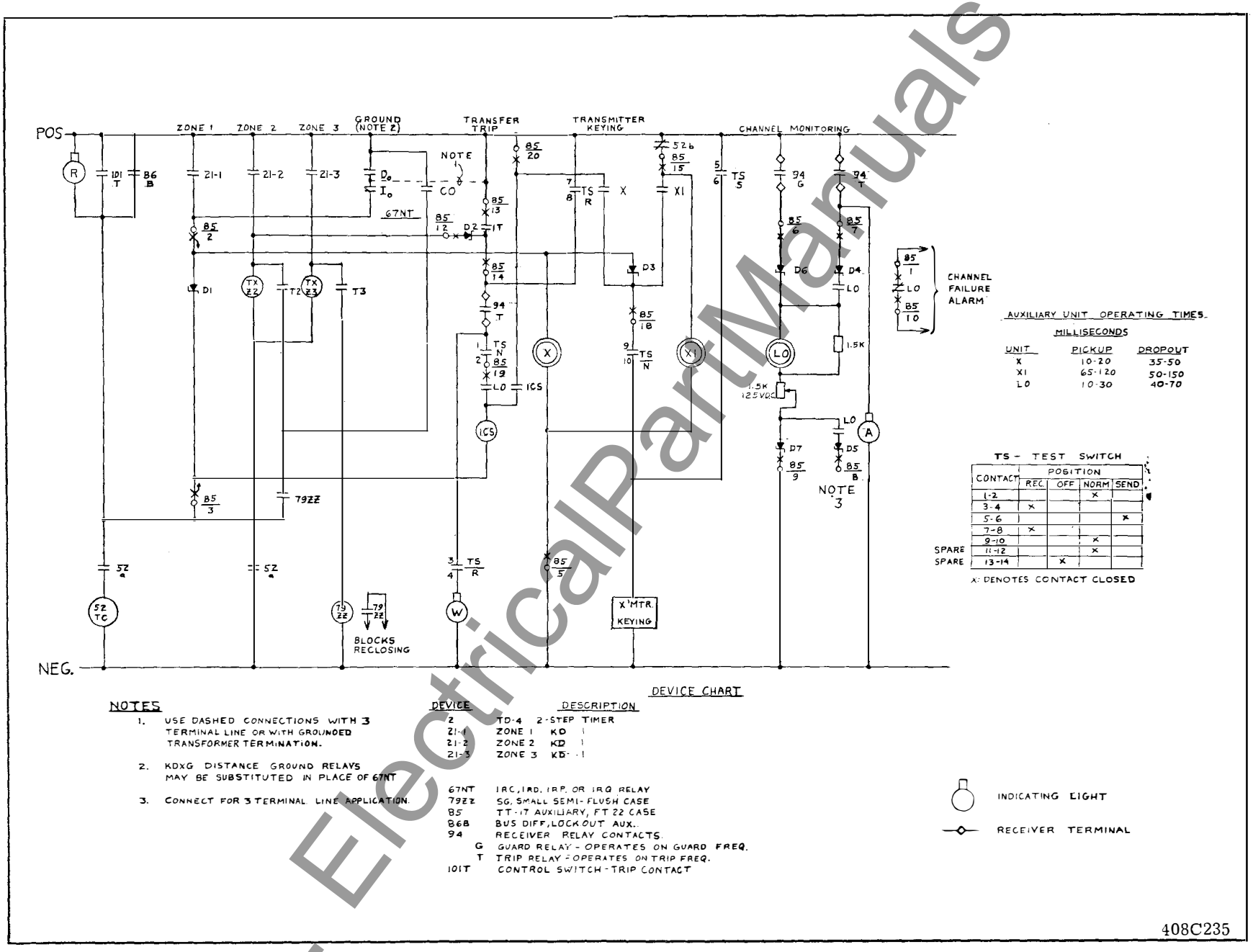

Fig. 1. K-Dar Underreaching Transfer Trip System.

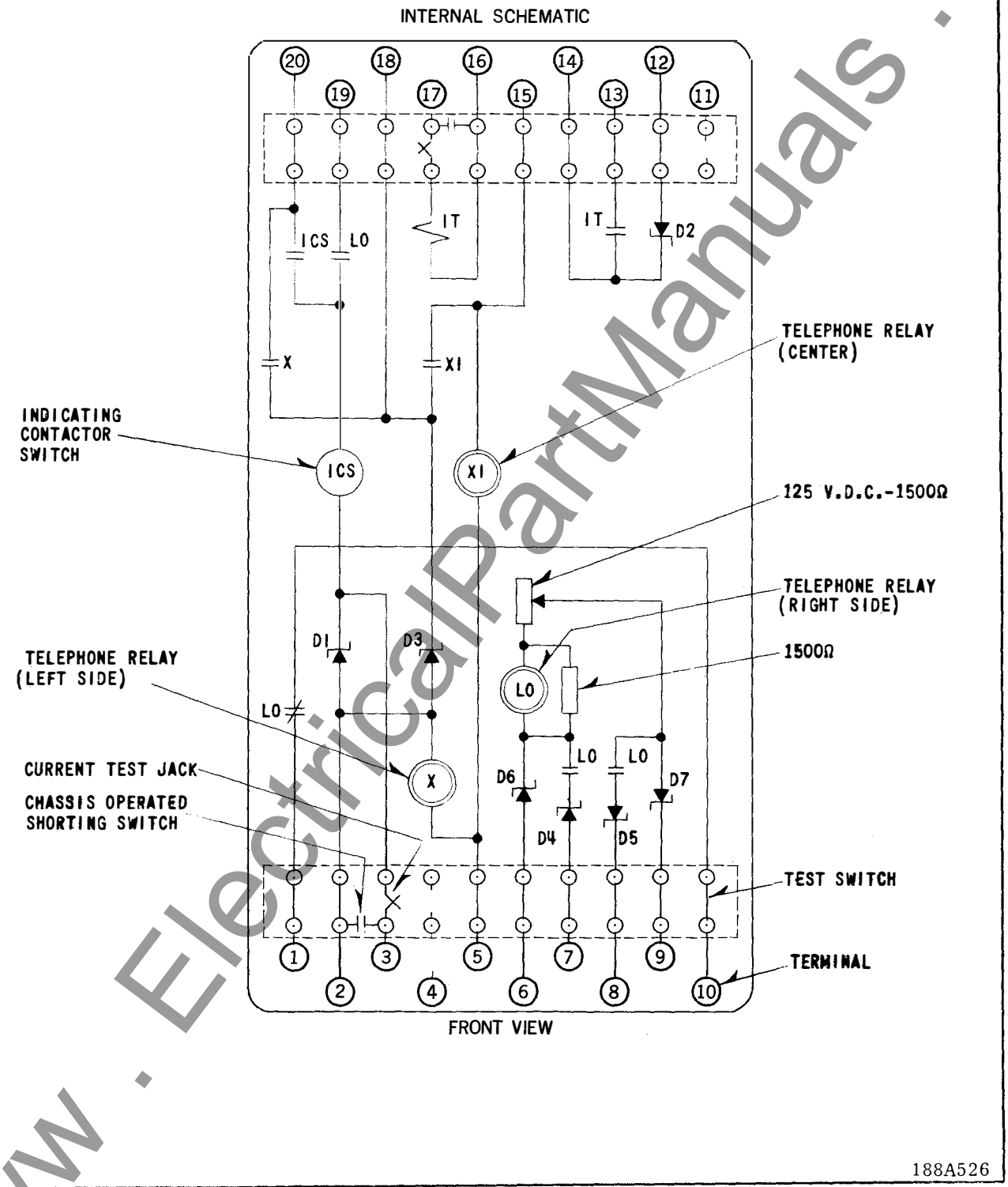

Fig. 2. Relay Type TT-17 Underreaching Auxiliary in Type FT-22 Case

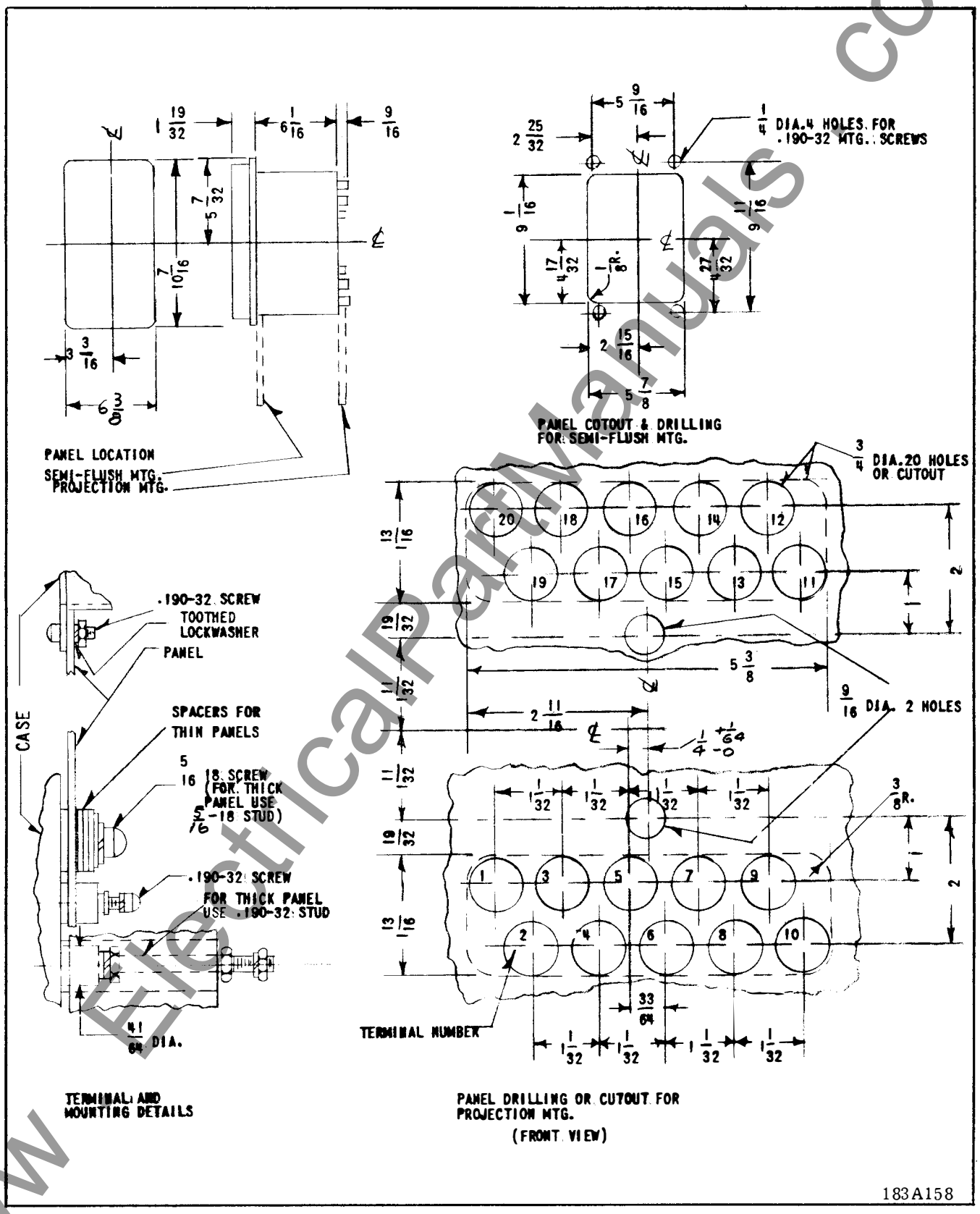

Fig. 3. Outline & Drilling for Relay Case Type FT22

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INSTRUCTIONS

TYPE TT-12 TRANSFER - TRIP RELAY

CAUTION Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

The type TT-12 is an auxiliary relay used in the K-DAR directional comparison tripping scheme (overreaching transfer trip). The TT-12 relay provides a circuit 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.

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

The TT-12 relay works with TA-1 audio tone channels or with any comparable equipment that contains receiver relay contacts as follows:

Guard relay: 1 form A or 1 form C
Trip relay: 2 form A and 1 form B or 3 form C contacts.

Use the TT-8 relay instead of the TT-12 where the channel receiver does not contain the necessary relay contact structure required for the TT-12 system. The TT-8 provides no monitoring facilities. Where monitoring is not integral with the receiver, use a TT-9 relay along with the TT-8.

CONSTRUCTION

The type TT-12 relay consists of a thermal type time delay relay, telephone type relays, silicon zener diodes, and an indicating contactor switch.

Auxiliary Unit X1

Auxiliary unit X1 is a thermostatic time delay relay that is actuated by a heater. The contacts are hermetically sealed.

Auxiliary Units X, Y and LO

The auxiliary units X, Y and LO are telephone type relays. In these relays, an electromagnet attracts a right angle iron bracket which in turn operates a set of make or break contacts.

Tripping Diodes D1 and D2

Tripping diodes D1 and D2 are zener type diodes having a 50 watt, 200 V rating (JEDEC No. 1N2846A for 125 volt and 48 volt relays).

Blocking Diodes D3 to D8

Blocking diodes D3 through D8 are zener type diodes having a one watt, 200 volt rating (JEDEC No. 1N3051.

Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also, during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

SUPERSEDES I.L. 41-958.3A
*Denotes Change from Superseded Issue.

EFFECTIVE JULY 1966

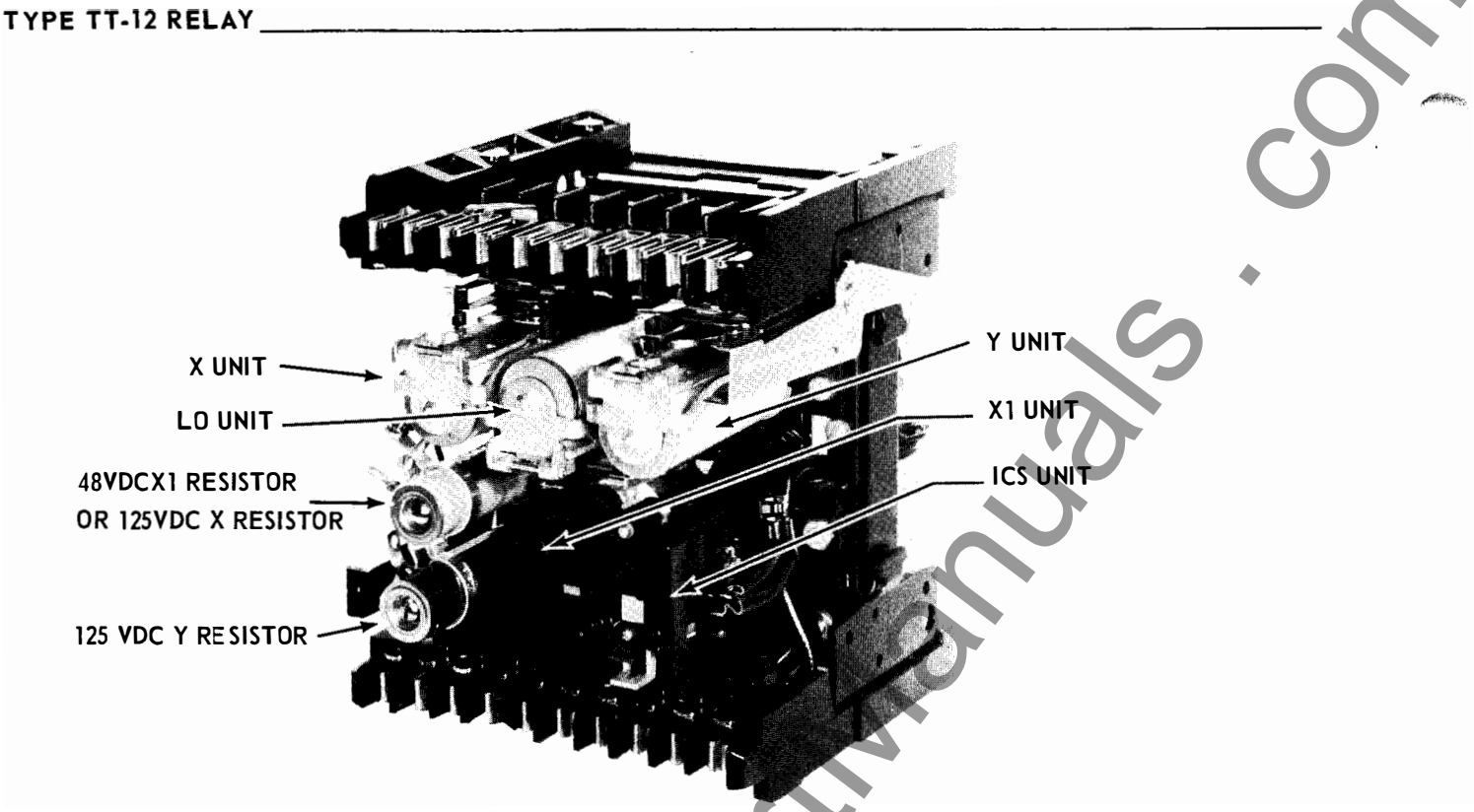


Fig. 1. Type TT-12 Relay without case (Front View)

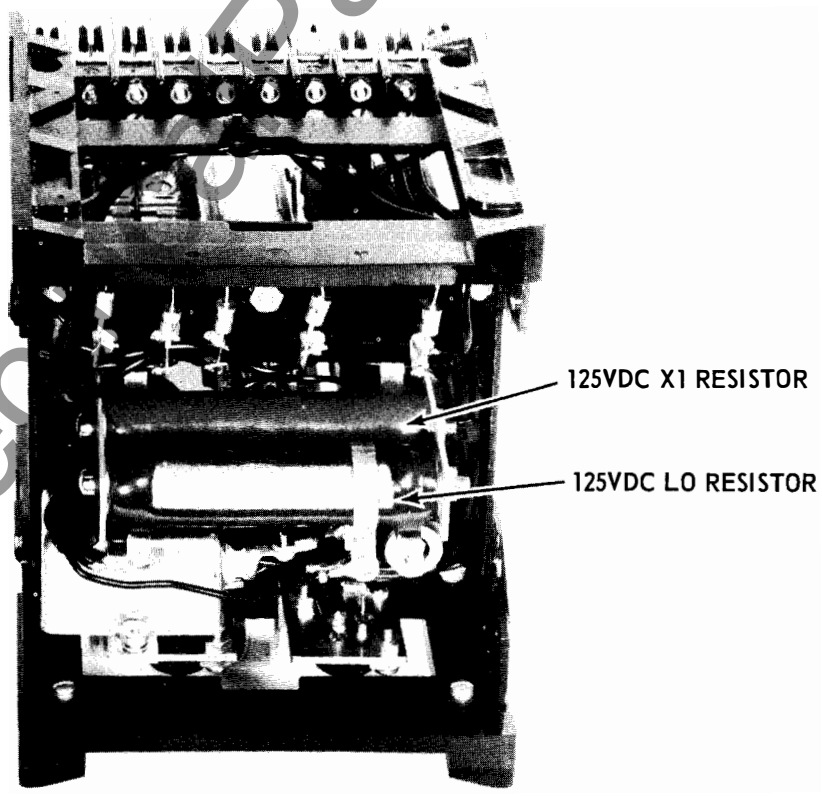
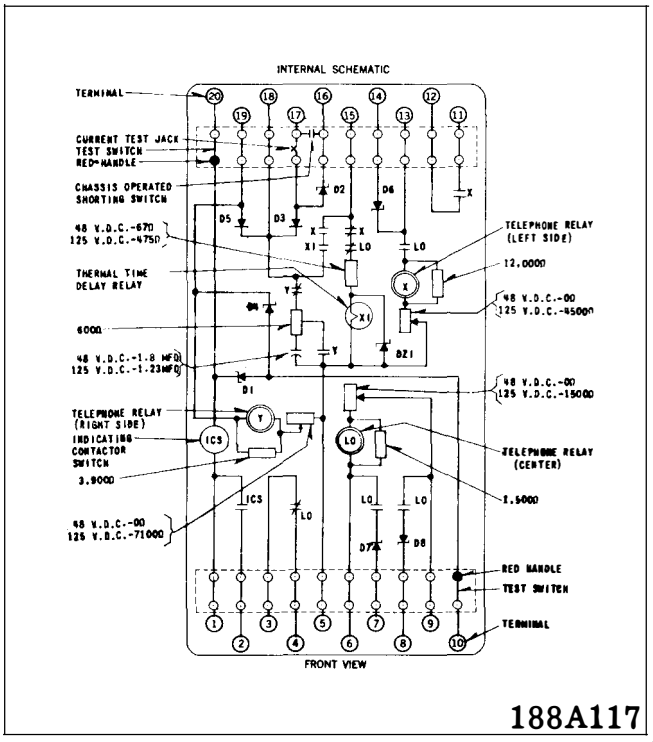
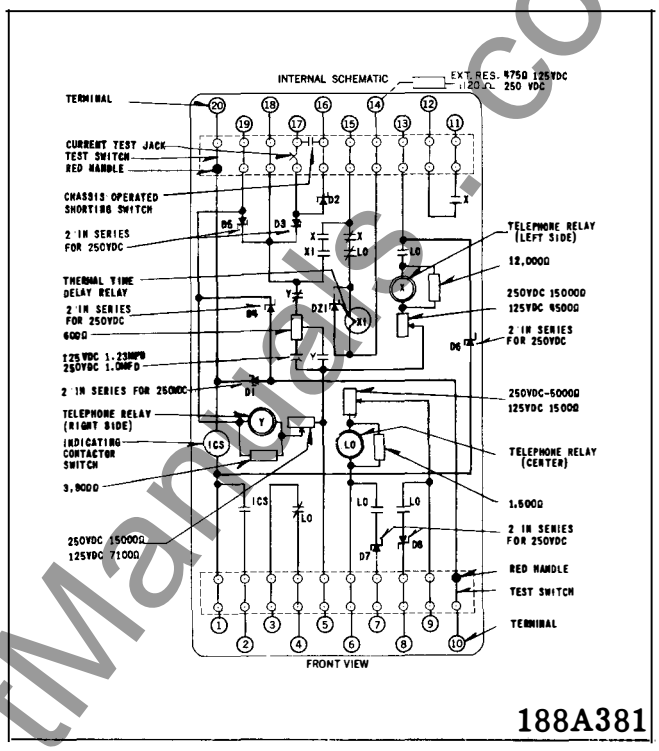


Fig. 2. Type TT-12 Relay without case (Rear View)



* *Fig. 3. Internal Schematic of the Type TT-12 Relay in the Type FT 22 case for 48 VDC Only.*



* *Fig. 4. Internal Schematic for the TT-12 Relay in the Type FT22 case for 125 & 250 VDC.*

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

The type TT-12 relay is used with a microwave or 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. See figs. 5, 6, 7 & 8.

The protective relays and the relay settings used in the TT-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 TT-12 scheme, however, uses a tripping signal rather than a blocking signal to provide improved security against undesired relay operation for external faults. Since the microwave or pilot wire tone channels are separate from the conductors of the protected power line, it is not necessary to use a blocking signal, as in the conventional directional comparison carrier scheme. This avoids having to send the signal on the conductors through a fault. The conventional directional comparison carrier scheme is arranged to trip on absence of the blocking signal, so that the channel failure will result in false tripping for external remote faults that are within reach of the protective relays. Since the TT-12 scheme requires reception of the trip signal as well as operation of the local protection relays, channel failure cannot result in undesired tripping.

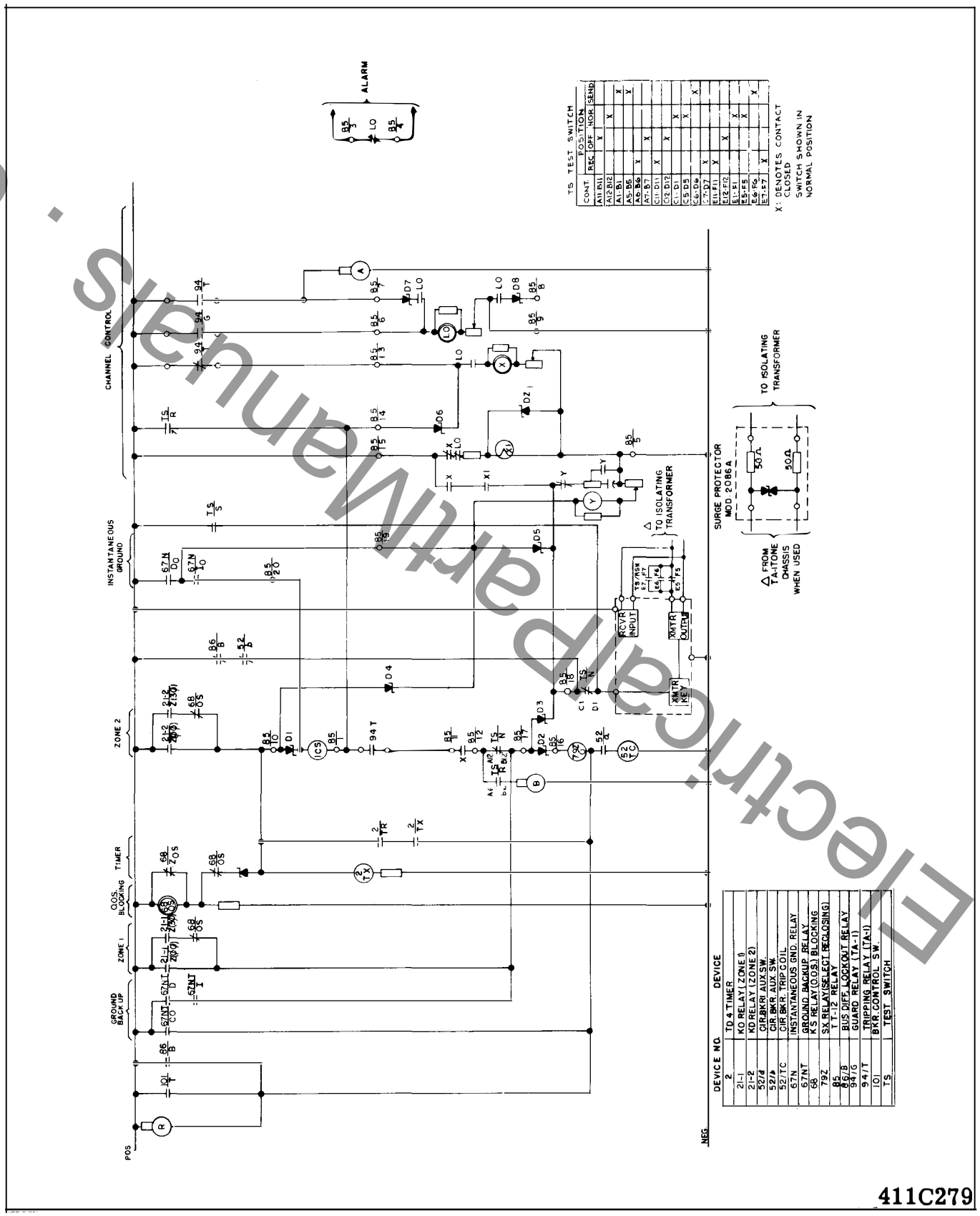
Auxiliary Unit X

The X-unit is used to provide a coordinating delay, if a sudden reversal occurs in the direction of fault power flow in the protected line. For an internal fault, the X-relay is preclosed and is kept closed by fault detecting relays (PR). These consist of the KRD directional overcurrent ground relay and the KD zone 2 phase distance relay.

Auxiliary Unit Y and Anti-bounce Circuit

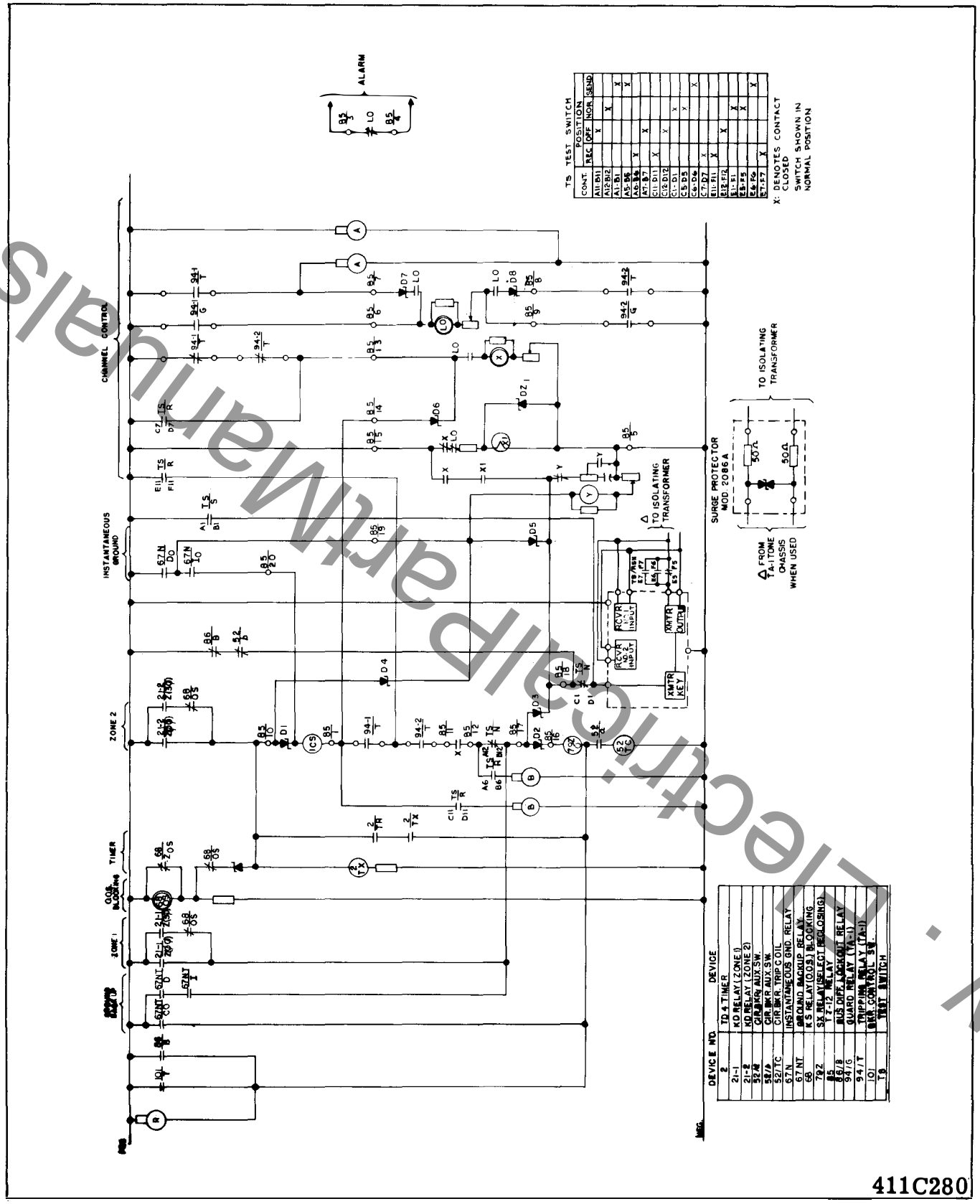
Auxiliary unit Y, in conjunction with capacitor and resistor provides for continuation of the audio tone tripping signal in case the protective relay (PR) contacts should have an initial bounce. The sequence of operation of this anti-bounce circuit is as follows:

As soon as a PR contact first closes, the capacitor charges almost instantaneously to the approximate value of the d-c control voltage through the resistor R and the normally closed Y contact, at the same time closing of the protective relay contact applies reverse bias to the keying tran-

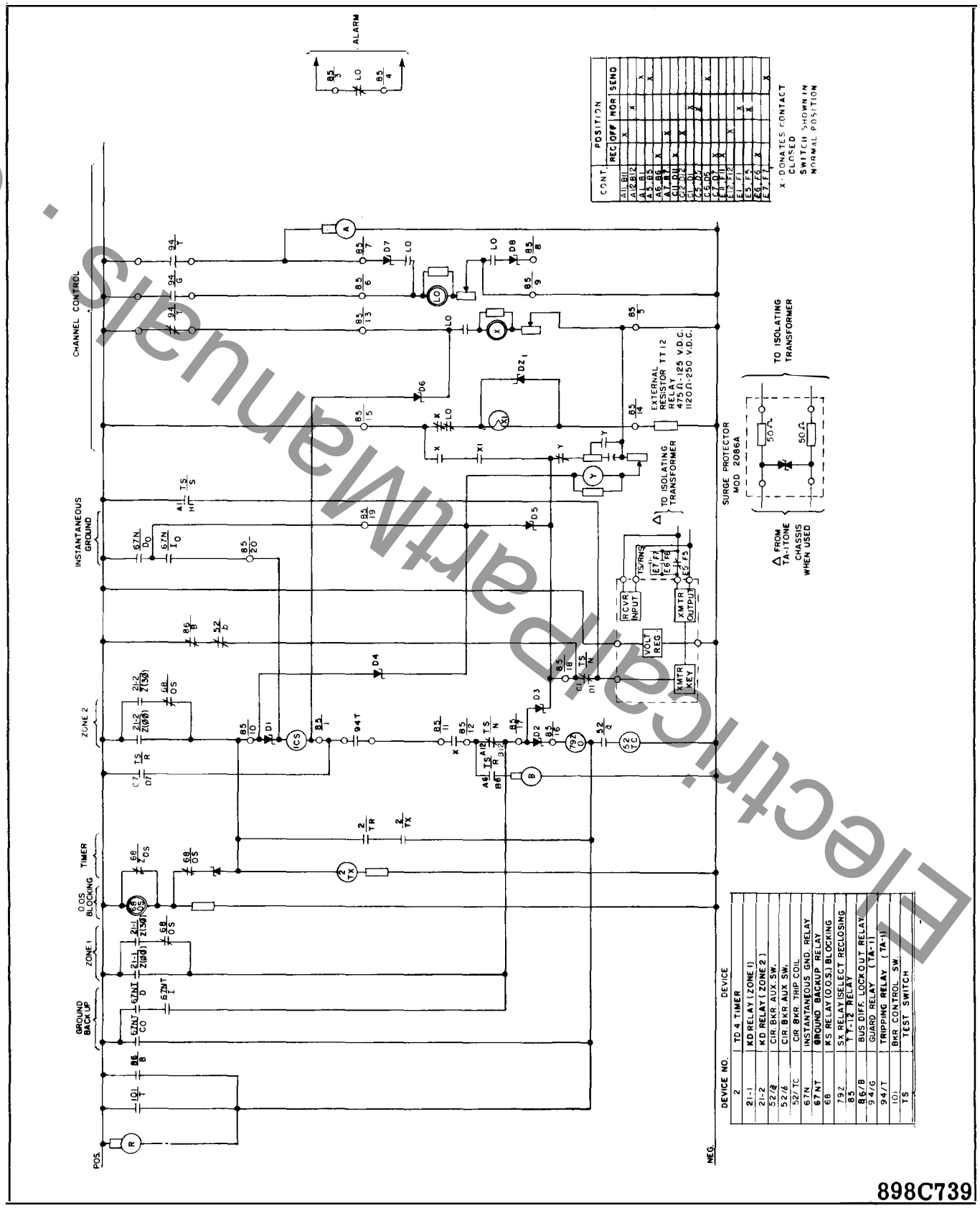


DEVICE NO.	DEVICE
2	TD 4 TIMER
21-1	KO RELAY (ZONE 1)
21-2	KO RELAY (ZONE 2)
52/d	CIR.BKR AUX.SW.
52/a	CIR.BKR. AUX.SW.
52/TC	CIR.BKR. TRIP COIL
67N	INSTANTANEOUS GND. RELAY
67NT	GROUND BACKUP RELAY
68	K.S RELAY (O.O.S.) BLOCKING
79Z	SX RELAY (SELECT RECLOSING)
85	TT-12 RELAY
86/B	BUS DIFF. LOCKOUT RELAY
94/G	GUARD RELAY (TA-1)
94/T	TRIPPING RELAY (TA-1)
101	BKR. CONTROL SW.
TS	TEST SWITCH

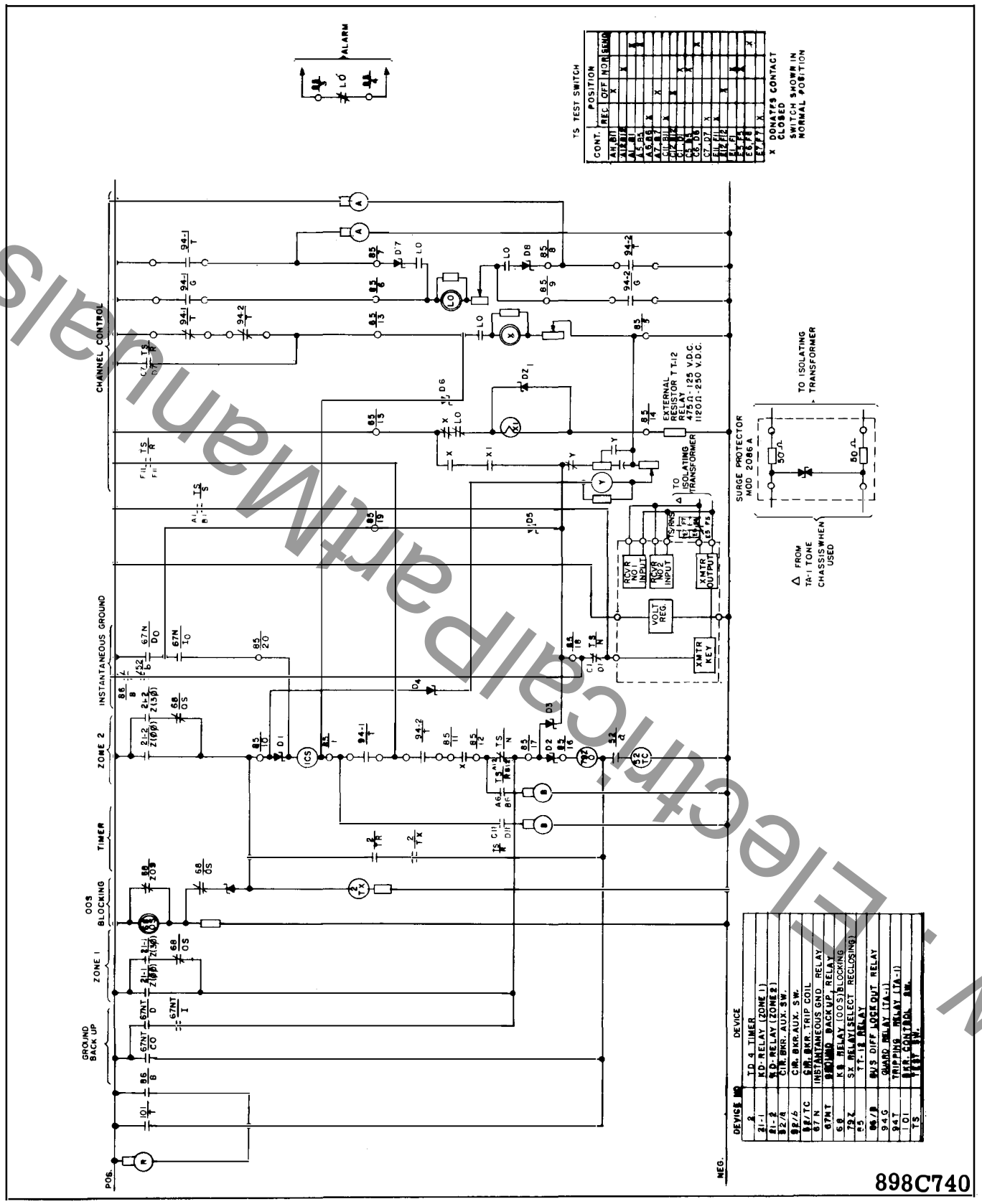
* *Fig. 5. K-Dar/TT12 Transfer Trip Scheme (Two Terminal Line) for 48 VDC Operation.*



** Fig. 6. K-Dar/TT12 Transfer Trip Scheme (Three Terminal Line) for 48 VDC Operation.*



* *Fig. 7. K-Dar/TT12 Transfer Trip Scheme (Two Terminal Line) for 125 & 250 VDC Operation.*



* *Fig. 8. K-Dar/TT12 Transfer Trip Scheme (Three Terminal Line) for 125 & 250 VDC Operation.*

sistor in the transmitter of the audio tone equipment, causing the transmitter to shift to the trip frequency. Should the PR contact bounce open, this reverse bias to "shift" is upheld by the capacitor voltage that is slowly discharged through a high resistance path in the transmitter circuit. When PR contact recloses the same sequence of events takes place. When finally PR closes "solid" or long enough for Y unit to operate, the anti-bounce circuit is cut off by the normally closed Y contact and the capacitor charge is dissipated through a normally open contact and its associated resistor.

Auxiliary Unit LO

The LO unit is energized by the tone receiver 94-G guard relay contact as shown in Figs. 5, 6, 7 & 8. One contact of the LO relay energizes the X unit. This makes it possible, in case of channel failure, to lock out the transfer tripping at the local terminal. A second LO contact is in series with the alarm circuit, and a third LO contact is in series with the tone receiver 94-T trip relay contact, as a second path to energize the LO unit coil, after the trip signal is received. A break contact is used, along with a break X relay contact, to supervise the X1 relay. The LO unit has prolonged dropout time, thus assuring that it will stay closed during a shift of frequency.

Auxiliary Unit X-1

The unit X-1 provides means for a check-back test. It is energized by a break contact of the X and LO units. Its contact energizes the keying circuit and is supervised by an X contact to avoid check-back keying during faults.

Operation of test facilities

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 the transmission of the guard signal from the local station to remote stations where the LO-unit drops out. The LO and X unit break contacts energize the X1-thermal unit which requires 2-3 seconds to pickup.

2. After holding the test switch in the "OFF" position for approximately 10 seconds, the operator next moves the test switch to the "RECEIVE" position. This re-establishes the transmission of guard signal. The LO-unit and X-unit at remote line terminals pick up again. With the thermal unit X1 still picked up the trip signal is transmitted from remote line terminals until X1 unit resets. The operator should see the "BLUE and "AMBER" test light for approximately 2 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.

   The test switch in Figs. 5, 6, 7, & 8 provides a "send" position so that the transmitter may be shifted during periodic maintenance checks.

Tripping Diodes D1, D2

Tripping diode D1 provides isolation of the KD timer circuit from the ground fault detector relay. Diode D2 prevents the keying circuit from being energized for operation of 86B contact for a bus fault behind the protected line. Otherwise, undesired tripping of remote terminals would result.

Blocking Diodes

D3 — blocks tripping current path through directional ground contact D_O and diode D5 and blocks tripping current path from battery positive thru X and X1 relay contacts during check-back tests.

D4 — blocks tripping current path through directional ground contact D_O, 94-T and X contacts.

D5 — blocks discharge of the anti-bounce capacitor through the Y unit

D6 — prevents energizing one of the blue lights during check-back test on 3-terminal line arrangement with test switch in "RECEIVE" position. See Fig. 6.

D7 & D8 — are in series with the lockout relay coil and are used to block the guard relay from energizing the amber light.

SETTINGS

There are no settings to be made on the relay.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay.

The electrical connections may be made directly to the terminals by means of screws for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments should be required.

Acceptance Check

The following check is recommended to insure that the relay is in proper working order:

Auxiliary Units X, X1, and Y, and LO

Energize each auxiliary unit with rated voltage and check contact action. If desired, the timing of the operation can be checked as outlined under calibration procedure.

Zener Tripping Diode

a. Reverse Characteristic:

Breakdown voltage is the value of voltage at which the reverse current just exceeds 5 milliamperes and should be between 160 to 240 volts for each diode. The breakdown voltage is determined by slowly increasing voltage until reverse current exceeds 5 milliamperes and starts to increase rapidly. Do not exceed 200 milliamperes reverse current.

b. Forward Characteristic:

With 10 amperes flowing in forward direction, the forward voltage across each diode should not exceed 1.5 volts.

Zener Blocking Diodes

a. Reverse Characteristic:

Breakdown voltage is the value of voltage at which the reverse current just exceeds 0.25 milliamperes and should be between 160 to 240 volts for each diode. The breakdown voltage is determined by slowly increasing the voltage until reverse current exceeds 0.25 milliamperes and starts to increase rapidly. Do not exceed 3 milliamperes reverse current.

b. Forward Characteristic:

With 200 milliamperes flowing in forward direction, the forward voltage across each diode should not exceed 1.5 volts.

Routine Maintenance

All relays should be inspected periodically and the operation should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. A contact burnisher S#182A836 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

NOTE: Whem making a dielectric test on the relay, the high voltage maybe applied at the relay terminal, from all circuits to ground, between coil and contact circuits. and between isolated coil circuits. However, the test voltage should not be applied across relay contacts, relay coils, or rectifier circuits.

CALIBRATION

Use the following procedure for calibrating the relay, if the relay has been taken apart for repairs or if the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order.

Auxiliary Units X, X1, Y, and LO

The operating time of units X, Y and LO should be checked with an electronic timer.

The residual air gap should not be less than .002" and the contact gaps should be between .020" to .035".

Auxiliary Unit X

The X relay is located at the left (FV) and is energized between terminals 5 and 13, with LO unit preclosed. Its adjusting resistor is located at the upper front. Contact circuitry between terminals 11 and 12. The closing time should be set for approximately one cycle. The approximate setting of the adjusting resistor is 3000 ohms for the 125 volt relays. The 48 volt relays do not use a calibrating resistor. The operating time for a variation of 85% and 115% of rated voltage is between 10 and 27 milliseconds. If necessary, adjustment to achieve timing may be made using adjustment resistor. Since there is no adjustment for the 48 volt relay, the 40 volt check limit is 32 milliseconds.

The dropout time should be approximately 25 milliseconds. If necessary, the dropout time can be adjusted using the residual screw and changing the armature gap. After final adjustment, the armature gap should not be less than .002"

Auxiliary Unit Y

* The Y unit is located at the right front and is energized between terminals 5 and 20. For contact circuitry, see Figures 3 & 4. The normally closed contact should open in 1.5 cycles at rated voltage. This adjustment is controlled by the Y unit resistor which is located at the lower left front. The approximate setting of the resistor is 5000 ohms for the 125 volt relays. The 48 volt relays do not use a calibrating resistor.

The dropout time at rated voltage should be 40-60 milliseconds. If necessary, the dropout time can be adjusted by using the residual screw and changing the armature gap. After final adjustment, the armature gap should not be less than .002".

Auxiliary Unit LO

* The LO unit is located at the upper center (FV) and is energized between terminals 6 and 9. Its adjusting resistor is located at the rear. See Figures 3 & 4. for contact circuitry. The closing time should be approximately one cycle at rated voltage. The approximate setting of the adjusting resistor is 1300 ohms for the 125 volt relays. The 48 volt relays do not use a calibrating resistor. The operating time for a variation of 85% and 115% of rated voltage is between 10 and 27 milliseconds. If necessary, adjustment to achieve timing may be made using adjusting resistor.

The dropout time at rated voltage should be 40-60 milliseconds. If necessary, the dropout time can be adjusted using the residual screw and changing the armature gap. After final adjustment, the armature gap should not be less than .002".

Auxiliary Unit X1

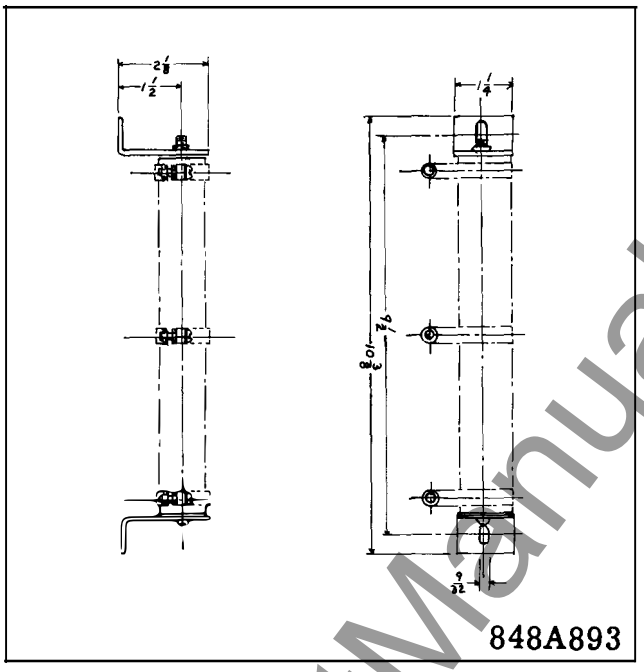
The X1 unit is located at the lower center (FV) and is energized between terminals 5 and 15 with the X and LO units de-energized. The X1 unit should have a dropout time of 2.5 ± 1 second, after being energized for 10 seconds. This time is measured at terminals 15 and 18, keeping in mind that the break contact of the X unit will have tc be jumpered. Adjust the timing if necessary, by means of adjusting a screw accessible from the top of the unit. To increase dropout time turn the screw slightly clockwise, and to decrease dropout time turn the screw slightly counterclockwise.

Indicating Contactor Switch (ICS)

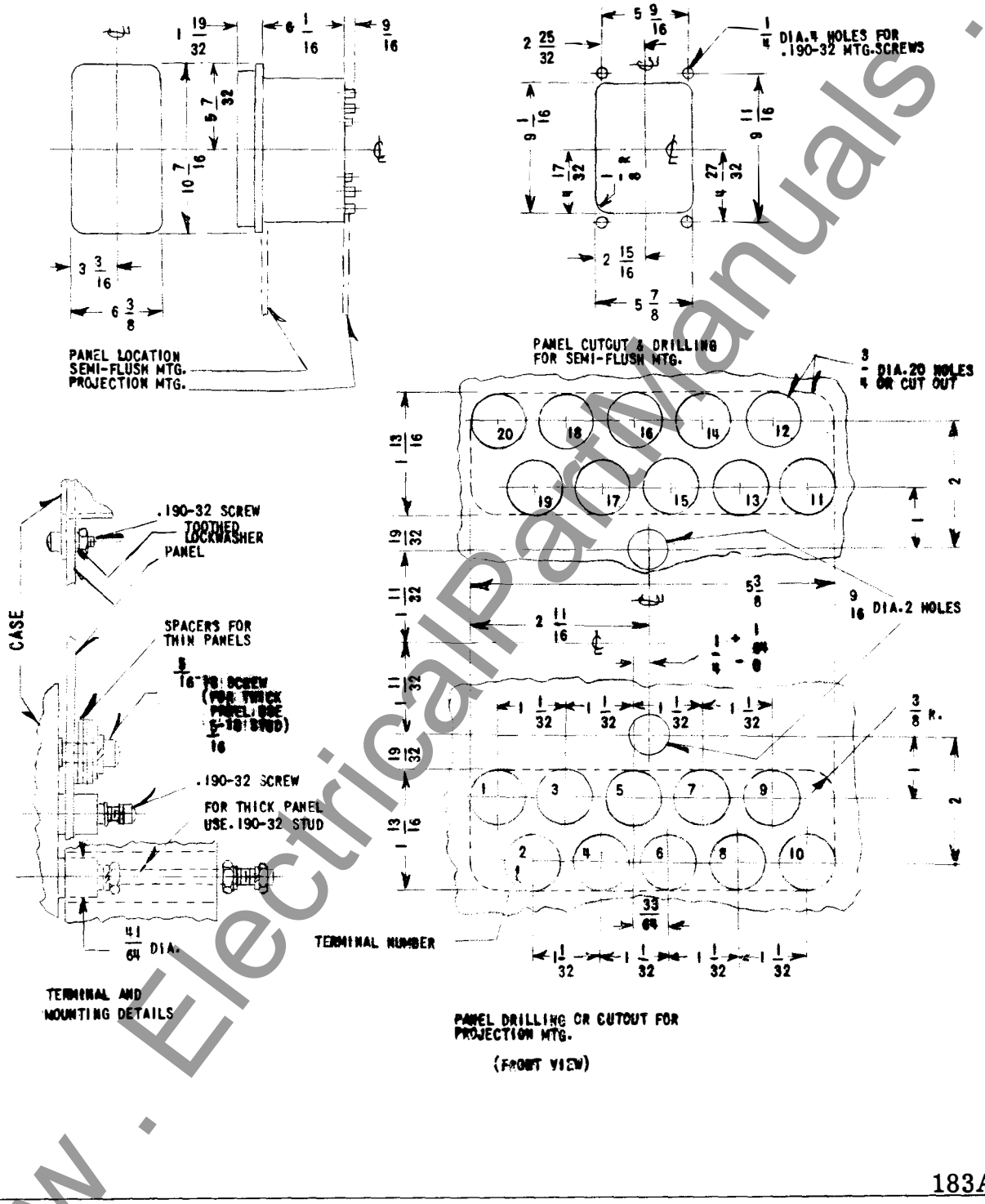
Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than 1.0 ampere. To increase the pickup current, bend the springs out, or away from cover. To decrease the pickup, bend the springs in toward the cover. Make sure that the target drops freely when energized.

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 repair work. When ordering parts, always give the complete nameplate data.



* *Fig. 9. Dwg. for External Resistor for TT12 Relay Outline.*



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* *Fig. 10. Outline and Drilling Plan for the Type TT-12 Relay in the Type FT22 case.*