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 DIT-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. 1N2846A and 1N2846RA).

BLOCKING DIODES D3 TO D4

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 dc 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.

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. 8 thru 15.

SUPERSEDES I.L. 41-958.91C, dated January 1975
***Denotes change from superseded issue.**

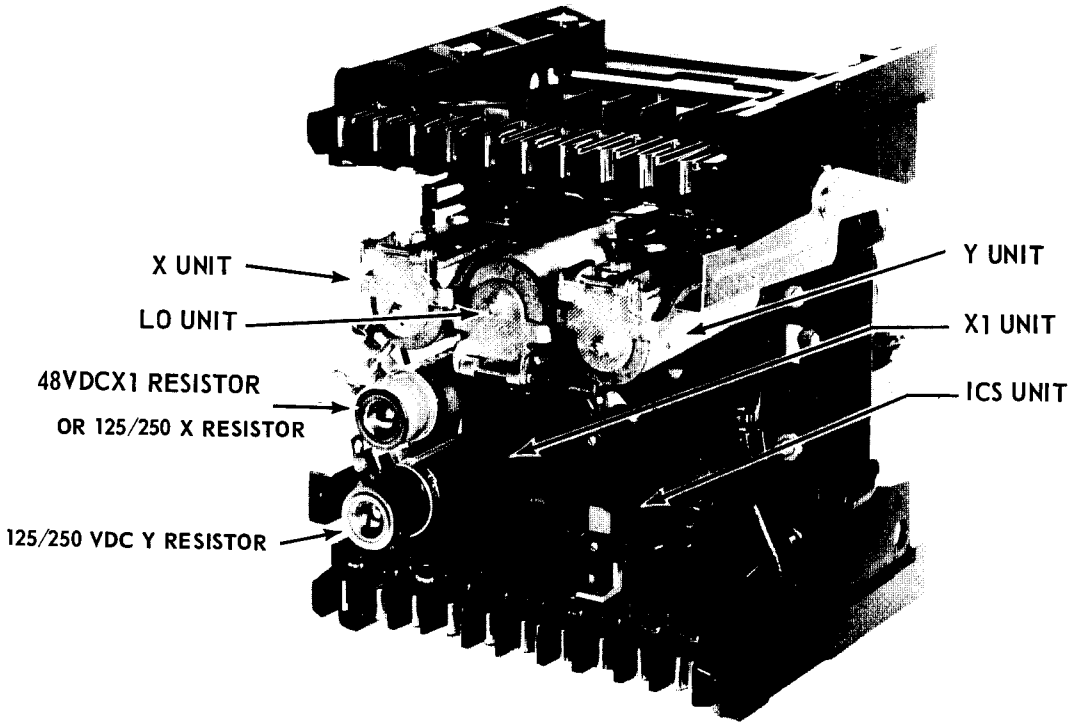


Fig. 1. Type TT-12 Relay without Case (Front View)

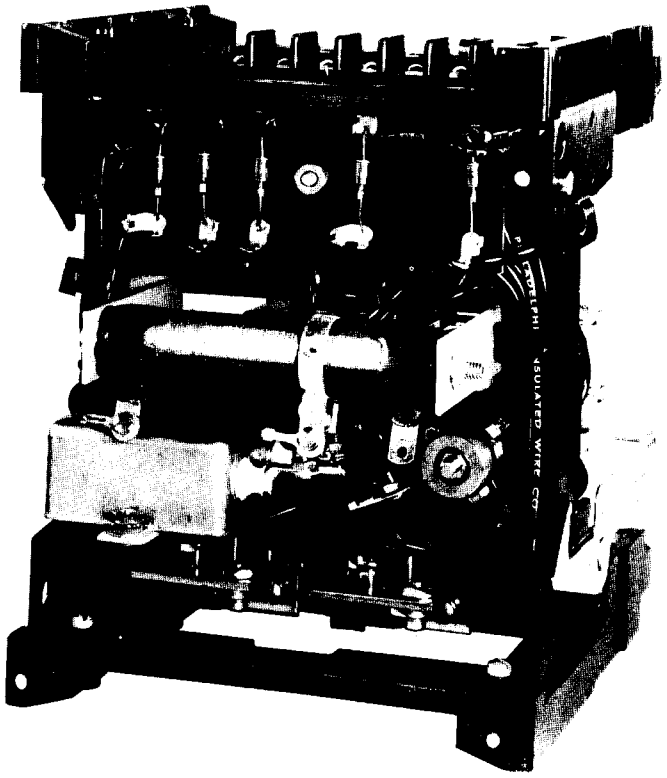


Fig. 2. Type TT-12 Relay without Case (Rear View)

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-4 directional overcurrent ground relay and the KD-10 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) contact 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 dc 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. 8, 9, 10 and 11. 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 or DIT-1 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 or DIT-1 tone 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 or DIT-1) drops out. The LO or AL and X unit break contacts energized to X-1 terminal 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 (AL for TCF or DIT-1) 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. 8 thru 15 provide a "send" position to 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_0 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_0, 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 of 3-terminal line arrangement with test switch in "RECEIVE" position. See Fig. 9.

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. 16.

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. 7.

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

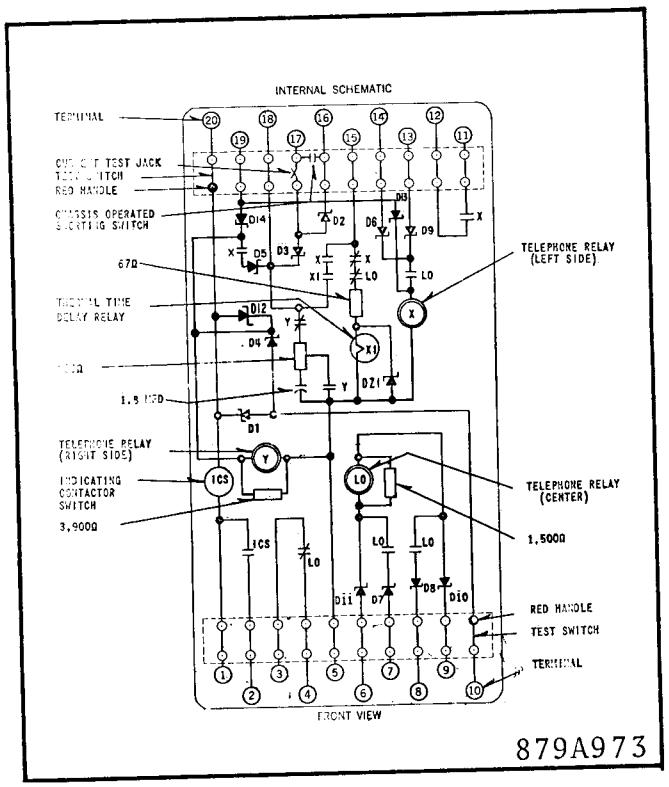


Fig. 3. Internal Schematic 48 VDC Universal TT-12 Relay in the Type FT22 Case

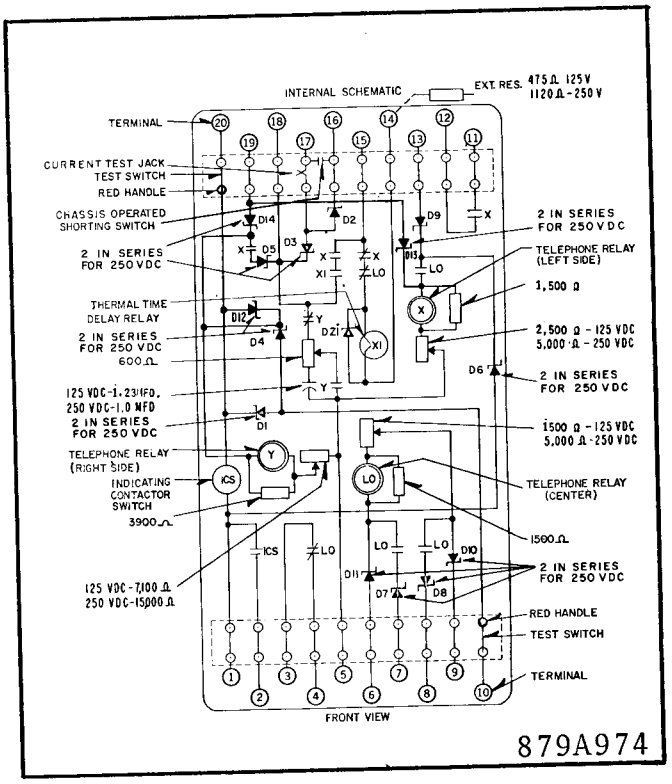
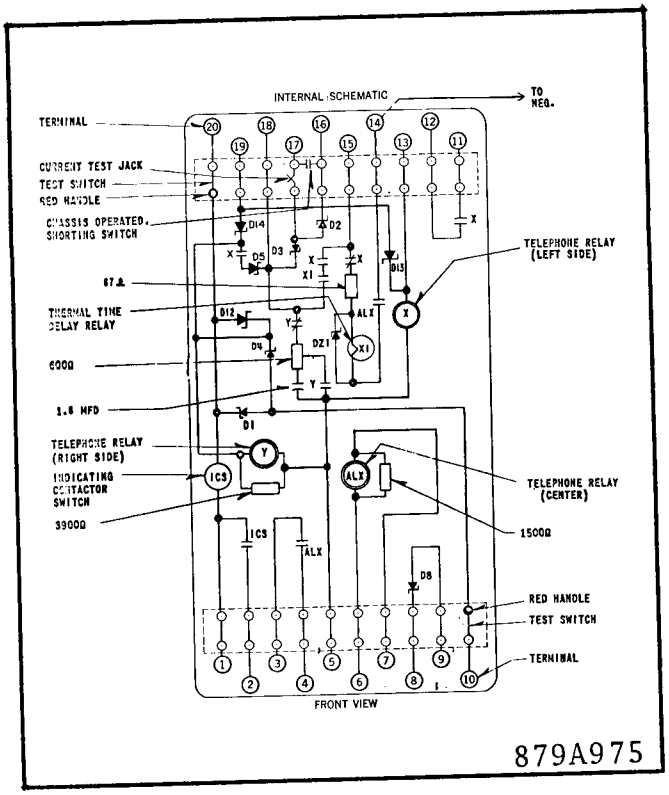
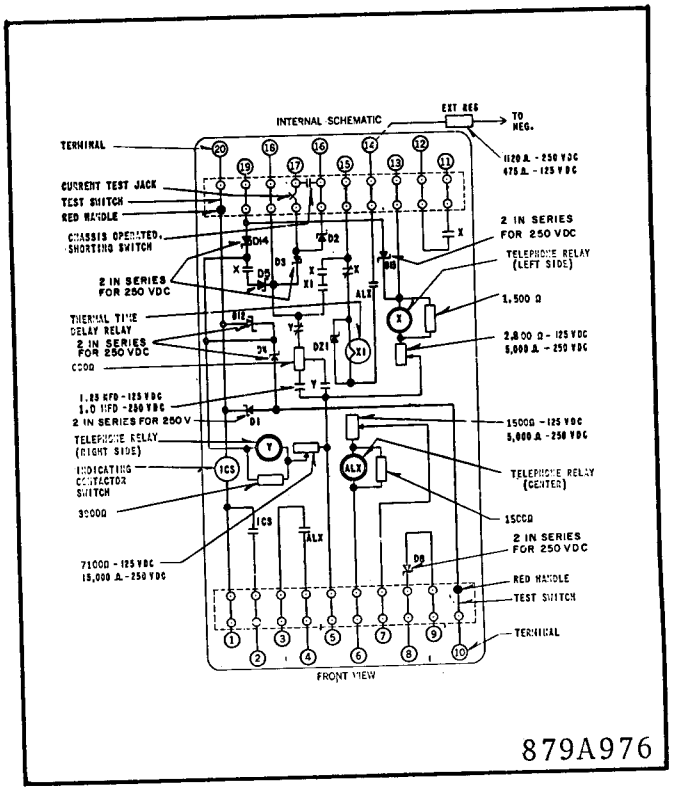


Fig. 4. Internal Schematic 125/250 VDC Universal TT-12 Relay in the Type FT22 Case



✪ *Fig. 5. Internal Schematic 48 VDC TT-12 Relay for TCF Carrier & DIT-1 Tones in the Type FT22 Case*



✪ *Fig. 6. Internal Schematic 125/250 VDC TT-12 Relay for TCF Carrier & DIT-1 Tones in the Type FT22 Case*

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 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 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 L 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 dc 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.

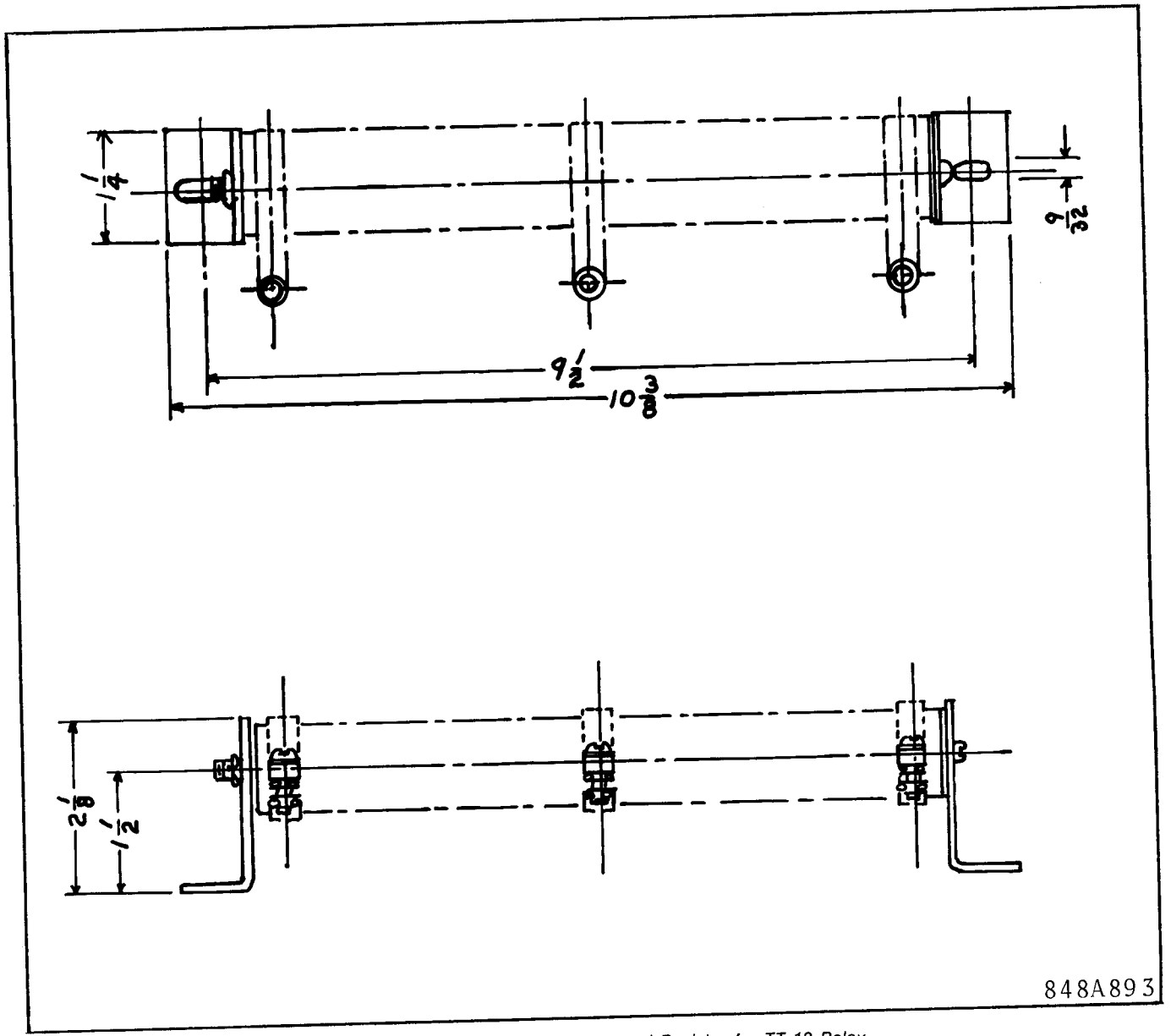


Fig. 7. Outline Dwg. for External Resistor for TT-12 Relay.

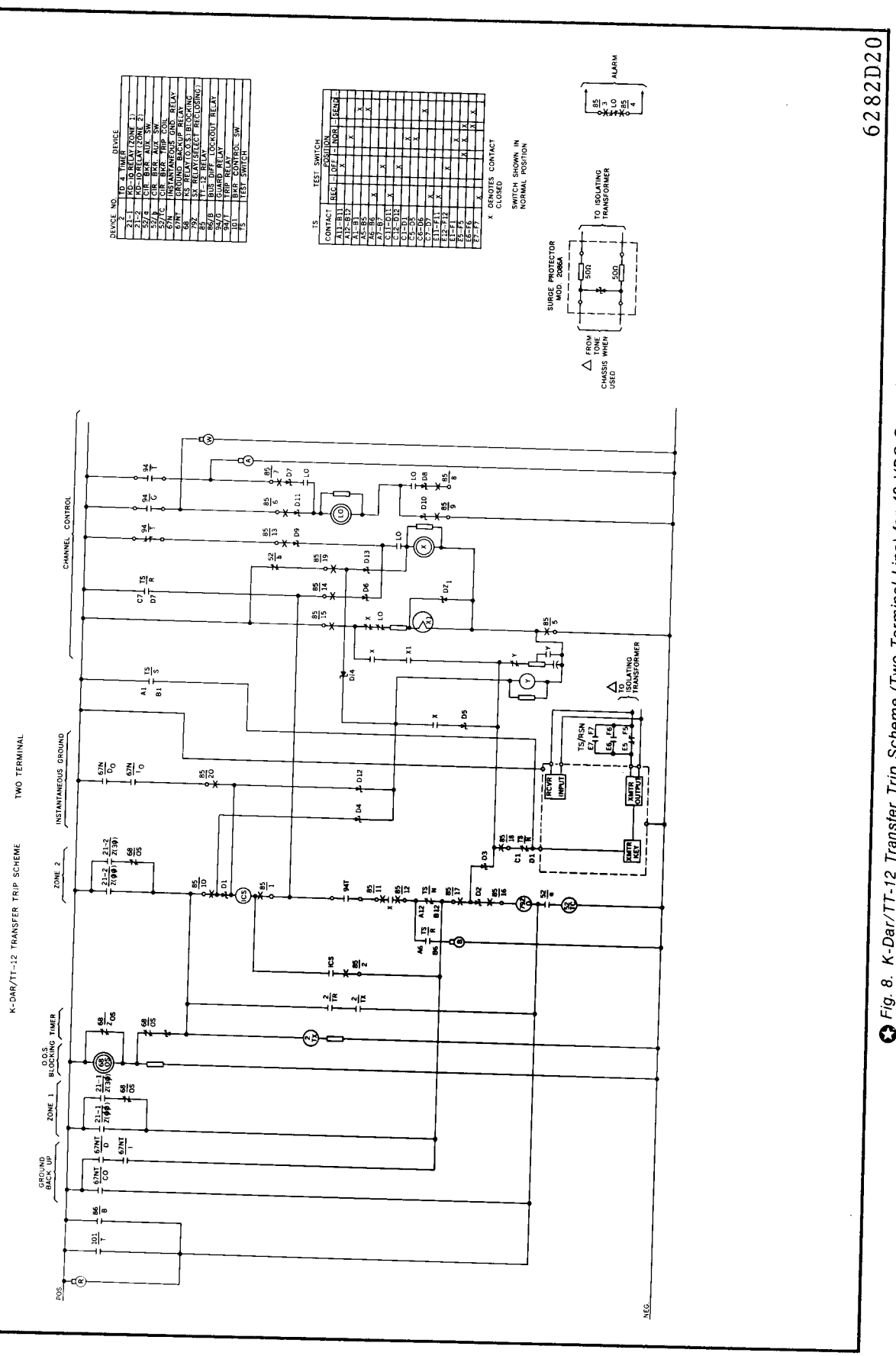


Fig. 8. K-Dar/TT-12 Transfer Trip Scheme (Two Terminal Line) for 48 VDC Operation.

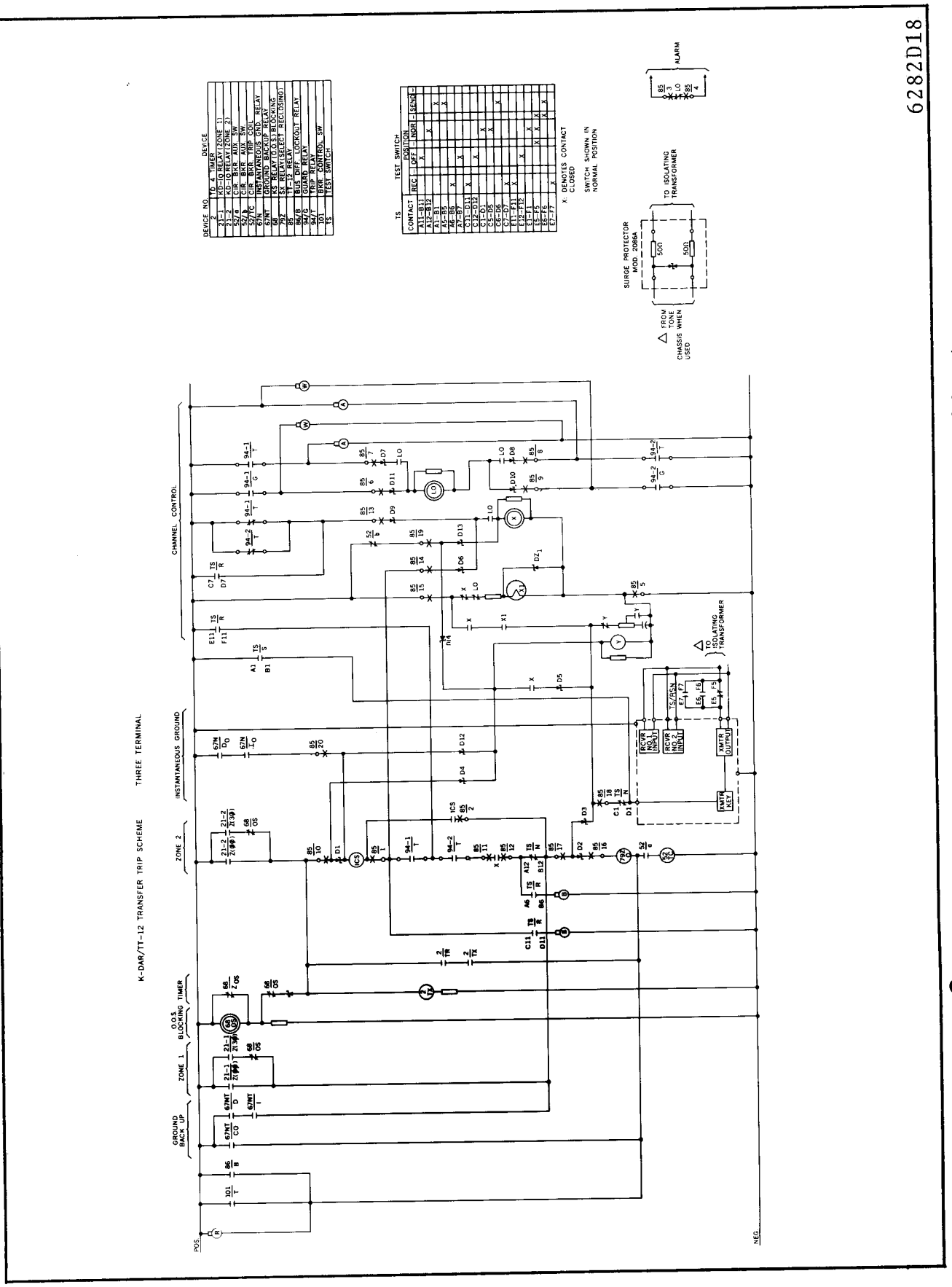


Fig. 9. K-Dar/TT-12 Transfer Trip Scheme (Three Terminal Line) for 48 VDC Operation.

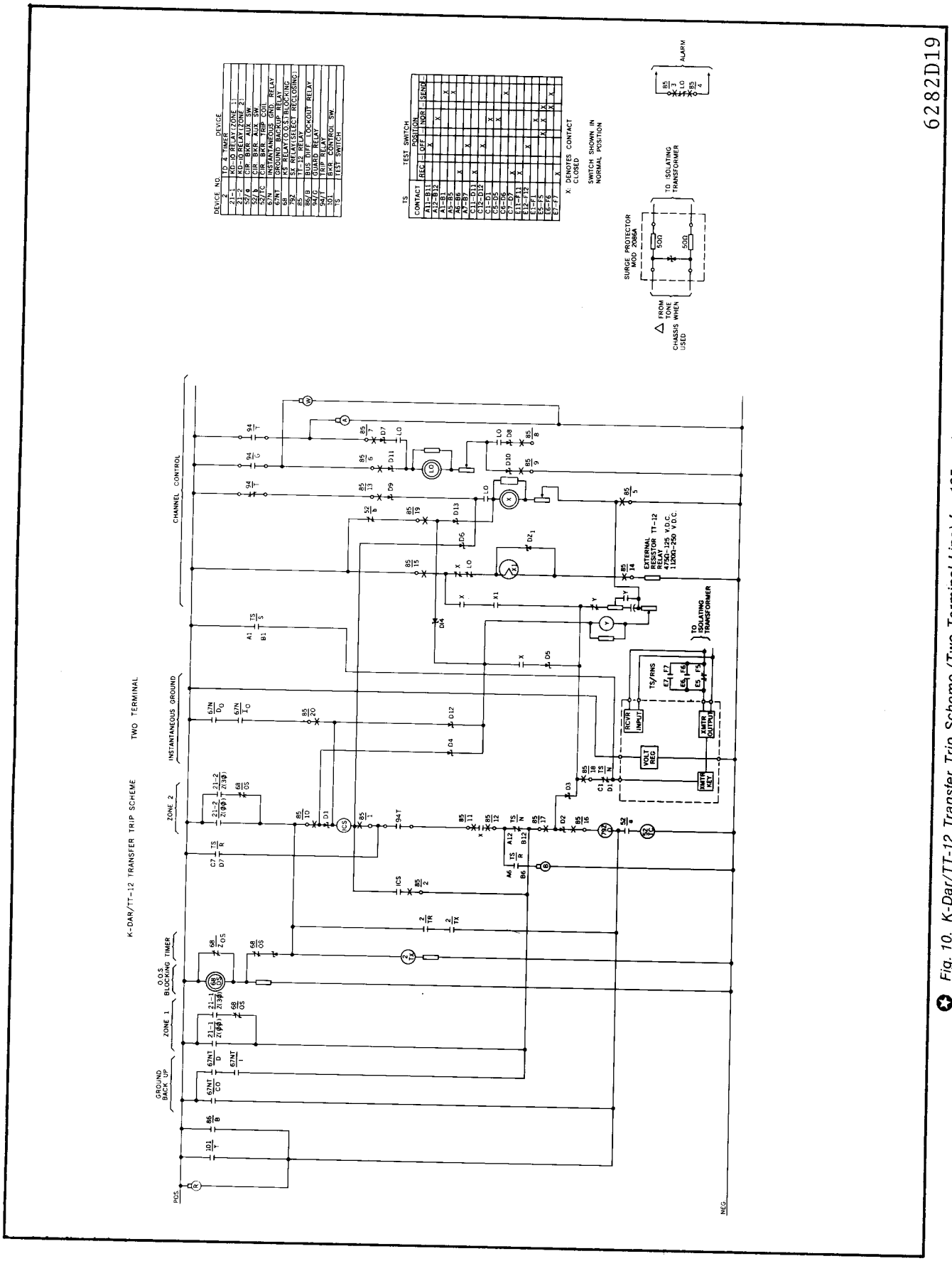


Fig. 10. K-Dar/TT-12 Transfer Trip Scheme (Two Terminal Line) for 125 and 250 VDC Operation.

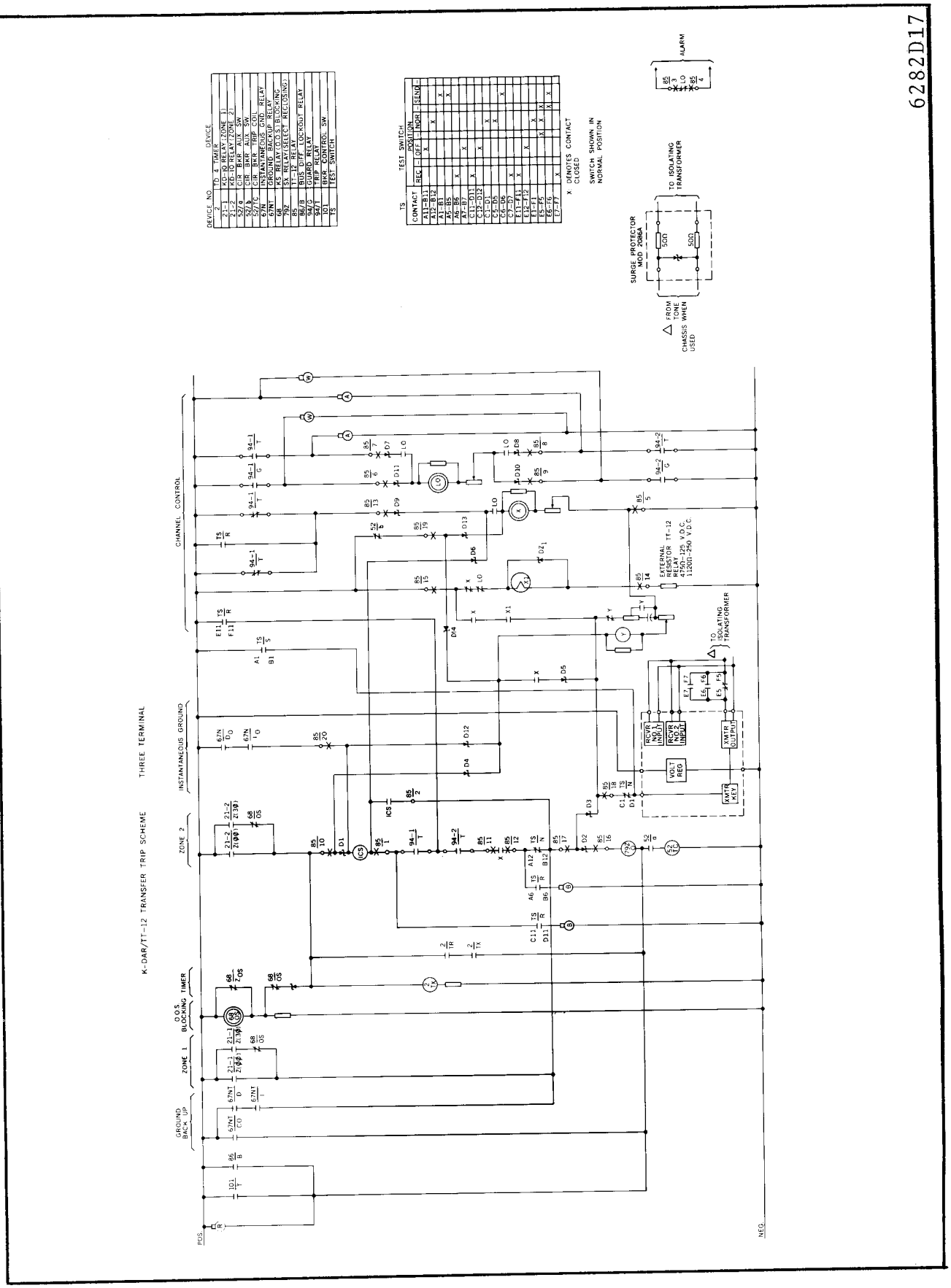
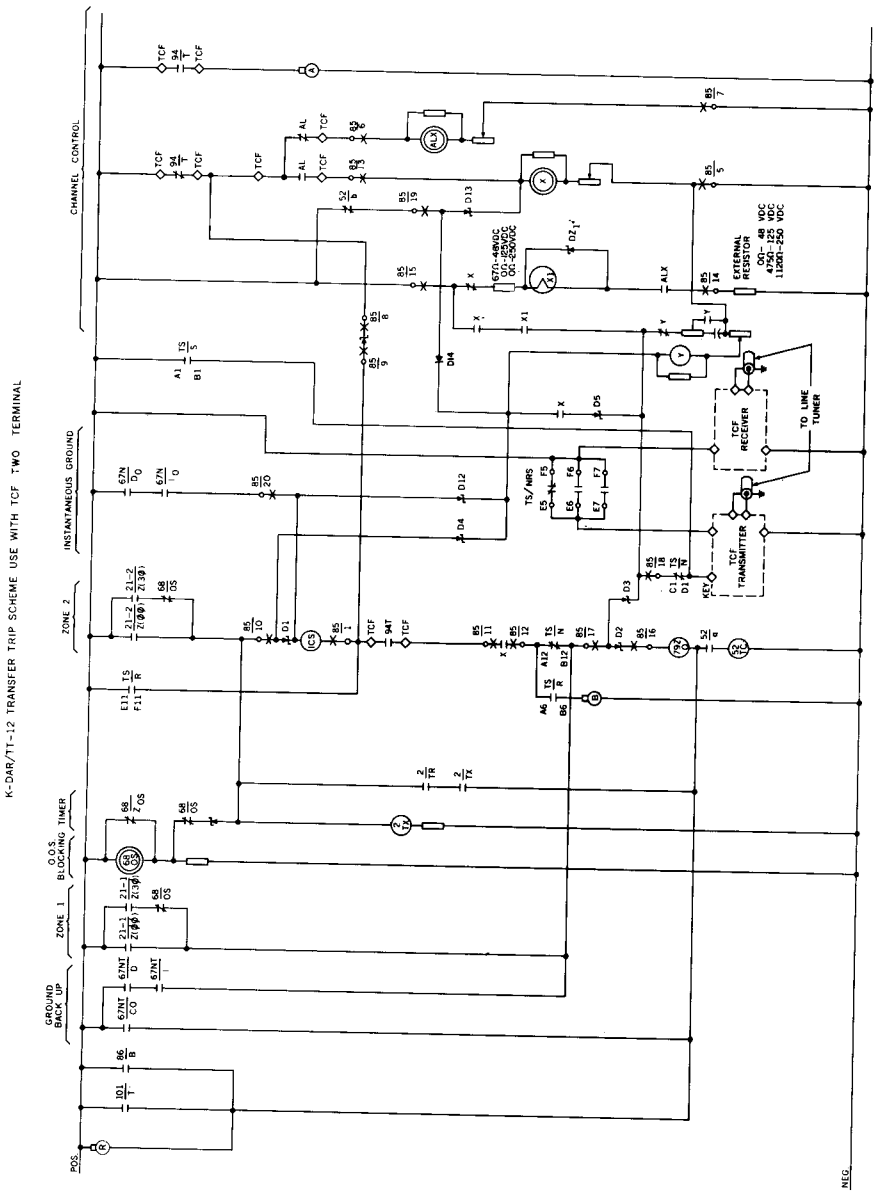


Fig. 11. K-Dar/TT-12 Transfer Trip Scheme (Three Terminal Line) for 125 and 250 VDC Operation.



DEVICE NO	DEVICE
2	TID 4 TIMER
21-1	KD-10 RELAY (ZONE 1)
21-2	KD-10 RELAY (ZONE 2)
52/a	CIR. BKR. AUX. SW.
52/b	CIR. BKR. AUX. SW.
52/TC	CIR. BKR. TRIP COIL
67N/T	INST. GROUND O.C. RELAY
67N/T	GROUND BACKUP RELAY
68	KS RELAY(O.O.S.) BLOCKING
79	SX RELAY(SELECT RECLOSING)
85	TCF RELAY
86/B	BUS DIFF. LOCKOUT RELAY
AL	ALARM RELAY (TCF)
94/T	TRIP RELAY (TCF)
TCS	TEST SWITCH SW.
TS	TEST SWITCH

TS	TEST SWITCH POSITION			
CONTACT	REC.	OFF	NOR.	SERVICE
A11-B11		X		
A12-B12	X		X	
A1-B1				X
A5-B5	X			
A6-B6				X
A7-B7	X			
C11-D11				
C12-D12	X		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	X
E6-F6	X			
E7-F7			X	X

X DENOTES CONTACT CLOSED

SWITCH SHOWN IN NORMAL POSITION

6282D21

Fig. 12. K-Dar/TT-12/TCF Scheme (Two Terminal Line) for 48, 125 or 250 VDC Operation.

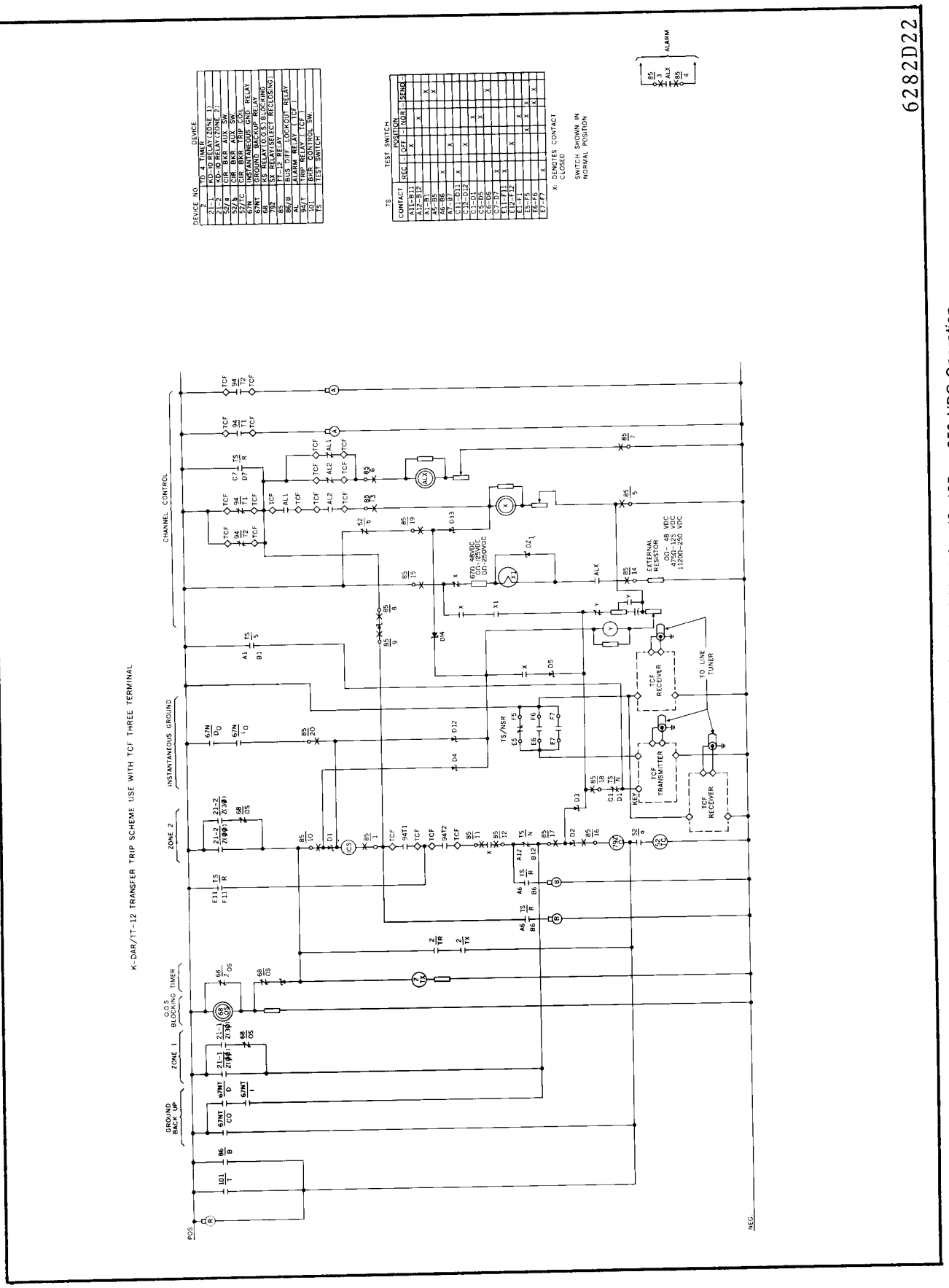


Fig. 13. K-Dar/TT-12/TCF Scheme (Three Terminal Line) for 48, 125 or 250 VDC Operation.

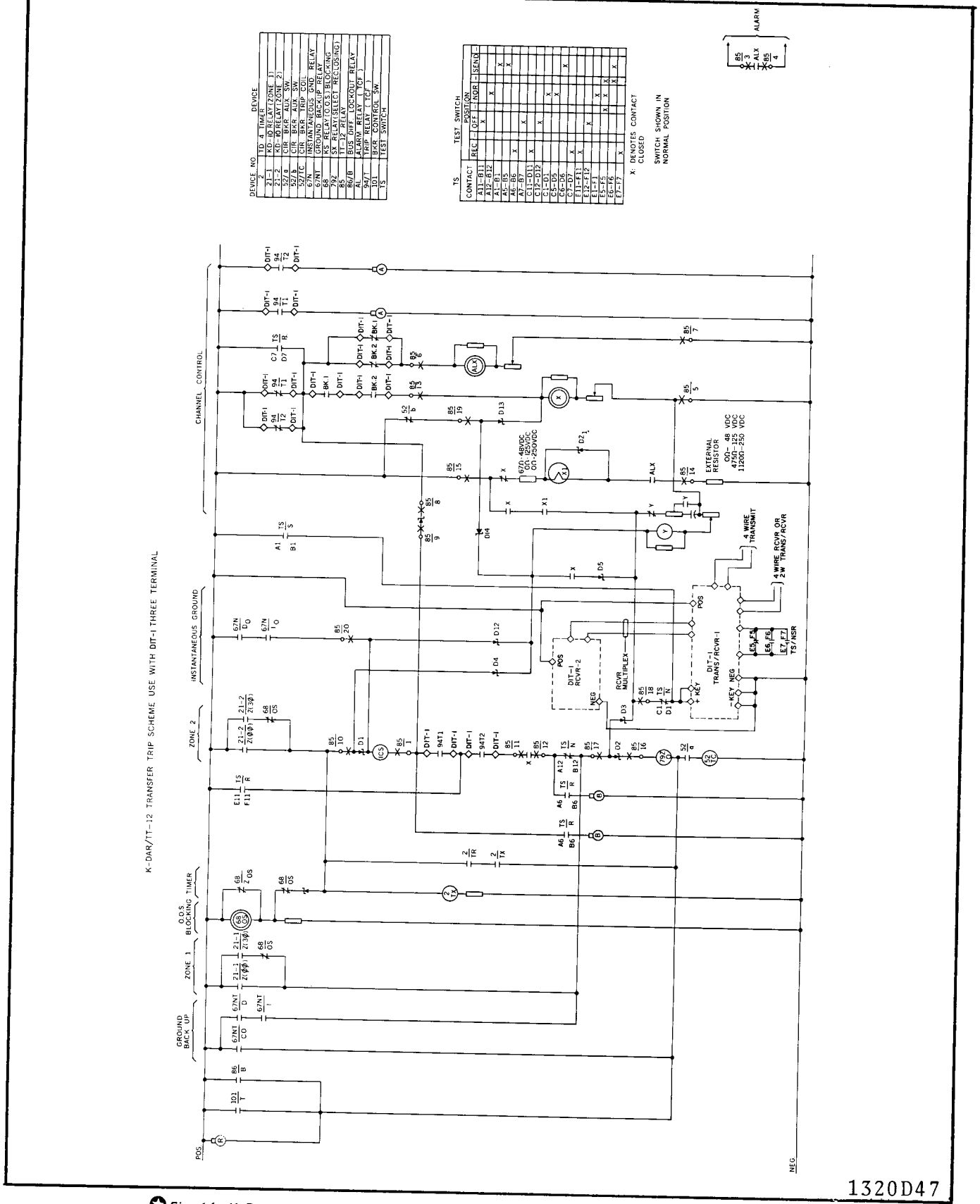


Fig. 14. K-Dar/TT-12/DIT-1 Scheme (Two Terminal Line) for 48, 125 or 250 VDC Operation.

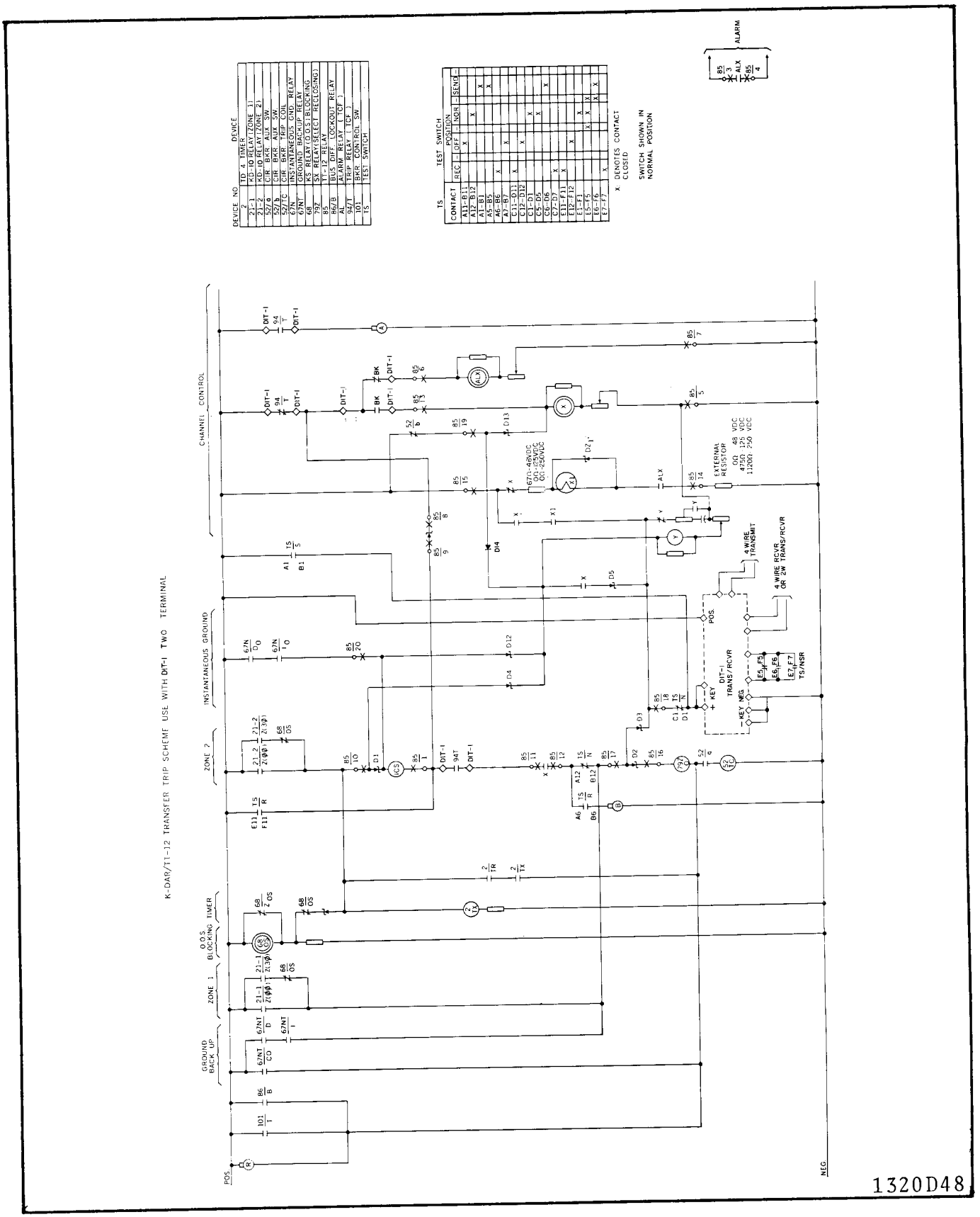


Fig. 15. K-Dar/TT-12/DIT-1 Scheme (Three Terminal Line) for 48, 125 or 250 VDC Operation.

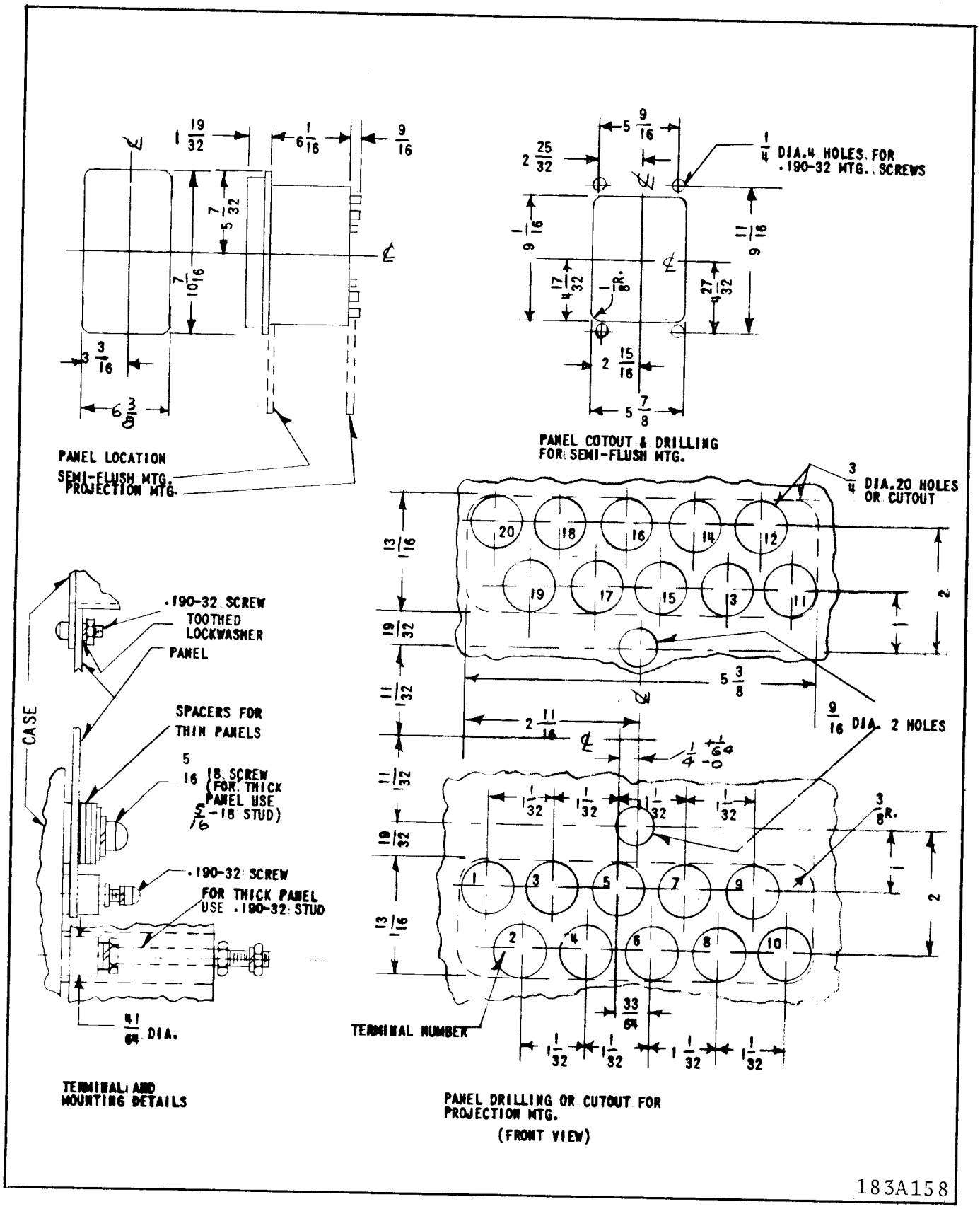


Fig. 16. Outline Drawing for FT22 Case.

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Indicating Contactor Switch Unit (ICS)

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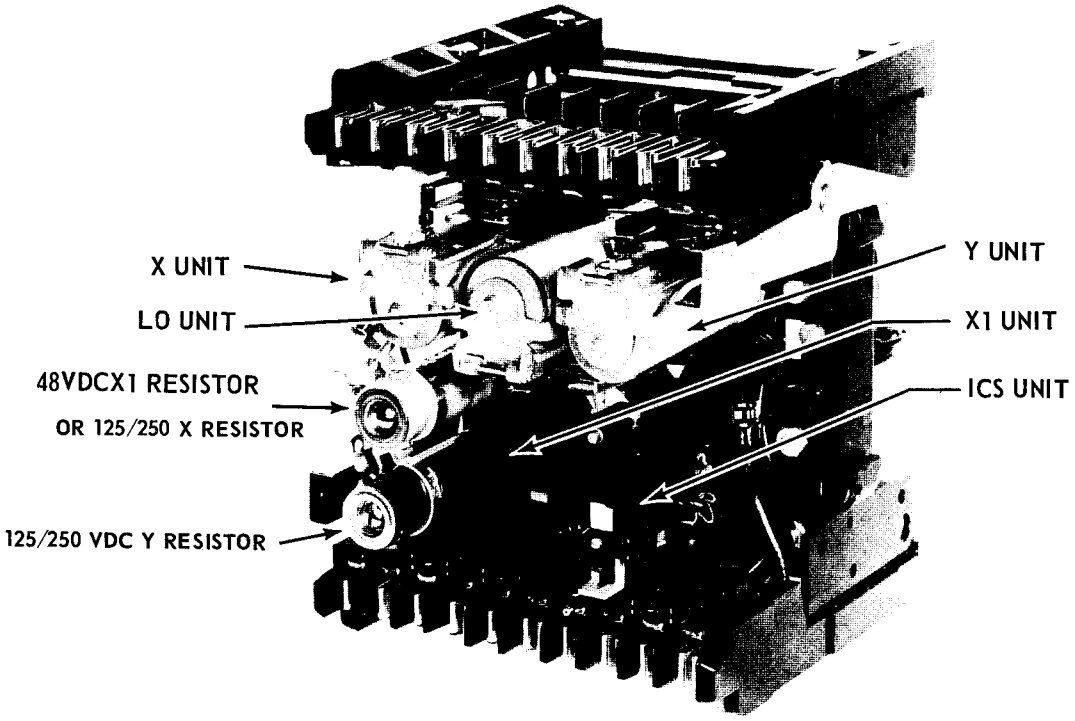


Fig. 1. Type TT-12 Relay without Case (Front View)

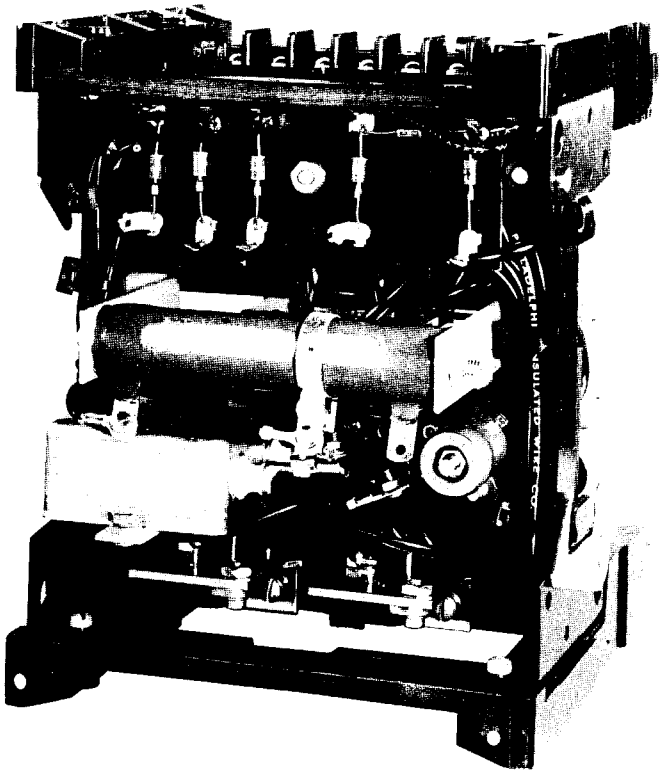


Fig. 2. Type TT-12 Relay without Case (Rear View)

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

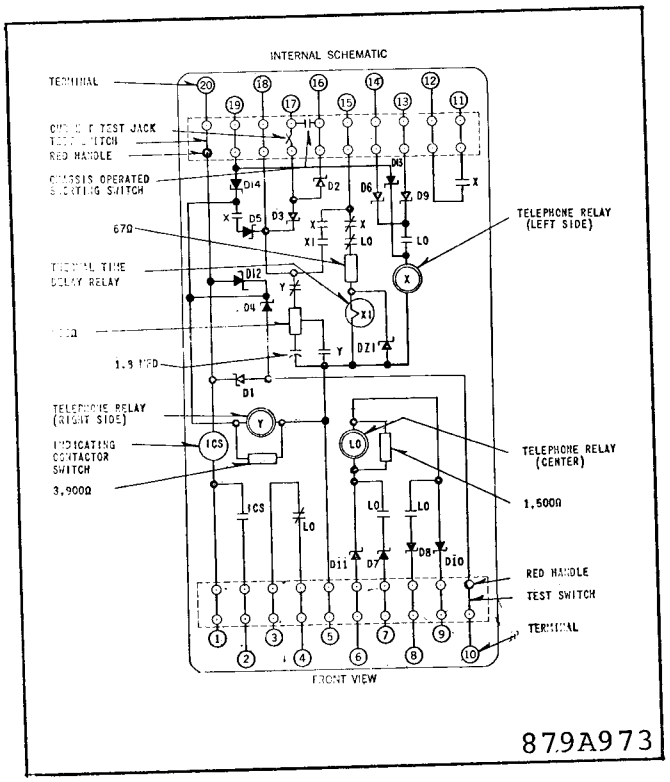
There are no settings to be made on the relay.

INSTALLATION

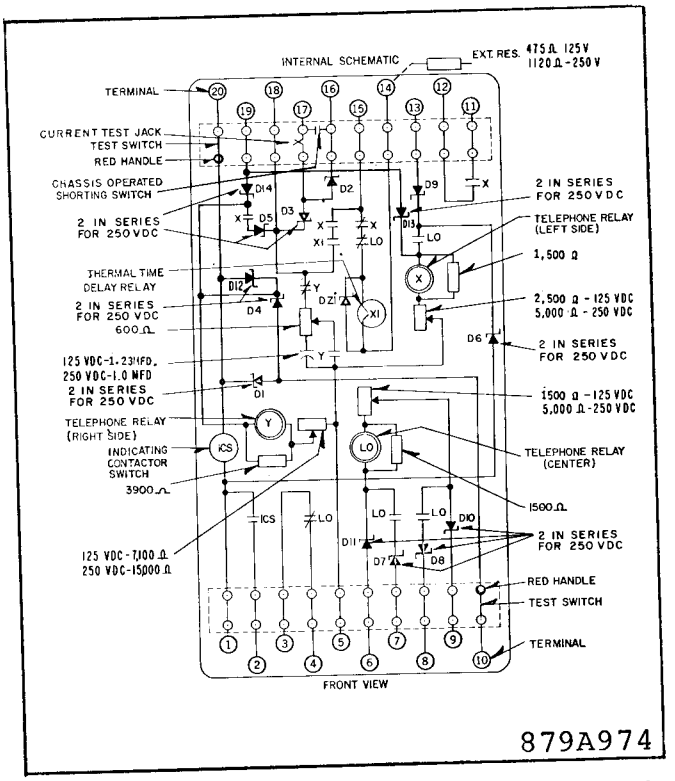
The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection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

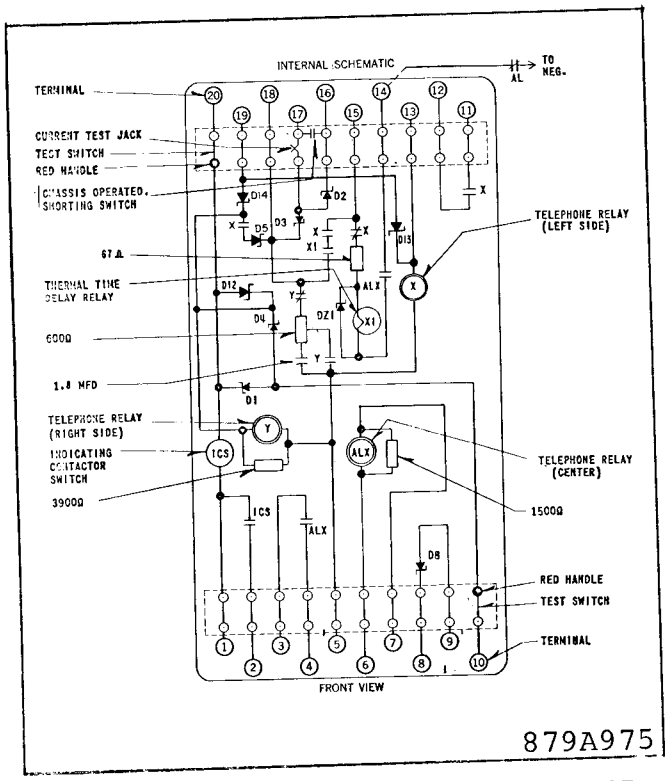
For 125 or 250 VDC TT-12 relays, an external X1 resistor is required. The outline drawing is shown in Fig. 13.



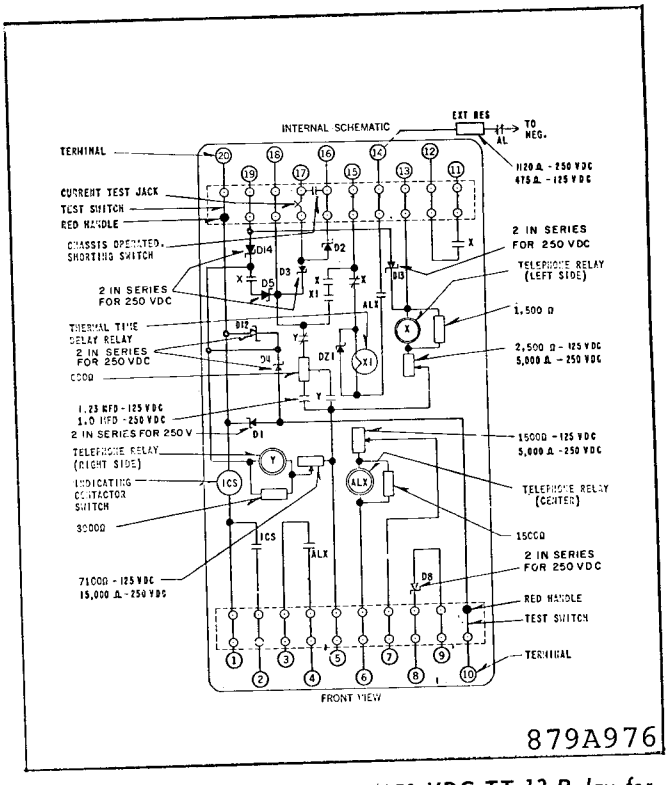
* *Fig. 3. Internal Schematic 48 VDC Universal TT-12 Relay in the Type FT22 Case*



* *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*

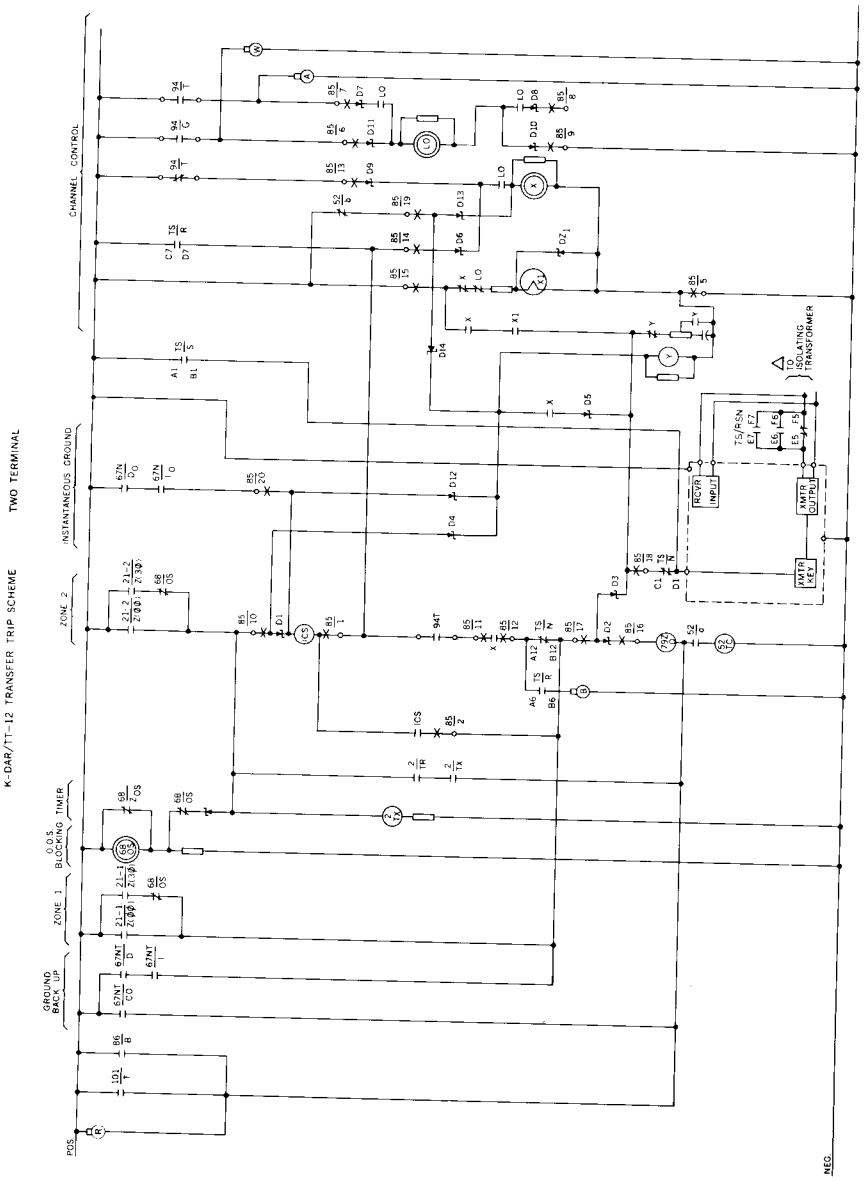


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Fig. 7. K-Dar/TT12 Transfer Trip Scheme (Two Terminal Line) for 48 VDC Operation.

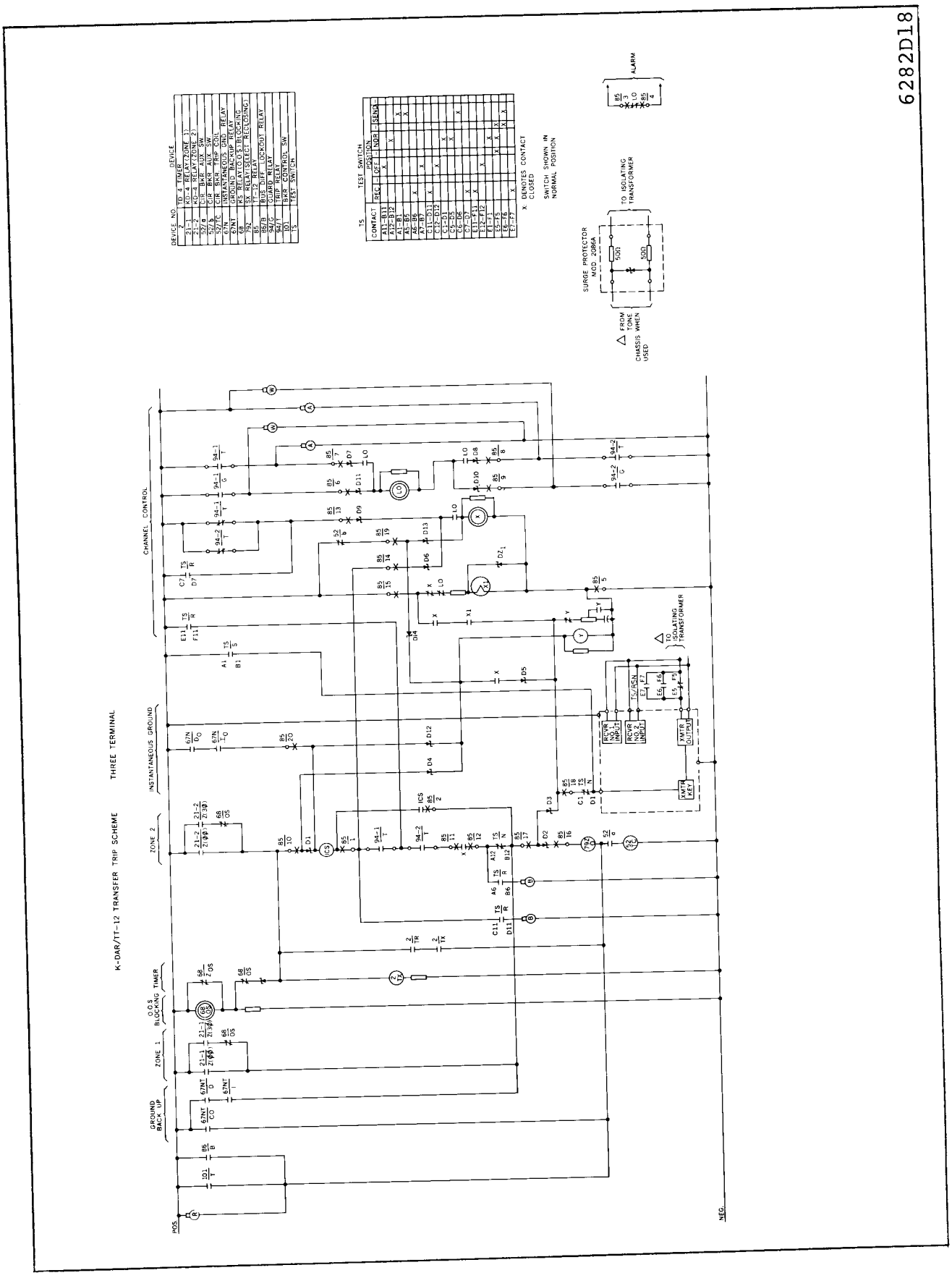

Fig. 8. K-Dar/TT12 Transfer Trip Scheme (Three Terminal Line) for 48 VDC Operation.

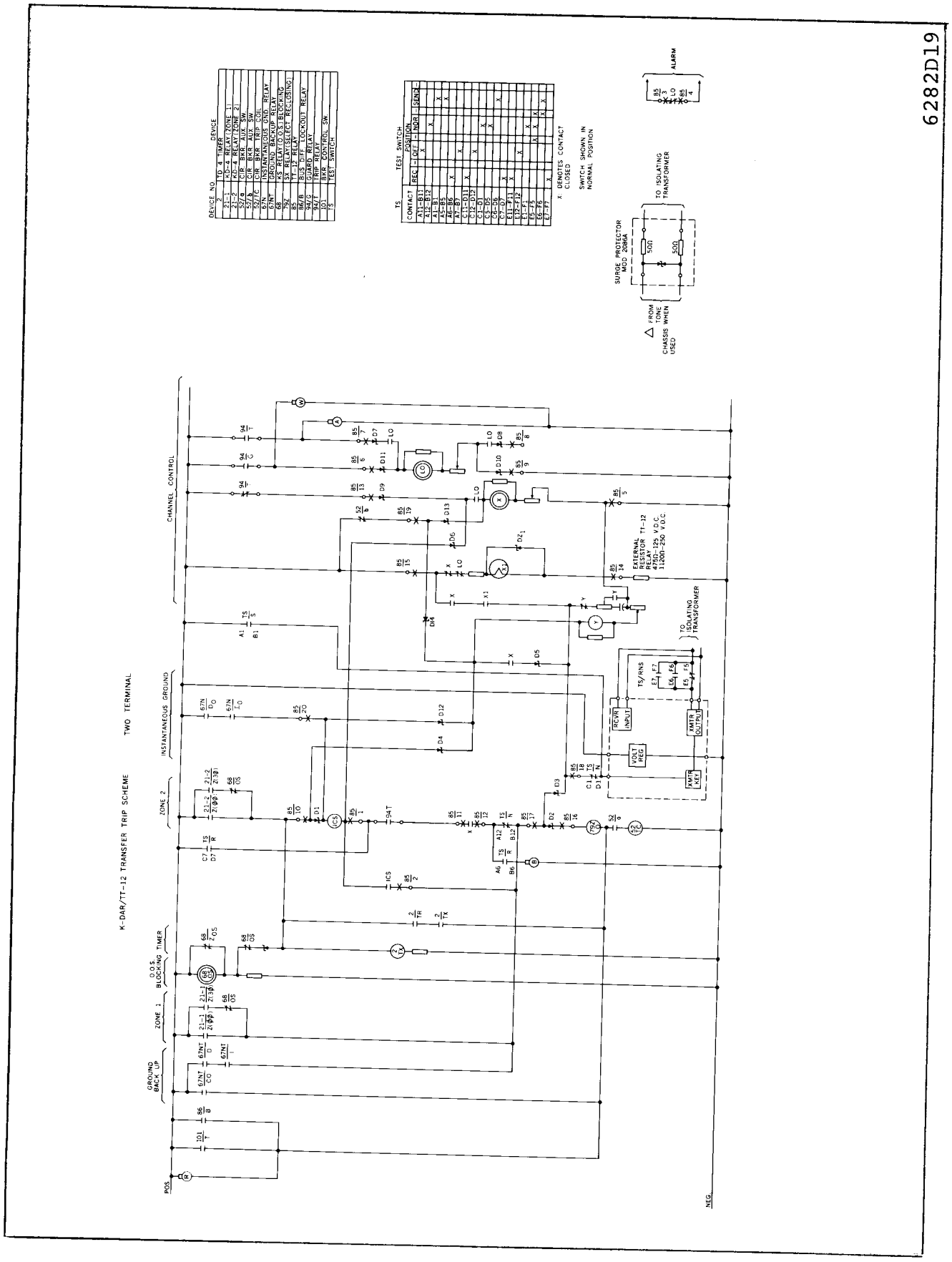

Fig. 9 K-Dat/TT12 Transfer Trip Scheme (Two Terminal Line) for 125 and 250 VDC Operation.

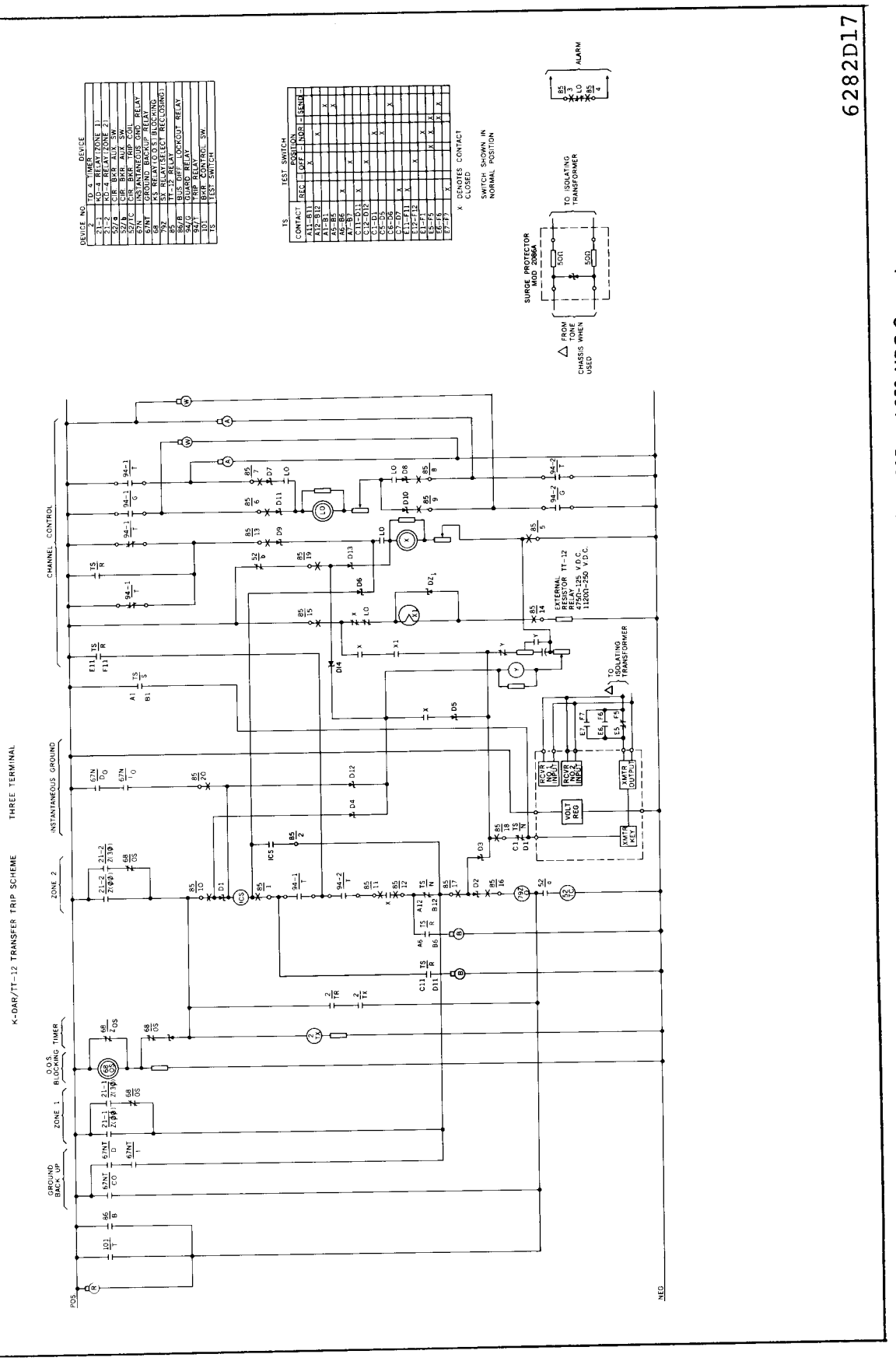

Fig. 10 K-Dat/TT12 Transfer Trip Scheme (Three Terminal Line) for 125 and 250 VDC Operation.

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 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 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.

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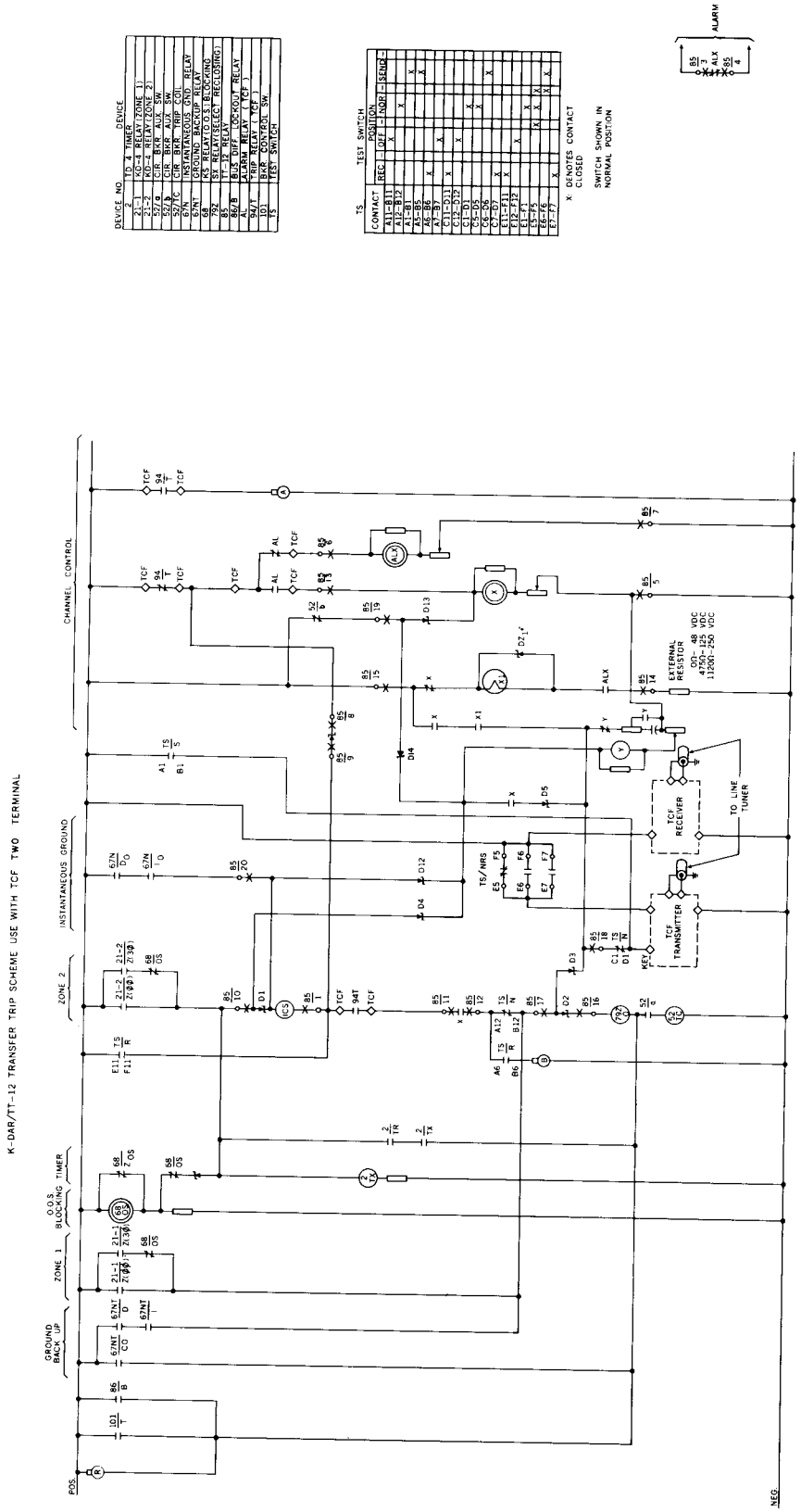


* *Fig. 11. Two Terminal 48 - 125-250 VDC TCF*

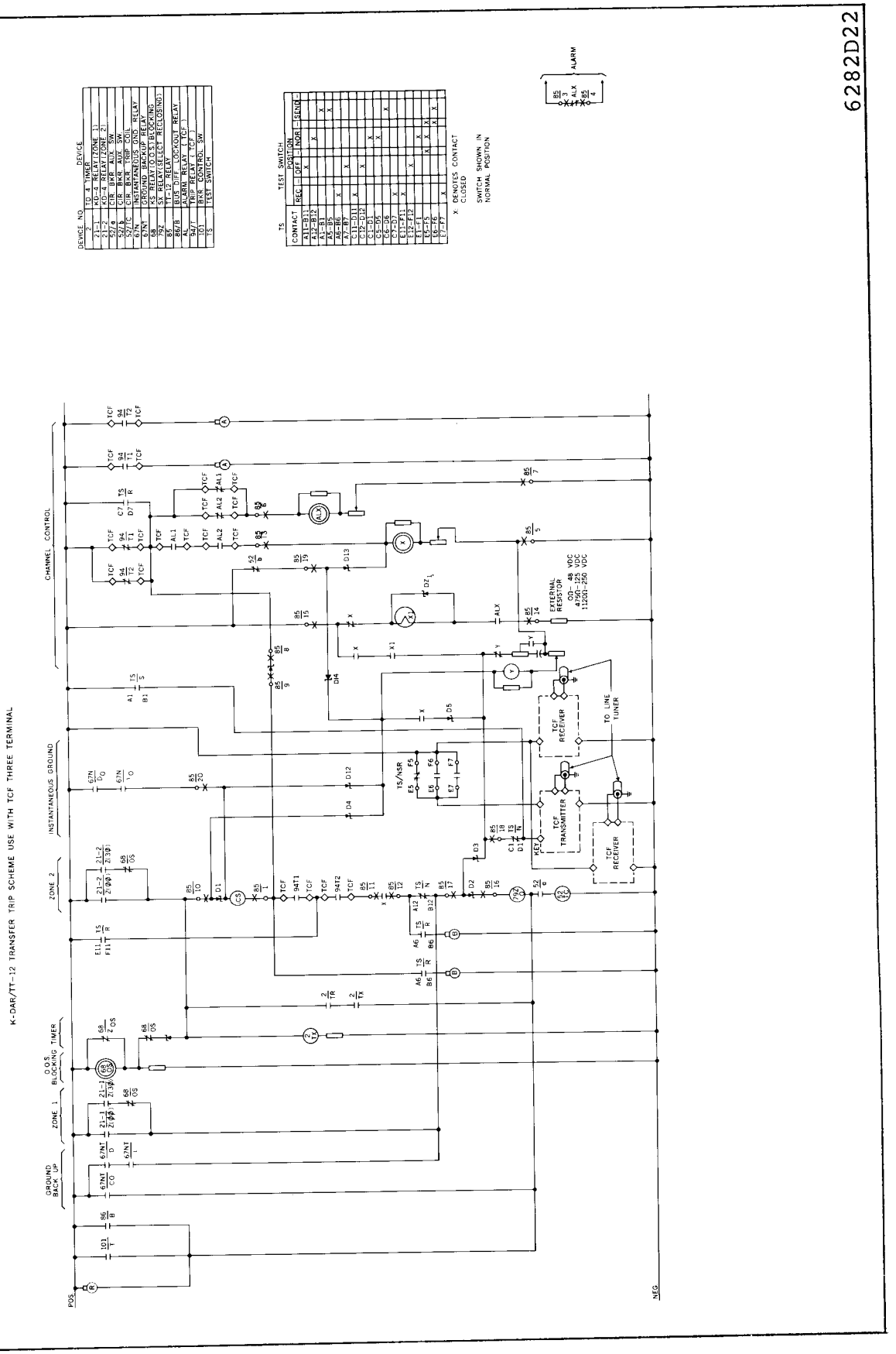


Fig. 12. Three Terminal 48-125-250 VDC TCF

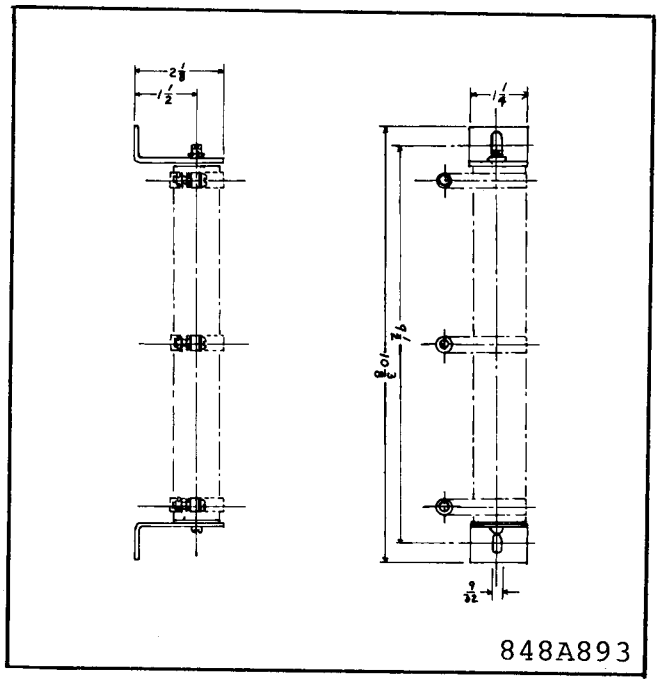


Fig. 13. Outline Dwg. for External Resistor for TT12 Relay

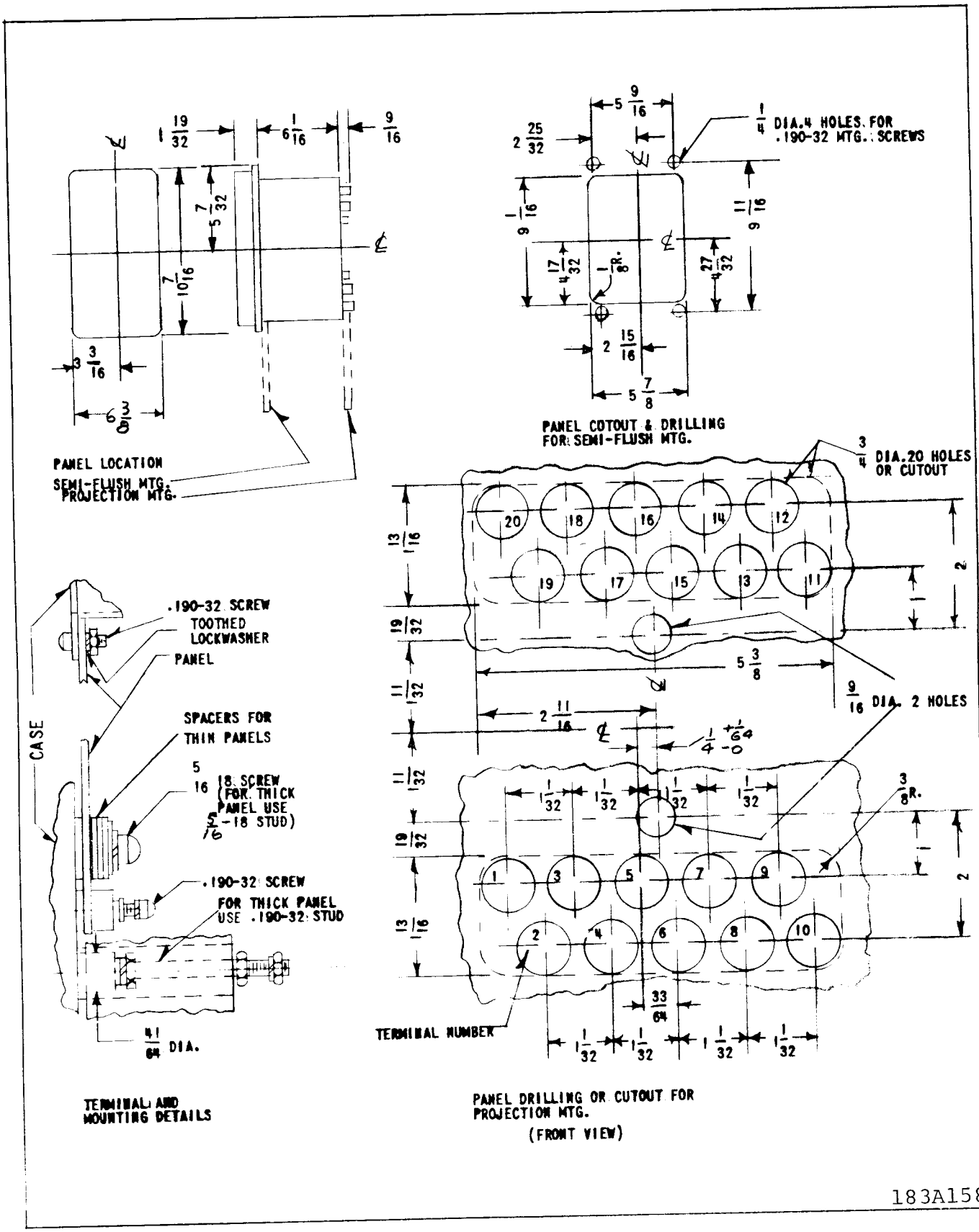


Fig. 14. Outline Drawing for FT22 Case

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.

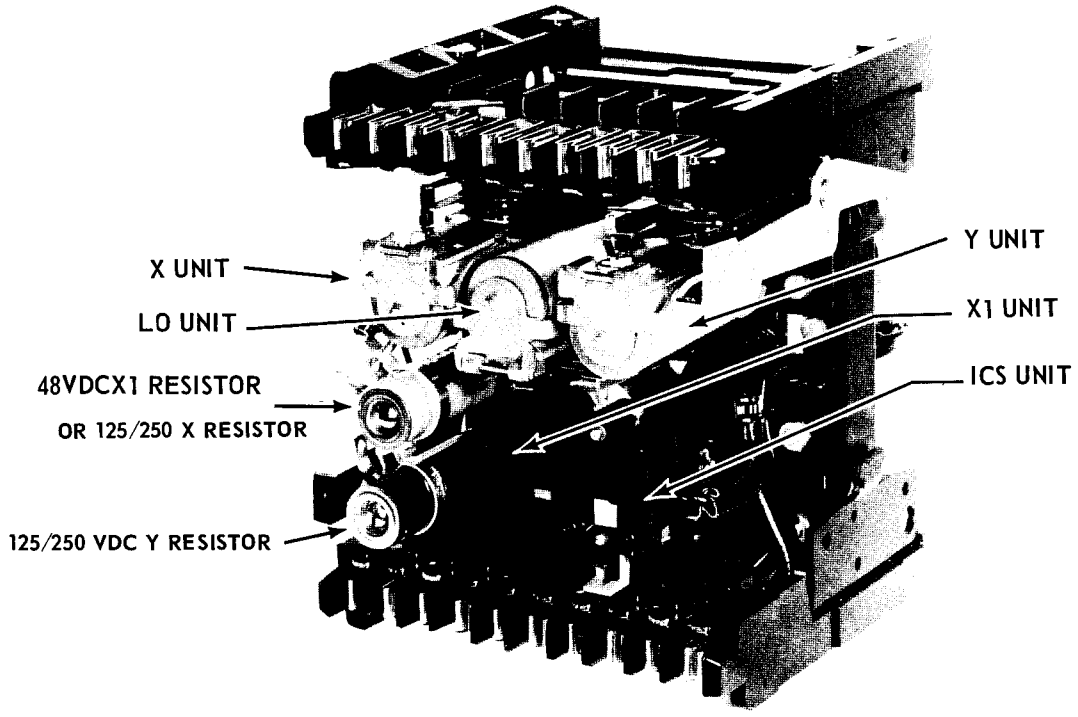


Fig. 1. Type TT-12 Relay without Case (Front View)

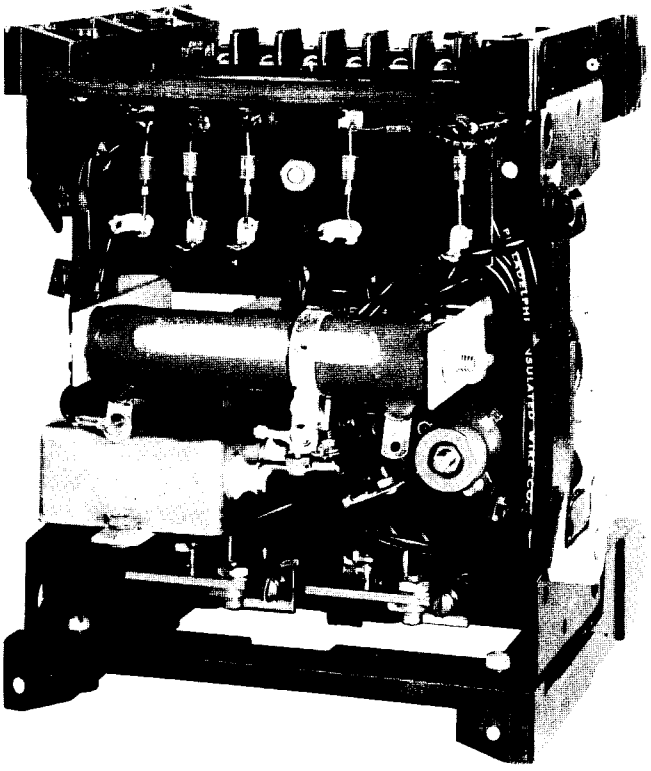


Fig. 2. Type TT-12 Relay without Case (Rear View)

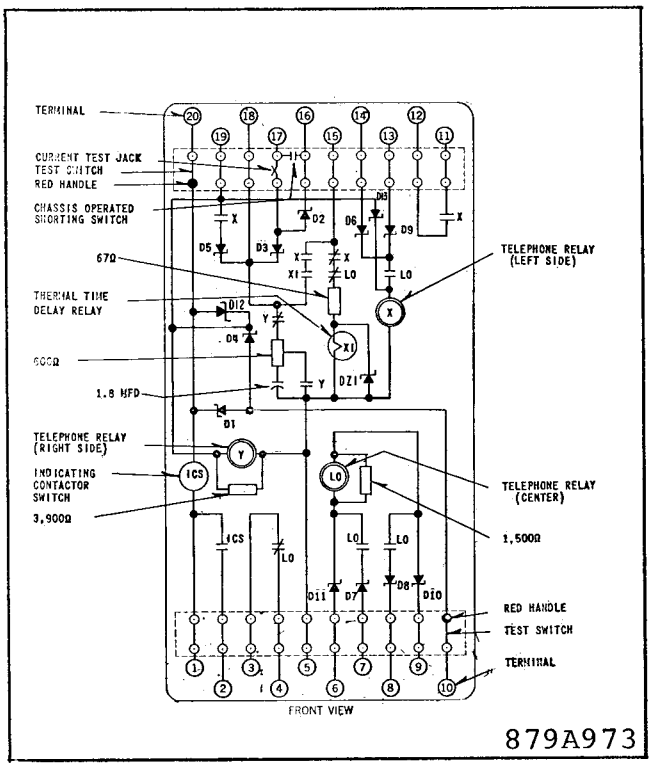


Fig. 3. Internal Schematic 48 VDC Universal TT-12 Relay in the Type FT22 Case

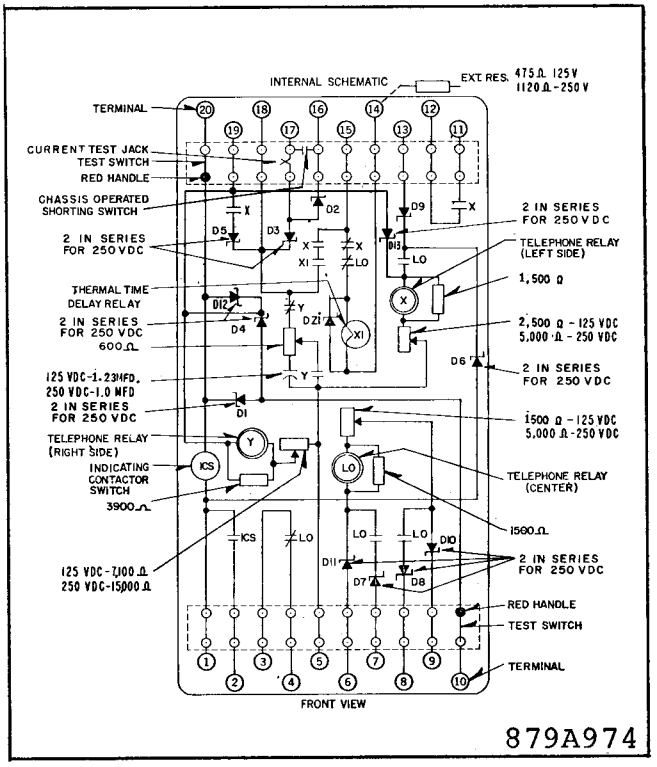


Fig. 4. Internal Schematic 125/250 VDC Universal TT-12 Relay in the Type FT22 Case

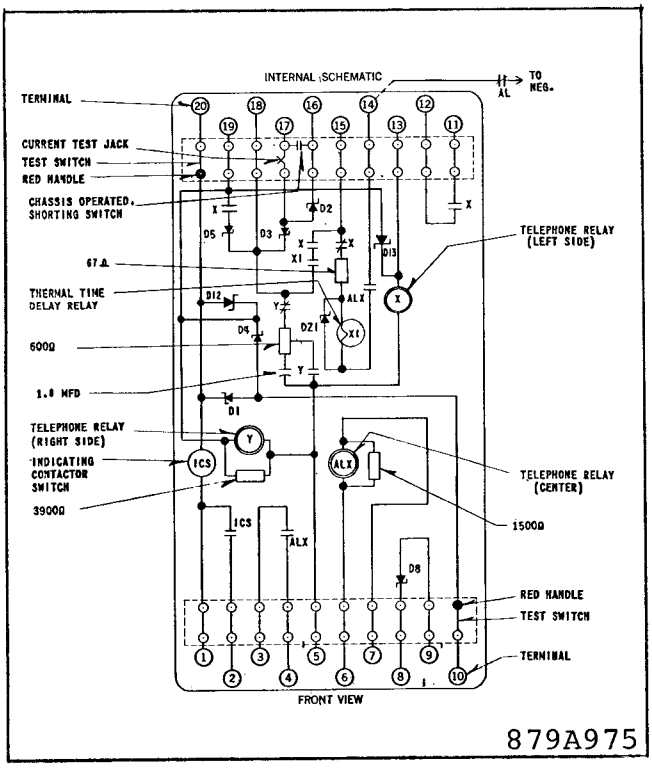


Fig. 5. Internal Schematic 48 VDC TT-12 Relay for TCF in the Type FT22 Case

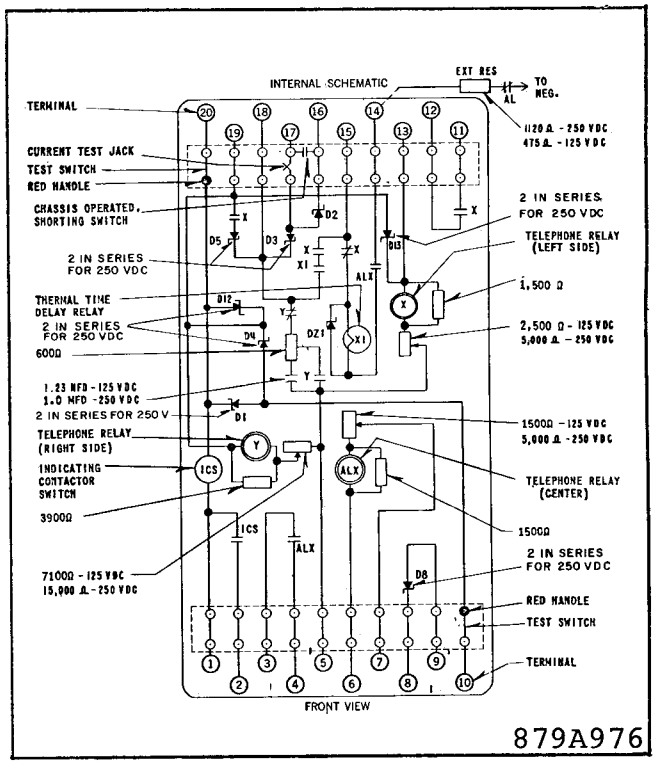


Fig. 6. Internal Schematic 125/250 VDC TT-12 Relay for TCF in the Type FT22 Case

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.

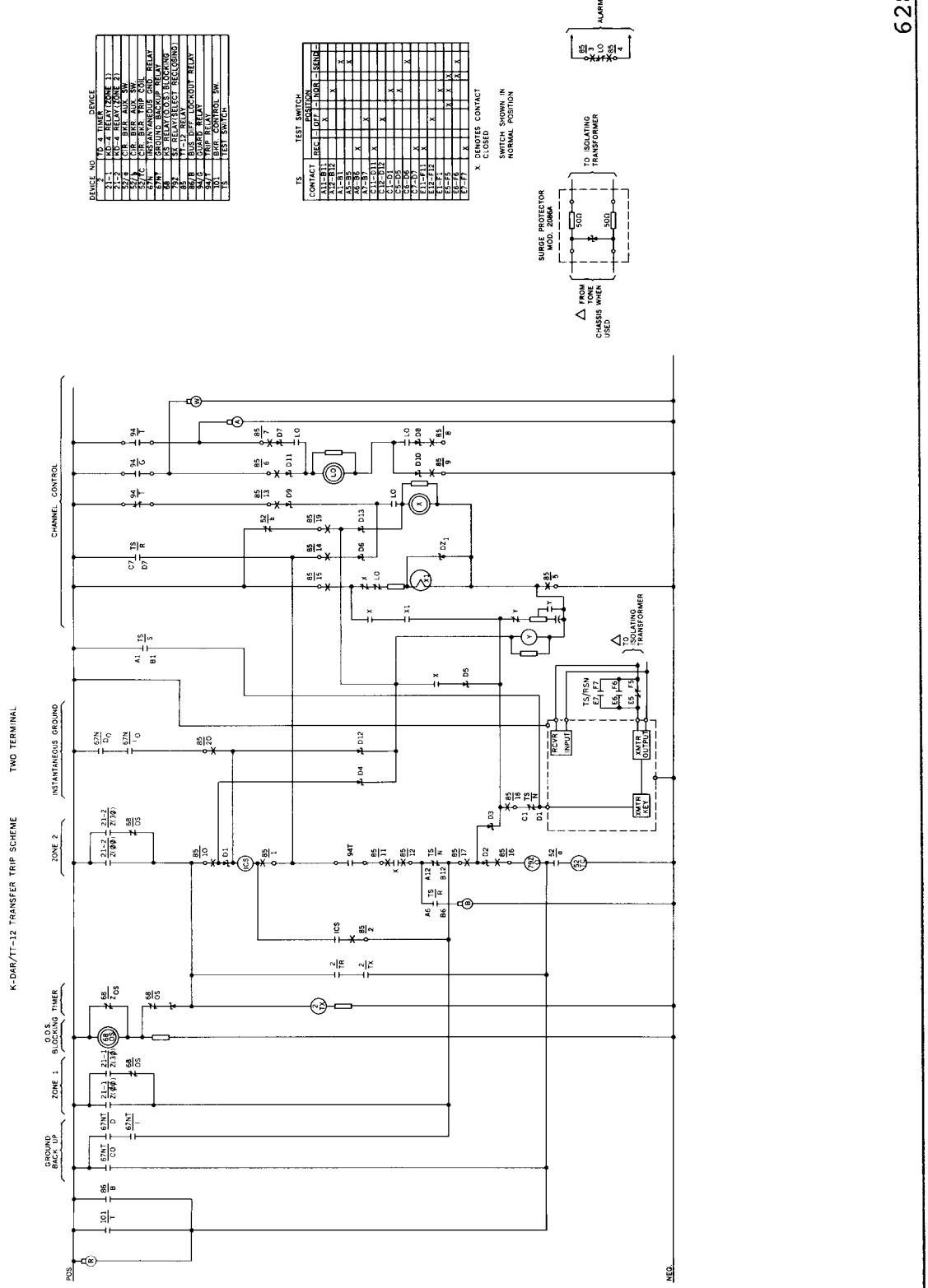


Fig. 7. K-Dar/TT12 Transfer Trip Scheme (Two Terminal Line) for 48 VDC Operation.

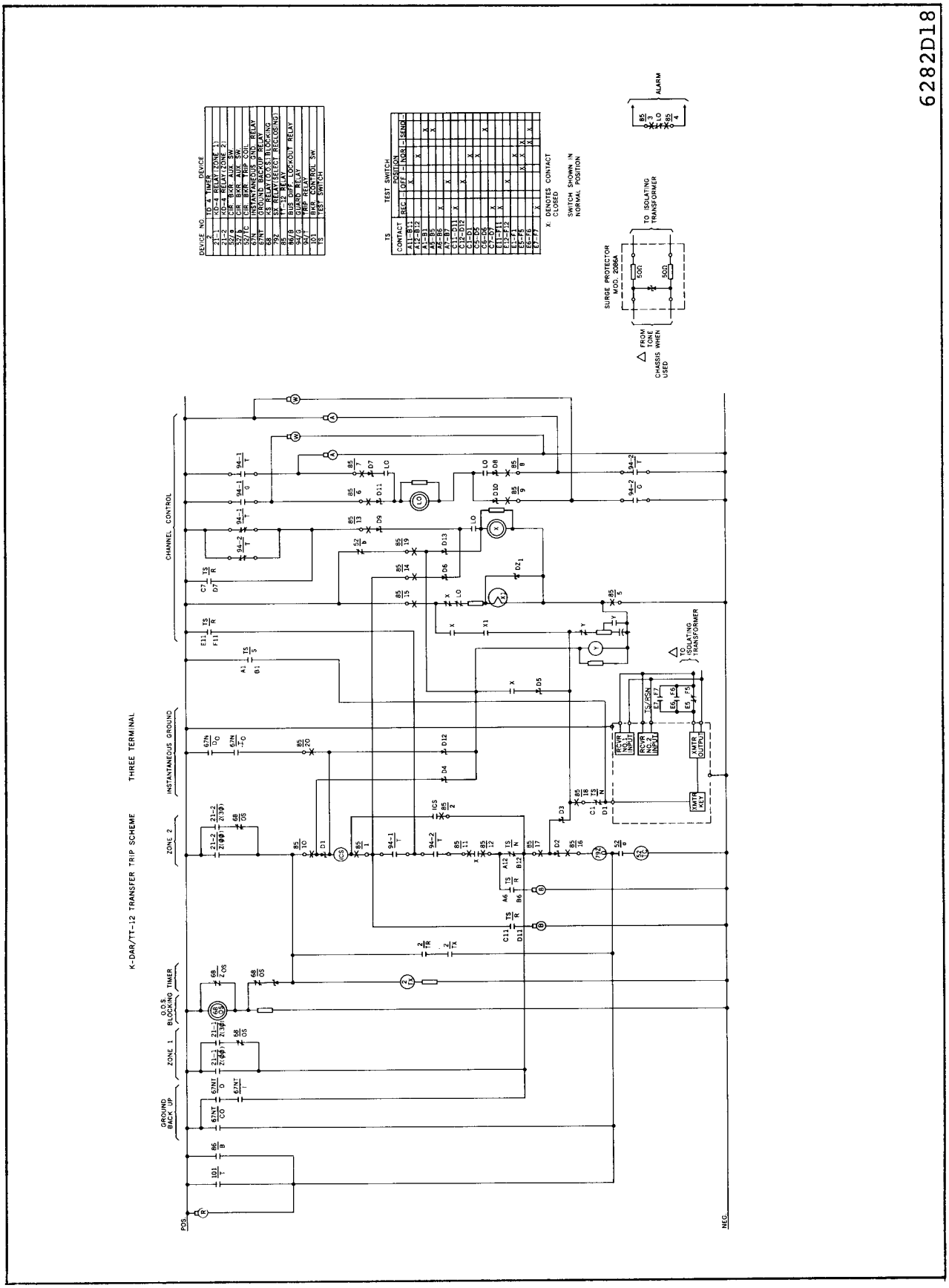


Fig. 8. K-Dar/TT12 Transfer Trip Scheme (Three Terminal Line) for 48 VDC Operation.

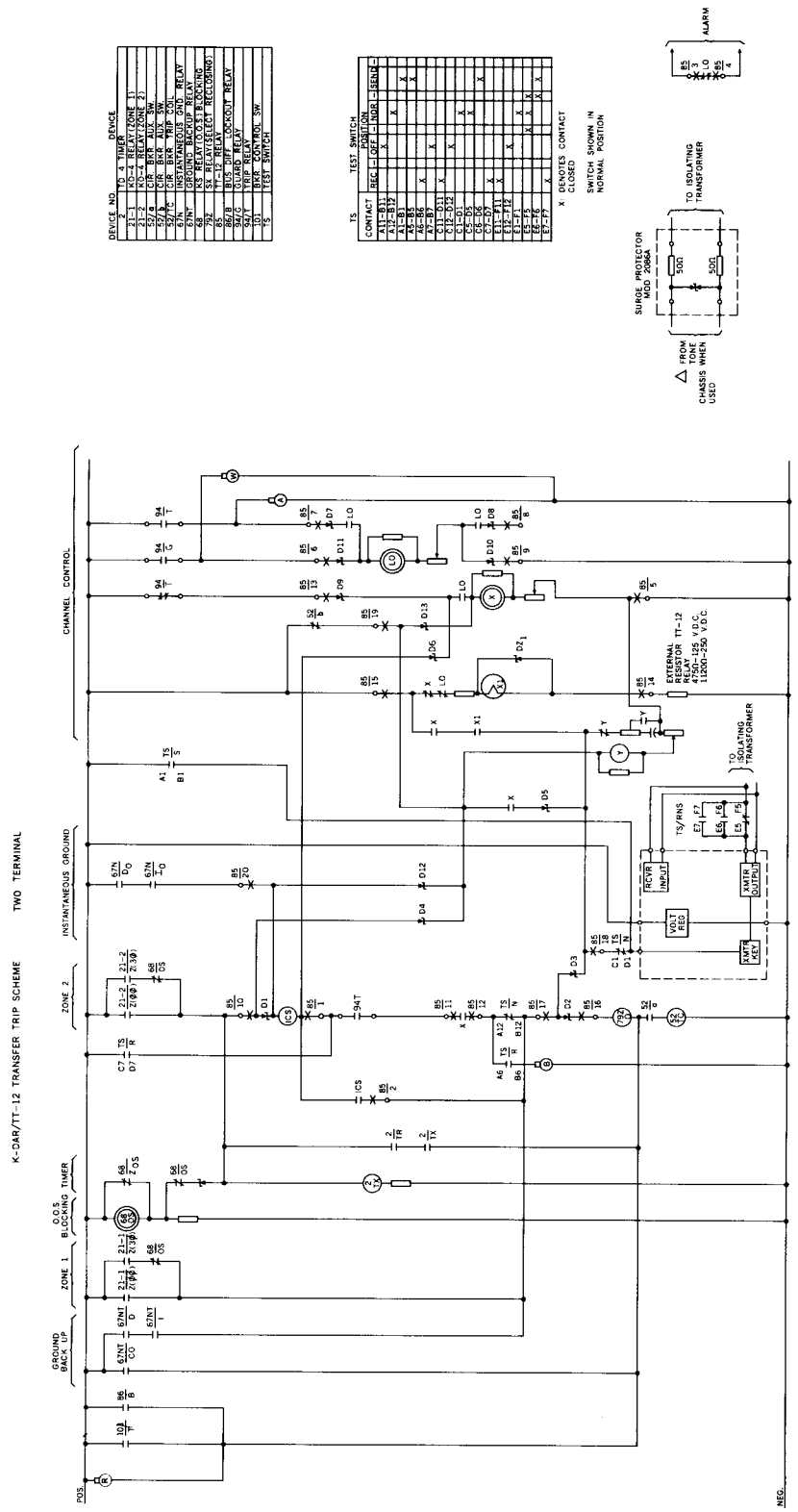


Fig. 9. K-Dat/TT12 Transfer Trip Scheme (Two Terminal Line) for 125 and 250 VDC Operation.

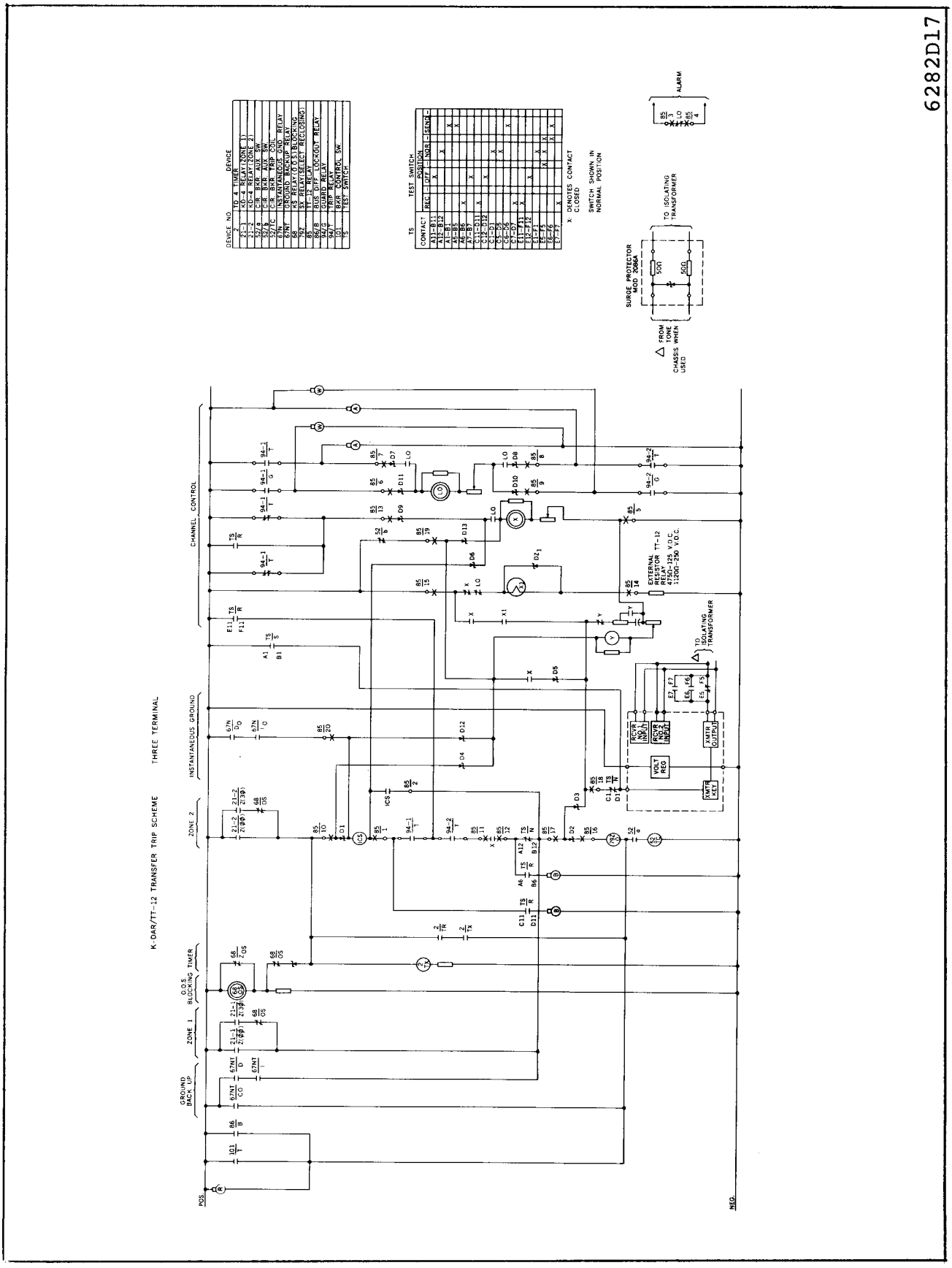


Fig. 10. K-Dat/TT12 Transfer Trip Scheme (Three Terminal Line) for 125 and 250 VDC Operation.

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 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 19. For contact circuitry, see Figure 3 and 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 or ALX

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 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

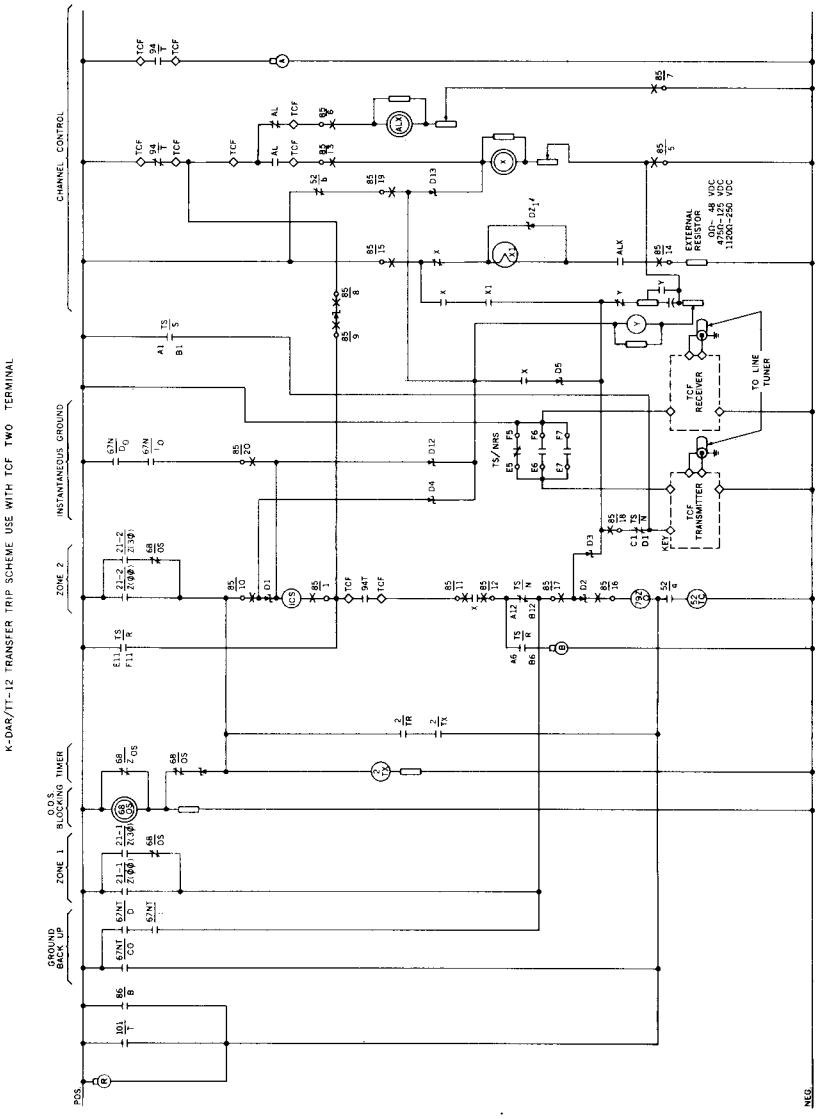
The X1 unit is located at the lower center (FV) and is energized between terminals 5 and 15 with the X and LO units de-energized. The X1 unit should have a dropout time of 2.5 ± 1 second, after being energized for 10 seconds. This time is measured at terminals 15 and 18, keeping in mind that the break 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.



6282D21

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

6282D22

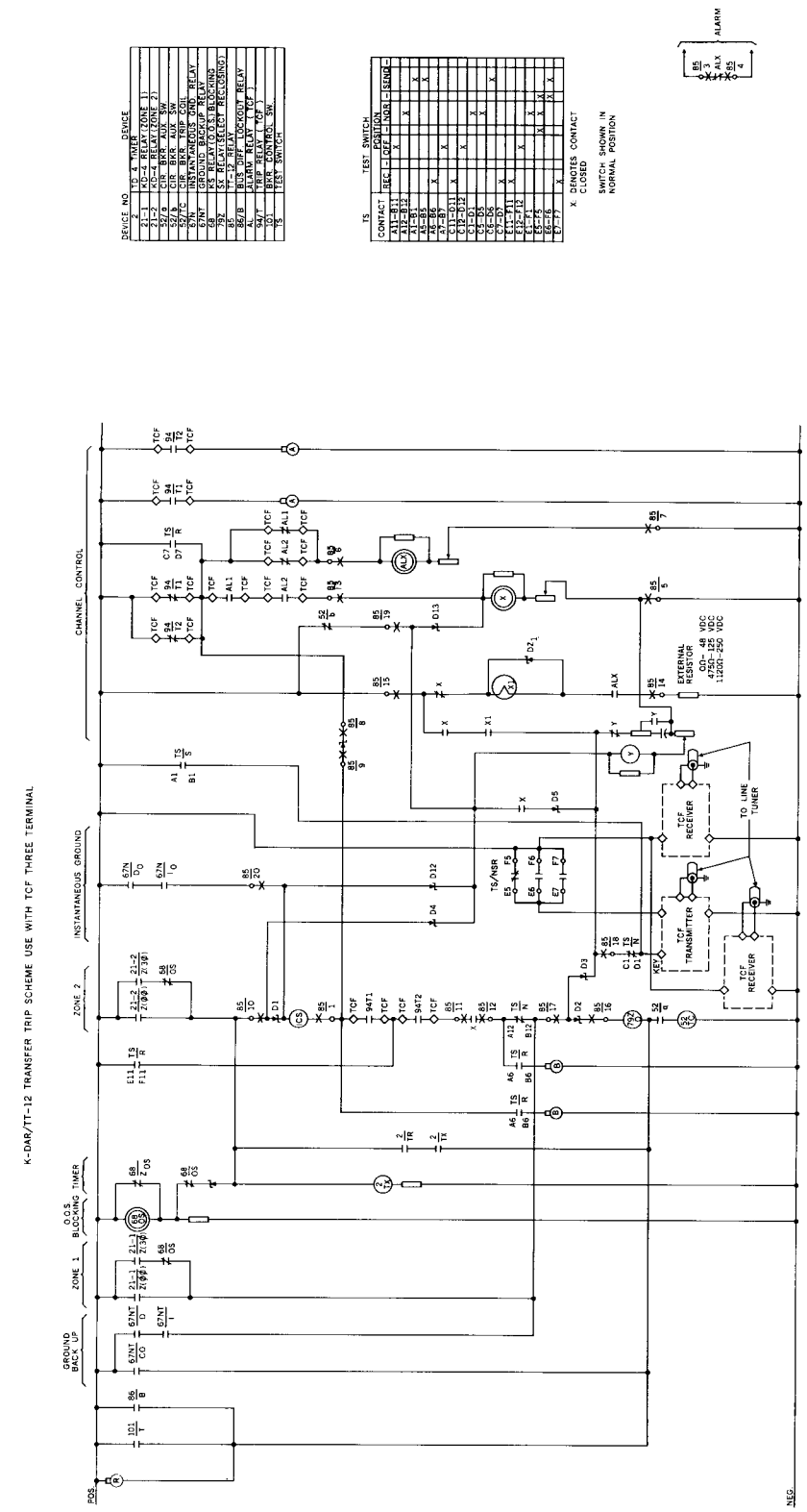


Fig. 12. Three Terminal 48-125-250 VDC TCF

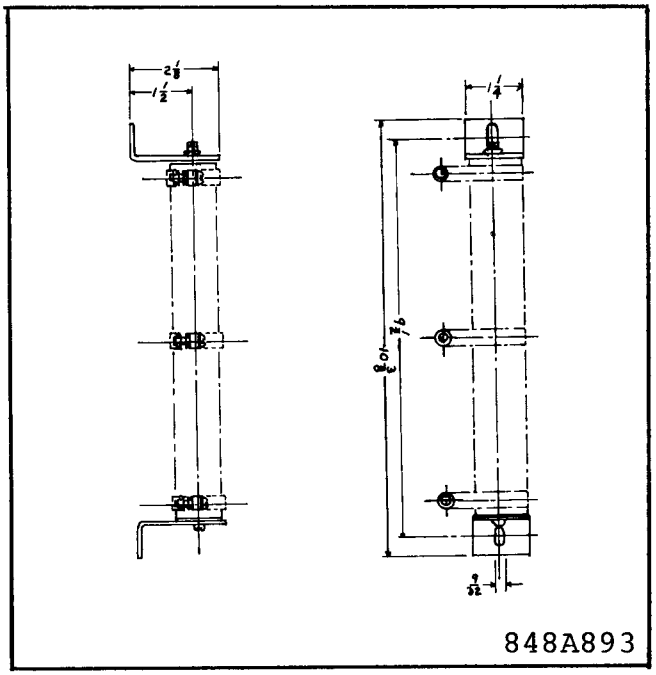


Fig. 13. Outline Dwg. for External Resistor for TT12 Relay

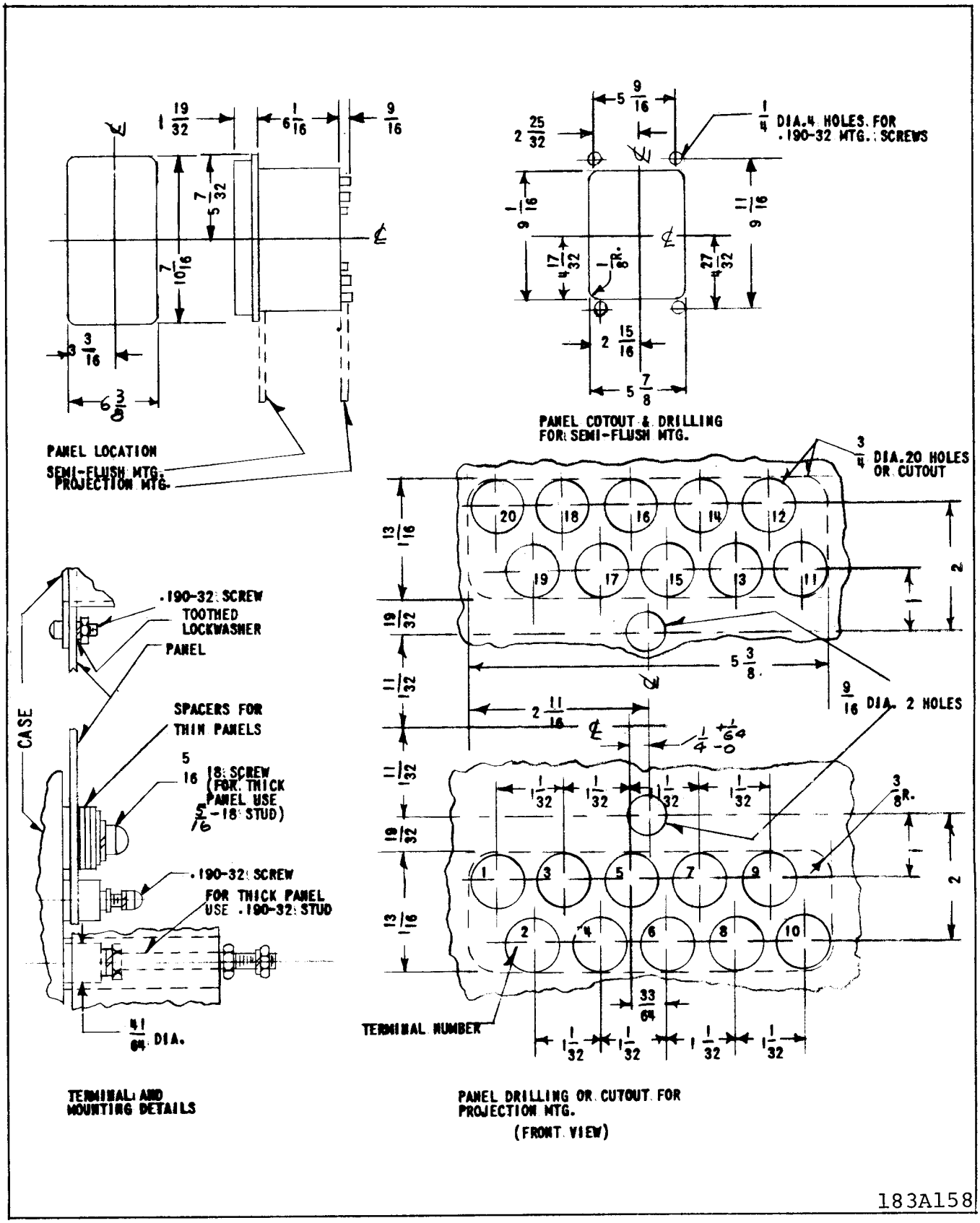


Fig. 14. Outline Drawing for FT22 Case

WESTINGHOUSE ELECTRIC CORPORATION

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

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