INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

STU-91 AND STU-92 TRANSFER TRIP RELAYS

CAUTION: It is recommended that the user of this equipment become acquainted with the information in this instruction leaflet before energizing the relay.

If transfer into a single channel mode of operation after a loss of one channel is not desired on STU-92 relay, the link on both "OR" boards must be changed to the OPEN position. The relay as shipped will transfer to a single channel mode if one channel is lost.

APPLICATION

The type STU–91 and STU–92 relays are solid state auxiliary relays for use with direct transfer trip systems. Direct transfer trip systems are usually applied to trip a remote breaker for a transformer or shunt reactor fault where no high side breaker exists at the local station. The direct transfer trip relaying system is also applied with breaker failure protection.

The STU–91 relay is for use with single channel transfer trip systems. It provides the channel monitoring logic, channel status indication, thyristor breaker tripping, and trip indication.

If it is desired to have a dual channel transfer trip system; the STU–92 should be used. The STU–92 provides the same logic for both channels as the STU–91 does for a single channel. The logic and tripping of each channel is completely isolated from each other, and where logic signals cross from one channel to the other DC isolation is provided. With this isolation, the STU–92 can provide a dual channel transfer tripping function which will switch to a single channel system if one channel fails. The STU–92 may also be operated such that if one channel fails the relay system is blocked from tripping.

The STU–91 & STU–92 may be used with audio tones or power line carrier equipment. The STU–92 provides further flexibility in that it may be used with dual channel tones, dual channel carrier, or one channel on tones and the other on power line carrier.

CONSTRUCTION

The type STU–92 relay consists of printed circuit boards, tripping AR relays, alarm relays, tripping thyristors, pulse transformers, switches, and monitoring lights mounted on a standard 19-inch wide panel, 7 inches high (4 rack units). Edge slots are provided for mounting the rack on a standard relay rack. The components are connected as shown in Figure 1 and Figure 2.

Printed Circuit Boards

The number of boards varies with the type of frequency shift channel equipment. For a tone channel, the STU–92 relay contains fourteen (14) printed circuit boards: two channel interface boards, two lockout boards, two transfer boards, two relay driver boards, two indicator boards, two OR boards, and two trip boards. For TCF frequency-shift power-line carrier channels, the lockout boards are not required since they are part of the TCF carrier assembly.

The STU–91 relay consists of one-half the boards of the STU–92 relay. For a tone channel, the STU–91 relay contains seven boards: a channel interface board, a lockout board, a transfer board, a relay driver board, an indicator board, an OR 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 removable 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 relay.

Following is a description of the STU–91/92 printed circuit boards:

1. CH. INTER (Channel Interface Board)

The interface board contains logic to connect the relay to the channel receiver. It also contains the power supply for the logic circuits of the STU–91 and STU–92 relay that are associated with one channel of the scheme. The following figures apply to this board.

TYPE CHANNEL	SCHEMATIC DIAGRAM	LOCATION OF COMPONENT
TA-3 Tones, TCF Carrier	Fig. 3	Fig. 4
937A Tones	Fig. 5	Fig. 6.

The logic circuits of this board include three buffer inputs, three line drivers, and OR and an AND.

2. Lockout Board (Tone Channel Only)

The lockout board contains the logic to lockout either the STU–92 or STU–91 relay on loss of a tone channel or noise on the channel. The circuits on this board:

a. Lockout the relay 150 milliseconds after a loss of tone channel or a loss of dc voltage on the tone receiver.
b. Initiate intelligence to the transfer board on a lost channel.
c. Lockout the relay when the tone receiver produces a noise clamp.
d. Provide channel trip intelligence to the trip OR of the relay.
e. Provide logic that requires the channel receiver return to a non-trip state after a loss of channel before the relay is enabled on that channel.

This board contains OR circuits, AND circuit and a 150/15 timer circuit. Figure 7 shows the schematic of the board, and Figure 8 shows the location of components on this board.

3. Transfer Board

The transfer boards consists of timing logic that initiates steps to sound an alarm and in the case of the STU–92 relay and to switch from a dual-channel mode of operation to a single channel mode of operation on the loss of one channel.

The circuits of the board include:

A. 500–2500 millisecond adjustable timer which allows a time delay in transferring to a single channel mode of operation after a loss of channel. An alarm relay drops out when the timer times out.
B. Two 10 millisecond timers which delay the inputs to the OR board to assure that tripping is blocked from:
   1. The loss of both channels.
   2. The re-energization of either one or both channels after a loss of both channels.

The schematic of the board is shown in Figure 9, and the location of the components is shown in Figure 10.

4. Relay Driver Board

The relay driver board contains the necessary circuits to drive:

A. The self-resetting white guard light.
B. The tripping relay (AR).
C. The noise and transfer alarm relay (AL)

Two AND circuits, three relay drivers, and a 500/0 timer are located on this board. The 500/0 timer provides a time delay on noise outputs from the channel receiver before the alarm relay drops out.

Figure 11 shows the schematic of the board, and Figure 12 shows the component location on the board.

5. Indicator Board

The indicator board contains the circuits that control all of the lights except the white guard light. These circuits consist of transistors and thyristors which drive the indicator lights. The thyristor requires the presence of an input signal for approximately 10 milliseconds before the thyristor will latch in its conducting state. It will remain in this state until the test switch is hand operated momentarily.

Figure 13 shows the schematic of the board, and Figure 14 shows the component location.

6. OR Board

The OR board either connects the lockout board (for tone channels) or the interface board (for TCF channels) to the trip board of the relay. The circuits of this board will:

A. Provide trip information to the trip board.
B. Allow the STU–92 relay to either lockout or

transfer to a single-channel mode of operation on a loss of channel. A link on the board determines in which manner the STU–92 relay will operate.

1. With the link closed the relay will be locked out on a loss of one channel. Tripping will not occur if a trip signal is received over the remaining good tone channel.
2. With the link open, the relay will operate in a single-channel mode of operation on a loss of one channel. Tripping will not occur if a trip signal is received over the remaining channel.

This function is not provided in the STU–91 relay because the relay is used on a single channel only.

Figure 15 shows the schematic of the board, and Figure 16 shows the component location for the STU–92 relay. Figure 17 shows the schematic of the board and Figure 18 shows the component location for the STU–91 relay.

7. Trip Board

The trip board connects the OR board to the tripping AR and tripping thyristors. This board contains transistor circuitry and isolator circuits that will provide a gate signal to the tripping thyristors.

The following figures apply to this relay:

TRIP VOLTAGE RATING	SCHEMATIC	LOCATION OF COMPONENTS
48/125	Fig. 19	Fig. 20
250	Fig. 21	Fig. 22

AR Tripping Relay

The tripping AR relay is a small high-speed attracted armature type of unit. An insulated member, fastened to the free end of the armature, draws down four moving-contact springs to close the trip-circuit contacts when the relay coil is energized. This relay is mounted on the rear hinged door and is available for inspection by removing the locking screw and swinging the door outward.

Alarm Relay

The alarm relays 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. These relays are mounted on the rear door with the tripping AR relays.

Pulse Transformer

This is a low impedance two-winding iron core transformer. The primary is connected into the trip circuit so that when trip current flows, a pulse is produced in the secondary and fed to the trip light indicator circuit.

Switches

These switches are hand toggle switches with a spring return and are used for resetting the lights as well as testing the light filament.

Lights

All lights are incandescent and removable from the front panel for replacement when necessary. The lights are energized below rated current so that they will have long life but yet provide sufficient illumination.

The lens colors are assigned according to functions. Red is used for trip indication, white for monitoring receipt of a channel guard, and amber for indicating channel noise and trip.

Card Extender

A card extender (style #849A019G01) is available for facilitating circuit voltage measurements or major adjustments. After withdrawing any one of the circuit boards, the extender is inserted in that position. 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 are readily accessible.

OPERATION

The circuits of the STU–91 and STU–92 relays use the signals from the channel receivers to perform the following functions:

1. The STU–92 relay provides a trip output to the trip coil of a breaker if a trip signal is received by both channel receivers from the remote terminal. For the STU–91 relay, the trip output is provided to the trip coil upon receipt of a trip signal from one channel receiver.
2. For tone channels, both relays prevent tripping of the circuit breakers for a noise clamp from the channel receiver.

3. The relays initiate action to do one of the following for a low-signal clamp from the channel receivers:
   a. For a STU–92 relay, transfer to a single-channel mode of operation after an adjustable time delay. For this condition, the system will trip upon receipt of a trip signal from the remote terminal on the remaining channel.
   b. For tone channels, lockout the STU–91 and STU–92 relays. For this condition, the system will not trip on receipt of a signal from the remote terminal.

   The low signal lockout of the STU–92 relay is determined by the position of a link on the OR board. With the link closed the relay will lockout on the loss of one channel. With the link open, the relay will transfer to a single-channel status, and lockout only on loss of both channels.
4. Both relays provide channel monitoring lights to determine the state of the channels.

When the frequency-shift channel equipment is transmitting a guard signal, the signals to the STU–92 relay are shown on the logic drawings of either Figure 23, 24 or 25. The signals to the STU–91 relay are shown on the logic drawing of Figure 26 and 27. The number "1" indicates that a voltage is obtained at that point, while a "0" indicates that the voltage is approximately zero. As seen in the logic diagrams, the relays require a "1" from the low-signal clamp, and "0" from the trip and noise clamps of the tone channels to indicate normal operating conditions. For the condition shown, the white lights are on and the alarm relays are picked up.

Trip Sequence

For a STU–92 system, both channels are shifted to trip and the "0" from the frequency shift receiver changes to a "1". The channel interface of the STU–92 relay see this change and puts a "1" into either the lockout board (tone channel) or the OR board (TCF channel). In the case of a tone channel, the change in state is applied to OR-2 (lockout board) whose output changes to a "0". This fulfills all the input requirements to AND 5.

1. A "1" from the 150/15 timer.
2. A "0" from OR-2.
3. A "0" from the noise interface.

The output of AND–5 goes to a "1" and the following occurs:

1. A "1" is applied to the relay driver board which will cause the output of AND–1 to change to a "0" thereby turning the white light off.
2. A "1" is applied to the indicator board which energizes driver 3 to turn on the amber channel trip light.
3. A "1" input is applied to OR-1 of the OR board. The output of OR-1 changes to a "0" which is applied to OR-2 and OR-3. With a change in state of the output of OR-2, the input to the isolator on the second OR board changes to a "0" and the output of the isolator to a "0". Since both channels are in a trip state, the output of the isolator on the first OR board changes to a "0" in the same manner. All the inputs to both OR-3 circuits of the two OR boards are thus "0". The outputs on the OR-3 circuits change to a "1" which is applied to the driver of a trip board. In turn, this "1" is applied to:
   a. Relay driver 2 of the driver board which operates the AR unit.
   b. The isolator of the trip board to gate the thyristors. The thyristors conduct to trip the breakers. When breaker trip current flows, the pulse transformers are energized to apply an input to the amplifiers of the indicator board to turn the red breaker trip lights on.

If trip is received only on one frequency shift receiver, the required three inputs to the two OR-3 logics of the OR board are not satisfied, and the STU–92 relay will not operate. For example, if channel 1 receives a trip signal and channel 2 does not, OR-3 of the channel 1 OR board will not be satisfied because of a "1" input from the isolator. OR-3 of the channel 2 OR board will not be satisfied. because of a "1" input from OR-1 of the channel 2 OR board.

The STU–91 operates in the same manner except that its performance is based on a single channel and the input to OR-3 of the OR board from the isolation is not required.

Loss of Channel

With reference to a tone channel, a low signal clamp from the tone receiver clamps into a "0" output, and the signal at terminal 2 of the lockout board changes to a "0" through the channel interface board. This change in signal is applied to OR-4 of the lockout board. Since a "0" input is applied

to OR-4, an output is obtained from this circuit and applied to the 150/15 timer. 150 milliseconds later, a "0" output is obtained from the timer which:

1. Locks out AND—5 of the lockout board.
2. Removes one "1" input to OR-3 of the lockout board.
3. Changes the input to AND—1 of the relay driver board to a "0". This changes the output of AND—1 to turn the white guard light off.
4. Changes the input to terminal 2 of the transfer board to a "0". The change in signal energizes the 500—2500 adjustable timer. After a time delay (depending on the timer setting), a "0" output is obtained at terminal 12 of the transfer board which is applied to three logic circuits.

   a. To AND—2 of the relay driver board. The "0" input changes the output of AND—2 to a "0", and the alarm relay drops out to close its contacts.

   b. To a 10/0 timer whose output instantaneously changes to a "1". This "1" is applied to OR-3 of the OR board to lockout OR-3 of that channel.

   c. To a 0/10 timer whose output changes to "1" 10 milliseconds later. This change in signal is applied to OR-1 and OR-2 of the OR board. The output of OR-1 changes to a "0" and is applied to OR-2 and OR-3. If the link is closed, the output of OR-2 does not change status, (because of "1" input from 0/10 timer) and the output of the isolator on the second channel OR board does not change state. Thus, the OR-3 circuit of the second OR board is locked out. If the link is open, the output of OR-2 (on OR board) will change to a "0". This changes the output of the isolator of the second OR board to a "0". This applies two "0" signals to OR-3 of this board, and tripping will occur if the receiver of the good channel gives a trip output.

If a trip signal is supplied to either the STU—92 relay or the STU—91 relay from the non-serviceable channel during a loss of channel condition, a "1" input is applied to OR-2 of the lockout board. OR-2 inverts the signal and applies a "0" to AND—5 and OR-3 of the lockout board. Since AND—5 had been previously locked out from the 150/15 timer (due to loss of channel) the output of AND—5 remains at "0". The change in signal to OR-3 causes a "1" input to OR-4 to hold the 150/15 timer picked up. Since AND—5 is locked out, tripping will not occur due to the trip input from the non-serviceable channel. However, for STU—92 relay tripping can occur on the remaining channel if the relay had been set to transfer to a single-channel status after the loss of one channel.

For the condition where the channel has been lost AND—5 will remain locked out when the channel is restored to normal if the channel receiver returns in a trip state. When loss of channel occured, the 150/15 timer picked up and applied a "0" to one input of OR-3. If a trip is received with this condition, then the other OR-3 input will become "0" and the output of OR-3 will go to "1" thereby applying an input to OR-4 thus preventing the 150/15 timer from dropping out. The trip signal must be removed from the lockout board before the 150/15 timer drops out to return AND-5 to normal.

With reference to a TCF carrier channel, the lockout features are included as a part of the TCF carrier receiver.

Loss of Second Channel

If the second channel is lost while the STU—92 relay is set up in a single-channel mode of operation, the following occurs:

1. The output of the low signal clamp interface changes to "0".
2. After a 150 millisecond time delay, AND—5 of the lockout board of second channel is clamped to a "0".
3. A "0" input is applied to the AND—1 of the relay driver board. This changes the output of AND—1 to turn the white guard light off.
4. A "0" input is applied to the 500—2500 timer of the transfer board, and the timer is energized. After a time delay (as determined by the setting), the 10/0 and 0/10 timers of the transfer board are energized. Instantaneously the 10/0 timer drops out to apply a "1" input to OR-3 of the OR board. This disables OR-3. 10 milliseconds later, the 0/10 timer times out to apply a "0" input to OR-3 through OR-1. An output from the 500—2500 timer also causes an alarm to dropout through AND—2 of the relay BD.

For the condition where both channels are out of service and one or both channels are restored to service, instantaneously the 0/10 millisecond timer puts a "0" into OR-1, thus a "1" into OR-3, and the 10/0 millisecond timer takes 10 milliseconds to change its input to OR-3 to a "0". Hence, OR-3 is locked out during the restoration period.

Noise

If an output is obtained from the noise clamp on the frequency shift receiver, the output of the noise interface circuit on the CH INTER board changes to a "1". This signal is applied to a 500/0 timer of the Relay Driver Board. After 500 milliseconds, the timer times out to apply a "1" input to AND–2 of the Relay Driver Board and the indicator circuit of the Indicator Board. This causes the alarm relay to drop out and the noise amber light to turn on.

In the case of a tone channel, the output of the noise interface circuit is applied to the lockout board. This input locks out AND–5 on this board to prevent tripping during the noise condition.

CHARACTERISTICS

The STU–92 relay is available for frequency-shift channels, either tone, carrier or a combination as shown in the logic diagrams 23, 24 and 25. The STU–91 relay is available for frequency shift tones or carrier as shown in the logic diagrams, Figures 26 and 27. Following are the three (3) types of trip outputs provided.

1. Thyristor Trip
2. Relay Trip
3. Voltage Trip

Noise Alarm Time	500 Milliseconds
Lockout Time (Tone Channel Only) (Lockout Time provided in TCF channel, when used)	150 Milliseconds
Transfer Time	Adjustable 0.5 to 2.5 Seconds
Operating Time	3 Milliseconds with AR Relay Output 75 Microseconds for solid-state thyristor or voltage output.
Maximum Allowable Output Current on Voltage Output Terminals	10 milliamperes at 20 volts dc
Ambient Temperature Range	-20°C to +55°C

Battery Voltage Variations

Rated Voltage	Allowable Variation
48 V DC	42-56 V DC
125 V DC	105-140 V DC
Battery Drain Normal	125 milliamperes - 48 V DC
	110 milliamperes - 125 V DC
Maximum	300 milliamperes - 48 V DC
	250 milliamperes - 125 V DC

Setting

The only setting required is the setting of the timer for transferring to a single-channel mode of operation upon a loss of one channel. This setting is made by means of the knob on the front of the transfer board of the relay. This knob should be locked after the setting is made.

If the application requires that the relay lockout after a loss of a single channel, the link on the two OR boards should be changed to the closed position.

Installation

The STU–92 and STU–91 relays are 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 55°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.

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

ADJUSTMENTS AND MAINTENANCE

The Acceptance Test listed below can be followed to verify that the STU–91 or STU–92 relays are functioning properly.

Acceptance Test

Connect the relay to the test circuit of Figure 24 which for test purposes represents the system to which the STU–92 relay is connected. The

switches shown represent 20 volt inputs to the relay. These inputs can be placed on the relay by the circuit or by jumpering the correct board terminals to the internal 20 volt board terminal.

For the STU–91 relay, only the information to channel 1 need be considered.

Test Equipment:

1. Timer or Cathode Ray Oscilloscope
2. Card Extender Style 849A534G01

With a jumper, connect the link on both "OR" boards. Close dc power switches 1 and 2: (1) White lamps will light, (2) Alarm relays will pickup.

Check lamps by means of test reset switches 1 and 2. All channel 1 lamps should light when test switch 1 is open, and all channel 2 lamps should light when test reset switch 2 is open.

I. Trip Circuit

A. Close channel 1 trip switch.
   1. White lamp of channel 1 will go off.
   2. Amber channel trip lamp of channel 1 will light.

B. With channel 1 trip switch closed, close channel 2 trip switch.
   1. WL switches will operate.
   2. Red breaker trip lamps will light
   3. External trip light will light.
   4. White lamp of channel 2 will go off.
   5. Amber channel trip lamp of channel 2 will light.

C. Open both channel 1 and channel 2 switches. Reset lamps and WL switches.

II. Noise Circuit (500 Millisecond Timer)

A. Channel 1
   1. Connect timer start (scope trigger) to terminal 8 of CH INTER board (A board).
   2. Set timer start (scope trigger) to positive pulse.
   3. Connect timer stop (scope probe) to terminal 13 of channel 1 relay driver board (D board). Connect ground to terminal 1 of the board.
   4. Close channel 1 noise switch.
      a. Timer (scope) will start and stop after 440 to 560 milliseconds.
      b. Channel 1 amber noise lamp will light.
      c. Channel 1 alarm relay will drop out.
   5. Open channel 1 noise switch. Reset lamps.

B. Channel 2
   1. Connect timer start (scope trigger) to terminal 8 of CH INTER board (F board).
   2. Set timer start (scope trigger) to positive pulse.
   3. Connect timer stop (scope probe) to terminal 13 of channel 2 relay driver board (I board). Connect ground to terminal 1 of the board.
   4. Close channel 2 Noise Switch.
      a. Timer will start and stop after 440 to 560 milliseconds.
      b. Channel 2 amber noise lamp will light.
      c. Channel 2 alarm relay will drop out.
   5. Open channel 2 Noise Switch. Reset lamps

C. Lockout (Tone Channel Only - where boards B or G are used)
   1. Close channel 1 Noise Switch.
      a. Channel 1 alarm relay will drop out.
      b. Channel 1 noise lamp will light.
   2. Close channel 1 and channel 2 trip switches. Channel 2 guard lamp will go off and channel 2 trip lamp will light.
   3. Open channel 1 Noise Switch.
      a. WL relays will operate.
      b. External trip light will light.
      c. Channel 1 guard lamp will go out.
      d. Channel 1 amber trip lamp will light.
      e. 4 red breaker trip lamps will light.
   4. Open channel 1 and 2 trip switches and reset lamps. If board G is not used go to step III.
   5. Close channel 2 Noise Switch.
      a. Channel 2 alarm relay will drop out.
      b. Channel 2 noise lamp will light.
   6. Close channel 1 and channel 2 trip switches. Channel 1 guard lamp will go off and channel 1 trip lamp will light.
   7. Open channel 2 Noise Switch.
      a. WL relays will operate.
      b. External trip light will light.
      c. Channel 2 guard lamp will go out.

d. Channel 2 amber lamp will light.

e. 4 red breaker trip lamps will light.

8. Open channel 1 and 2 trip switches and reset lamps.

III. Low Signal Clamp (Tone Channel Only - where boards B or G are used)

A. Channel 1

1. 150 Millisecond Timer

a. Connect timer start (scope trigger) to terminal 5 of CH INTER (A board)

a. Set timer start (scope trigger) to negative pulse.

c. Connect timer stop (scope probe) to terminal 13 of channel 1 lockout board (B board). Set timer stop on negative pulse.

Use terminal 1 as common or ground.

d. Open channel 1 low-signal switch.

1. Timer (scope) will start and stop after a time delay of 125 to 185 milliseconds (scope voltage will drop from 20 volts to 0 volts in same time).

2. Channel 1 guard lamp will go out.

3. After a time delay, channel 1 alarm relay will drop out.

2. 15 Millisecond Delay.

a. Set timer start (scope trigger) to positive pulse.

b. Close channel 1 low-signal switch. Timer should start and should stop after a delay of 12 to 18 milliseconds (scope voltage will change from 0 volts in the same time).

c. Open channel 1 low-signal switch

3. Guard Return

a. Close channel 1 and channel 2 trip switches.

1. Channel 2 guard lamp will go out.

2. Channel 2 trip lamp will light.

b. Close channel 1 low-signal clamp switch. No change in status should occur.

c. Open channel 1 trip switch.

a. Channel 1 guard lamp will light.

2. Channel 1 alarm relay will pickup.

d. Open channel 2 trip switch and reset lamps.

B. Channel 2 (If board G not used to to step IV)

1. 150 Millisecond Timer.

a. Connect timer start (scope trigger) to terminal 5 of CH INTER (F board).

b. Set timer start (scope trigger) to negative pulse.

c. Connect timer stop (scope probe) to terminal 13 of channel 2 lockout board (G board). Set timer stop on negative pulse.

Use terminal 1 as common or ground.

d. Open channel 2 low-signal switch.

1. Timer (Scope will start and stop after a time delay of 125 to 185 milliseconds (scope voltage will drop from 20 volts to 0 volts in same time).

2. Channel 2 guard lamp will go out.

3. After a time delay, channel 2 alarm relay will drop out.

2. 15 Millisecond Delay

a. Set timer start (scope trigger) to positive pulse.

b. Close channel 2 low-signal switch. Timer should start and should stop after a delay of 12 to 18 milliseconds (scope voltage will change from 0 volts to 20 volts in same time).

c. Open channel 2 low-signal switch.

3. Guard Return

a. Close channel 2 and channel 2 trip switches.

1. Channel 1 guard lamp will go out.

2. Channel 1 trip lamp will light.

b. Open channel 2 low signal clamp switch. No change in status should occur.

c. Open channel 2 trip switch.

1. Channel 2 guard lamp will light.

2. Channel 2 alarm relay will pickup.

d. Open channel 1 trip switch and reset lamps.

IV. Transfer Timers

A. Channel 1

1. Adjustable 500 to 2500 Millisecond Timer

a. Connect timer start (scope trigger) to terminal 2 of channel 1 transfer board (C board).
b. Set timer start (scope trigger) to negative pulse.
c. Connect timer stop (scope probe) to red test point on front of transfer module. Set timer stop on negative pulse. Use black test point on front of module as common or ground.
d. Set timer knob at minimum setting.
e. Open channel 1 low-signal clamp switch.
   1. Timer should start and stop within ±5% of the time specified on the calibration plate (scope voltage will drop from 20 volts to zero volts in same time).
   2. Check each setting of timer by moving knob to that setting. Time should be within ±5% of marking.
f. Close channel 1 low-signal clamp switch.

2. 0/10 Timer
   a. Connect timer start (scope trigger) to red test point of channel 1 transfer board (C board).
   b. Set timer start (scope trigger) to negative pulse.
   c. Connect timer stop (scope probe) to terminal 13 of channel 1 transfer board (C board). Set timer stop on positive pulse. Use black test point or terminal 1 as common or ground.
   d. Open channel 1 low-signal clamp switch. Timer should start and stop after a time delay of 7 to 13 milliseconds (scope voltage will change from zero to 13.5 volts in same time).
   e. Set timer start (scope trigger) to positive pulse.
   f. Set timer stop to negative pulse.
   g. Close channel 1 low-signal clamp switch. Timer should start and stop in less than 1 millisecond (scope voltage will change from 13.5 volts to zero volts in same time).

3. 10/0 Timer
   a. Connect timer start (scope trigger) to red test point of channel 1 transfer board.
   b. Set timer start (scope trigger) to negative pulse.
   c. Connect timer stop (scope probe) to terminal 8 of channel 1 transfer board (C board). Set timer stop on positive pulse. Use black test point or terminal 1 as common or ground.
   d. Open channel 1 low-signal clamp switch. Timer should start and stop after a time delay of less that 1 millisecond. (Scope voltage will change from zero volts to 9 volts in same time.)
   e. Set timer start (scope trigger) to positive pulse.
   f. Set timer stop to negative pulse.
   g. Close channel 1 low-signal clamp switch. Timer should start and stop after a time delay of 7 to 13 ms (scope voltage will change from 9 volts to 0 volts in same time).

B. Channel 2

1. Adjustable 500 to 2500 Millisecond Timer
   a. Connect timer start (scope trigger) to terminal 2 of channel 2 transfer board (H board).
   b. Set timer start (scope trigger) to negative pulse.
   c. Connect timer stop (scope probe) to red test point on front of transfer module. Set timer stop on negative pulse. Use black test point on front of module as common or ground.
   d. Set timer knob at minimum setting.
   e. Open channel 2 low-signal clamp switch.
      1. Timer should start and stop within ±5% of the time specified on the calibration plate (scope voltage will drop from 20 volts to zero volts in same time).
      2. Check each setting of timer by moving knob to that setting. Time should be within ±5% of marking.
   f. Close channel 2 low-signal clamp switch.

2. 0/10 Timer
   a. Connect timer start (scope trigger) to red test point of channel 2 transfer board (H board).

b. Set timer start (scope trigger) to negative pulse.

c. Connect timer stop (scope probe) to terminal 13 of channel 2 transfer board (H board). Set timer stop on positive pulse. Use black test point or terminal 1 as common or ground.

d. Open channel 2 low-signal clamp switch. Timer should start and stop after a time delay of 7 to 13 milliseconds (scope voltage will change from zero volts to 13.5 volts in same time).

e. Set timer start (scope trigger) to positive pulse.

f. Set timer stop to negative pulse.

g. Close channel 2 low-signal clamp switch. Timer should start and stop in less than 1 millisecond (scope voltage will change from 13.5 volts to zero volts in same time).

3. 10/0 Timer

a. Connect timer start (scope trigger) to red test point of channel 2 transfer board.

b. Set timer start (scope trigger) to negative pulse.

c. Connect timer stop (scope probe) to terminal 8 of channel 2 transfer board (H board). Set timer stop on positive pulse. Use black test point on terminal 1 as common or ground.

d. Open channel 2 low-signal clamp switch. Timer should start and stop after a time delay of less than 1 millisecond. (Scope voltage will change from zero volts to 9 volts in same time.)

e. Set timer start (scope trigger) to positive pulse.

f. Set timer stop to negative pulse.

g. Close channel 2 low-signal clamp switch. Timer should start and stop after a time delay of 7 to 13 milliseconds (scope voltage will change from 9 volts to zero volts in same time.)

V. Transfer To Single Channel

A. Loss of Signal

1. Open link on both "OR" boards by removing jumper placed there at beginning of test.
2. Open channel 1 low-signal clamp switch. Channel 1 white guard lamp will go off.
3. After STU–92 has transferred to a single channel as indicated by alarm relay dropping out, close channel 2 trip switch.
4. External trip light will light, and WL relays will operate, breakers 1 and 2, trip 2 red lamps will light, white lamp of channel 2 will go off and amber trip lamp of channel 2 will light.
5. Close channel 1 low-signal clamp switch, and open channel 2 trip switch, reset lamps and WL switches.
6. Open channel 2 low-signal clamp switch. Channel 2 white guard lamp will go off.
7. After STU–92 has transferred to a single channel as indicated by alarm relay dropping out, close channel 1 trip switch.
8. External trip light will light and WL relays will operate, breakers 1 and 2 trip 1 red lamps will light, white lamp of channel 1 will go off, and amber trip lamp of channel 1 will light.
9. Close channel 1 low-signal clamp switch, and open channel 1 trip switch, reset lamps and WL switches.

B. Loss of DC Voltage

1. Open dc power supply switch 1.
   a. Alarm relay 1 should drop out.
   b. White guard light 1 should go out.
2. Close trip switch of channel 2.
   a. WL should operate.
   b. Red breaker trip lamps of channel 2 should light.
   c. Amber trip lamp of channel 2 will light.
   d. External trip light should light.
3. Open trip switch of channel 2, close dc power supply switch 1, and open dc power supply switch 2.

a. Alarm relay 2 should drop out.
b. White guard light 2 should go out.

4. Close trip switch of channel 1.
   a. WL should operate.
   b. Red breaker trip lamps of channel 1 should light.
   c. Amber trip lamp of channel 1 will light.
   d. External trip light should light.

Tripping Relay (AR)

The type AR tripping relay unit has been properly adjusted at the factory to insure correct operation and should not be disturbed after receipt by the customer. If, however, the adjustments are disturbed in error, or it becomes necessary to replace some part in the field, use the following adjustment procedure. This procedure should not be used until it is apparent that the AR unit is not in proper working order, and then only if suitable tools are available for checking the adjustments.

a. Adjust the set screw at the top of the frame to obtain a 0.009 inch gap at the rear end of the armature air gap.

b. Adjust each contact spring to obtain 4 grams pressure at the very end of the spring. This pressure is measured when the spring moves away from the edge of the slot in the insulated crosspiece.

c. Adjust each stationary contact screw to obtain a contact gap of 0.020 inch. This will give 15—30 grams contact pressure.

Trouble Shooting

The components of the STU—92 and STU—91 relays are operated well within their ratings, and under normal conditions, they should give long, trouble-free service. However, if a relay has given an indication of trouble in service or during routine checks, the "truth tables" of Figure 32 should be checked to determine the faulty component. All voltages are measured with respect to negative except where noted.

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, and style numbers from the electrical parts list.

ELECTRICAL PATRS LIST

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
INTERFACE BOARD S#202C482G01		
	Capacitors	
C1	6.8 MFD	184A661H10
C2,C3,C4	0.047 MFD	849A437H04
	Diodes	
D1	1N645A	837A692H03
	Transistors	
Q1	2N3589	837A617H01
Q2,Q4, Q6	2N3417	848A851H02
Q3,Q5,Q7	2N3645	849A441H01
	Resistors	
R1,R2,R8,R9,R15,R16	4.7 k-ohm	629A531H48
R3,R7,R17,R21	82 k-ohm	629A531H78
R4,R5,R11,R12,R18,R19	10 k-ohm	629A531H56
R6,R13,R20	6.8 k-ohm	629A531H52
R14	47 k-ohm	629A531H72
	Zener Diodes	
Z1	1N3050A, 120 V	187A936H16
Z2	1N4747A, 20 V	849A487H01
Z3,Z5,Z7	1N3686B, 20 V	185A212H06
Z4,Z6,Z8	1N957B, 6.8 V	186A797H06
INTERFACE BOARD S#202C491G01		
	Capacitors	
C1	6.8 MFD	184A661H10
C2,C3,C4	0.047 MFD	849A437H04
	Diodes	
D1	1N645A	837A692H03
	Transistors	
Q1	2N3589	837A617H01
Q2.Q5,Q8	2N4356	849A441H02
Q3,Q6,Q9	2N3417	848A851H02
Q4,Q7,Q10	2N3645	849A441H01

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
INTERFACE BOARD S#202C491G01 Cont.		
	Resistors	
R1,R2,R5,R6,R13,R14	4.7 k-ohm	629A531H48
R3,R7,R12,R21,R27	82 k-ohm	629A531H78
R4,R9,R10,R15,R17,R18 R22,R24,R25	10 k-phm	629A531H56
R8,R16,R20,R23	47 k-ohm	629A531H72
R11,R19,R26	6.8 k-ohm	629A531H52
	Zener Diodes	
Z1	1N2050A, 180 V	187A936H16
Z2	1N4747A, 20 V	849A487H01
Z3,Z5,Z7	1N3686B, 20 V	185A212H06
Z4,Z6,Z8	2N957B, 6.8 V	186A797H06
Z9	UZ5875, 75 V	837A693H04
LOCKOUT BOARD (WHERE USED) S#202C456G01		
	Capacitors	
C1	6.8 MFD	184A661H10
	Diodes	
D1 to D4-D6 to D10	1N645A	837A692H03
	Transistors	
Q1,Q2,Q3,Q4,Q5,Q6 Q7,Q8,Q9,Q11	2N3417	848A851H02
Q10, Q12	2N3645	849A441H01
	Resistors	
R1,R4,R7,R14,R25	39 k-ohm	629A531H70
R2,R5,R8,R11,R15 R19,R22,R26,R29, R30,R34,R35	10 k-ohm	629A531H56
R3,R9,R16,R23,R27 R31,R36	6.8 k-ohm	629A531H52
R6, R13, R33	33 k-ohm	629A531H68
R10,R12,R17,R18 R20, R21, R28	27 k-ohm	629A531H66
R24, R38	12 k-ohm	629A531H58
R32	82 k-ohm	629A531H78
R37	47 k-ohm	629A531H72

ELECTRICAL PARTS LIST Cont.

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
LOCKOUT BOARD (WHERE USED) S#202C456G01		
Zener Diodes		
Z1	1N957B, 6.8 V	186A797H06
OR BOARD S#202C446G01		
Capacitors		
C1-C2	0.27 MFD	849A437H02
C3	1.5 MFD	187A508H09
Diodes		
D1,D2,D4 to D15	1N645A	837A692H03
D3	MAL3053	629A370H04
Transistors		
1Q,Q3,Q4,Q5,Q6,Q7	2N3417	848A851H02
Q2,Q8	2N3645	849A441H01
Resistors		
R1,R3,R5,R7,R10 R14,R21,R24,R25	10 k-ohm	629A531H56
R2,R8,R11,R15,R22,R26	6.8 k-ohm	629A531H52
R4	47 k-ohm	629A531H72
R6	4.7 k-ohm	629A531H48
R9,R12,R13,R16,R17 R18,R19,R20,R23	27 k-ohm	629A531H66
R27	82 k-ohm	629A531H78
R28	150 ohm, 3W	762A679H01
Transformers		
TR1	FD 505	629A372H01
Zener Diodes		
Z1,Z2	1N3688A, 24 V	872A288H01
TRIP BOARD 48/125 VOLTS DC, S#899C826G01 250 VOLTS DC, S#201C416G01		
Capacitors		
C1,C2	2 MFD	187A624H05
C3,C4	.27 MFD	188A669H05

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
TRIP BOARD (Cont.) 48/125 & 250 VOLTS DC		
Diodes		
D1 to D4	1N645A	837A692H03
Transistors		
Q1	2N2647	629A453H01
Q1	2N3645	849A441H01
Q3	2N3417	848A851H02
Resistors		
R1 to R4	470 ohm,1W	187A643H19
R5	300 ohm	629A531H19
R6	15 k-ohm	629A531H60
R7	3.3 k-ohm	629A531H44
R8	22 k-ohm	629A531H64
R9	6.8 k-phm	629A531H52
R10	10 k-ohm	629A531H56
R11 to R13	27 k-ohm	629A531H66
Zener Diodes		
Z1 to Z6	1R200	629A369H01
Transformer		
TR1	FD505	629A372H01
TRANSFER BOARD, S#5489D25G01		
Capacitors		
C1	100 MFD	184A761G01
C2,C3	1.5 MFD	187A508H09
Diodes		
D1 to D4	1N645A	837A692H03
Transistors		
Q1,Q2,Q3,Q5,Q6 Q7,Q8,Q9,Q10	2N3417	848A851H02
Q4	2N3645	849A441H01

ELECTRICAL PARTS LIST (Cont.)

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
TRANSFER BOARD, S#5489D25G01 (Cont.)		
Resistors		
R1,R12,R17,R21,R29	33 k-ohm	629A531H68
R2,R3,R6,R9,R10 R13,R16,R19,R22 R25,R28	10 k-ohm	629A531H56
R4,R15,R27	470 ohm	629A531H24
R5	50 k-ohm pot.	862A303H01
R7,R8,R18,R23,R24	27 k-ohm	629A531H66
R11	47 k-ohm	629A531H72
R14,R26	15 k-ohm	629A531H60
R20	6.8 k-ohm	629A531H52
Zener Diodes		
Z1,Z2,Z3	1N957B, 6.8V	186A797H06
RELAY DRIVER, S#202C488G01		
Capacitors		
C1	22 MFD	184A661H16
Diodes		
D1 to D4	1N645A	837A692H03
Transistors		
Q1,Q2,Q4,Q5,Q6 Q8,Q9	2N3417	848A851H02
Q3,Q10,Q11	2N3589	837A617H01
Q7	2N3645	849A441H01
Resistors		
R1,R5,R26	39 k-ohm	629A531H70
R2,R6,R9,R12,R15,R18, R19,R23,R27,R30,R32	10 k-ohm	629A531H56

CIRCUIT SYMBOL	DESCRIPTION	WESTINGHOUSE STYLE NUMBER
RELAY DRIVER, S#202C488G01		
Resistors		
R3,R4,R24,R25	22 k-ohm	629A531H64
R7,R8,R28,R29	3.3 k-ohm	629A531H44
R10	15 ohm, 3 W	763A127H36
R11,R13,R14	33 k-ohm	629A531H68
R14,R20,R21	47 k-ohm	629A531H72
R17	470 ohm	629A531H24
R22	27 k-ohm	629A531H66
R31	6.8 k-ohm	629A531H52
Zener Diodes		
Z1	1N3688A, 24V	862A288H01
Z2	1N957B, 6.8V	186A797H06
INDICATOR BOARD 48 VOLT DC, S#202C502G01		
Capacitors		
C1,C2	0.56 MFD	763A219H18
C3,C5,C7,C9	0.082 MFD	849A437H01
C4,C6,C8,C10	0.01 MFD	763A219H03
Diodes		
D1 to D10	1N645A	837A692H03
Transistors		
Q1,Q3	2N3417	848A851H02
Q2,Q4	2N3645	849A441H01
Q5,Q7,Q9,Q11	2N2646	629A43: H03
Q6,Q8,Q10,Q12	K1149-13 SCR	184A640H13
Resistors		
R1,R2,R7,R8,R13,R17	20 k-ohm	629A531H63
R3,R4,R9, R10	10 k-ohm	629A531H56
R5,R11	6.8 k-ohm	629A531H52
R6,R12	27 k-ohm	629A531H66
R14,R18,R22,R26	300 ohms	629A531H19
R15,R19,R23,R27	51 ohms	629A531H01
+R16, R20,R24,R28	1.2 k-ohms, 3W	763A127H03
R21,R25	100 k-ohm	629A531H80
R29	15 ohms, 3W	763A127H36

+ NOT USED ON 48 VOLT DC INDICATOR BOARD

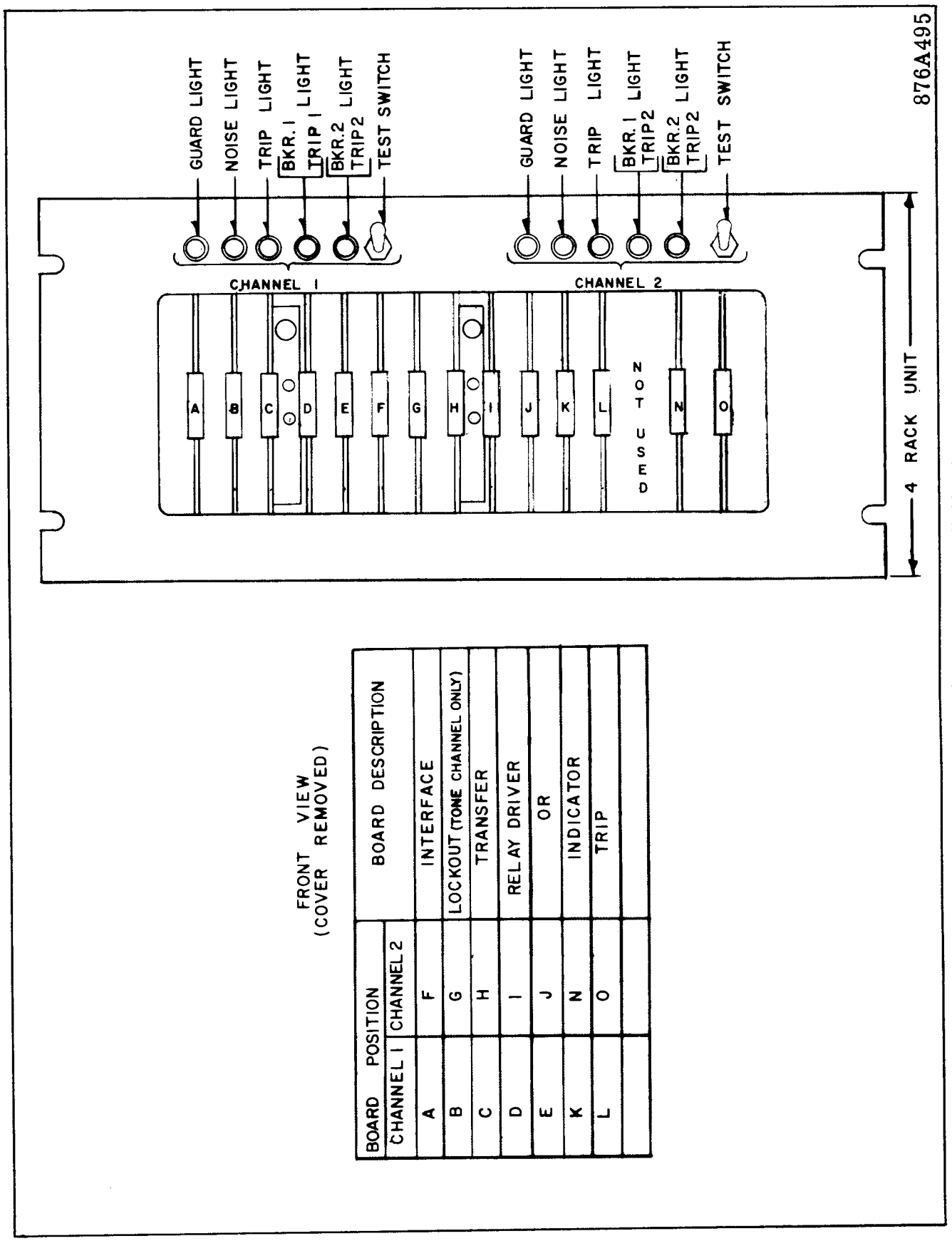


Fig. 1. Front View of STU-92 Relay

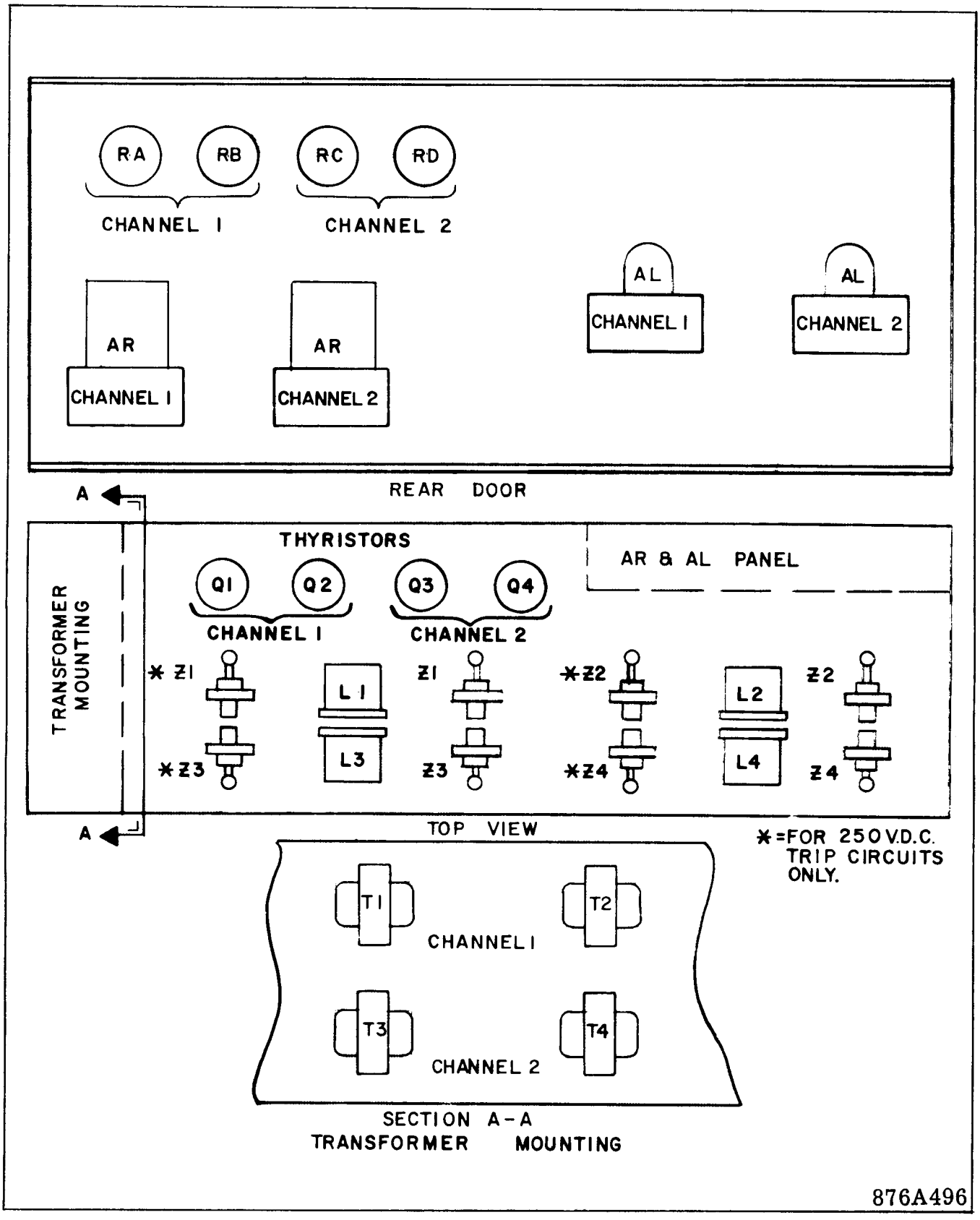


Fig. 2. Conponent Location in the STU–92 Relay

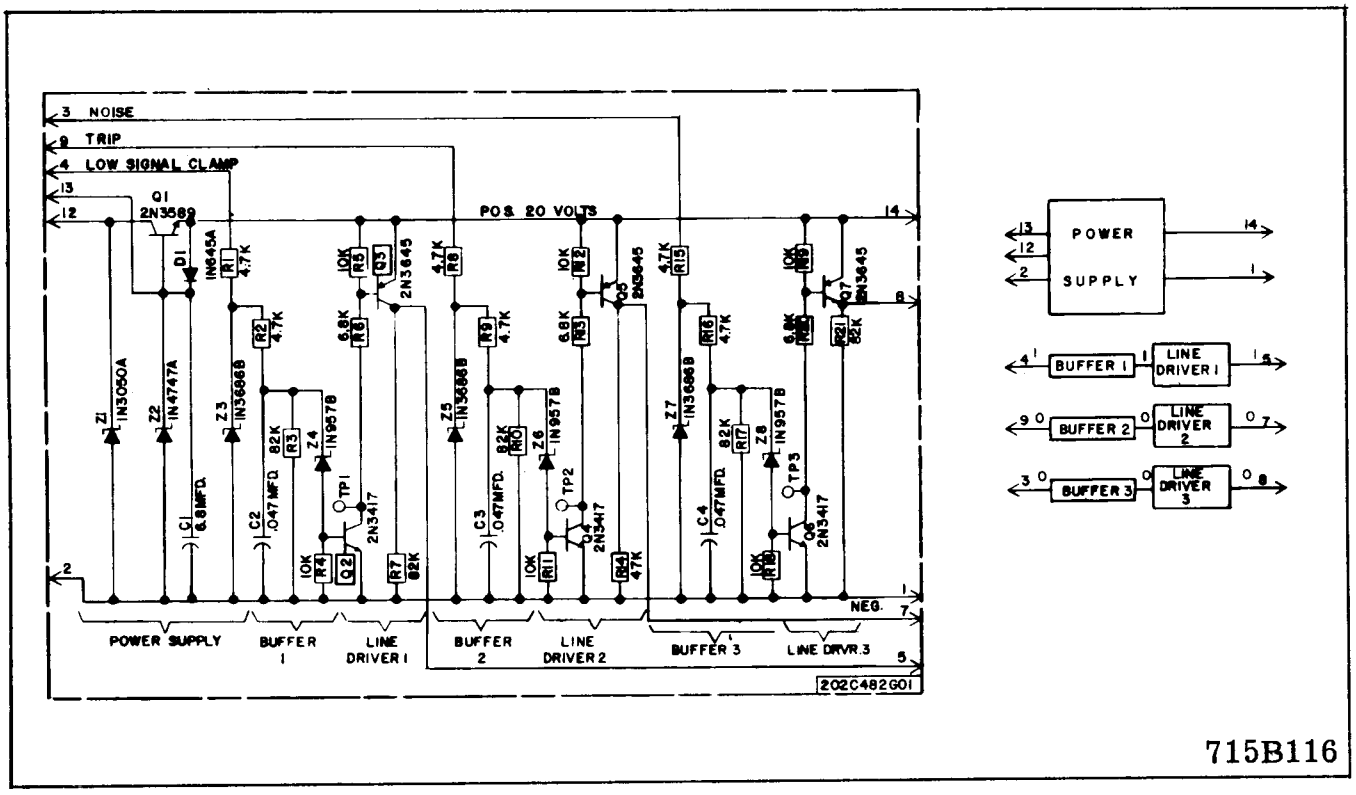


Fig. 3. Schematic Diagram of the Channel Interface Board for TA-3 Tone Channel and TCF Carrier

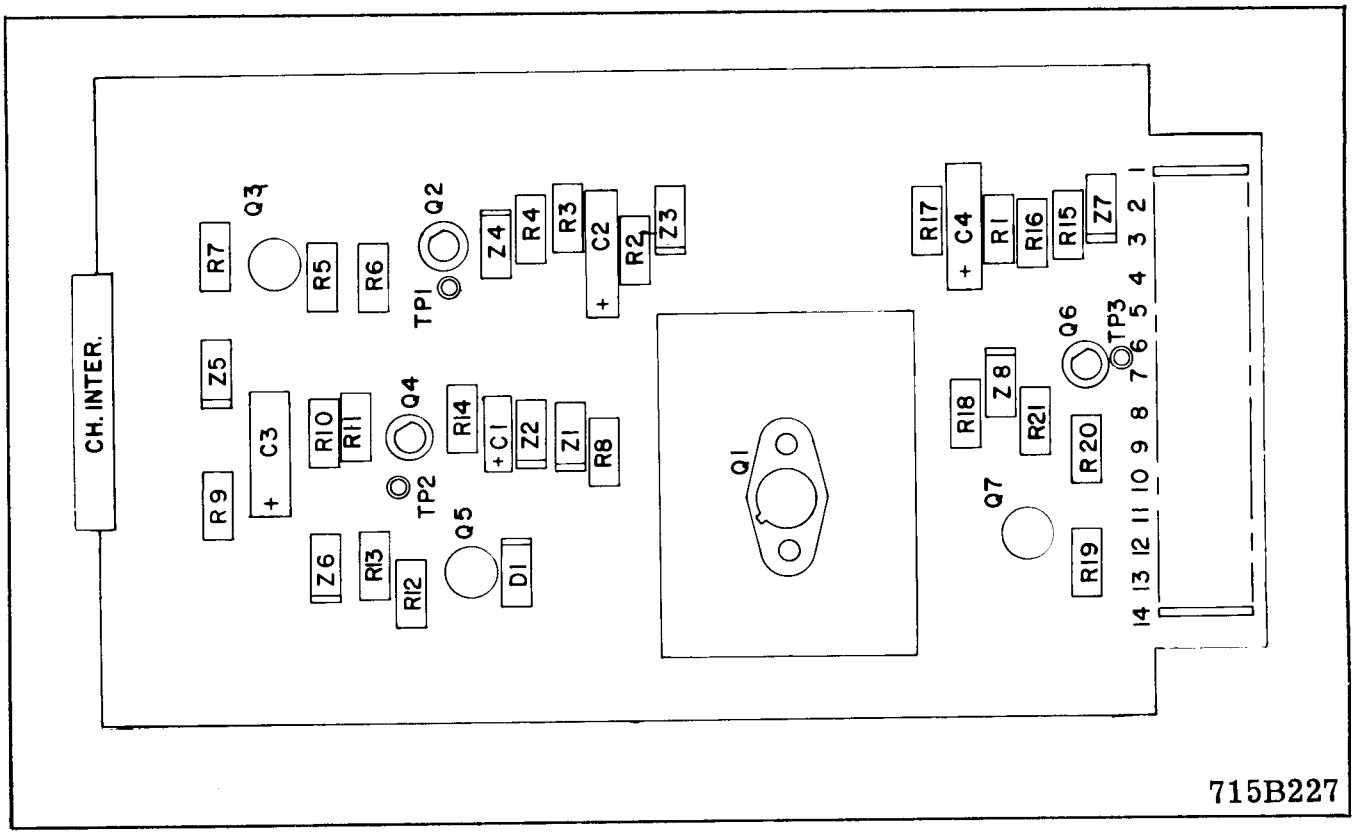


Fig. 4. Component Location on the Channel Interface Board for TA-3 Tone Channel and TCF Carrier

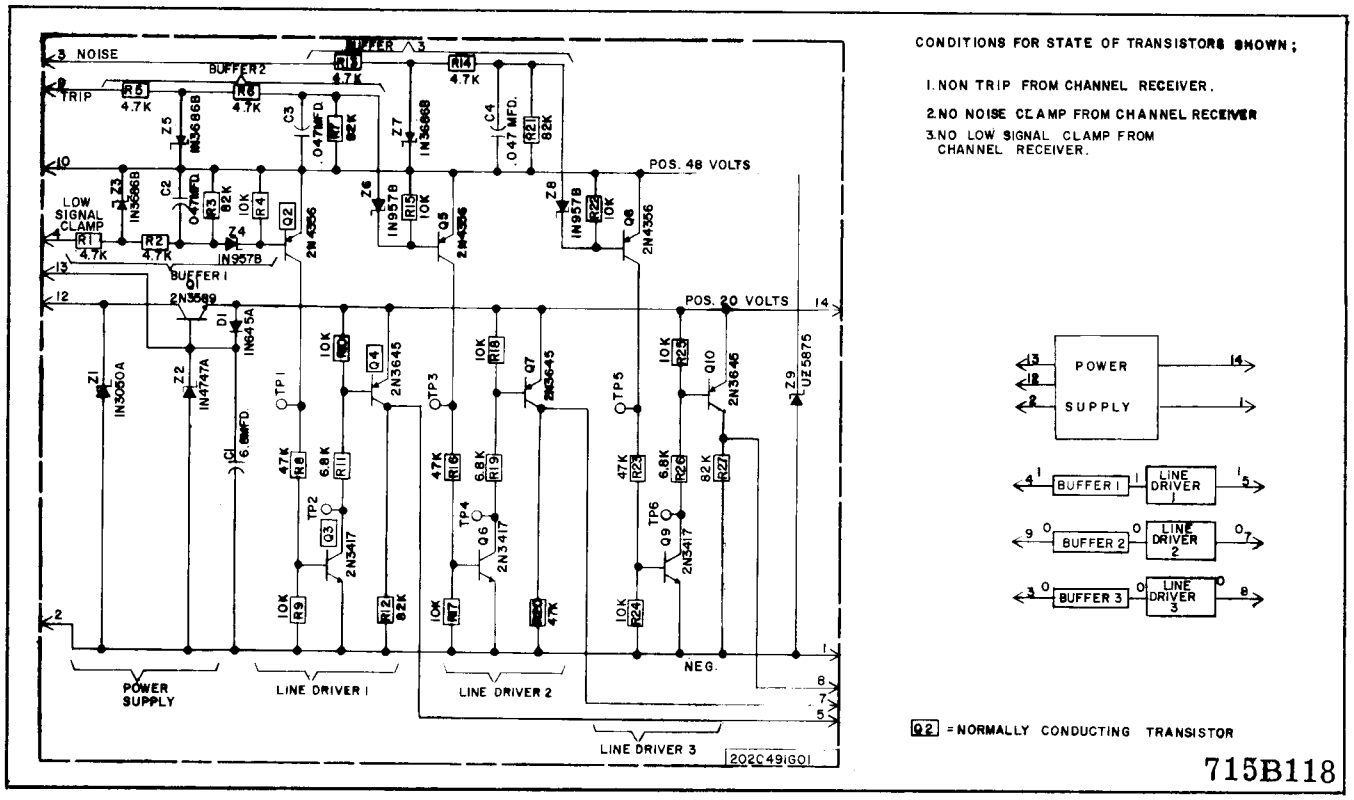


Fig. 5. Schematic Diagram of the Channel Interface Board for Lenkurt 937A Tone Channel

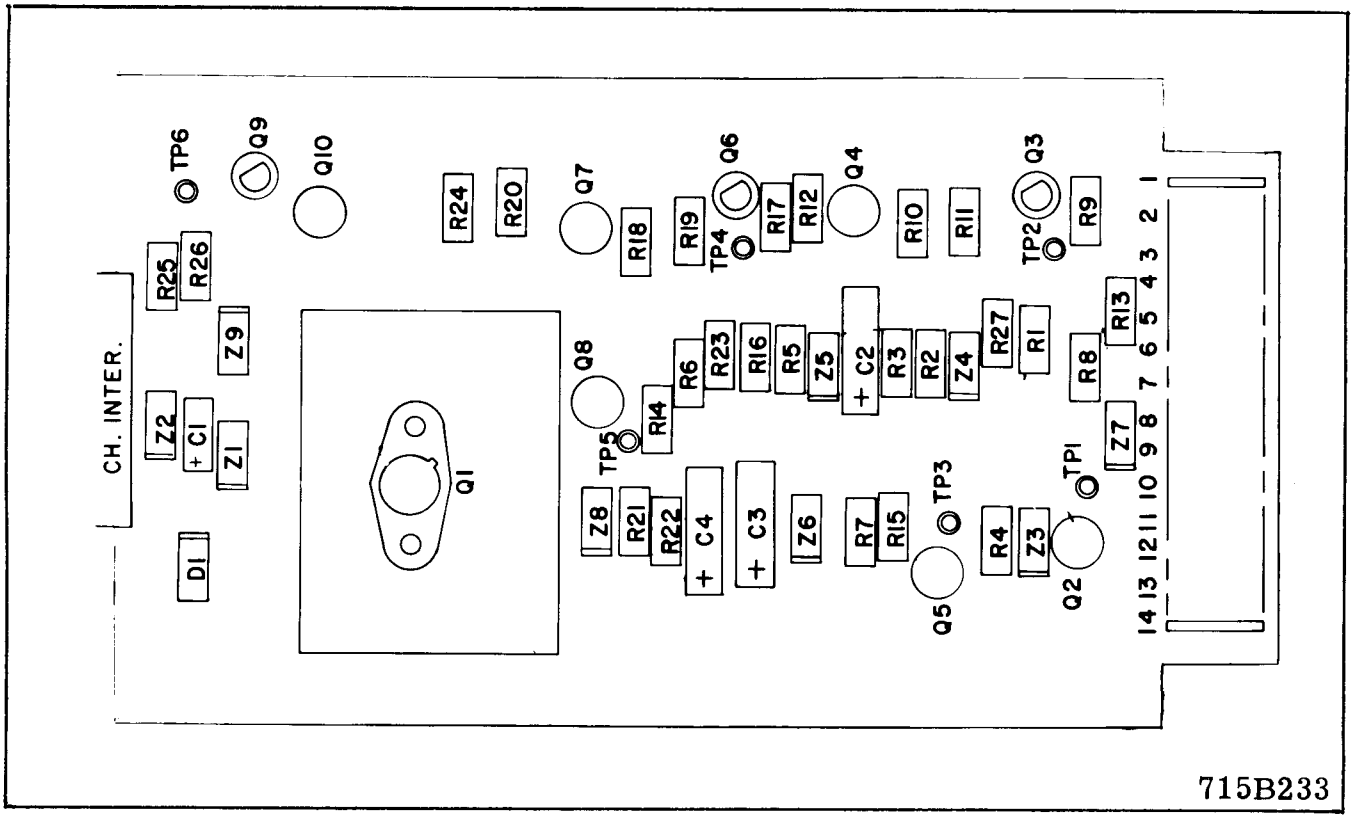


Fig. 6. Component Location on the Channel Interface Board for Lenkurt 937A Tone Channel

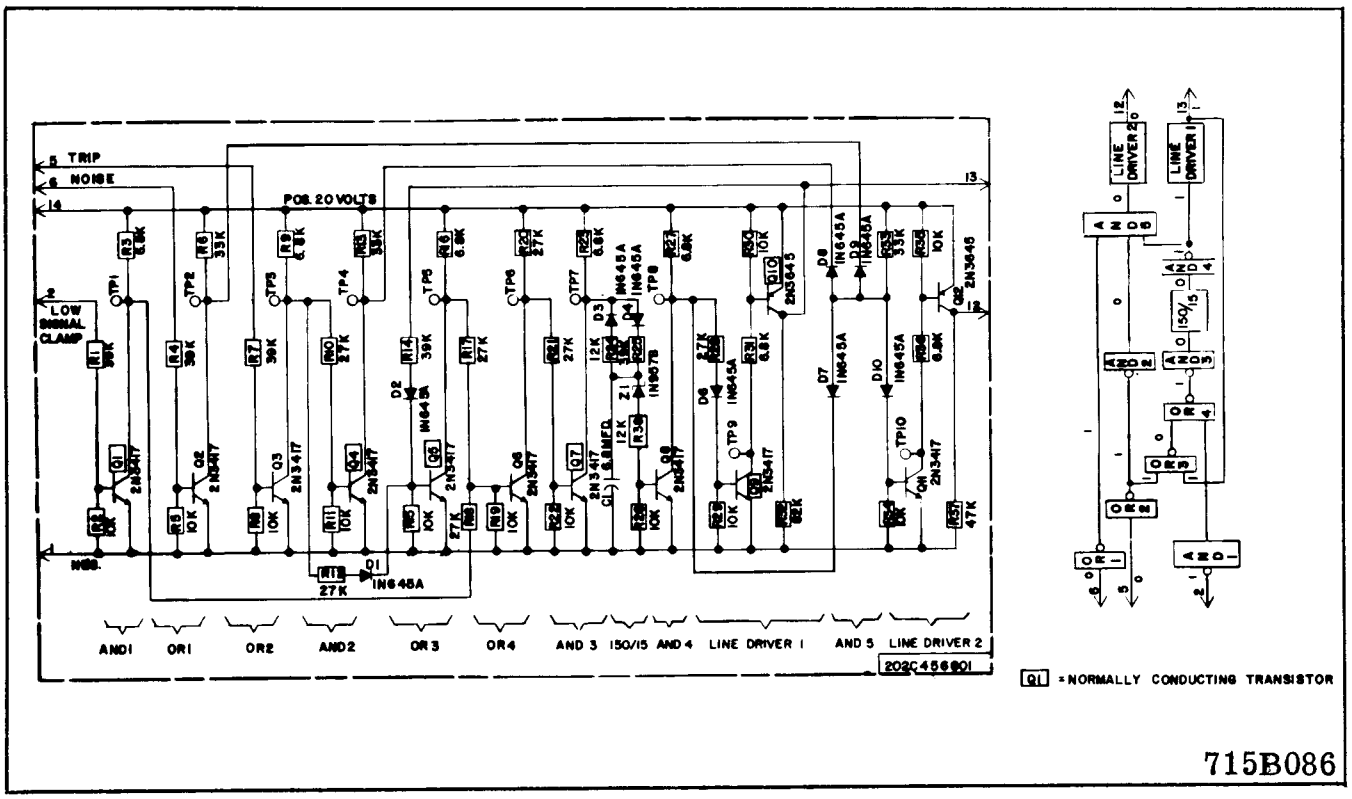


Fig. 7. Schematic Diagram of the Lockout Boa rd for TA-3 and 937A Tone Channel

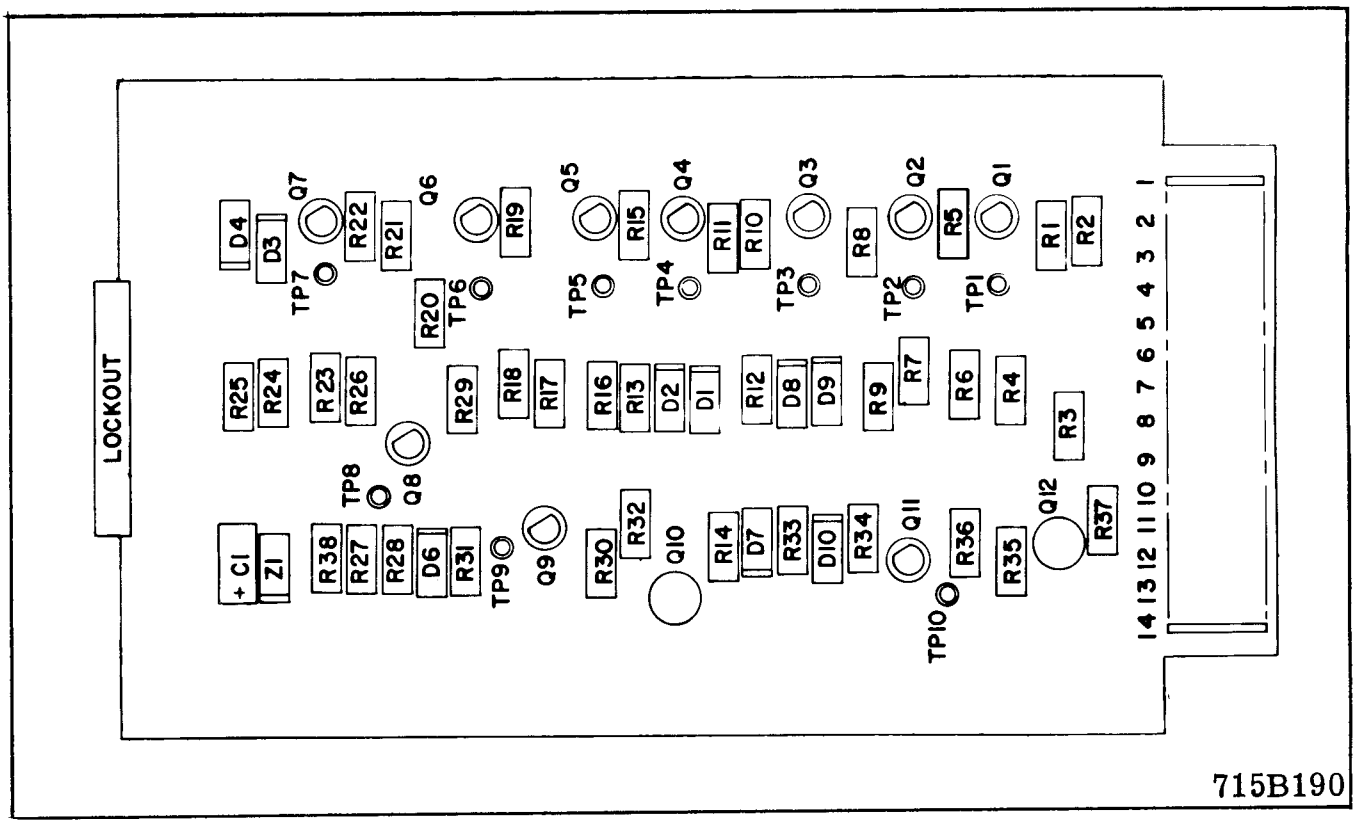


Fig. 8. Component Location on the Lockout Board of the STU-92 Relay for TA-3 and 937A Tone Channels

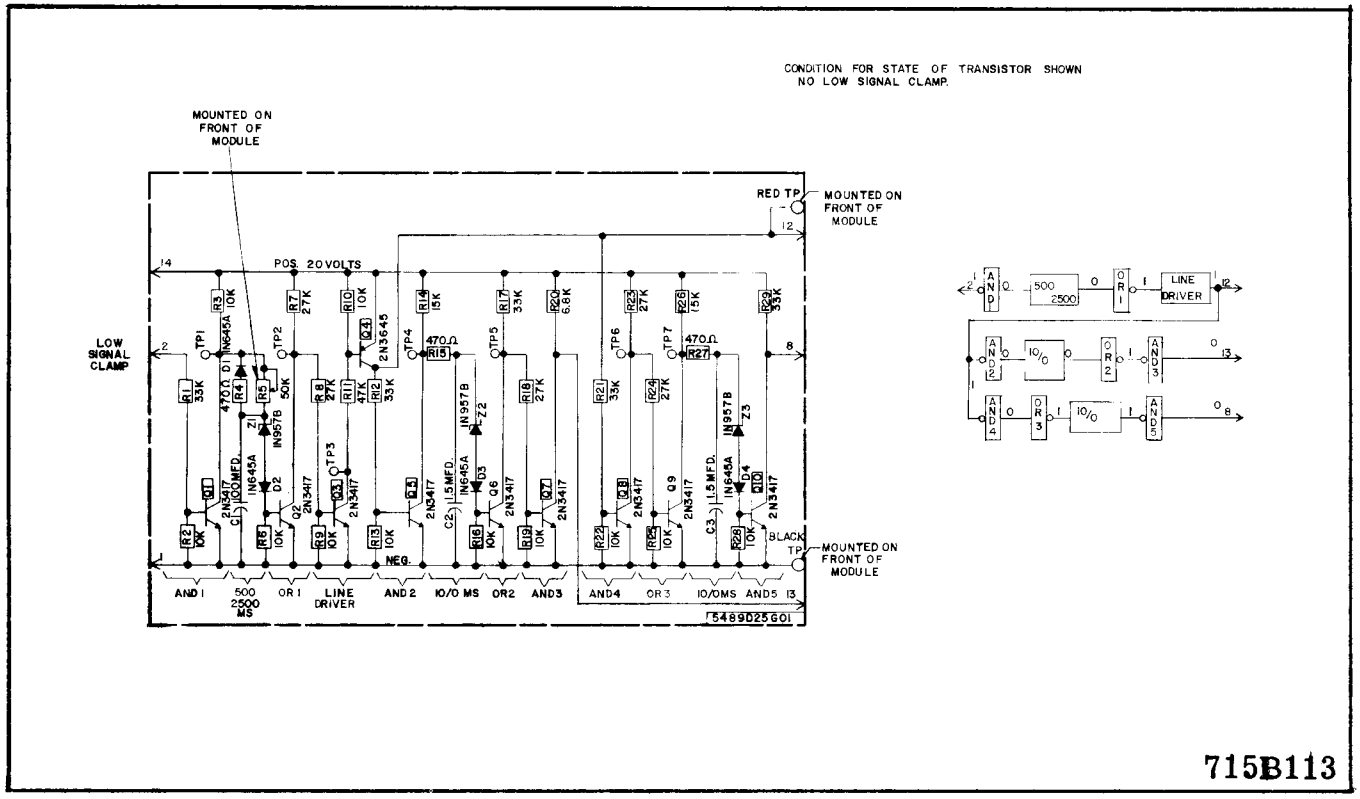


Fig. 9. Schematic Diagram of the Transfer Board of the STU–92 Relay

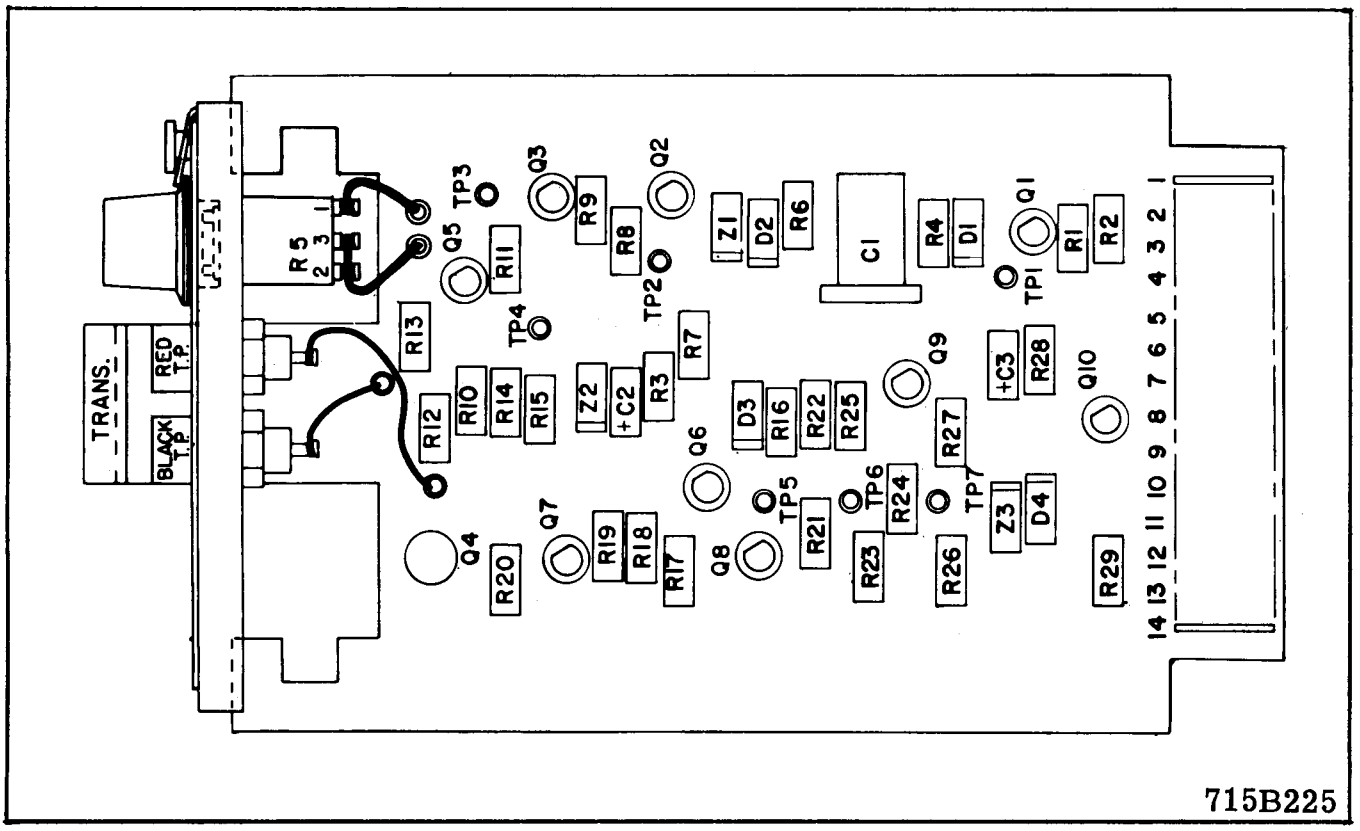


Fig. 10. Component Location on the Transfer Board

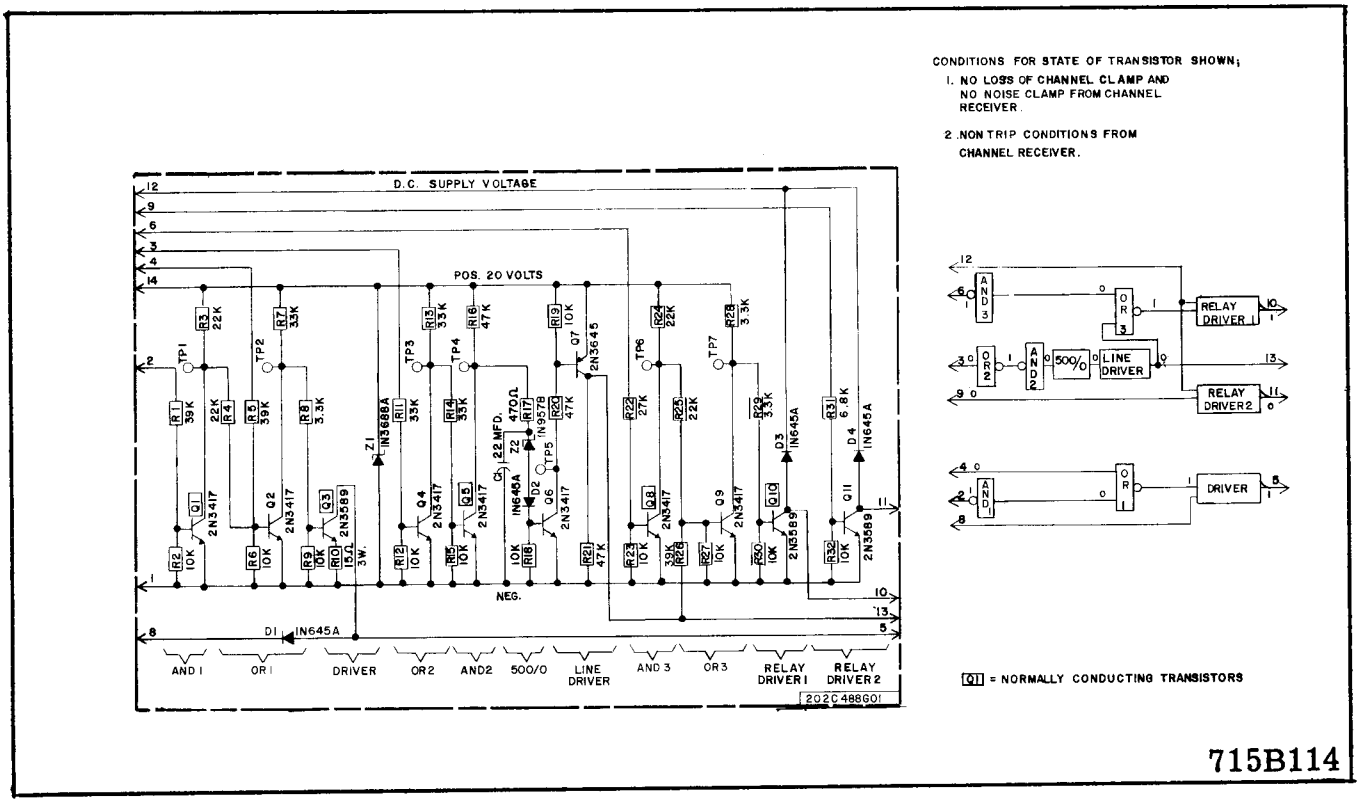


Fig. 11. Schematic Diagram of the Relay Driver Board

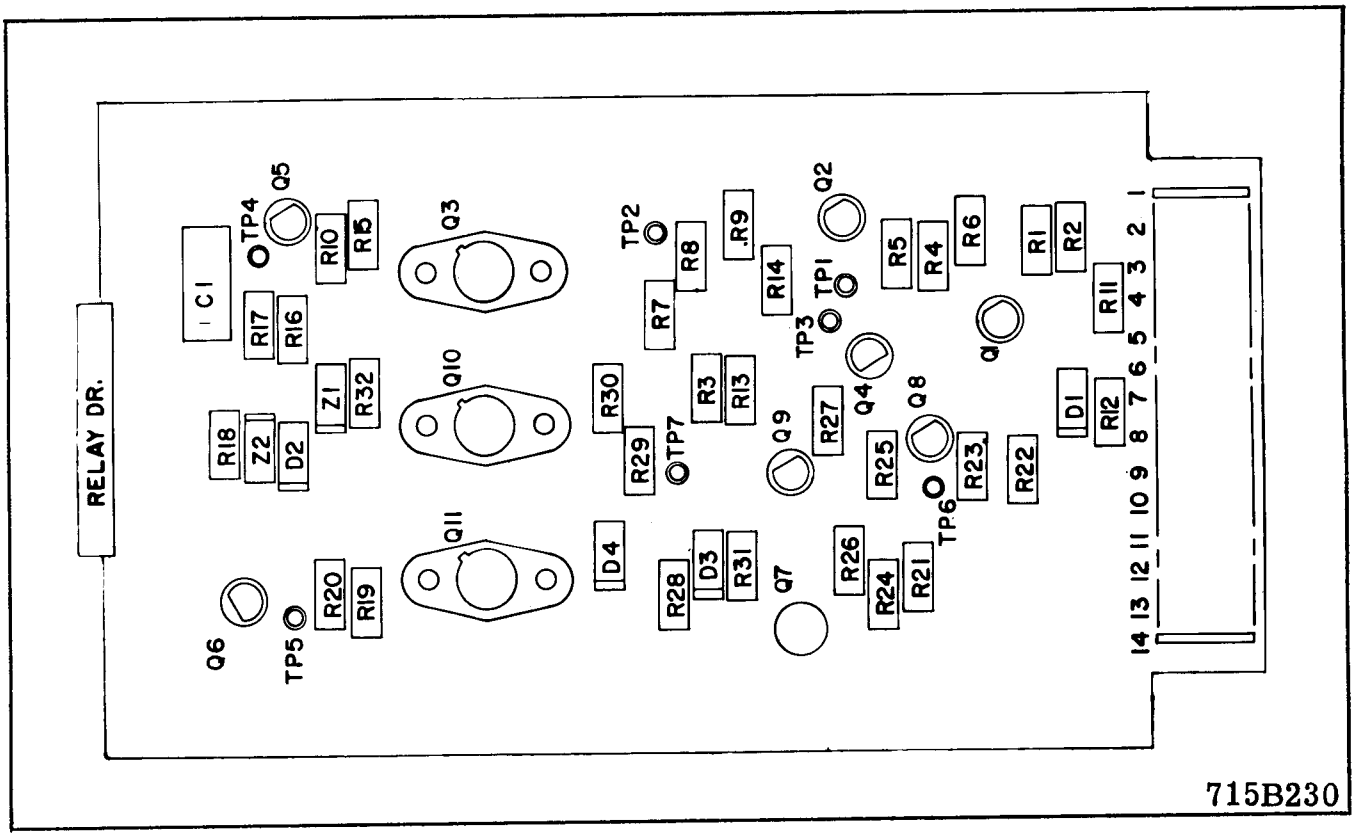


Fig. 12. Component Location on the Relay Driver Board

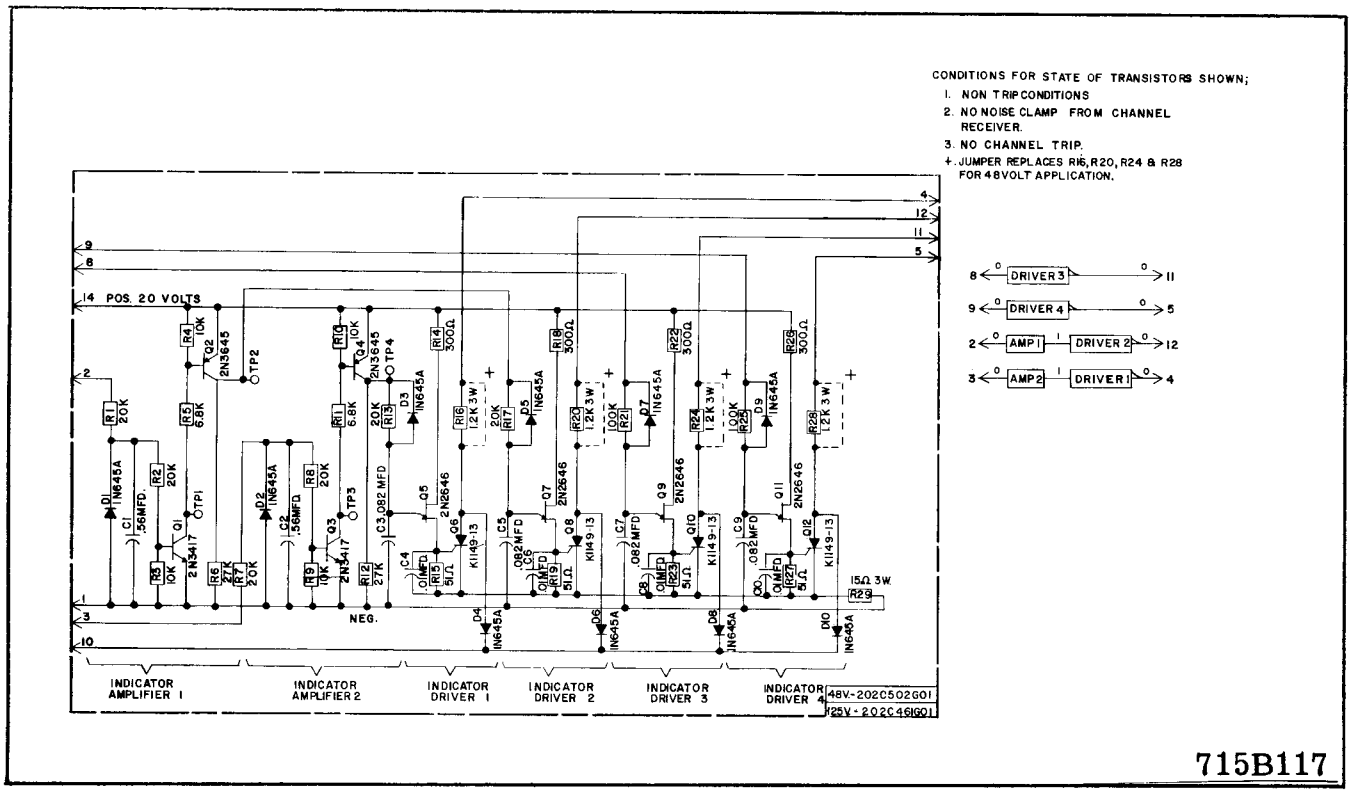


Fig. 13. Schematic Diagram of the Indicator Board

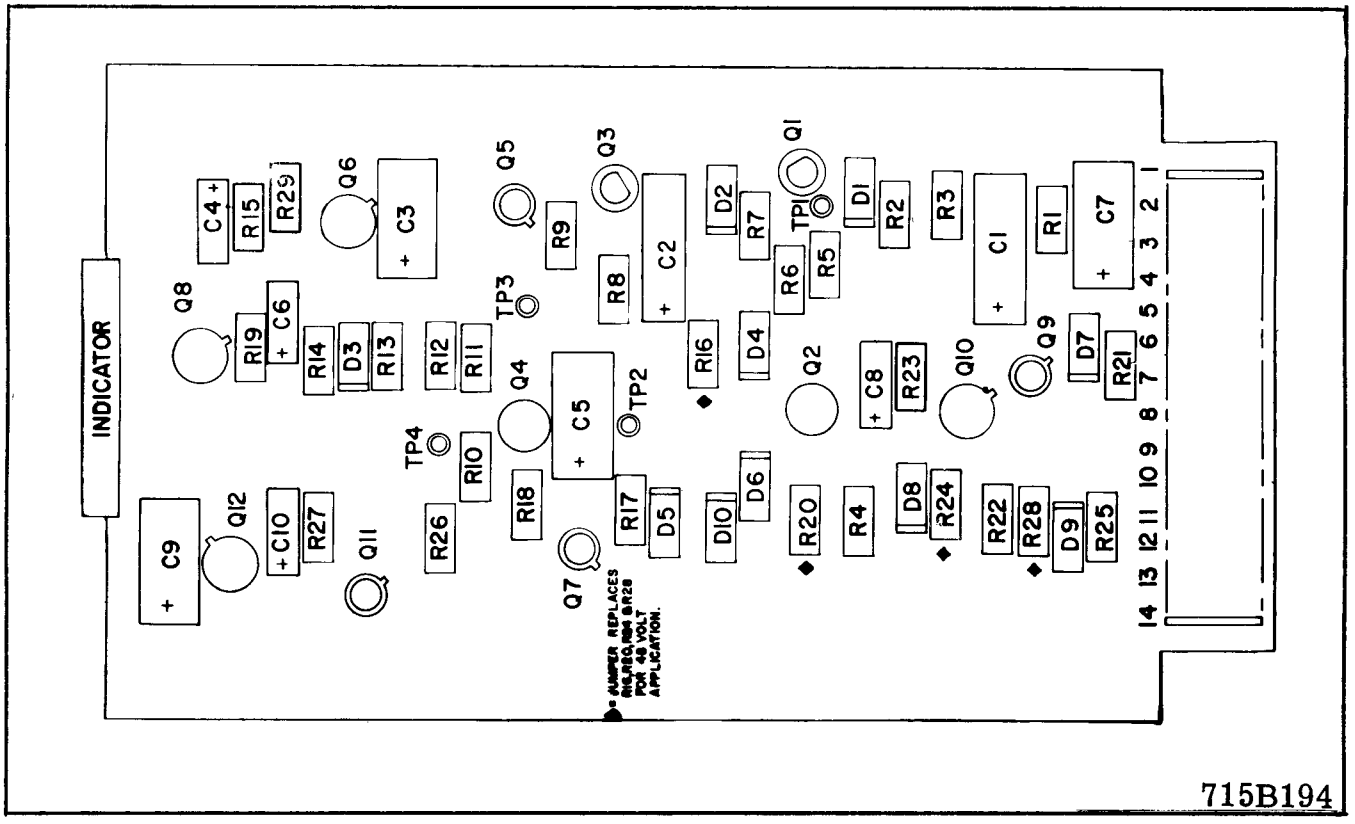


Fig. 14. Component Location on the Indicator Board

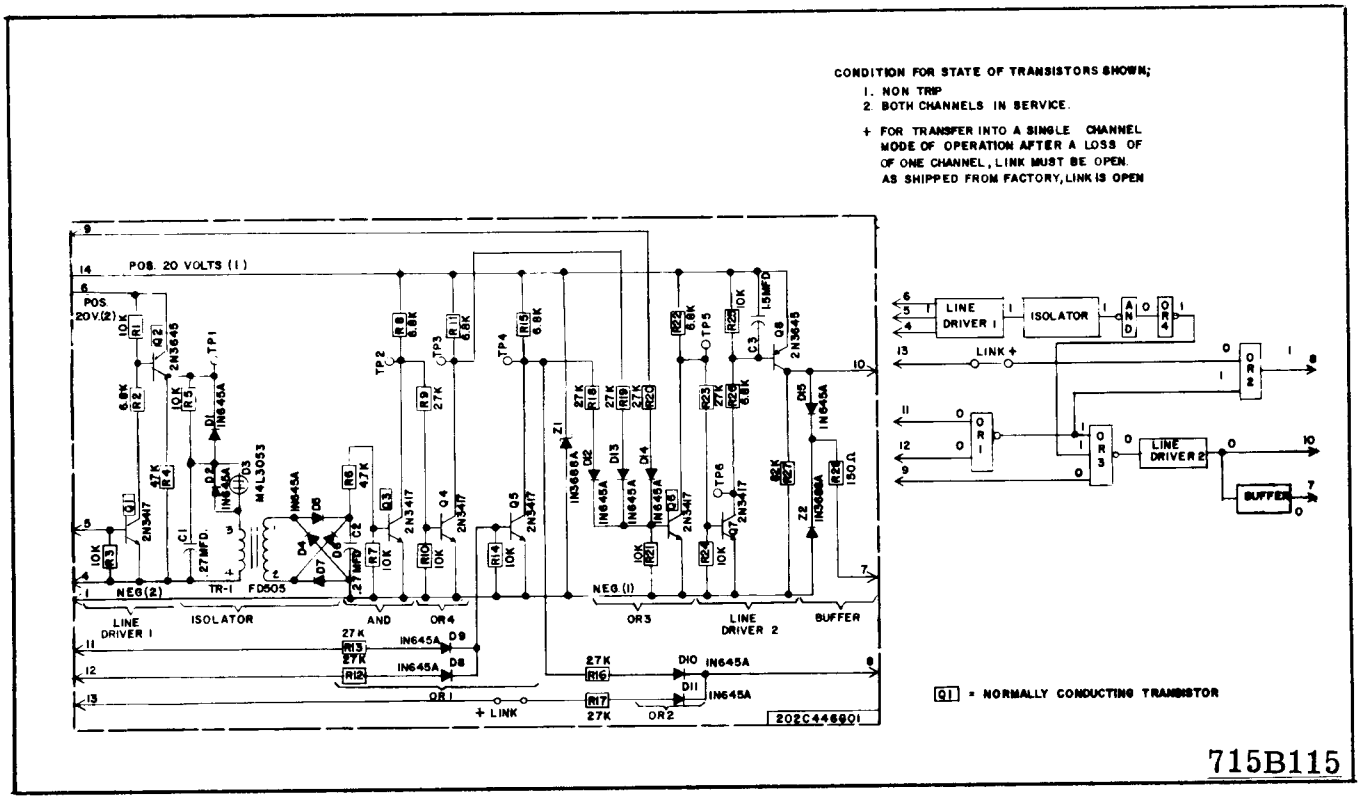


Fig. 15 Schematic Diagram of the OR Board of the STU–92 Relay

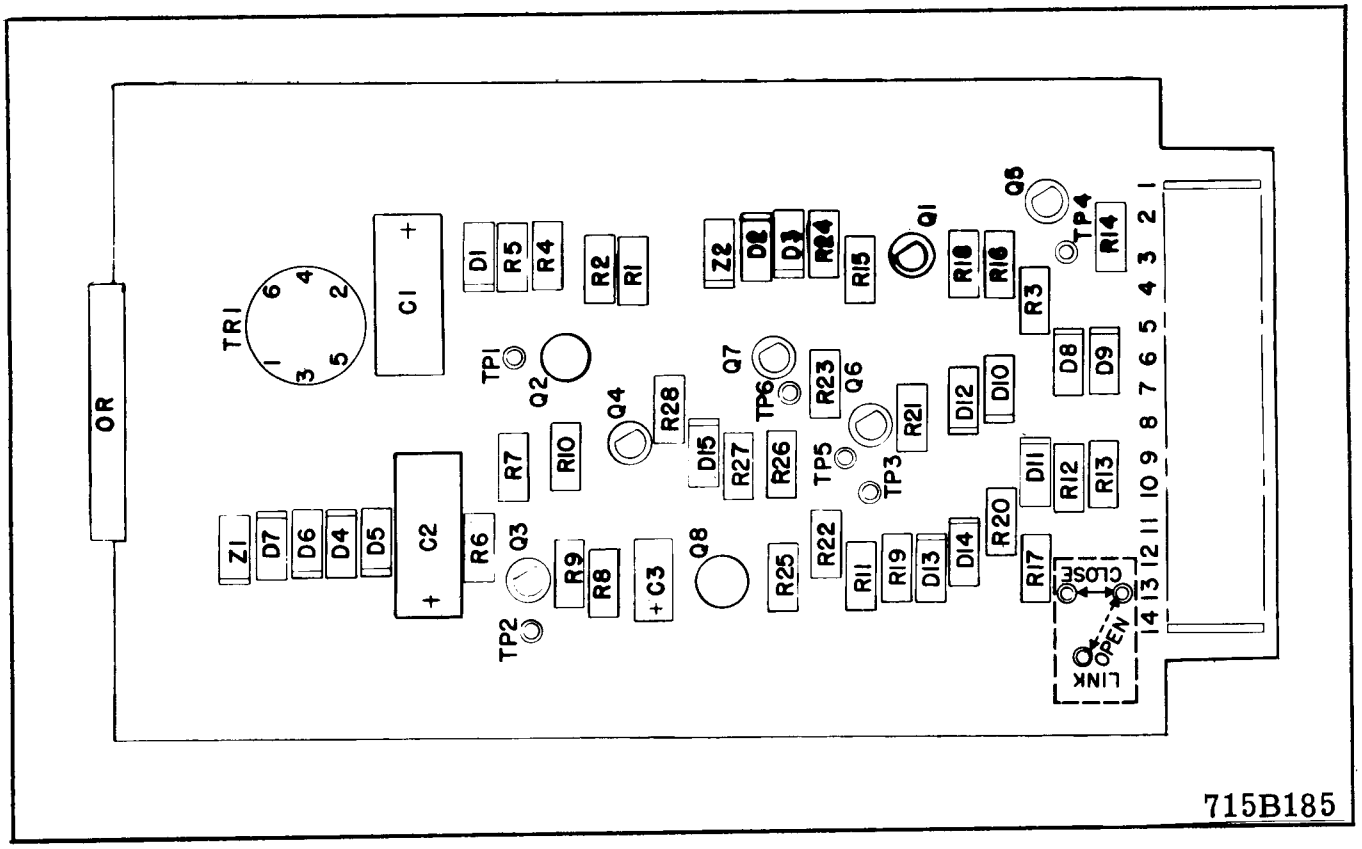


Fig. 16. Component Location on the OR Board of the STU–92 Relay

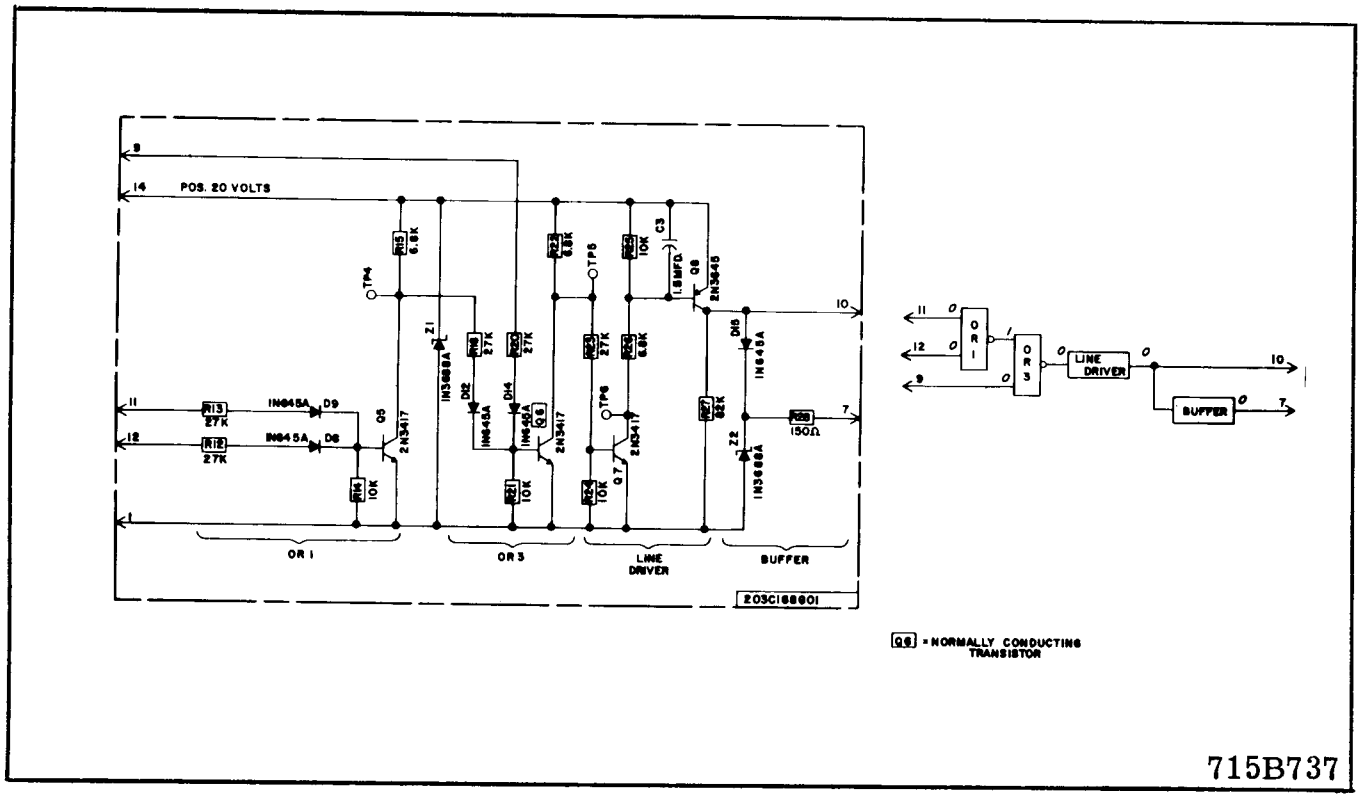


Fig. 17. Schematic Diagram of the OR Board of the STU–91 Relay

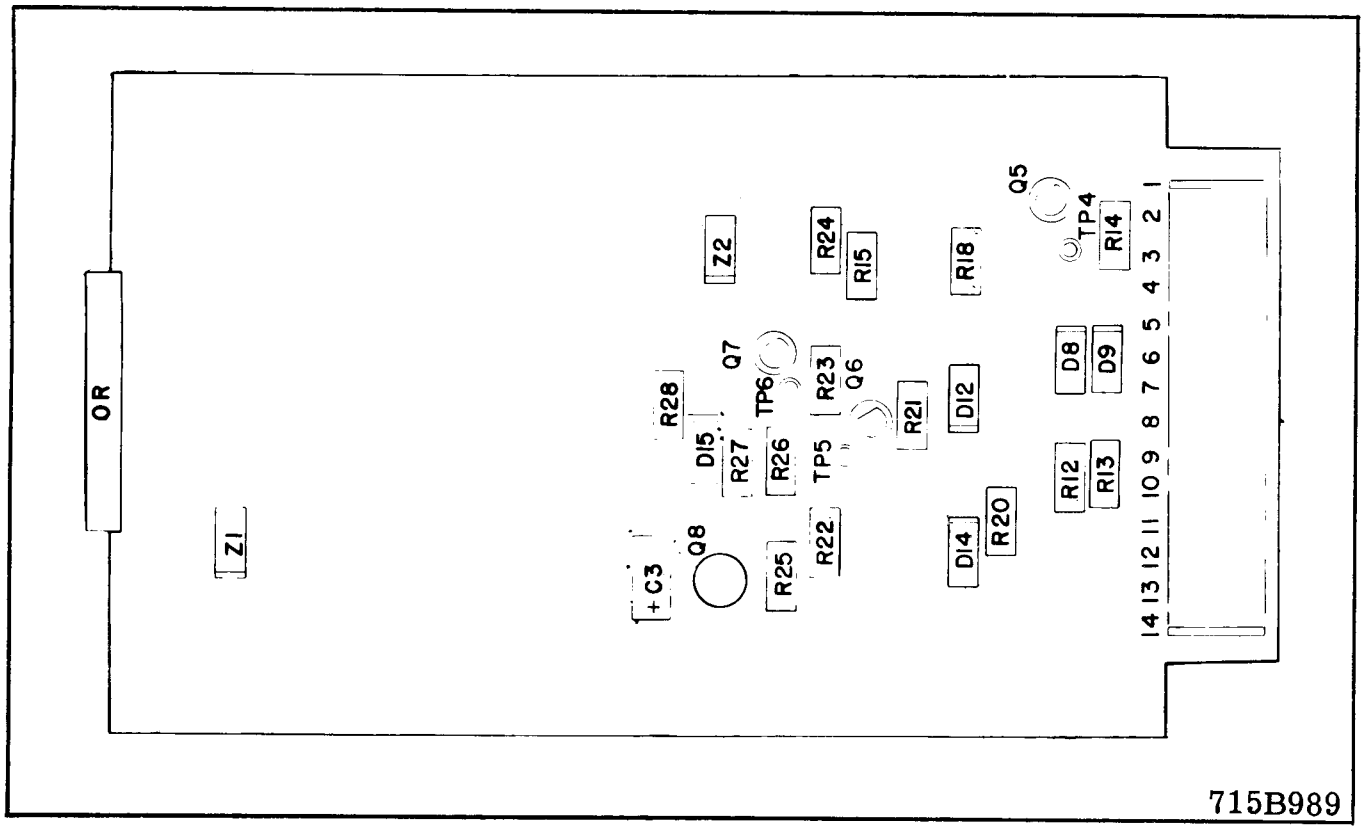
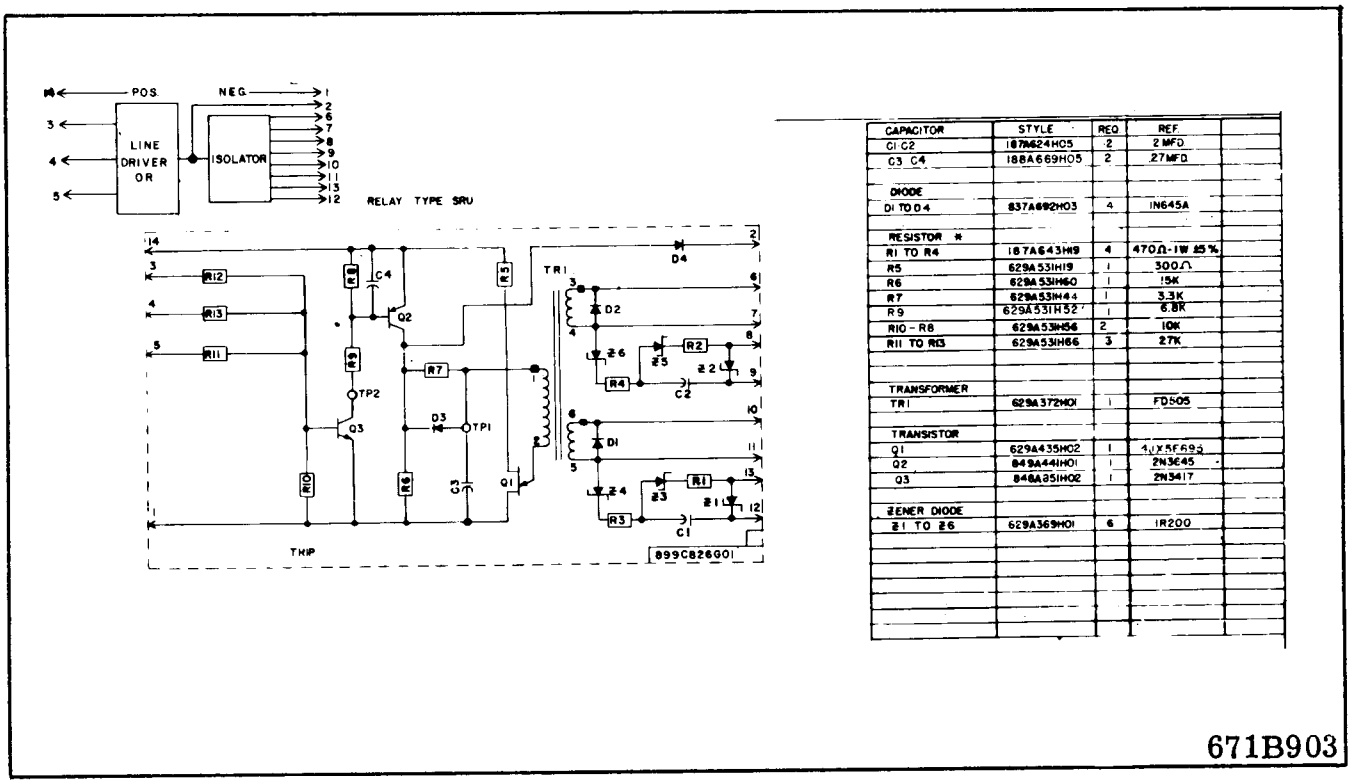


Fig. 18. Component Location on the OR Board of the STU–91 Relay



CAPACITOR	STYLE	REQ	REF
C1 C2	187A624H05	2	2 MFD
C3 C4	188A669H05	2	27MFD
DIODE			
D1 TO D4	837A692H03	4	IN645A
RESISTOR *			
R1 TO R4	187A643H19	4	470Ω-1W 5%
R5	629A531H19	1	300Ω
R6	629A531H60	1	15K
R7	629A531H44	1	3.3K
R9	629A531H52	1	6.8K
R10 - R8	629A531H56	2	10K
R11 TO R13	629A531H66	3	27K
TRANSFORMER			
TRI	629A372H01	1	FD505
TRANSISTOR			
Q1	629A435H02	1	4JX5E695
Q2	849A441H01	1	2N3645
Q3	848A351H02	1	2N3417
ZENER DIODE			
Z1 TO Z6	629A369H01	6	1R200

Fig. 19. Schematic of the Trip Board for 48/125 Volt DC Operation

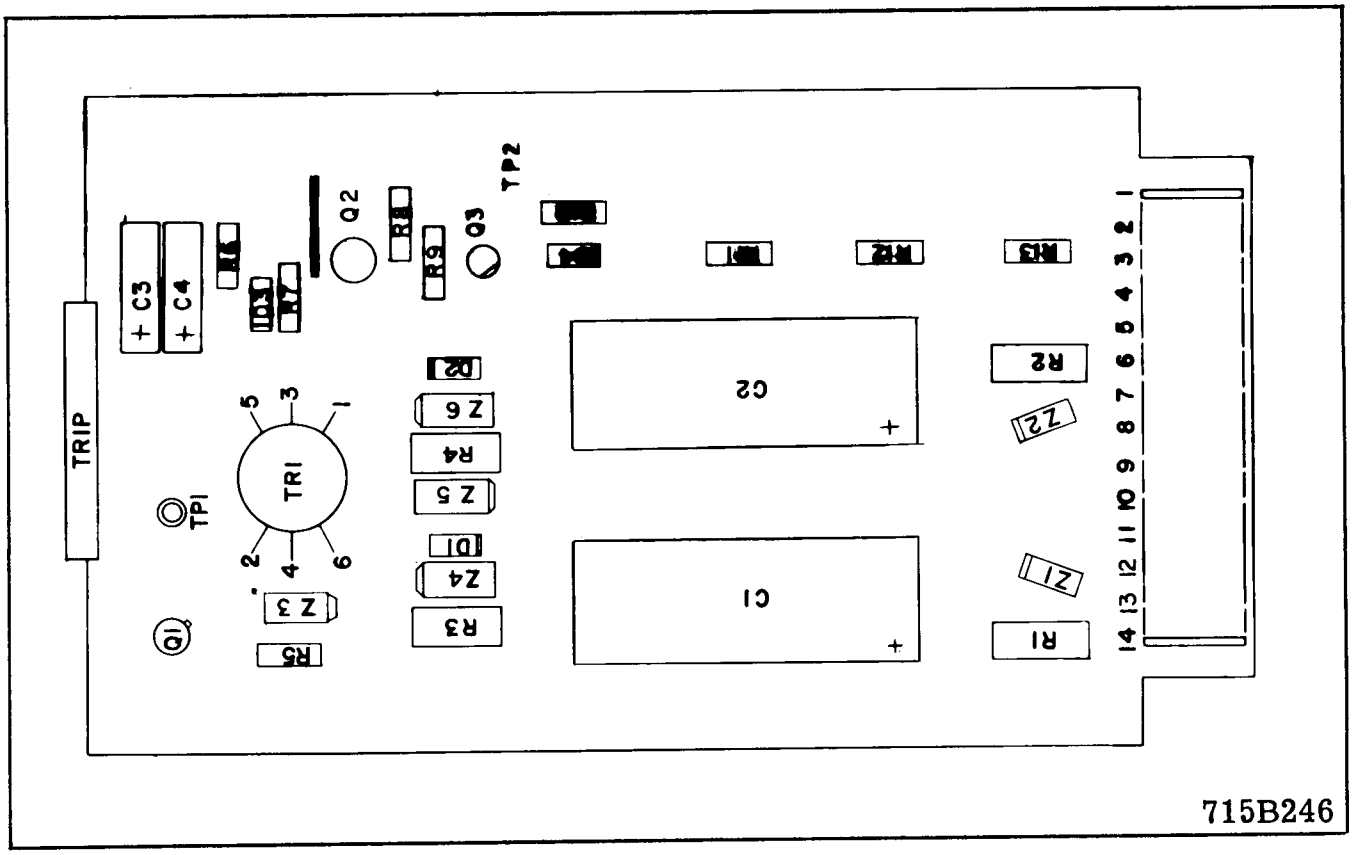
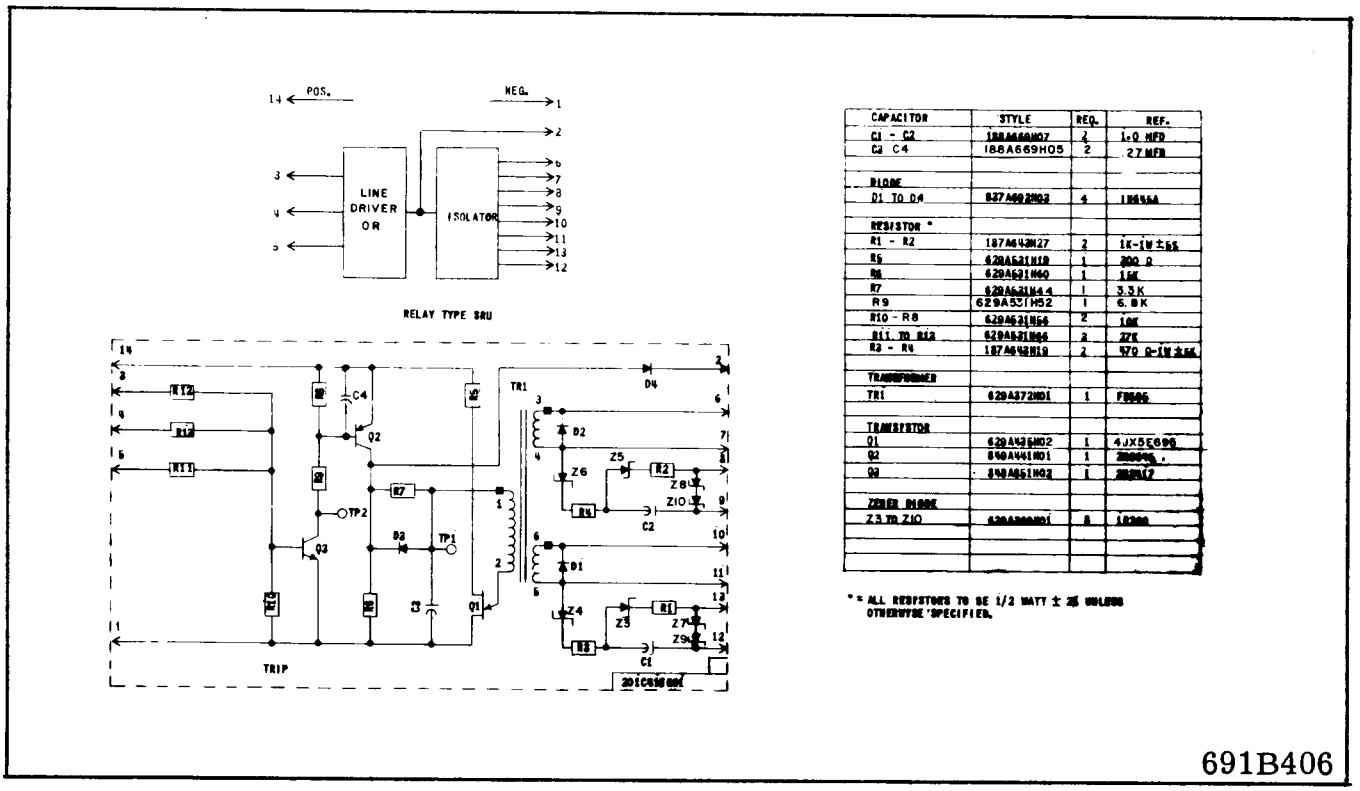


Fig. 20. Component Location on the Trip Board for 48/125 Volt DC Operation



CAPACITOR	STYLE	REQ.	REF.
C1 - C2	188A666H07	2	1.0 MFD
C3 C4	188A669H05	2	27 MFD
DIODE			
D1 TO D4	837A902H03	4	1N645A
RESISTOR *			
R1 - R2	187A643H27	2	1K-1W ±5%
R5	629A621H19	1	200 Ω
R6	629A621H40	1	1.5K
R7	629A621H44	1	3.3K
R9	629A621H52	1	6.8K
R10 - R8	629A621H56	2	10K
R11 TO R12	629A621H64	2	22K
R3 - R4	187A643H19	2	470 Ω-1W ±5%
TRANSFORMER			
TR1	629A372H01	1	F8606
TRANSISTOR			
Q1	629A425H02	1	4JX5E696
Q2	848A441H01	1	2N6096
Q3	848A651H02	1	2N6417
ZENER DIODE			
Z3 TO Z10	629A666H01	8	1N2980

* ALL RESISTORS TO BE 1/2 WATT ± 2% UNLESS OTHERWISE SPECIFIED.

Fig. 21. Schematic of the Trip Board for 250 Volt DC Operation

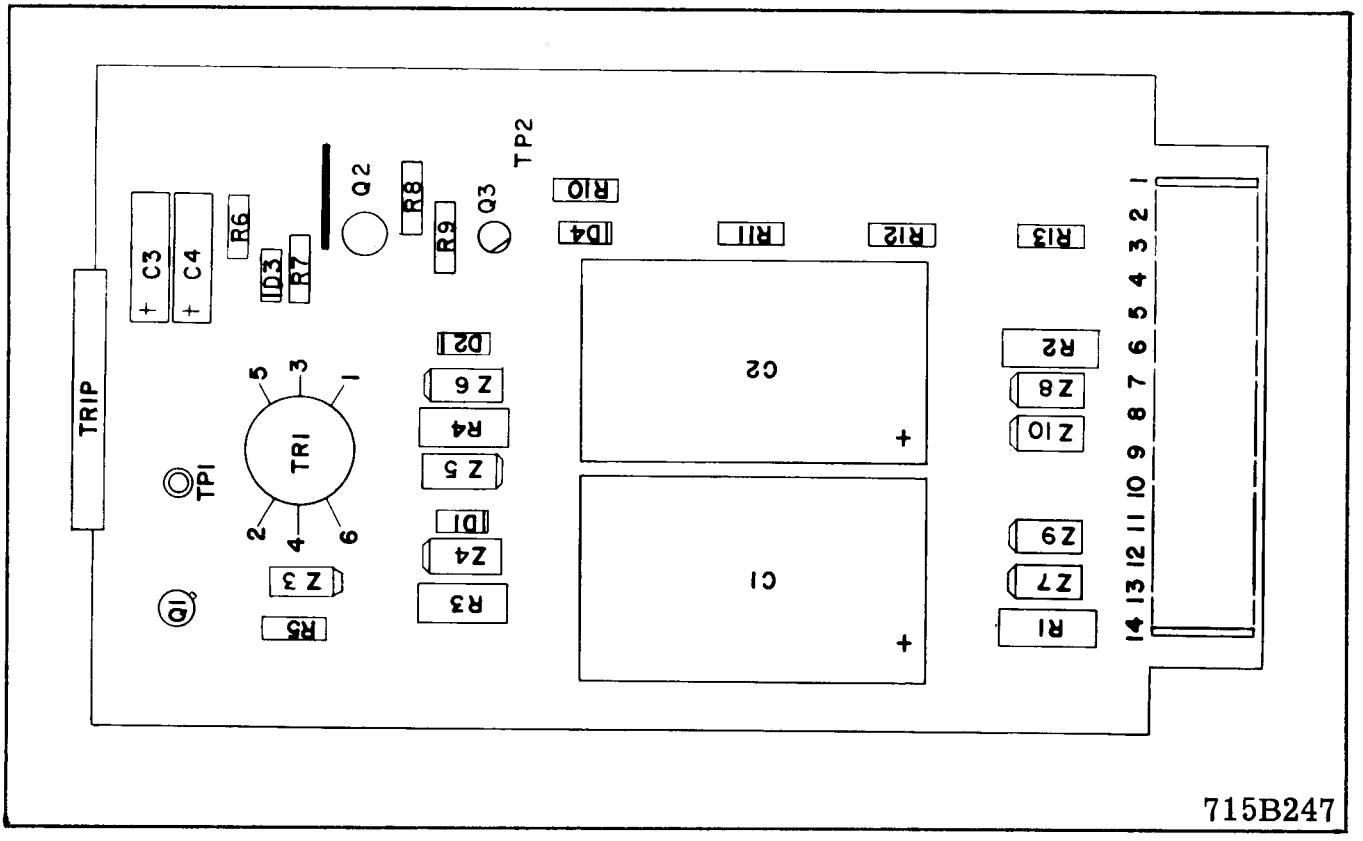
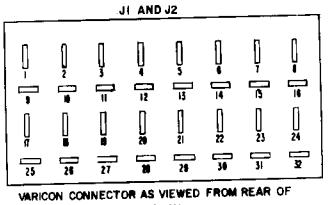


Fig. 22. Component Location on the Trip Board for 250 Volt DC Operation



VARICON CONNECTOR AS VIEWED FROM REAR OF RELAY.

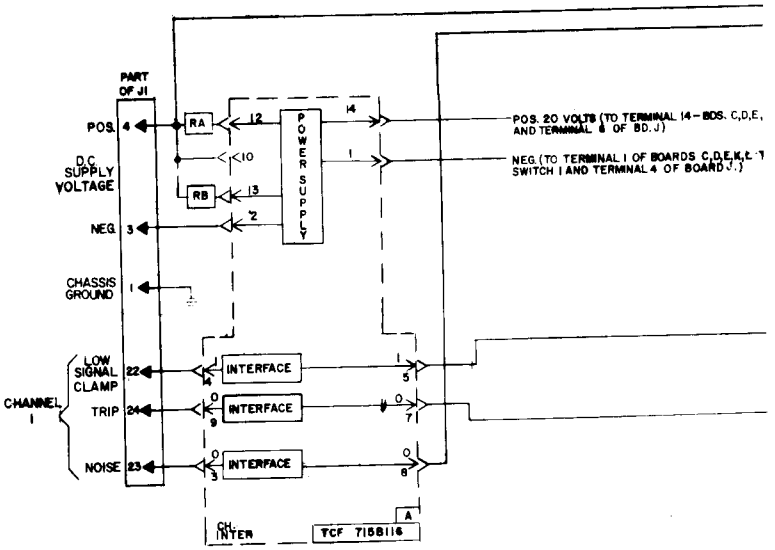
POWER SUPPLY RESISTORS			
	RA ——— RC	RB ——— RD	
48 VDC	S — 1287272 150 OHMS	S — 1291804 1.8 K	
125 VDC	S — 1287287 900 OHMS	S — 1295214 5 K	

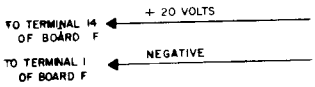
AR RELAYS		
VOLT	4 - 16	28 - 28
125 VOLT — 2W	4808845606	4808845626
48 VOLT — 2W	6718472689	6718472611

TELEPHONE RELAYS		
AL	125 VOLT	541D514H13
	48 VOLT	541D514H11

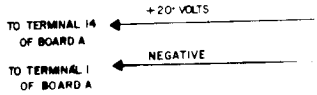
DESCRIPTION	STYLE	LOCATION
THYRISTORS (DOR)	1N4814 MOS	Q1 - Q2 - Q3 - Q4
PULSE TRANSFORMER	6708592G02	T1 - T2 - T3 - T4
48V LAMP	883M632P02	ALL LAMPS
125V LAMP	883M632P07	ALL LAMPS
NUTRAL REACTOR	6819878G01	L1-L2-L3-L4
ZENER DIODE 1N3350A	762A851H05	Z1 - Z2 - Z3 - Z4

TRIP BOARD SCHEMATIC	
48/125 VDC	6718883
250 VDC	6818408





= FOR TRANSFER INTO A SINGLE CHANNEL MODE OF OPERATION AFTER A LOSS OF ONE CHANNEL, LINK ON "OR" BOARDS (POSITION E AND J) MUST BE OPEN, AS SHIPPED FROM FACTORY, LINKS ARE OPEN.



NUMBERS 0 AND 1 REPRESENT LOGIC VOLTAGES. FOR LOGIC VOLTAGES SHOWN, THE FOLLOWING INPUT CONDITIONS EXIST FROM CHANNEL RECEIVER.

1. NO TRIP SIGNAL
2. NO LOW SIGNAL CLAMP.
3. NO NOISE CLAMP

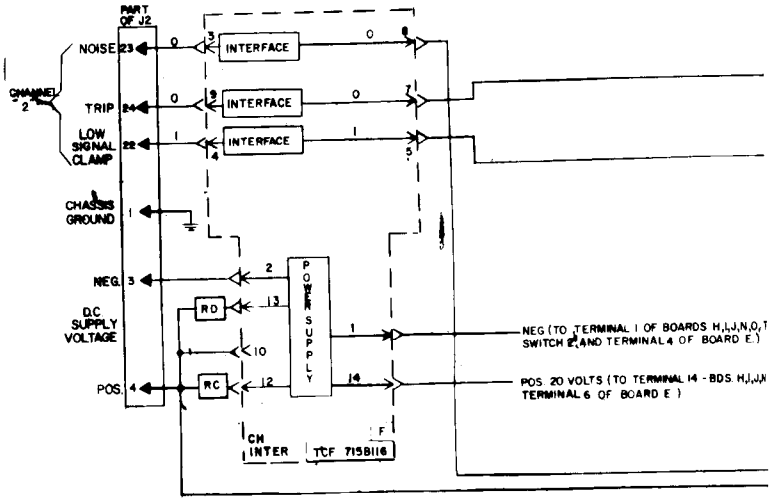
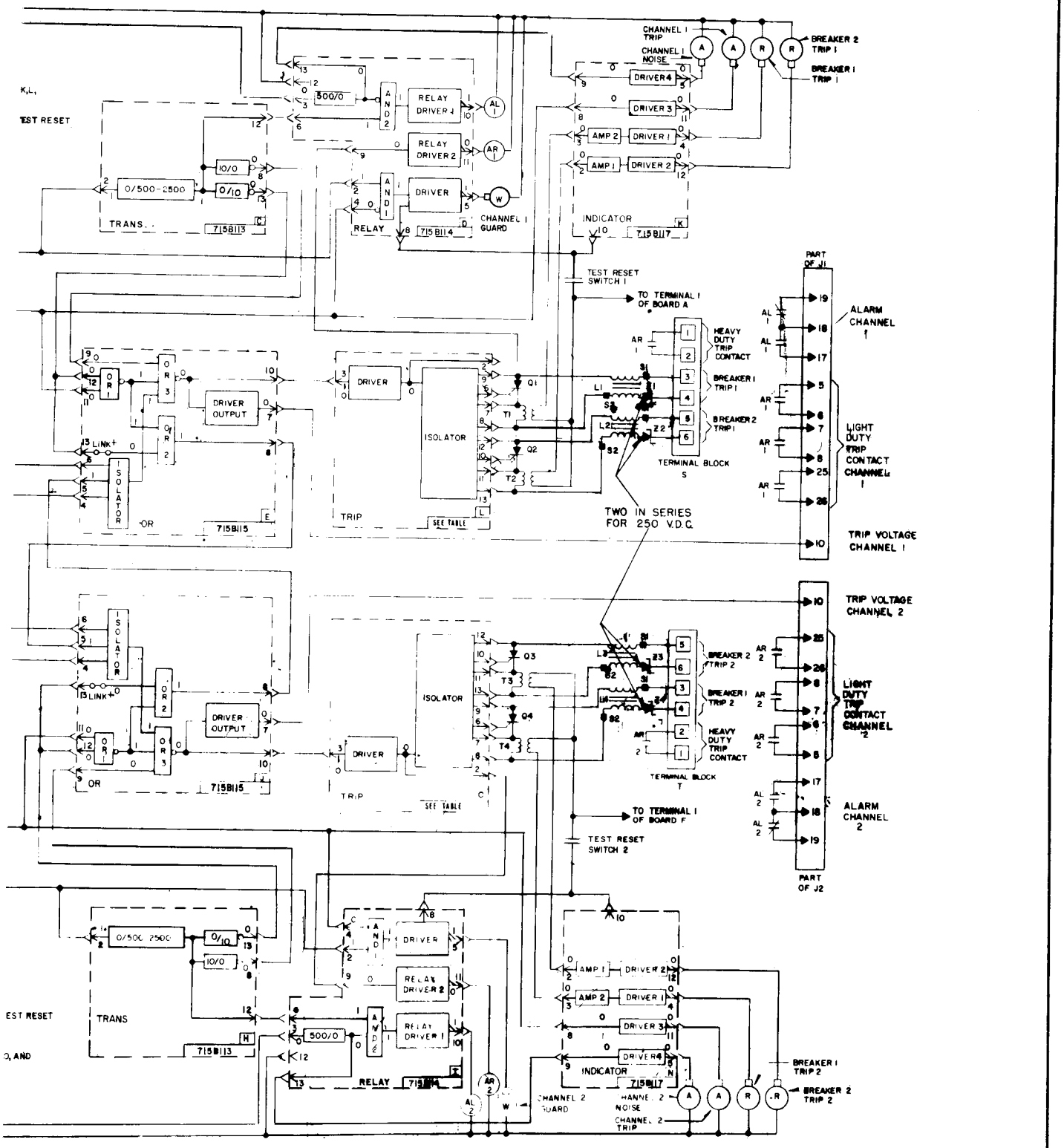
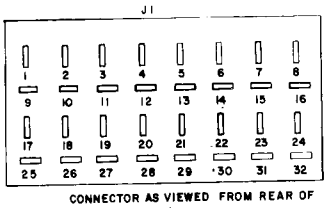


Fig. 24. Logic Diagram of the S



'U-92 Relay for Dual TCF Carrier Channel

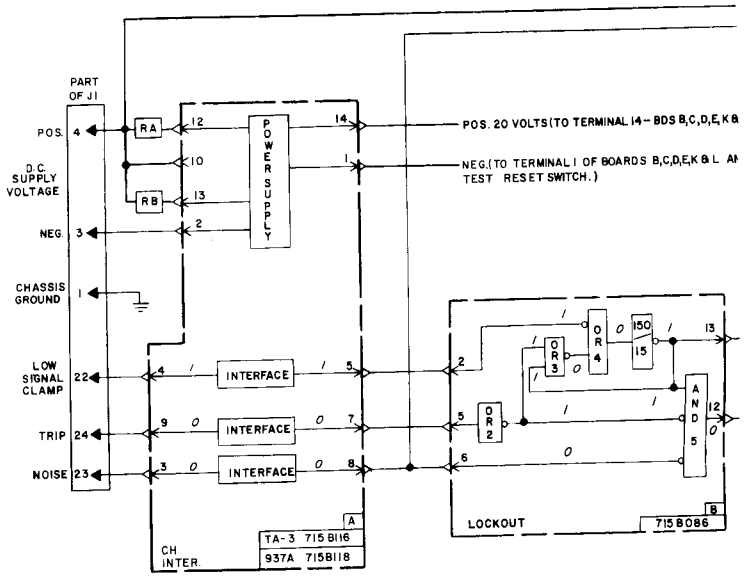


CONNECTOR AS VIEWED FROM REAR OF RELAY.

POWER SUPPLY RESISTOR			
	RA	RB	
48 VDC	S-1267272 150 OHMS	S-1201004 1.8 K OHMS	
125 VDC	S-1267287 900 OHMS	S-1205214 5K OHMS	

AR RELAY		
VOLT	4-M	2M-2B
125 VOLT-2W	408C845G08	408C845G26
48 VOLT-2W	671B472G09	671B472G11

TELEPHONE RELAY		
AL	125 VOLT	541D514H13
	48 VOLT	541D514H11

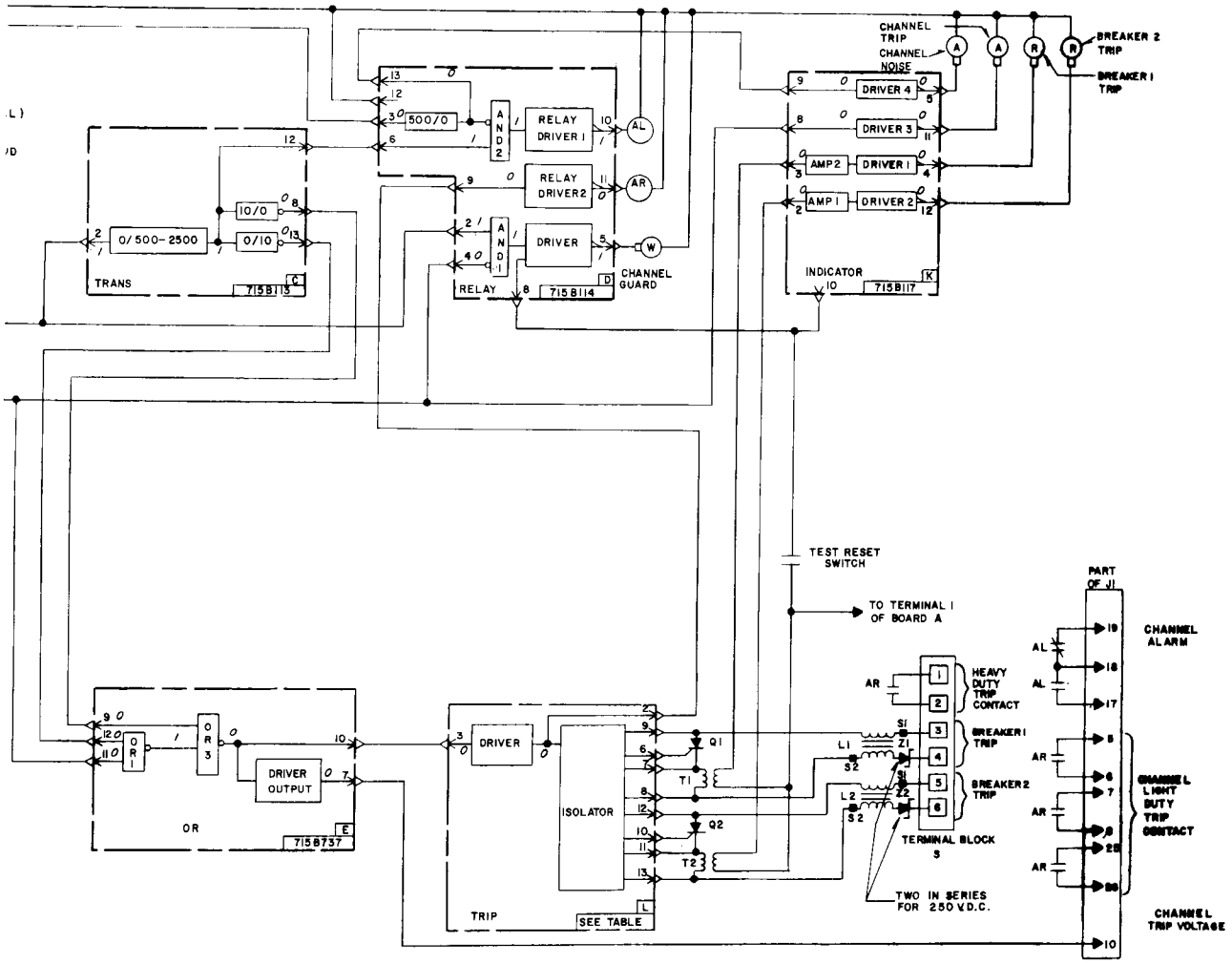


DESCRIPTION	STYLE	LOCATION
THYRISTORS (SCR)	184A614H05	Q1-Q2
PULSE TRANSFORMER	670B398G02	T1-T2
MUTUAL REACTORS	691B678G01	L1-L2
48V LAMP	837A832H02	ALL LAMPS
125V LAMP	837A832H07	ALL LAMPS
ZENER DIODE IN3350A	762A631H05	Z1-Z2

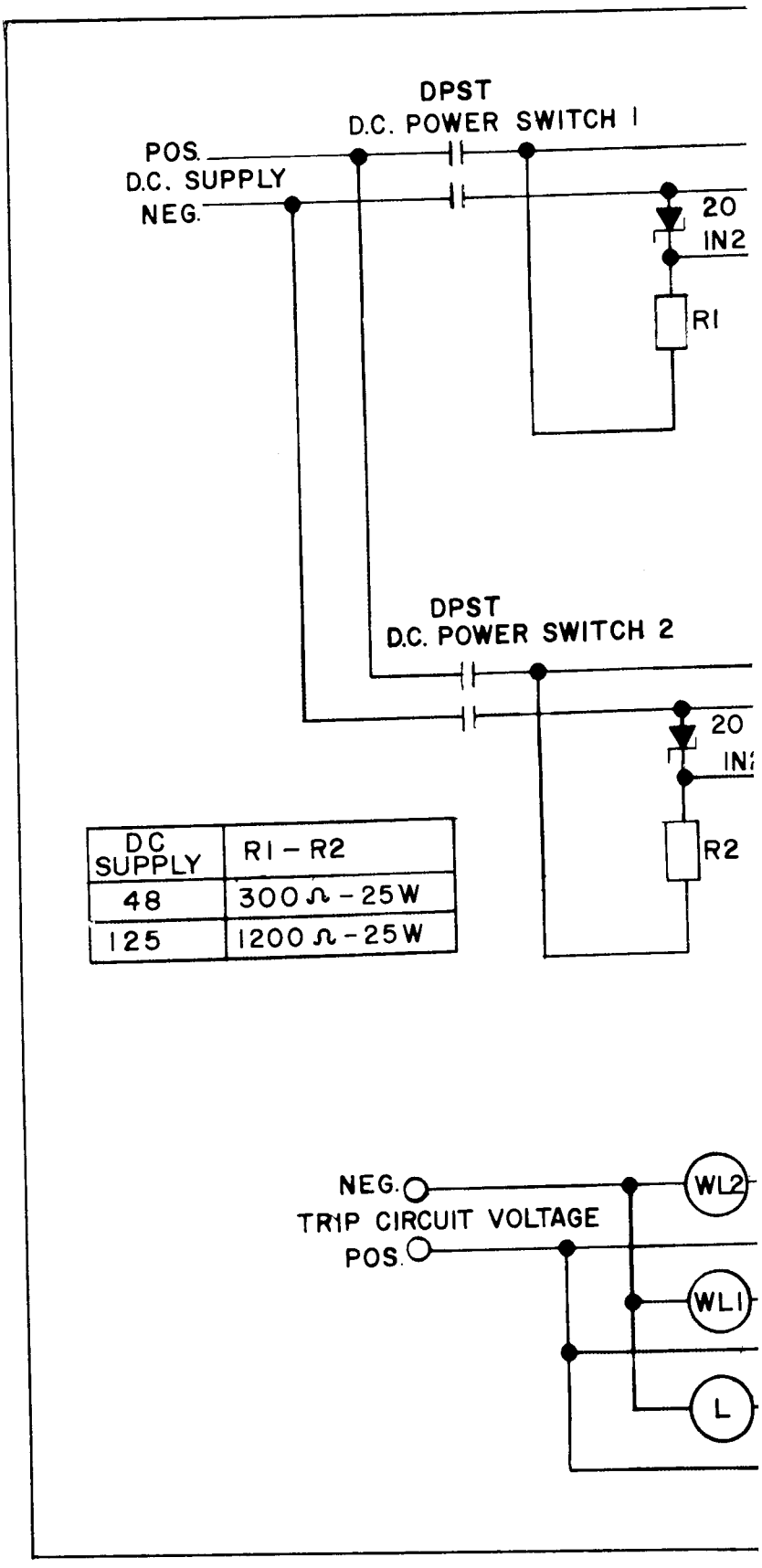
NUMBERS / AND 0 REPRESENT LOGIC VOLTAGES.
FOR LOGIC VOLTAGES SHOWN, THE FOLLOWING INPUT CONDITIONS EXIST FROM CHANNEL RECEIVER
1. NO TRIP SIGNAL
2. NO LOW SIGNAL CLAMP
3. NO NOISE CLAMP

TRIP BOARD SCHEMATIC	
48/125VDC	671B903
250VDC	691B406

Fig. 26. Logic Diagram of 1

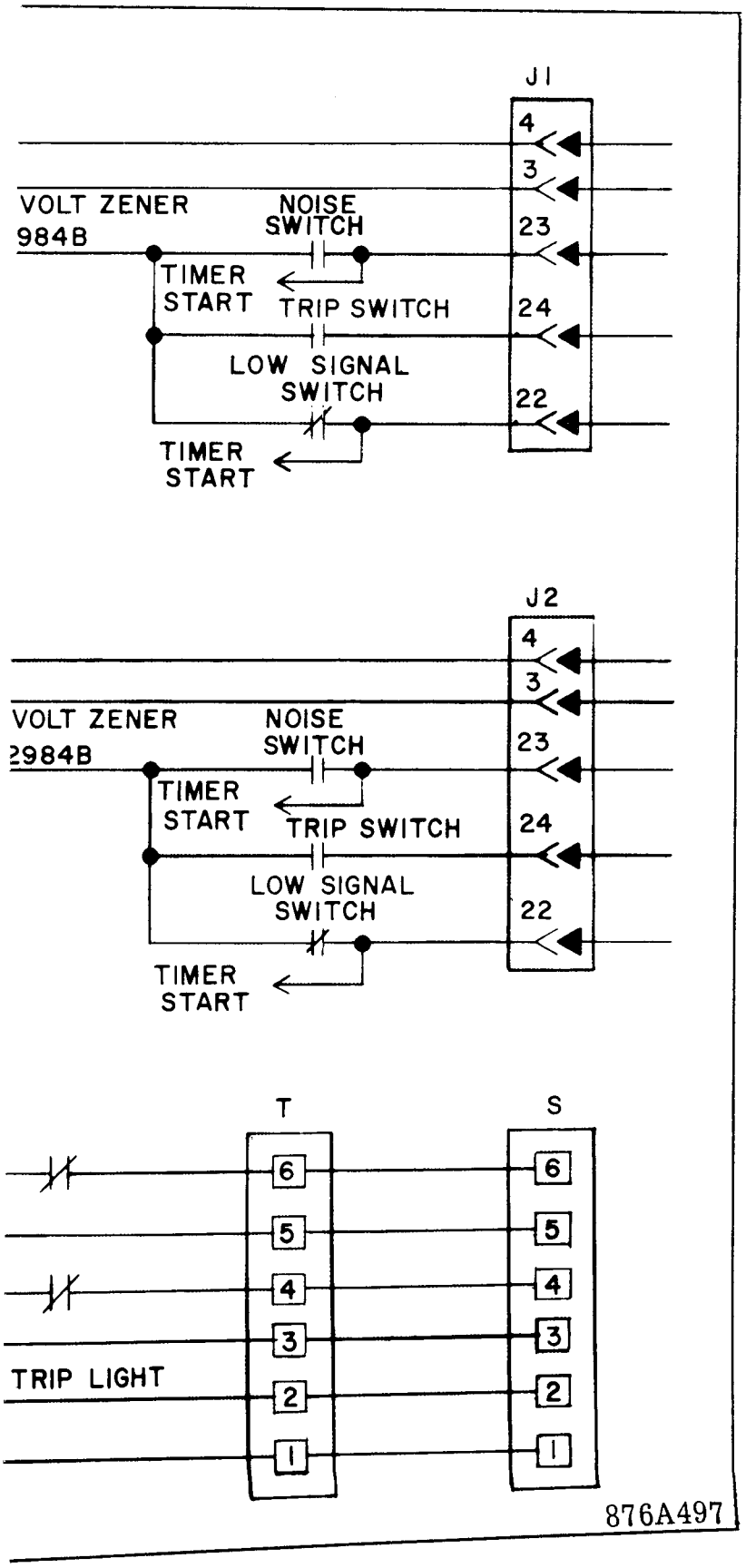

CHANNEL TRIP
CHANNEL NOISE
BREAKER 2 TRIP
BREAKER 1 TRIP
DRIVER 4
DRIVER 3
AMP 2
DRIVER 1
AMP 1
DRIVER 2
500/0
RELAY DRIVER 1
RELAY DRIVER 2
DRIVER
AND 2
AND 1
AL
AR
W
0/500-2500
10/0
0/10
TRANS
715B113
RELAY
715B114
CHANNEL GUARD
INDICATOR
715B117
TEST RESET SWITCH
TO TERMINAL 1 OF BOARD A
PART OF J1
CHANNEL ALARM
HEAVY DUTY TRIP CONTACT
BREAKER 1 TRIP
BREAKER 2 TRIP
CHANNEL LIGHT DUTY TRIP CONTACT
CHANNEL TRIP VOLTAGE
TERMINAL BLOCK S
TWO IN SERIES FOR 250 V.D.C.
OR
DRIVER OUTPUT
715B737
ISOLATOR
TRIP
SEE TABLE
Q1
Q2
T1
T2
L1
L2
S1
S2

5501D33



DC SUPPLY	R1 – R2
48	300 Ω – 25W
125	1200 Ω – 25W

Fig. 28. Test Circui



t of STU-92 Relay

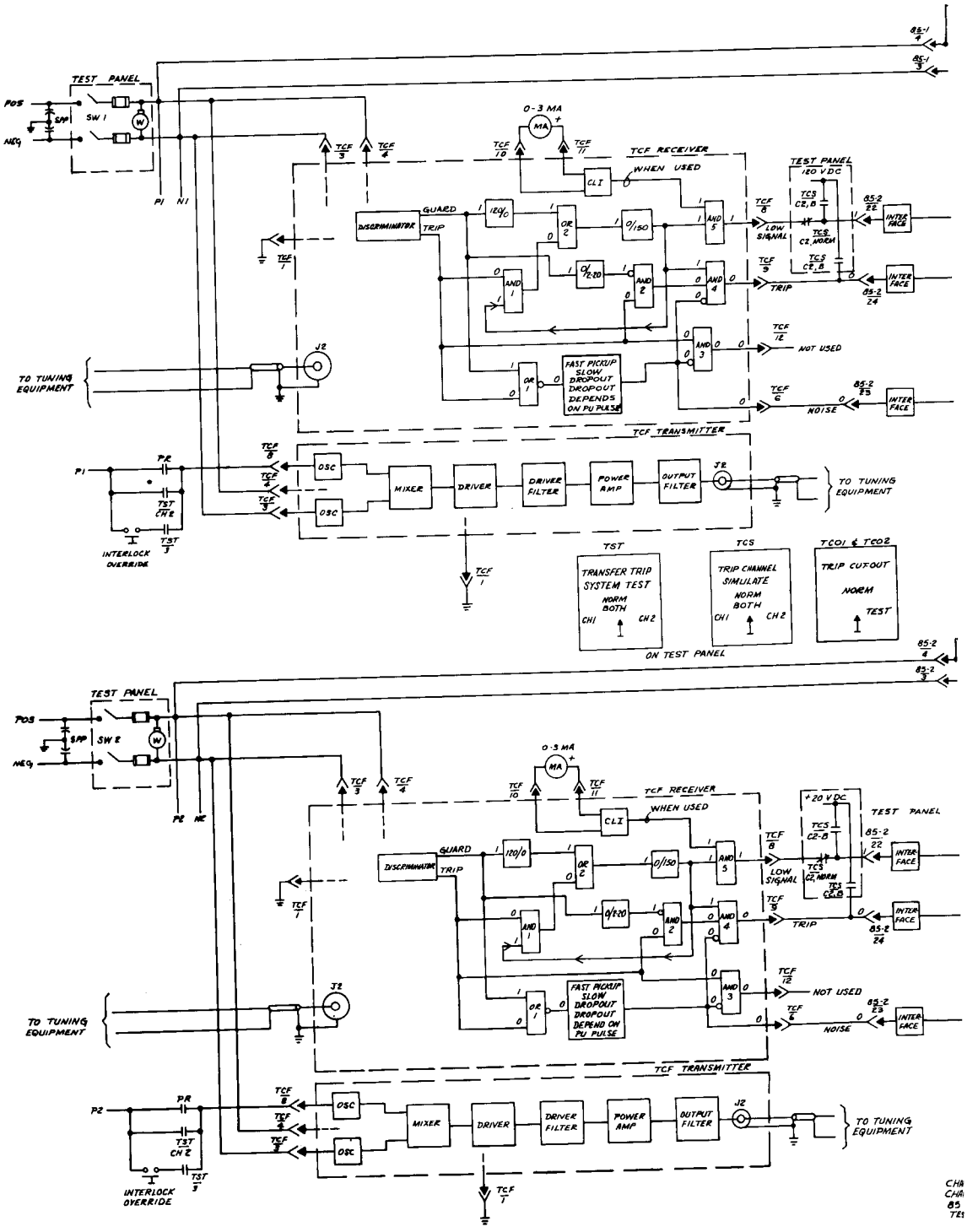
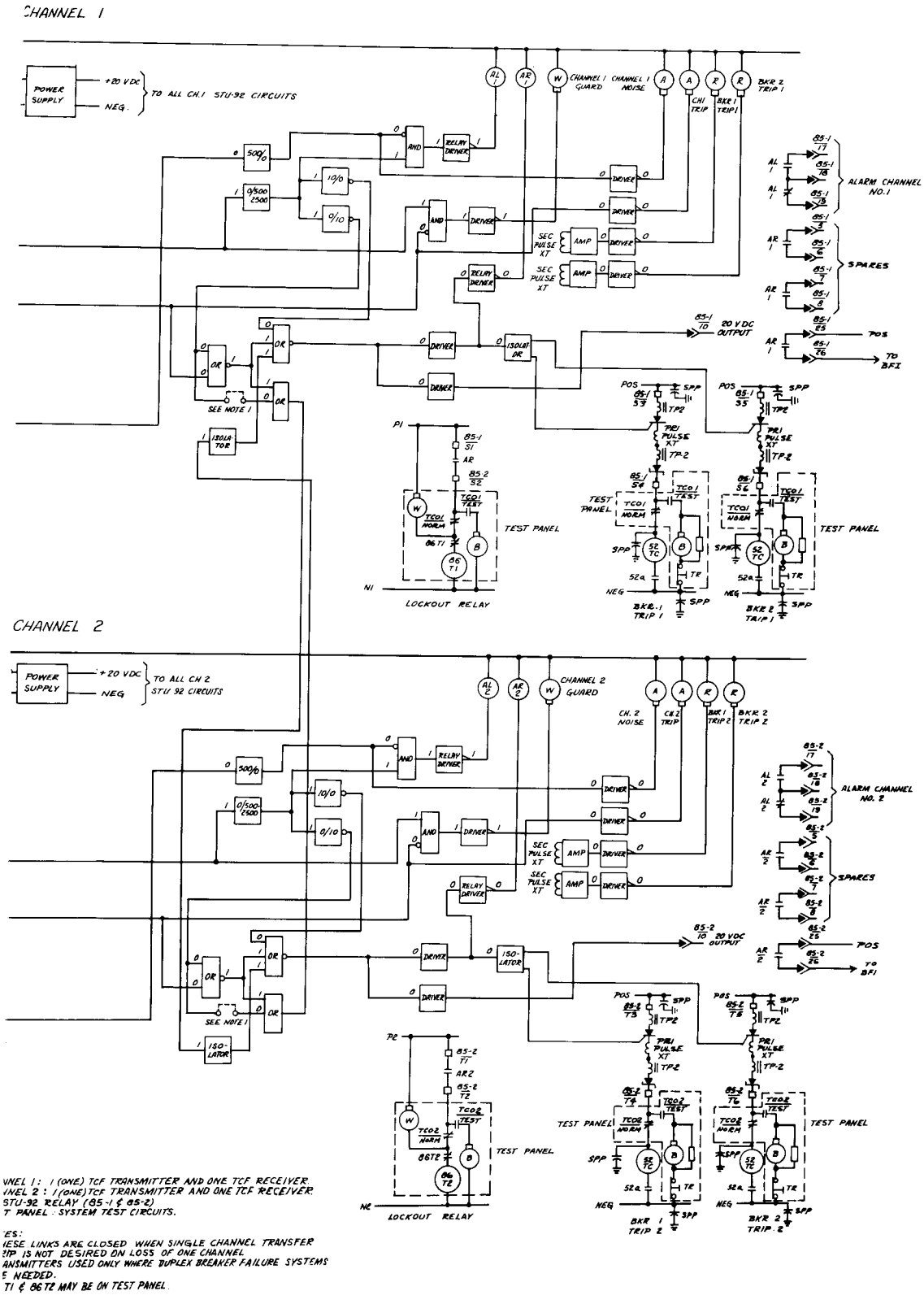


Fig. 30. Schematic Diagram of the STU-9



VNEL 1 : 1 (ONE) TCF TRANSMITTER AND ONE TCF RECEIVER.
VNEL 2 : 1 (ONE) TCF TRANSMITTER AND ONE TCF RECEIVER.
STU-92 RELAY (85-1 & 85-2)
T PANEL : SYSTEM TEST CIRCUITS.

ES:
IESE LINKS ARE CLOSED WHEN SINGLE CHANNEL TRANSFER
IP IS NOT DESIRED ON LOSS OF ONE CHANNEL.
ANSMITTERS USED ONLY WHERE DUPLEX BREAKER FAILURE SYSTEMS
E NEEDED.
TI & 86T2 MAY BE ON TEST PANEL.

612F395

2 Transfer Trip Scheme with TCF Power Line Carrier Channel

TRANSFER BOARD

CONDITION	CIRCUITS																					
	AND-1		500/2500		OR-1		LINE DRIVER 1		AND-2		10/0		OR-2		AND-3		AND-4		OR-3		10/0		AND-5	
	INPUT	OUTPUT	INPUT	OUTPUT+	INPUT+	OUTPUT	INPUT	OUTPUT	INPUT	OUTPUT	INPUT	OUTPUT+	INPUT+	OUTPUT	INPUT	OUTPUT	INPUT	OUTPUT	INPUT	OUTPUT	INPUT	OUTPUT+	INPUT+	OUTPUT
NORMAL	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	0	1	1	0	1	0
LOSS OF CHANNEL	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	1	0	1	1	0	0	0	0	1
VOLTS FOR 1 STATUS AT TP OR TERMINAL	20 TERM. 2	7 TP 1	7 TP 1	0.6 Q2	0.6 Q2	10 TP 2	10 TP 2	20 TERM. 12	20 TERM. 12	7 TP 4	7 TP 4	0.6 Q6	0.6 Q6	9 TP 5	9 TP 5	13.5 TERM. 13	20 TERM. 12	10 TP 6	10 TP 6	7 TP 7	7 TP 7	0.6 Q10	0.6 Q10	9 TERM. 8

+ = TEST POINTS NOT AVAILABLE. VOLTAGE MEASURED ON BASE OF TRANSISTOR SHOWN.
O = MEASURED ON MINIMUM SETTING.
OO = WITH LINK CLOSED.

RELAY DRIVER BOARD

CONDITION	AND-1		OR-1			DRIVER	
	INPUT	OUTPUT	INPUT AND-1	INPUT TERM.4	OUTPUT	INPUT	OUTPUT O
NORMAL	1	0	0	0	1	1	1
TRIP	1	0	0	1	0	0	0
LOSS OF CHANNEL	0	1	1	0	0	0	0
NOISE	1	0	0	0	1	1	1
VOLTS FOR 1 STATUS AT TP OR TERMINAL	20 TERM. 2	10 TP 1	10 TP 1	20 TERM. 4	10 TP 2	10 TP 2	-48 TERM. 5

O = MEASURED WITH REFERENCE TO TERMINAL 1.
+ = TEST POINTS NOT AVAILABLE. VOLTAGE MEASU

CHANNEL INTERFACE BOARD

CONDITION	CIRCUITS															
	O BUFFER 1		LINE DRIVER 1		O BUFFER 2		LINE DRIVER 2		O BUFFER 3		LINE DRIVER 3					
	INPUT	OUTPUT+	INPUT+	OUTPUT	INPUT	OUTPUT+	INPUT+	OUTPUT	INPUT	OUTPUT+	INPUT+	OUTPUT				
NORMAL	1	1	1	1	0	0	0	0	0	0	0	0				
TRIP	1	1	1	1	1	1	1	1	0	0	0	0				
NOISE	1	1	1	1	0	0	0	0	1	1	1	1				
LOSS OF CHANNEL	0	0	0	0	0	0	0	0	0	0	0	0				
VOLTS FOR 1 STATUS AT TP OR TERMINAL	20 TERM. 4	0.6 Q2 Q2	0.6 Q2 Q2	20 TERM. 5	20 TERM. 9	0.6 Q4 Q5	0.6 Q4 Q5	20 TERM. 7	20 TERM. 3	0.6 Q6 Q8	0.6 Q6 Q8	20 TERM. 8				

+ = TEST POINTS NOT AVAILABLE. VOLTAGE MEASURED ON BASE OF TRANSISTOR SHOWN.
O = FOR 937A CHANNEL, INPUTS ARE MEASURED WITH REFERENCE TO POS. 48 V.D.C., AND ARE NEGATIVE SIGNALS.

LOCKOUT BOARD (WHEN USED)

CONDITION	CIRCUITS															
	AND-1		OR-1		OR-2		AND-2		OR-3			OR-4				
	INPUT	OUTPUT	INPUT	OUTPUT	INPUT	OUTPUT	INPUT	OUTPUT	INPUT OR-2	INPUT LINE DRIVER 1	OUTPUT	INPUT AND-1	INPUT OR-3			
NORMAL	1	0	0	1	0	1	1	0	1	1	0	0	0			
TRIP	1	0	0	1	1	0	0	1	0	1	0	0	0			
NOISE	1	0	1	0	0	1	1	0	1	1	0	0	0			
NOISE WITH TRIP	1	0	1	0	1	0	0	1	0	1	0	0	0			
LOSS OF CHANNEL OO	0	1	0	1	0	1	1	0	1	0	0	1	0			
LOSS OF CHANNEL THEN TRIP OO	0	1	0	1	1	0	0	1	0	0	1	1	1			
LOSS OF CHANNEL THEN TRIP OO AND RETURN TO NORMAL CHANNEL	1	0	0	1	1	0	0	1	0	0	1	0	1			
VOLTS FOR 1 STATUS AT TP OR TERMINAL	20 TERM. 2	16 TP 1	20 TERM. 6	20 TP 2	20 TERM. 5	13.5 TP 3	13.5 TP 3	20 TP 4	13.5 TP 3	20 TERM. 13	16 TP 5	16 TP 1	16 TP 5			

+ = TEST POINTS NOT AVAILABLE. VOLTAGE MEASURED ON BASE OF TRANSISTOR SHOWN.
OO = 150 MILLISECONDS AFTER LOSS OF CHANNEL.

Fig. 32. Trut

CIRCUITS																							
OR-2		AND-2		500/0		LINE DRIVER		AND-3		OR-3			RELAY DRIVER 1		RELAY DRIVER 2								
INPUT	OUTPUT	INPUT	OUTPUT	INPUT	OUTPUT+	INPUT+	OUTPUT	INPUT	OUTPUT	INPUT LINE DRIVER	INPUT AND-3	OUTPUT	INPUT	O OUTPUT	INPUT TERM. 9	O OUTPUT							
0	1	1	0	0	0	0	0	1	0	0	0	1	1	1	0	0							
0	1	1	0	0	0	0	0	1	0	0	0	1	1	1	1	1							
0	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0							
1	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0							
20 TERM. 3	10 TP 3	10 TP 3	7 TP 4	7 TP 4	06 06	0.6 Q6	20 TERM. 13	20 TERM. 6	10 TP 6	20 TERM. 13	10 TP 6	10 TP 7	10 TP 7	-48 TERM. 10	20 TERM. 9	-48 TERM. 11							

2. VOLTAGE SHOWN IS FOR 48 VOLT RELAY. VOLTAGE IS 125V FOR 125 VOLT RELAY.
URED ACROSS BASE OF TRANSISTOR SHOWN.

INDICATOR BOARD

CIRCUITS																	
CONDITION	AMP-1		DRIVER 2		AMP-2		DRIVER 1		DRIVER 3		DRIVER 4						
	INPUT+	OUTPUT+	INPUT+	O OUTPUT	INPUT+	OUTPUT+	INPUT+	O OUTPUT	INPUT	O OUTPUT	INPUT	O OUTPUT					
NORMAL	0	0	0	0	0	0	0	0	0	0	0	0					
TRIP	1	1	1	1	1	1	1	1	1	1	0	0					
NOISE	0	0	0	0	0	0	0	0	0	0	1	1					
VOLTS FOR I STATUS AT TP OR TERMINAL	— TERM. 2	— TP 2	— TP 2	−48 (−125) TERM. 12	— TERM. 3	— TP 4	— TP 4	−48 (−125) TERM. 4	20 TERM. 8	−48 (−125) TERM. 11	20 TERM. 9	−48 (−125) TERM. 8					

+ = VOLTAGE IS A PULSE.
O = MEASURED WITH REFERENCE TO SOURCE VOLTAGE. (48 OR 125 VOLTS D.C.)

	AND 3		150 15		AND 4		LINE DRIVER 1		AND-5				LINE DRIVER 2	
OUTPUT	INPUT	OUTPUT	INPUT	OUTPUT+	INPUT +	OUTPUT	INPUT	OUTPUT	INPUT OR-1	INPUT AND-2	INPUT AND-4	OUTPUT +	INPUT +	OUTPUT
1	1	0	0	0	0	1	1	1	1	0	1	0	0	0
1	1	0	0	0	0	1	1	1	1	1	1	1	1	1
1	1	0	0	0	0	1	1	1	0	0	1	0	0	0
1	1	0	0	0	0	1	1	1	0	1	1	0	0	0
0	0	1	1	1	1	0	0	0	1	0	0	0	0	0
0	0	1	1	1	1	0	0	0	1	1	0	0	0	0
0	0	1	1	1	1	0	0	0	1	1	0	0	0	0
10 TP 6	10 TP 6	18 TP 7	18 TP 7	0.6 Q8	0.6 Q8	16 TP 8	16 TP 8	20 TERM. 13	20 TP 2	20 TP 4	16 TP 8	0.6 Q11	0.6 Q11	20 TERM. 12

OR BOARD

CIRCUITS																									
CONDITION	LINE DRIVER 1		ISOLATOR		AND		OR-4		OR-1			OR-2			OR-3				LINE DRIVER 2		BUFFER	
	INPUT	OUTPUT	INPUT	OUTPUT+	INPUT+	OUTPUT	INPUT	OUTPUT	INPUT TERM.11	INPUT TERM.12	OUTPUT	INPUT OR-1	INPUT TERM.13	OUTPUT	INPUT OR-1	INPUT OR-4	INPUT TERM.9	OUTPUT	INPUT	OUTPUT	INPUT	OUTPUT
NORMAL	1	1	1	1	1	0	0	1	0	0	1	1	0	1	1	1	0	0	0	0	0	0
TRIP	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	1	1	1
LOSS OF CHANNEL LINK CLOSED	1	1	1	1	1	0	0	1	0	1	0	0	1	1	0	1	1	0	0	0	0	0
LOSS OF CHANNEL LINK OPEN	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0
VOLTS FOR I STATUS AT TP OR TERMINAL	0.6 TERM. 5	20 TP 1	20 TP 1	0.6 Q3	0.6 Q3	16 TP 2	16 TP 2	16 TP 3	20 TERM. 11	13.5 TERM. 12	13.5 TP 4	13.5 TERM. 13	0.6 TERM. 8	13.5 TP 4	16 TP 3	9 TERM. 9	16 TP 5	16 TP 5	20 TERM. 10	20 TERM. 7	20 TERM. 10	20 TERM. 7

O = 13.5 WITH LINK CLOSED, 16 VOLTS WITH LINK OPEN.
+ = TEST POINTS NOT AVAILABLE. VOLTAGE MEASURED ACROSS BASE OF TRANSISTOR SHOWN.

5504D85

h Table of STU-92 Relay

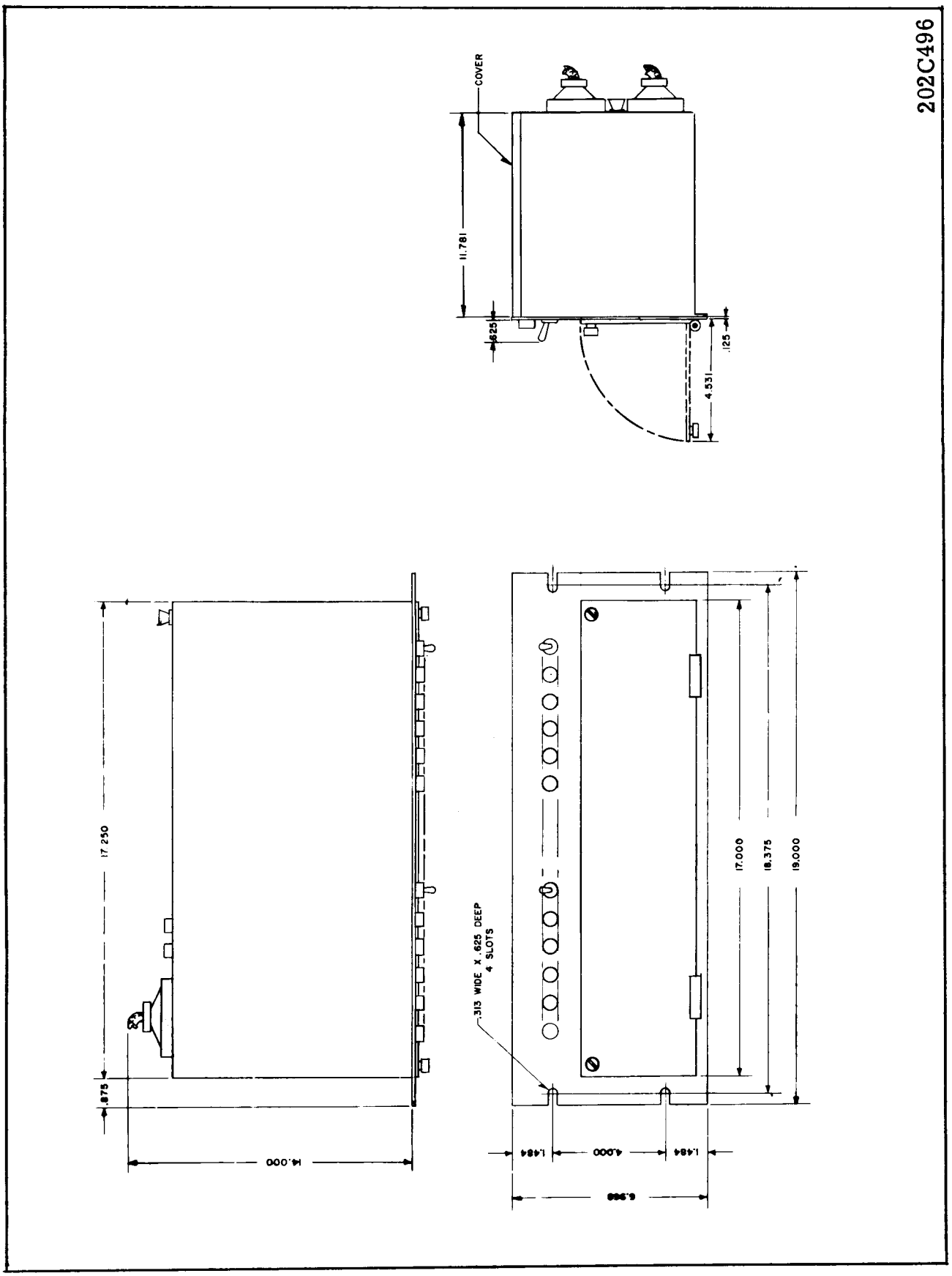
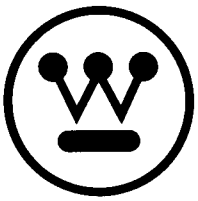


Fig. 33. Outline and Drilling Plan of the STU-92 and STU-91 Relays



WESTINGHOUSE ELECTRIC CORPORATION

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

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