INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KA CARRIER AUXILIARY RELAY

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

APPLICATION

The type KA relay is an auxiliary relay used in the distance carrier relaying scheme to block or prevent instantaneous tripping for faults external to the line section to which it is applied, and to permit instantaneous simultaneous tripping for internal faults. The relay is arranged to respond to indications of fault power and direction provided by the phase and ground relays, thereby controlling the transmission of the carrier signals.

CONSTRUCTION AND OPERATION

The type KA relay consists of directional auxiliary units, receiver and alarm units, and a phase fault carrier operation indicator. In addition, the type KA relay contains a high speed overcurrent unit used to start carrier transmission for ground faults. The construction and operation of the relay units are described below. Complete details of the operation of this relay in the distance carrier relaying scheme is described in I.L. 41-911.

Overcurrent Unit

The overcurrent unit is a product induction cylinder type unit. The time phase relationship of the two air gap fluxes necessary for the development of torque is achieved by means of a capacitor connected in series with one pair of pole windings.

Mechanically, the overcurrent unit is composed of four basic components: a die-cast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a locking nut. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing, which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearing, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.

With the contacts closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

When the current in the overcurrent unit exceeds the pick-up value the contacts open, allowing positive potential to be applied to the carrier transmitter.

A transformer and varistor assembly is used in conjunction with the overcurrent unit. The transformer is of the saturating type which limits the energy to the overcurrent unit and reduces the burden

SUPERSEDES I.L. 41-923
*Denotes change from superseded issue.

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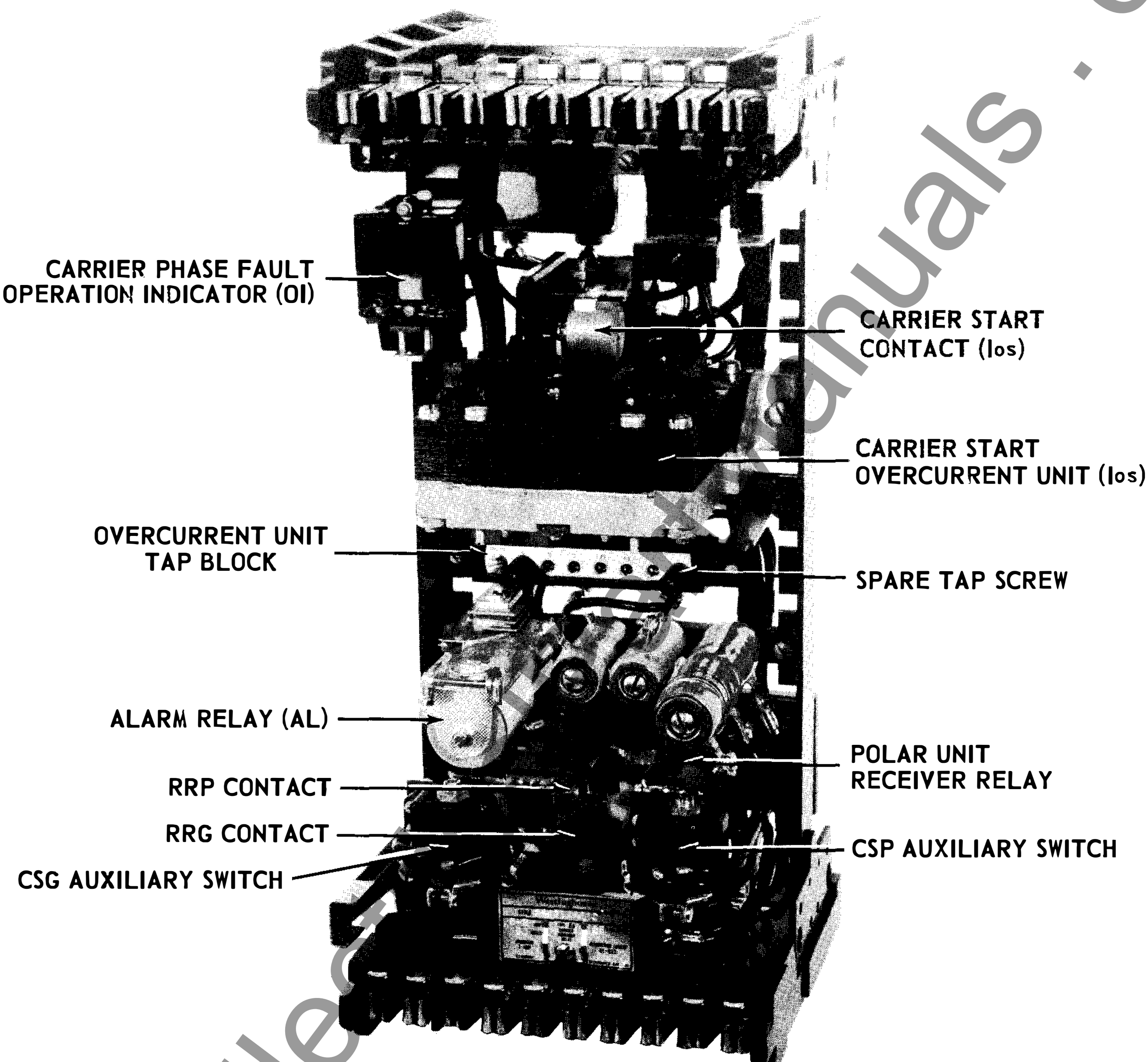


FIG. 1 TYPE KA RELAY WITHOUT CASE. (FRONT VIEW)

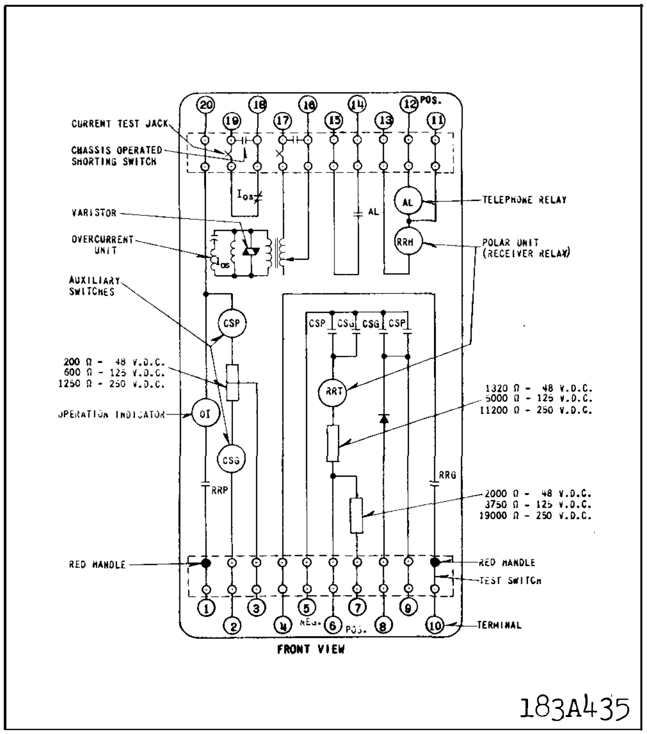
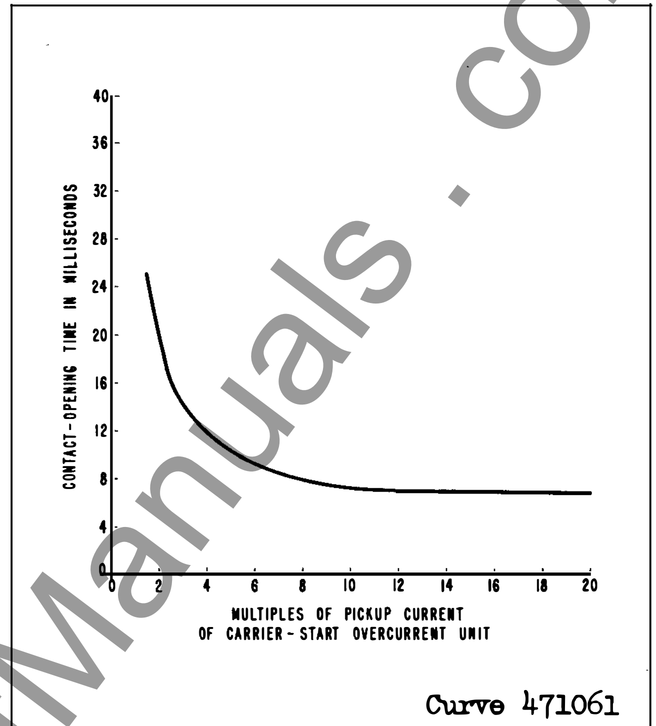


Fig. 2. Internal Schematic of the Type KA Relay in Type FT 32 Case.



✱ *Fig. 3. Typical Time Characteristics of carrier start overcurrent unit of the type KA Relay.*

on the operating CT.

The primary of the transformer is tapped and brought out to a tap connector block for ease in changing the pick-up current of the relay. The use of a tapped transformer provides approximately the same energy level at a given multiple of pick-up current for any tap setting, resulting in one time curve throughout the range of the relay.

Across the secondary is connected a non-linear resistor known as a varistor. The effect of the varistor is to reduce the voltage peaks applied to the overcurrent unit and phase shifting capacitor.

Directional Auxiliary Units

These are two solenoid-type contactor switches designated as CSP and CSG. The plunger of the contactor switch has a circular conducting disc mounted on its lower end and as the plunger travels upward, the disc bridges three silver stationary contacts. The CSP switch is energized by the operation of the second zone unit of the KD distance relay, and the CSG switch, by the operation of the directional and overcurrent units of the ground relay. The contacts of the two switches are connected in parallel as shown in the internal schematic. The operation of either of these switches connects the carrier control circuit to negative to stop carrier, and energizes the RRT operating coil of the receiver relay unit.

Receiver Unit

The polarized relay consists of an armature and contacts mounted on a leaf spring supported symmetrically within a magnet frame. The armature rides in the front air gap of the frame with the contacts projecting outside. The poles of a permanent magnet clamp directly to each side of the frame. Two adjustable shunts are located across the rear air gaps. These change the reluctance of the magnetic path as shown in Fig. 4 so as to force some of the flux thru the moving armature which is fastened to the frame midway between the two rear air gaps. Flux in the armature polarizes it and creates a magnetic bias, causing it to move towards either the left or right, depending upon the adjustment.

Two stationary contact screws are mounted to the left (front view) of the moving contact assembly and adjusted for normally open contacts. These contacts are designated, RRP and RRG, and are connected in the phase and ground trip circuits respectively. These contacts are operated by two concentric coils, RRT and RRH, which are placed around the armature

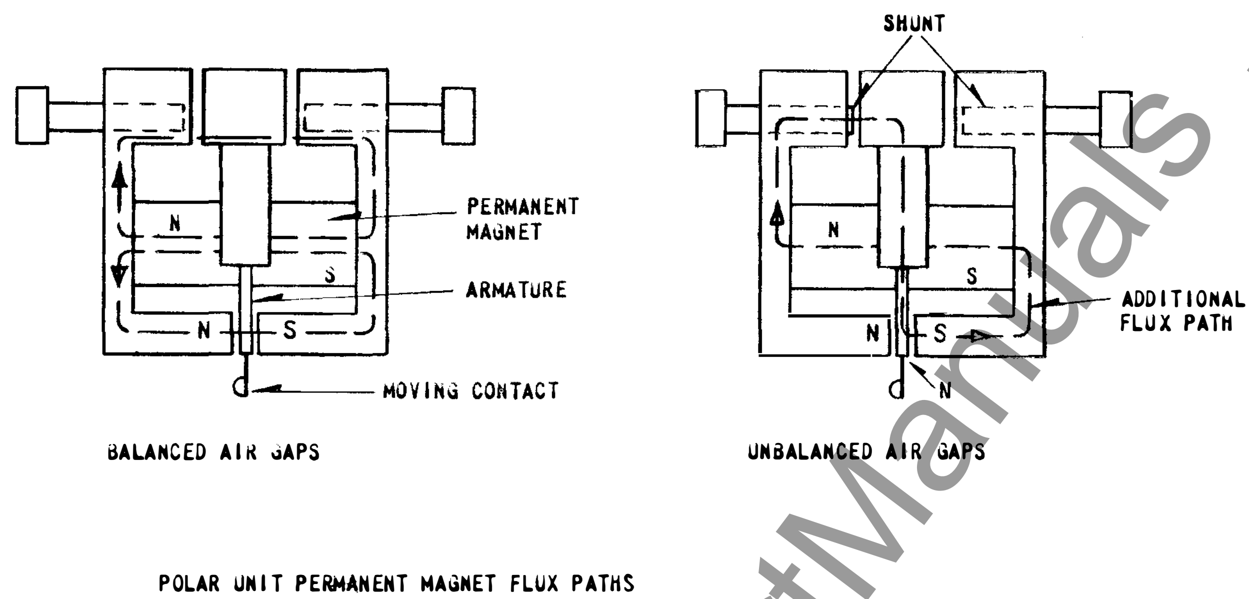


Fig. 4. Polar Unit Permanent Magnet Flux Paths.

and within the magnetic frame. RRT is the operating coil and receives its energy from the local battery when either CSP or CSG is closed. RRH is the holding coil and receives its energy from the carrier transmitted either from the local transmitter or the one at the other end of the line section. These two coils are connected to oppose each other with the operating coil, RRT operating to close the RRP and RRG contacts and trip; and the holding coil, RRH to hold the RRP and RRG contacts open and block tripping. The restraining torque of the RRH coil is sufficient to overcome the operating torque of the RRT coil. Consequently, RRP and RRG contacts cannot close as long as RRH is energized.

Alarm Unit

The alarm unit is an auxiliary single coil and a single set of contacts. The coil is energized by the received carrier to close the contacts and give an alarm. This unit has a higher pick-up than that of the receiver unit in order to obtain a direct check on the sensitivity of the carrier transmitter-receiver. The failure of the alarm relay to pickup when carrier is started indicates insufficient output from the transmitter-receivers.

Operation Indicator

The operation indicator gives a visual indication of a carrier tripping operation for phase faults by the distance relay through the RRP contacts. For a ground fault carrier relaying operation, the indicating contactor switch (ICS) located in the ground relay will drop a target.

CHARACTERISTICS

The characteristics of the various elements of the relays are as follows:

	48V Avg. Ohms	125V Avg. Ohms	250V Avg. Ohms
CSP or CSG Coil	27	27	27
CSP & CSG Tapped Resistor	200	600	1250
* Carrier Resistor	2000	3750	19000
RRT Operating Coil	1100	1100	1100
RRT Coil Resistor	1320	5000	11200
RRH Holding Coil	1700	1700	1700
AL Alarm Coil	650	650	650
Operation Indicator (1 amp.)	0.1	0.1	0.1

The pick-up and operating values of these units are given under "Adjustments and Maintenance".

The time characteristic of the overcurrent unit is shown in Fig. 3. The overcurrent unit is generally available in the following current ranges:

Range	Taps					
0.5 – 2 amps	0.5	0.75	1.0	1.25	1.5	2.0
1 – 4	1.0	1.5	2.0	2.5	3.0	4.0

The tap value is the minimum current required to just open the relay contacts. For pick-up settings in between taps, refer to the section under Adjustments.

SETTINGS

The only setting required is for the overcurrent unit which is made by inserting the tap screw in the tap to give the required pick-up.

Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

✱ The carrier-start overcurrent unit at each line terminal is set on a lower tap than the tripping element at the opposite end of the line. This arrangement insures proper blocking for remote external faults which may not pick up both overcurrent elements at each line terminal.

INSTALLATION

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

The carrier relaying schematic (supplied with the carrier order) should be consulted for details of the external connections of these relays.

ADJUSTMENTS AND MAINTENANCE

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

ACCEPTANCE CHECK

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

Overcurrent Unit

With the tap screw in the desired tap hole, pass rated alternating current through the relay terminals. ✱ The contact should pick up within ±5% of tap value.

Directional Auxiliary Units (CSP and CSG).

Each contactor switch has a section of a tapped resistor in series with it, and will pick up positively ✱ when rated control voltage is applied across the coil and its section of the resistor.

The pick-up of the coil and its resistor is 14-17 volts for the 48-volt relay, 45-60 volts for the 125-volt relay, and 90-120 volts for 250-volt relay. These units have an intermittent rating, and should not be energized for more than a few seconds.

Polar Unit (Receiver Relay)

Connect a jumper between the middle and left hand contact connection of the CSG or CSP switch. The CSG switch is located on the left-hand pedestal and CSP is located on the right-hand pedestal on the relay (front view). Apply rated voltage across the RRT coil and the RRT coil resistor, observing polarity as shown in the internal schematic. The armature should move to the left.

To the holding coil (RRH) relay terminals, apply direct current observing correct polarity. Increase the current until the armature moves to the right. The armature should move to the right at approximately 6 ma. Now reduce the current and the armature should move to the left at approximately 4 ma.

Alarm Unit (AL)

Connect direct current to the alarm unit relay terminals. Increase the current until the contacts pick up. The contacts should pick up at approximately 8 ma. Now reduce the current and the contacts should open at 4 to 6 ma.

Operation Indicator (OI)

With the polar unit contacts closed, apply direct current to the operation indicator relay terminals. The operation indicator should pick up and drop the indicator target between 1 ampere and 1.2 amperes d-c.

ROUTINE MAINTENANCE

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

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

CALIBRATION

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

Overcurrent Unit

The upper bearing screw should be screwed down until there is approximately 1/64" clearance between it and the top of the shaft bearing. Securely lock in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

With the moving contact in the normally closed position, i.e., against the right side of the bridge, screw in the stationary contact until both contacts
* just close. Then screw in the stationary contact approximately one-half turn farther to provide the correct amount of follow.

The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

With the tap screw in the desired tap hole, pass rated a-c through the relay terminals.

The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver or similar tool into one of the notches
* located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

Adjust the spring until the contacts just open. With this adjustment, the pick-up of the relay for any other tap setting should be within ±5% of tap value.

If settings in between taps are desired, place the tap screw in the next lower tap hole and adjust the spring until the contacts just open at the desired pick-up current.

Directional Auxiliary Units (CSP and CSG)

The two contactor switches, CSP and CSG, have adjustable plunger travel. Adjust the stationary core of the switch for a clearance between the stationary core and the moving core of 1/64" when the switch is picked up. This can be done by turning the relay up-side-down and screwing up the core screw of the switch until the contacts just separate. Then back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 5/64" ± 1/64" by means of the two small nuts on either side of the Micarta disc.

Each contactor switch has a section of a tapped resistor in series with it, and will pick up positively when rated trip circuit voltage is applied across the coil and its section of the resistor.

The pick-up of the coil and its resistor is 14-17 volts for the 48-volt relay, 35-45 volts for the 125-volt relay and 70-90 volts for 250-volt relay. These units have an intermittent rating, and should not be energized for more than a few seconds.

Polar Receiver Unit

Back off contact screws so that they do not make contact. Screw magnetic shunts into the all-out position (5 or 6 screw threads showing.) The armature should remain against whichever side it is pushed with this adjustment.

Adjust the stationary contacts for a contact gap of approximately .050". This perhaps can best be done by inserting a .025" steel thickness gage between the large rivet head on the moving armature and the right hand pole face (a .025" travel of the rivet head is equal to .050" travel of the moving contacts). Using an indicating light in each contact circuit, adjust the upper and lower stationary contacts to touch the moving contact at the same time. With the feeler gauge removed the contact gap is .050" and the moving contacts close simultaneously.

Connect a jumper between the middle and left hand contact connection of the CSG or CSP switch. The CSG switch is located on the left-hand pedestal and CSP is located on the right hand pedestal of the relay (front view). Apply rated voltage across the RRT coil and the RRT coil resistor observing polarity as shown in the interval schematic diagram. The armature should move to the left.

To the holding coil, RRH, apply 10 to 20 milliamperes d.c. current observing correct polarity. The armature should now move to the right. De-energize both coils and see that the armature stays up against the right hand side.

Run both shunt screws all the way in, and then back out the left hand shunt screw approximately 6 turns. Back out the right hand shunt screw approximately 9 turns.

Re-energize the operating coil with rated voltage and the holding coil with 4 milliamperes d.c. Adjust the right hand contact shunt screw until the armature moves to the left. If the armature moves to the left, at a value of holding coil current greater than 4 milliamperes, the right hand shunt screw should be turned out to lower this value to the correct 4 milliampere point.

Increase the holding coil current to 6 milliamperes and adjust the left hand shunt screw until the armature resets, or moves to the right. If the armature resets at a value of current less than 6 milliamperes, the left hand shunt screw should be turned out. This will increase the reset value of the armature and provide for the correct 6 milliampere reset value.

Minor adjustments of both shunt screws must be made several times until the desired operating points are obtained, since the adjustments of one shunt screw affect the adjustment on the other shunt screw.

Alarm Unit

The contacts should close with 8 milliamperes d-c ± 5% applied to the alarm coil. The armature rest may be adjusted slightly to obtain this pick-up. However, the contact gap should not be less than .015".

Reduce the current and the contact should drop out between 4 and 6 milliamperes. If the armature drops out below 4 ma the armature gap may be increased by means of the nut and screw on the armature plate. The armature gap should be between .004" and .007" with the armature picked up.

Check to be sure that a good contact is made by means of a light circuit and observing some deflection of the contacts in closing.

Operation Indicator

The operation indicator should pick up and drop the indicator target when the current is between 1 and 1.2 amperes d-c. To increase the pick-up current, remove the molded cover and bend the springs out or away from the cover. To decrease the pick-up current, bend the springs in toward the cover.

Make sure that the target drops freely when the unit operates.

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.

ENERGY REQUIREMENTS

BURDEN DATA OPERATING CURRENT CIRCUIT - 60 CYCLES

Range Amps	Taps	Volt-Amperes Tap Value Current	Power Factor Angle ¢	Volt Amperes at 5 amperes	Power Factor Angle ¢
	.5	.37	39°	24	46°
	.75	.38	36	13	37
.5-2	1	.39	35	8.5	34
	1.25	.41	34	6.0	32
	1.5	.43	32	4.6	31
	2	.45	30	2.9	28
	1	.41	36°	9.0	36°
	1.5	.44	32	5.0	32
1-4	2	.47	30	3.0	29
	2.5	.50	28	2.1	27
	3	.53	26	1.5	26
	4	.59	24	.93	24

RATINGS OF OVERCURRENT UNIT

Range	Continuous Rating Amps	One Second Rating Amps
.5-2	5	100
1-4	5	140

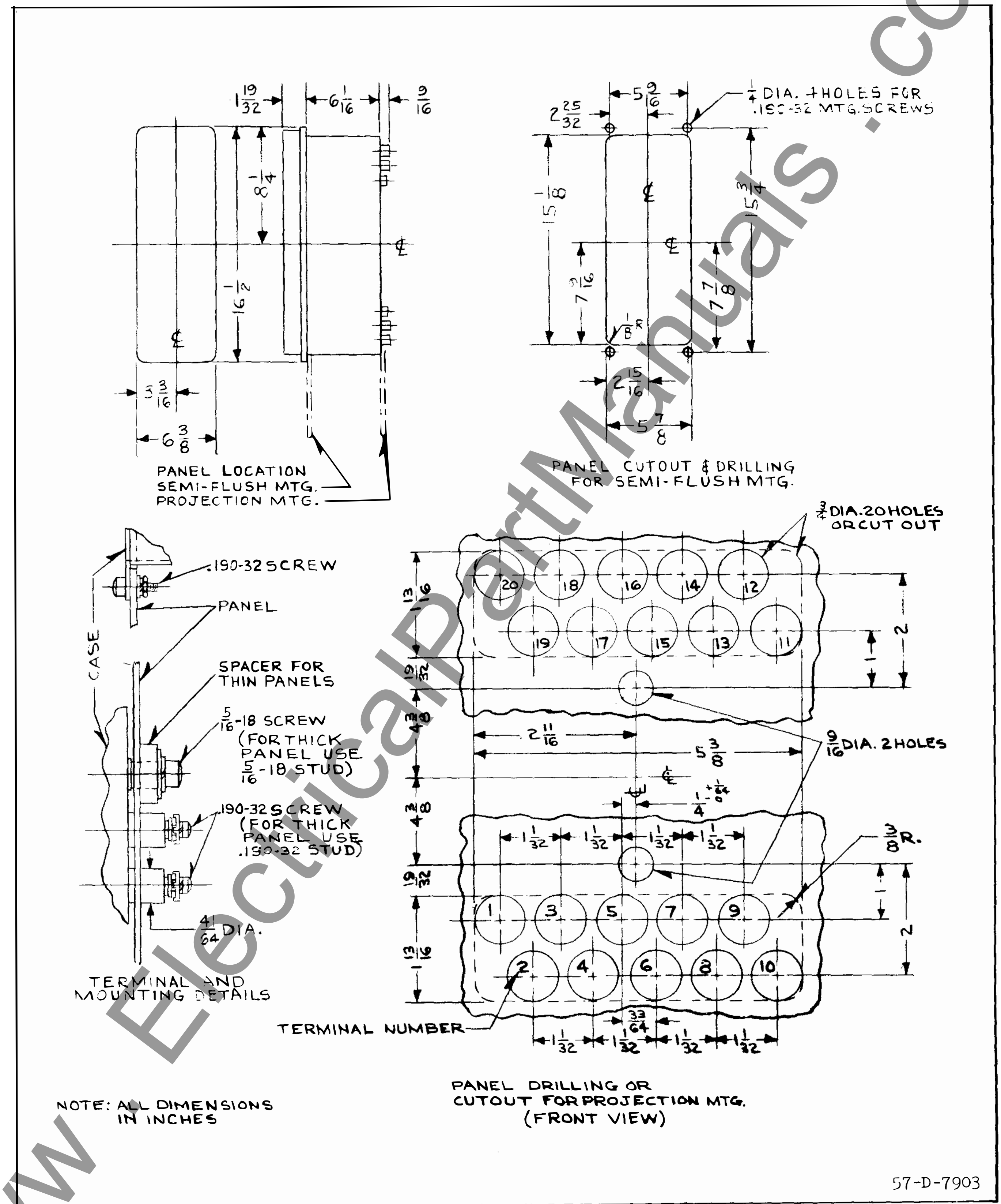


Fig. 5. Outline and Drilling Plan for the type KA Relay in the type FT 32 Case.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION • **NEWARK, N.J.**

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APPLICATION

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CONSTRUCTION AND OPERATION

The type KA relay consists of directional auxiliary units, receiver and alarm units, and a phase fault carrier operation indicator. In addition, the type KA relay contains a high speed overcurrent unit used to start carrier transmission for ground faults. The construction and operation of the relay units are described below. Complete details of the operation of this relay in the distance carrier relaying scheme is described in I.L. 41-911.

Overcurrent Unit

The overcurrent unit is a product induction cylinder type unit. The time phase relationship of the two air gap fluxes necessary for the development of torque is achieved by means of a capacitor connected in series with one pair of pole windings.

Mechanically, the overcurrent unit is composed of four basic components: a die-cast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a locking nut. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing, which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearing, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.

With the contacts closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

When the current in the overcurrent unit exceeds the pick-up value the contacts open, allowing positive potential to be applied to the carrier transmitter.

A transformer and varistor assembly is used in conjunction with the overcurrent unit. The transformer is of the saturating type which limits the energy to the overcurrent unit and reduces the burden

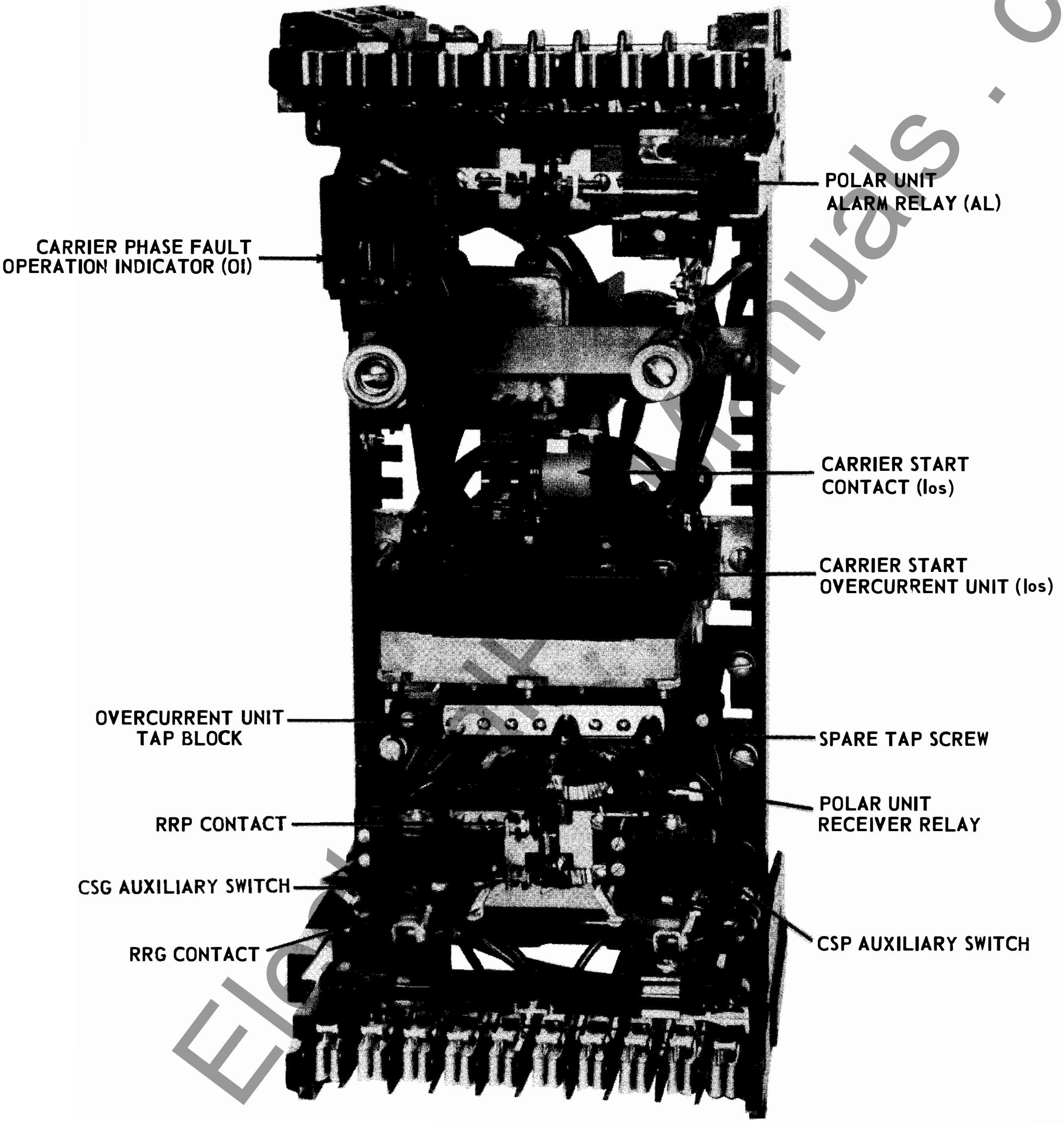


FIG. 1 TYPE KA RELAY WITHOUT CASE. (FRONT VIEW)

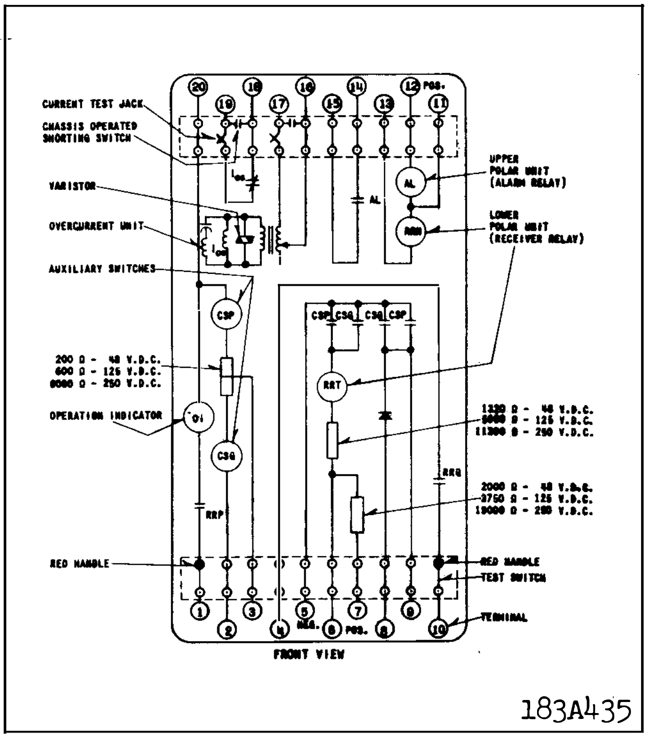


Fig. 2. Internal Schematic of the Type KA Relay in Type FT 32 Case.

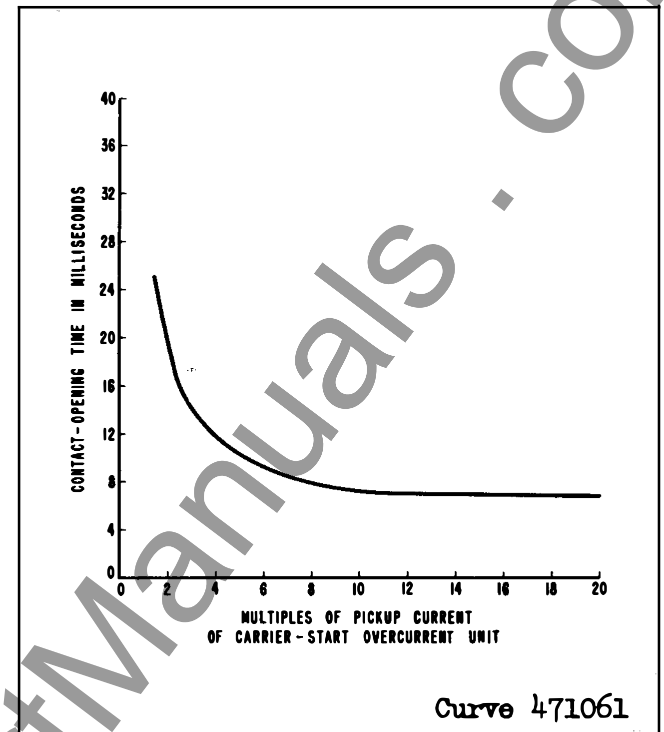


Fig. 3. Typical Time Characteristics of carrier start overcurrent unit of the type KA Relay.

on the operating CT.

The primary of the transformer is tapped and brought out to a tap connector block for ease in changing the pick-up current of the relay. The use of a tapped transformer provides approximately the same energy level at a given multiple of pick-up current for any tap setting, resulting in one time curve throughout the range of the relay.

Across the secondary is connected a non-linear resistor known as a varistor. The effect of the varistor is to reduce the voltage peaks applied to the overcurrent unit and phase shifting capacitor.

Directional Auxiliary Units

These are two solenoid-type contactor switches designated as CSP and CSG. The plunger of the contactor switch has a circular conducting disc mounted on its lower end and as the plunger travels upward, the disc bridges three silver stationary contacts. The CSP switch is energized by the operation of the second zone unit of the KD distance relay, and the CSG switch, by the operation of the directional and overcurrent units of the ground relay. The contacts of the two switches are connected in parallel as shown in the internal schematic. The operation of either of these switches connects the carrier control circuit to negative to stop carrier, and energizes the RRT operating coil of the receiver relay unit.

Receiver Unit

The polarized relay consists of an armature and contacts mounted on a leaf spring supported symmetrically within a magnet frame. The armature rides in the front air gap of the frame with the contacts projecting outside. The poles of a permanent magnet clamp directly to each side of the frame. Two adjustable shunts are located across the rear air gaps. These change the reluctance of the magnetic path as shown in Fig. 4 so as to force some of the flux thru the moving armature which is fastened to the frame midway between the two rear air gaps. Flux in the armature polarizes it and creates a magnetic bias, causing it to move towards either the left or right, depending upon the adjustment.

Two stationary contact screws are mounted to the left (front view) of the moving contact assembly and adjusted for normally open contacts. These contacts are designated, RRP and RRG, and are connected in the phase and ground trip circuits respectively. These contacts are operated by two concentric coils, RRT and RRH, which are placed around the armature

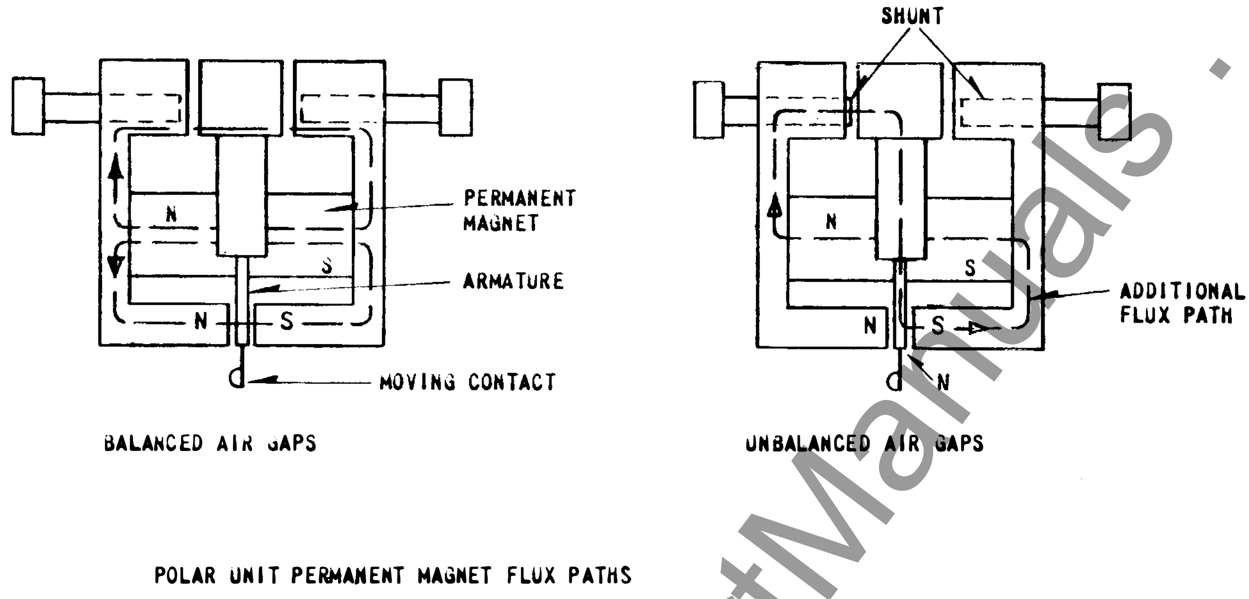


Fig. 4. Polar Unit Permanent Magnet Flux Paths.

and within the magnetic frame. RRT is the operating coil and receives its energy from the local battery when either CSP or CSG is closed. RRH is the holding coil and receives its energy from the carrier transmitted either from the local transmitter or the one at the other end of the line section. These two coils are connected to oppose each other with the operating coil, RRT operating to close the RRP and RRG contacts and trip; and the holding coil, RRH to hold the RRP and RRG contacts open and block tripping. The restraining torque of the RRH coil is sufficient to overcome the operating torque of the RRT coil. Consequently, RRP and RRG contacts cannot close as long as RRH is energized.

Alarm Unit

The alarm element is similar in construction to the receiver element except that it is energized by a single coil and operates a single set of contacts. The coil is energized by the received carrier to close the contacts and give an alarm. This element has a higher-pick-up than that of the receiver element in order to obtain a direct check on the sensitivity of the tubes in the carrier transmitter-receiver. The failure of the alarm relay to pick-up when carrier is started indicates insufficient output from the transmitter-receivers.

Operation Indicator

The operation indicator gives a visual indication of a carrier tripping operation for phase faults by the distance relay through the RRP contacts. For a ground fault carrier relaying operation, the indicating contactor switch (ICS) located in the ground relay will drop a target.

CHARACTERISTICS

The characteristics of the various elements of the relays are as follows:

	48V Avg. Ohms	125V Avg. Ohms	250V Avg. Ohms
CSP or CSG Coil	27	27	27
CSP & CSG Tapped Resistor	200	600	1250
Carrier Resistor	2000	3750	19000
RRT Operating Coil	1100	1100	1100
RRT Coil Resistor	1320	5000	11200
RRH Holding Coil	1700	1700	1700
AL Alarm Coil	500	500	500
Operation Indicator (1 amp.)	0.1	0.1	0.1

The pick-up and operating values of these units are given under "Adjustments and Maintenance".

The time characteristic of the overcurrent unit is shown in Fig. 3. The overcurrent unit is generally available in the following current ranges:

Range	Taps					
0.5 – 2 amps	0.5	0.75	1.0	1.25	1.5	2.0
1 – 4	1.0	1.5	2.0	2.5	3.0	4.0

The tap value is the minimum current required to just open the relay contacts. For pick-up settings in between taps, refer to the section under Adjustments.

SETTINGS

The only setting required is for the overcurrent unit which is made by inserting the tap screw in the tap to give the required pick-up.

Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

The carrier-start overcurrent unit at each line terminal is set on a lower tap than the tripping element at the opposite end of the line. This arrangement insures proper blocking for remote external faults which may not pick up both overcurrent elements at each line terminal.

INSTALLATION

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

The carrier relaying schematic (supplied with the carrier order) should be consulted for details of the external connections of these relays.

ADJUSTMENTS AND MAINTENANCE

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

ACCEPTANCE CHECK

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

Overcurrent Unit

With the tap screw in the desired tap hole, pass rated alternating current through the relay terminals. The contact should pick up within ±5% of tap value.

Directional Auxiliary Units (CSP and CSG).

Each contactor switch has a section of a tapped resistor in series with it, and will pick up positively when rated control voltage is applied across the coil and its section of the resistor.

These units should operate at 24 volts for the 48-volt relay, 60 volts for the 125-volt relay, and 120 volts for 250-volt relay. These units have an intermittent rating, and should not be energized for more than a few seconds.

Polar Unit (Receiver Relay)

Connect a jumper between the middle and left hand contact connection of the CSG or CSP switch. The CSG switch is located on the left-hand pedestal and CSP is located on the right-hand pedestal on the relay (front view). Apply rated voltage across the RRT coil and the RRT coil resistor, observing polarity as shown in the internal schematic. The armature should move to the left.

To the holding coil (RRH) relay terminals, apply direct current observing correct polarity. Increase the current until the armature moves to the right. The armature should move to the right at approximately 6 ma. Now reduce the current and the armature should move to the left at approximately 4 ma.

Alarm Unit (AL)

Connect direct current to the alarm unit relay terminals. Increase the current until the contacts pick up. The contacts should pick up at approximately 8 ma. Now reduce the current and the contacts should open at 4 to 6 ma.

Operation Indicator (OI)

With the polar unit contacts closed, apply direct current to the operation indicator relay terminals. The operation indicator should pick up and drop the indicator target between 1 ampere and 1.2 amperes d-c.

ROUTINE MAINTENANCE

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

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

CALIBRATION

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

Overcurrent Unit

The upper bearing screw should be screwed down until there is approximately 1/64" clearance between it and the top of the shaft bearing. Securely lock in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

With the moving contact in the normally closed position, i.e., against the right side of the bridge, screw in the stationary contact until both contacts just close. Then screw in the stationary contact approximately one-half turn farther to provide the correct amount of follow.

The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

With the tap screw in the desired tap hole, pass rated a-c through the relay terminals.

The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver or similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

Adjust the spring until the contacts just open. With this adjustment, the pick-up of the relay for any other tap setting should be within ±5% of tap value.

If settings in between taps are desired, place the tap screw in the next lower tap hole and adjust the spring until the contacts just open at the desired pick-up current.

Directional Auxiliary Units (CSP and CSG)

The two contactor switches, CSP and CSG, have adjustable plunger travel. Adjust the stationary core and the moving core of 1/64" when the switch is picked up. This can be done by turning the relay upside-down and screwing up the core screw of the switch until the contacts just separate. Then back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for approximately 1/32" by means of the two small nuts on either side of the Micarta disc.

Each contactor switch has a section of a tapped resistor in series with it, and will pick up positively when rated trip circuit voltage is applied across the coil and its section of the resistor.

The units should operate at 24 volts for the 48-volt relay, 60 volts for the 125-volt relay and 120 volts for 250-volt relay. These units have an intermittent rating, and should not be energized for more than a few seconds.

Polar Receiver Unit

Back off contact screws so that they do not make contact. Screw magnetic shunts into the all-out position (5 or 6 screw threads showing.) The armature should remain against whichever side it is pushed with this adjustment.

Adjust the stationary contacts for a contact gap of approximately .020". This perhaps can best be done by inserting a .010" steel thickness gage between the large rivet head on the moving armature and the right hand pole face (a .010" travel of the rivet head is equal to .020" travel of the moving contacts). Using an indicating light in each contact circuit, adjust the upper and lower stationary contacts to touch the moving contact at the same time. With the feeler gauge removed the contact gap is .020" and the moving contacts close simultaneously.

Connect a jumper between the middle and left hand contact connection of the CSG or CSP switch. The CSG switch is located on the left-hand pedestal and CSP is located on the right hand pedestal of the relay (front view). Apply rated voltage across the RRT coil and the RRT coil resistor observing polarity as shown in the interval schematic diagram. The armature should move to the left.

To the holding coil, RRH, apply 10 to 20 milliamperes d.c. current observing correct polarity. The armature should now move to the right. De-energize both coils and see that the armature stays up against the right hand side.

Run both shunt screws all the way in, and then back out the left hand shunt screw approximately 6 turns. Back out the right hand shunt screw approximately 9 turns.

Re-energize the operating coil with rated voltage and the holding coil with 4 milliamperes d.c. Adjust the right hand contact shunt screw until the armature moves to the left. If the armature moves to the left, at a value of holding coil current greater than 4 milliamperes, the right hand shunt screw should be turned out to lower this value to the correct 4 milliampere point.

Increase the holding coil current to 6 milliamperes and adjust the left hand shunt screw until the armature resets, or moves to the right. If the armature resets at a value of current less than 6 milliamperes, the left hand shunt screw should be turned out. This will increase the reset value of the armature and provide for the correct 6 milliampere reset value.

Minor adjustments of both shunt screws must be made several times until the desired operating points are obtained, since the adjustments of one shunt screw affect the adjustment on the other shunt screw.

Polar Alarm Unit

The contacts should close with 8 milliamperes d-c ± 5% applied to the alarm coil. Adjust the contact screws to obtain an .050" contact gap such that the armature motion between the left and right hand contacts is in the central part of the air gap between the pole faces. Tighten the contact locking nuts. Approximate adjustments of the two magnetic shunt screws are as follows:

Turn both shunt screws all the way in. Then back out both shunt screws approximately seven turns. Apply 8 milliamperes d.c. to the coil observing correct polarity, and then screw in the left hand shunt screw until the armature moves to the right at a value of current less than 8 milliamperes, screw the left hand shunt out until the armature moves to the right at 8 milliamperes. Check the dropout point by reducing the d.c. current. The armature should move to the left between the limits of 4 and 6 milliamperes. If it fails to do so, adjust the right hand shunt screw until it does. It will then be necessary to recheck the pickup and dropout points again and make any minor adjustments to the shunt screws that may be necessary until correct calibration is obtained.

In general, screwing in the left hand shunt screw reduces the pickup current of the relay. Screwing in the right hand shunt screw increases the dropout current. This will in turn cause a change in the pickup current, making necessary several slight readjustments of both shunt screws to obtain the desired calibration. The armature as finally calibrated should pickup and dropout with a snappy action.

Operation Indicator

The operation indicator should pick up and drop the indicator target when the current is between 1 and 1.2 amperes d-c. To increase the pick-up current, remove the molded cover and bend the springs out or away from the cover. To decrease the pick-up current, bend the springs in toward the cover.

Make sure that the target drops freely when the unit operates.

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.

ENERGY REQUIREMENTS

BURDEN DATA OPERATING CURRENT CIRCUIT - 60 CYCLES

Range Amps	Taps	Volt-Amperes Tap Value Current	Power Factor Angle ¢	Volt Amperes at 5 amperes	Power Factor Angle ¢
	.5	.37	39°	24	46°
	.75	.38	36	13	37
.5-2	1	.39	35	8.5	34
	1.25	.41	34	6.0	32
	1.5	.43	32	4.6	31
	2	.45	30	2.9	28
	1	.41	36°	9.0	36°
	1.5	.44	32	5.0	32
1-4	2	.47	30	3.0	29
	2.5	.50	28	2.1	27
	3	.53	26	1.5	26
	4	.59	24	.93	24

RATINGS OF OVERCURRENT UNIT

Range	Continuous Rating Amps	One Second Rating Amps
.5-2	5	100
1-4	5	140

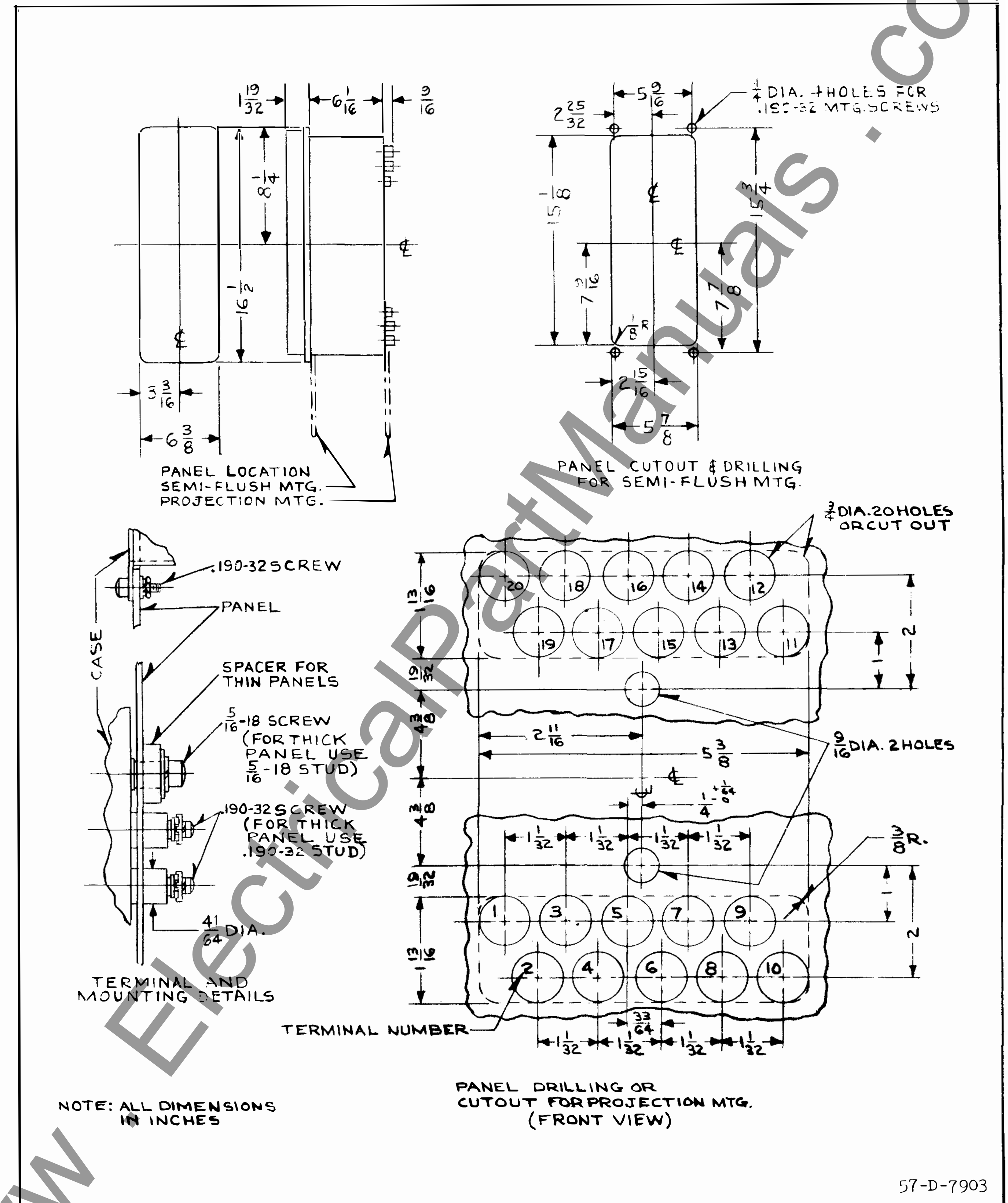


Fig. 5. Outline and Drilling Plan for the type KA Relay in the type FT 32 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY DEPARTMENT

NEWARK, N. J.

Printed in U. S. A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KA CARRIER AUXILIARY RELAY

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

APPLICATION

The type KA relay is an auxiliary relay used in the distance carrier relaying scheme to block or prevent instantaneous tripping for faults external to the line section to which it is applied, and to permit instantaneous simultaneous tripping for internal faults. The relay is arranged to respond to indications of fault power and direction provided by the phase and ground relays, thereby controlling the transmission of the carrier signals.

CONSTRUCTION AND OPERATION

The type KA relay consists of directional auxiliary units, receiver and alarm units, and a phase fault carrier operation indicator. In addition, the type KA relay contains a high speed overcurrent unit used to start carrier transmission for ground faults. The construction and operation of the relay units are described below. Complete details of the operation of this relay in the distance carrier relaying scheme is described in I.L. 41-911.

Overcurrent Unit

The overcurrent unit is a product induction cylinder type unit. The time phase relationship of the two air gap fluxes necessary for the development of torque is achieved by means of a capacitor connected in series with one pair of pole windings.

Mechanically, the overcurrent unit is composed of four basic components: a die-cast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a locking nut. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing, which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearing, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.

With the contacts closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

When the current in the overcurrent unit exceeds the pick-up value the contacts open, allowing positive potential to be applied to the carrier transmitter.

A transformer and varistor assembly is used in conjunction with the overcurrent unit. The transformer is of the saturating type which limits the energy to the overcurrent unit and reduces the burden

SUPERSEDES I.L. 41-923.2
* Denotes change from superseded issue.

EFFECTIVE JUNE 1960

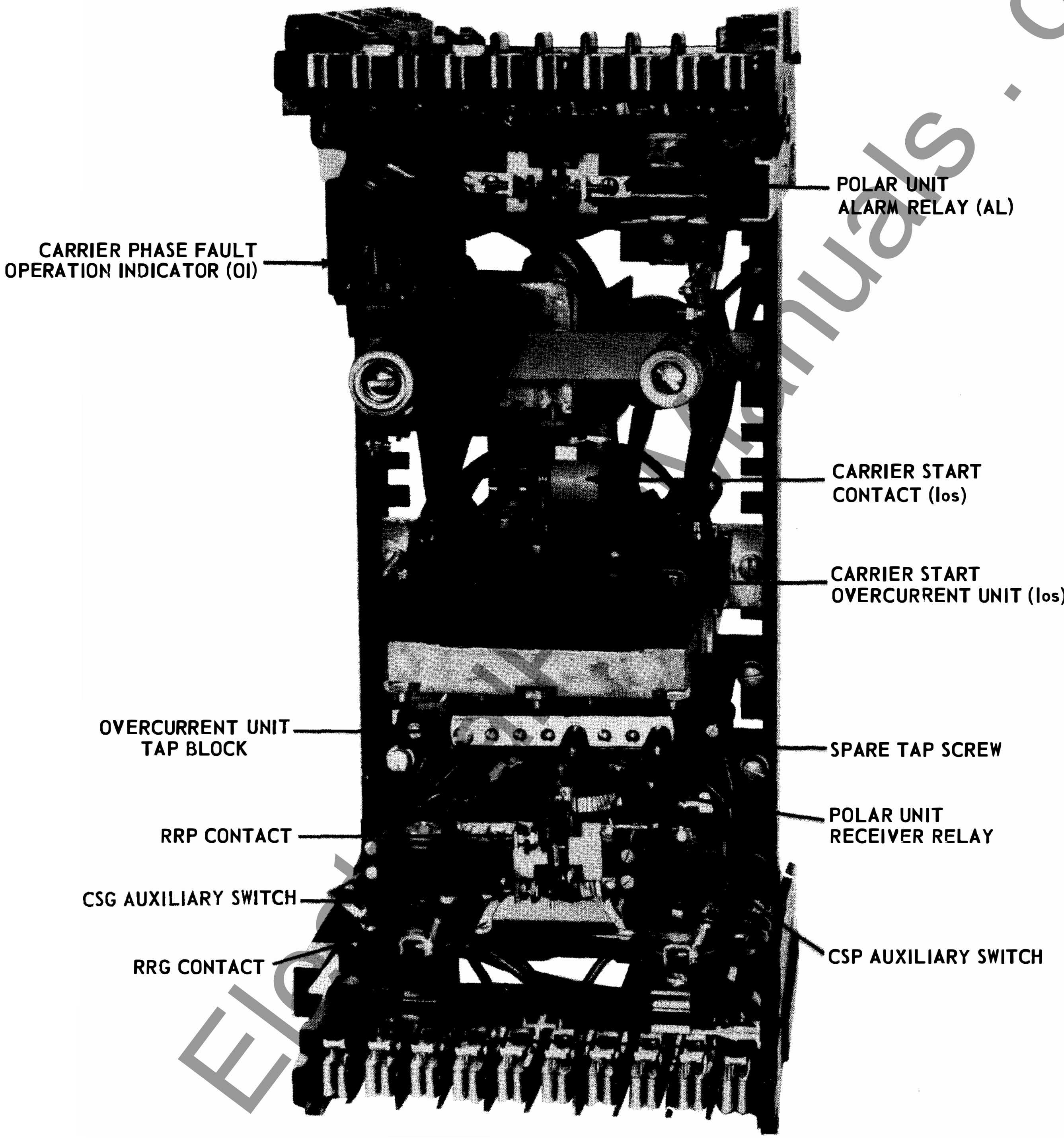
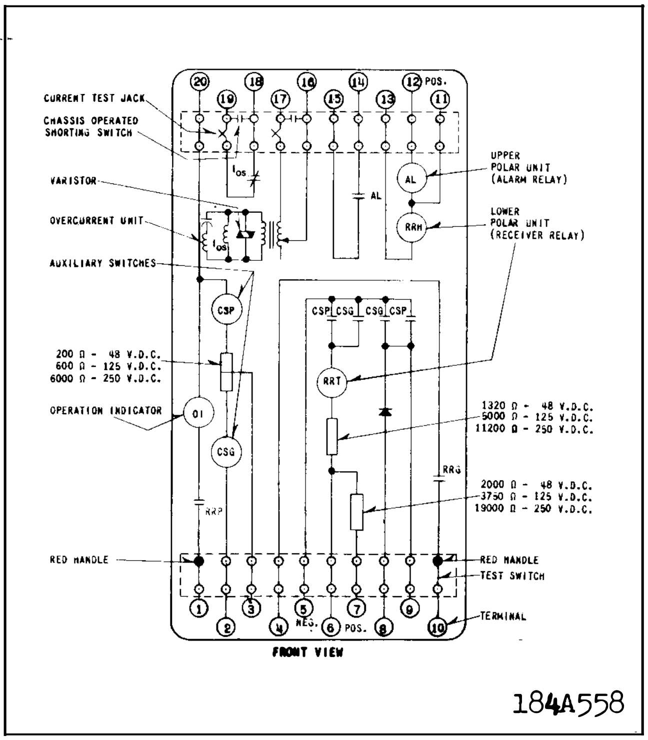


FIG. 1 TYPE KA RELAY WITHOUT CASE. (FRONT VIEW)



✱ *Fig. 2. Internal Schematic of the Type KA Relay in Type FT 32 Case.*

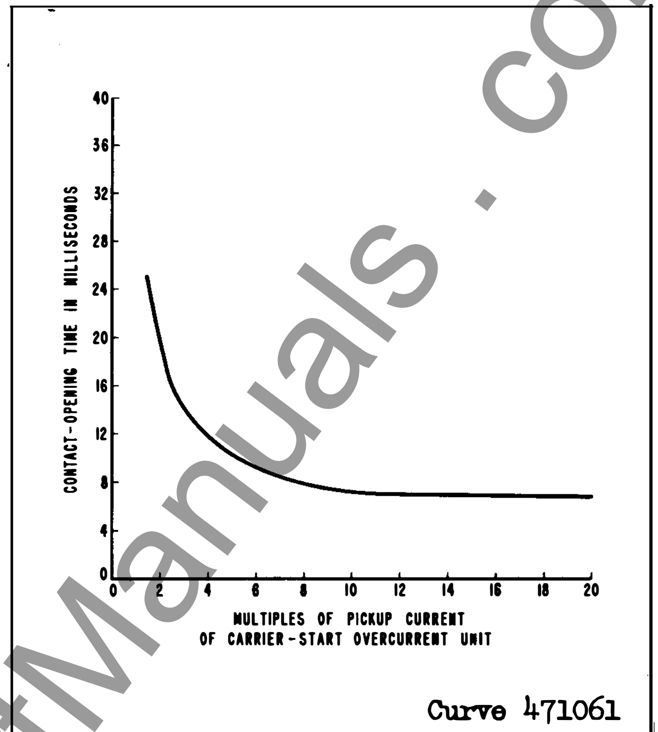


Fig. 3. Typical Time Characteristics of carrier start overcurrent unit of the type KA Relay.

on the operating CT.

The primary of the transformer is tapped and brought out to a tap connector block for ease in changing the pick-up current of the relay. The use of a tapped transformer provides approximately the same energy level at a given multiple of pick-up current for any tap setting, resulting in one time curve throughout the range of the relay.

Across the secondary is connected a non-linear resistor known as a varistor. The effect of the varistor is to reduce the voltage peaks applied to the overcurrent unit and phase shifting capacitor.

Directional Auxiliary Units

These are two solenoid-type contactor switches designated as CSP and CSG. The plunger of the contactor switch has a circular conducting disc mounted on its lower end and as the plunger travels upward, the disc bridges three silver stationary contacts. The CSP switch is energized by the operation of the second zone unit of the KD distance relay, and the CSG switch, by the operation of the directional and overcurrent units of the ground relay. The contacts of the two switches are connected in parallel as shown in the internal schematic. The operation of either of these switches connects the carrier control circuit to negative to stop carrier, and energizes the RRT operating coil of the receiver relay unit.

Receiver Unit

The polarized relay consists of an armature and contacts mounted on a leaf spring supported symmetrically within a magnet frame. The armature rides in the front air gap of the frame with the contacts projecting outside. The poles of a permanent magnet clamp directly to each side of the frame. Two adjustable shunts are located across the rear air gaps. These change the reluctance of the magnetic path as shown in Fig. 4 so as to force some of the flux thru the moving armature which is fastened to the frame midway between the two rear air gaps. Flux in the armature polarizes it and creates a magnetic bias, causing it to move towards either the left or right, depending upon the adjustment.

Two stationary contact screws are mounted to the left (front view) of the moving contact assembly and adjusted for normally open contacts. These contacts are designated, RRP and RRG, and are connected in the phase and ground trip circuits respectively. These contacts are operated by two concentric coils, RRT and RRH, which are placed around the armature

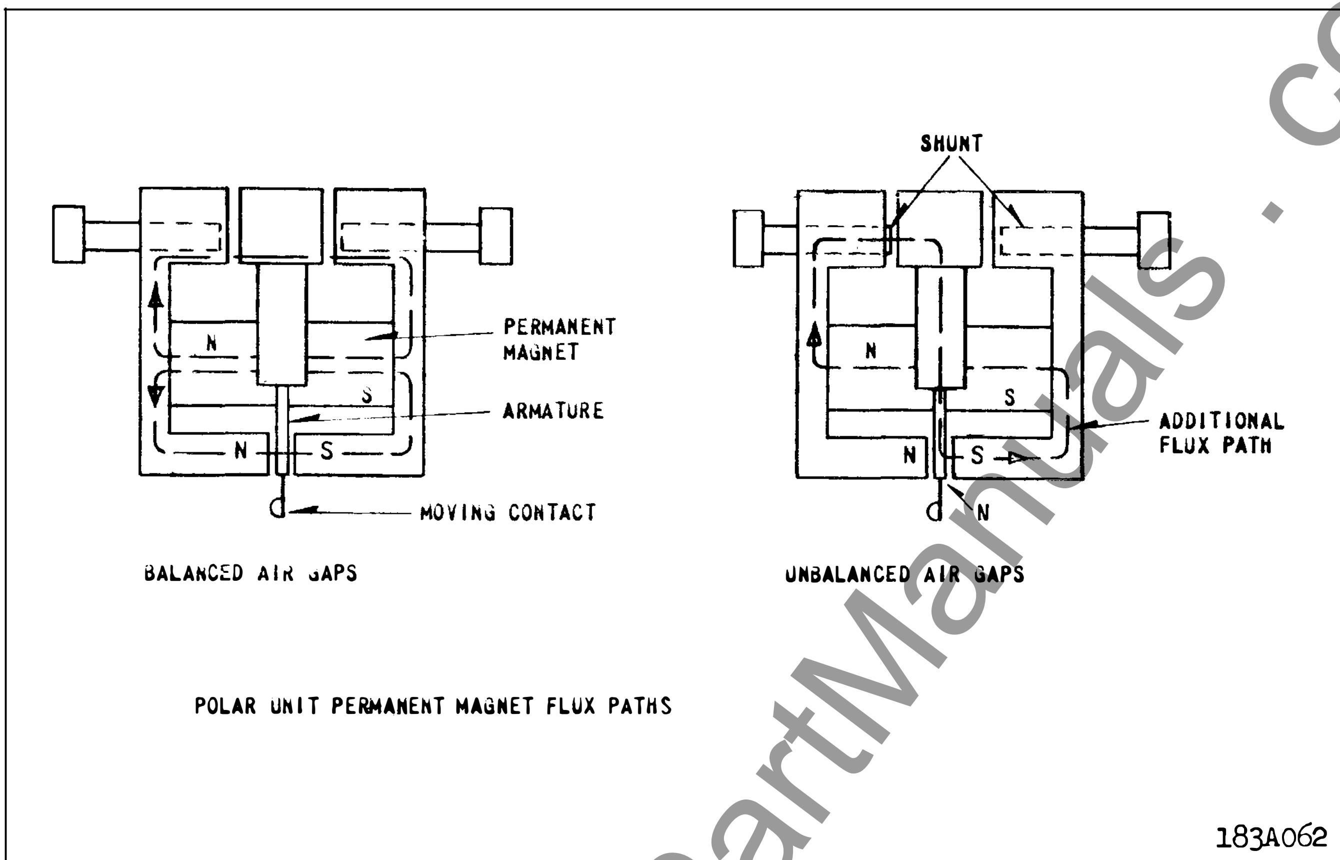


Fig. 4. Polar Unit Permanent Magnet Flux Paths.

and within the magnetic frame. RRT is the operating coil and receives its energy from the local battery when either CSP or CSG is closed. RRH is the holding coil and receives its energy from the carrier transmitted either from the local transmitter or the one at the other end of the line section. These two coils are connected to oppose each other with the operating coil, RRT operating to close the RRP and RRG contacts and trip; and the holding coil, RRH to hold the RRP and RRG contacts open and block tripping. The restraining torque of the RRH coil is sufficient to overcome the operating torque of the RRT coil. Consequently, RRP and RRG contacts cannot close as long as RRH is energized.

Alarm Unit

The alarm element is similar in construction to the receiver element except that it is energized by a single coil and operates a single set of contacts. The coil is energized by the received carrier to close the contacts and give an alarm. This element has a higher-pick-up than that of the receiver element in order to obtain a direct check on the sensitivity of the tubes in the carrier transmitter-receiver. The failure of the alarm relay to pick-up when carrier is started indicates insufficient output from the transmitter-receivers.

Operation Indicator

The operation indicator gives a visual indication of a carrier tripping operation for phase faults by the distance relay through the RRP contacts. For a ground fault carrier relaying operation, the indicating contactor switch (ICS) located in the ground relay will drop a target.

CHARACTERISTICS

The characteristics of the various elements of the relays are as follows:

	48V Avg. Ohms	125V Avg. Ohms	250V Avg. Ohms
CSP or CSG Coil	27	27	435 *
CSP & CSG Tapped Resistor	200	600	6000 *
Carrier Resistor	2000	3750	19000
RRT Operating Coil	1100	1100	1100
RRT Coil Resistor	1320	5000	11200
RRH Holding Coil	1700	1700	1700
AL Alarm Coil	500	500	500
Operation Indicator (1 amp.)	0.1	0.1	0.1

The pick-up and operating values of these units are given under "Adjustments and Maintenance".

The time characteristic of the overcurrent unit is shown in Fig. 3. The overcurrent unit is generally available in the following current ranges:

Range	Taps					
0.5 – 2 amps	0.5	0.75	1.0	1.25	1.5	2.0
1 – 4	1.0	1.5	2.0	2.5	3.0	4.0

The tap value is the minimum current required to just open the relay contacts. For pick-up settings in between taps, refer to the section under Adjustments.

SETTINGS

The only setting required is for the overcurrent unit which is made by inserting the tap screw in the tap to give the required pick-up.

Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

The carrier-start overcurrent unit at each line terminal is set on a lower tap than the tripping element at the opposite end of the line. This arrangement insures proper blocking for remote external faults which may not pick up both overcurrent elements at each line terminal.

INSTALLATION

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

The carrier relaying schematic (supplied with the carrier order) should be consulted for details of the external connections of these relays.

ADJUSTMENTS AND MAINTENANCE

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

ACCEPTANCE CHECK

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

Overcurrent Unit

With the tap screw in the desired tap hole, pass rated alternating current through the relay terminals. The contact should pick up within ±5% of tap value.

Directional Auxiliary Units (CSP and CSG).

Each contactor switch has a section of a tapped resistor in series with it, and will pick up positively when rated control voltage is applied across the coil and its section of the resistor.

These units should operate at 24 volts for the 48-volt relay, 60 volts for the 125-volt relay, and 120 volts for 250-volt relay. These units have an intermittent rating, and should not be energized for more than a few seconds.

Polar Unit (Receiver Relay)

Connect a jumper between the middle and left hand contact connection of the CSG or CSP switch. The CSG switch is located on the left-hand pedestal and CSP is located on the right-hand pedestal on the relay (front view). Apply rated voltage across the RRT coil and the RRT coil resistor, observing polarity as shown in the internal schematic. The armature should move to the left.

To the holding coil (RRH) relay terminals, apply direct current observing correct polarity. Increase the current until the armature moves to the right. The armature should move to the right at approximately 6 ma. Now reduce the current and the armature should move to the left at approximately 4 ma.

Alarm Unit (AL)

Connect direct current to the alarm unit relay terminals. Increase the current until the contacts pick up. The contacts should pick up at approximately 8 ma. Now reduce the current and the contacts should open at 4 to 6 ma.

Operation Indicator (OI)

With the polar unit contacts closed, apply direct current to the operation indicator relay terminals. The operation indicator should pick up and drop the indicator target between 1 ampere and 1.2 amperes d-c.

ROUTINE MAINTENANCE

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

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

CALIBRATION

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

Overcurrent Unit

The upper bearing screw should be screwed down until there is approximately 1/64" clearance between it and the top of the shaft bearing. Securely lock in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

With the moving contact in the normally closed position, i.e., against the right side of the bridge, screw in the stationary contact until both contacts just close. Then screw in the stationary contact
* approximately one-quarter turn farther to provide the correct amount of follow.

The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

With the tap screw in the desired tap hole, pass rated a-c through the relay terminals.

The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver or similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

Adjust the spring until the contacts just open. With this adjustment, the pick-up of the relay for any other tap setting should be within ±5% of tap value.

If settings in between taps are desired, place the tap screw in the next lower tap hole and adjust the spring until the contacts just open at the desired pick-up current.

Directional Auxiliary Units (CSP and CSG)

The two contactor switches, CSP and CSG, have adjustable plunger travel. Adjust the stationary core and the moving core of 1/64" when the switch is picked up. This can be done by turning the relay upside-down and screwing up the core screw of the switch until the contacts just separate. Then back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for approximately 1/32" by means of the two small nuts on either side of the Micarta disc.

Each contactor switch has a section of a tapped resistor in series with it, and will pick up positively when rated trip circuit voltage is applied across the coil and its section of the resistor.

The units should operate at 24 volts for the 48-volt relay, 60 volts for the 125-volt relay and 120 volts for 250-volt relay. These units have an intermittent rating, and should not be energized for more than a few seconds.

Polar Receiver Unit

Back off contact screws so that they do not make contact. Screw magnetic shunts into the all-out position (5 or 6 screw threads showing.) The armature should remain against whichever side it is pushed with this adjustment.

Adjust the stationary contacts for a contact gap of approximately .020". This perhaps can best be done by inserting a .010" steel thickness gage between the large rivet head on the moving armature and the right hand pole face (a .010" travel of the rivet head is equal to .020" travel of the moving contacts). Using an indicating light in each contact circuit, adjust the upper and lower stationary contacts to touch the moving contact at the same time. With the feeler gauge removed the contact gap is .020" and the moving contacts close simultaneously.

Connect a jumper between the middle and left hand contact connection of the CSG or CSP switch. The CSG switch is located on the left-hand pedestal and CSP is located on the right hand pedestal of the relay (front view). Apply rated voltage across the RRT coil and the RRT coil resistor observing polarity as shown in the interval schematic diagram. The armature should move to the left.

To the holding coil, RRH, apply 10 to 20 milliamperes d.c. current observing correct polarity. The armature should now move to the right. De-energize both coils and see that the armature stays up against the right hand side.

Run both shunt screws all the way in, and then back out the left hand shunt screw approximately 6 turns. Back out the right hand shunt screw approximately 9 turns.

Re-energize the operating coil with rated voltage and the holding coil with 4 milliamperes d.c. Adjust the right hand contact shunt screw until the armature moves to the left. If the armature moves to the left, at a value of holding coil current greater than 4 milliamperes, the right hand shunt screw should be turned out to lower this value to the correct 4 milliampere point.

Increase the holding coil current to 6 milliamperes and adjust the left hand shunt screw until the armature resets, or moves to the right. If the armature resets at a value of current less than 6 milliamperes, the left hand shunt screw should be turned out. This will increase the reset value of the armature and provide for the correct 6 milliampere reset value.

Minor adjustments of both shunt screws must be made several times until the desired operating points are obtained, since the adjustments of one shunt screw affect the adjustment on the other shunt screw.

Polar Alarm Unit

The contacts should close with 8 milliamperes d-c ± 5% applied to the alarm coil. Adjust the contact screws to obtain an .050" contact gap such that the armature motion between the left and right hand contacts is in the central part of the air gap between the pole faces. Tighten the contact locking nuts. Approximate adjustments of the two magnetic shunt screws are as follows:

Turn both shunt screws all the way in. Then back out both shunt screws approximately seven turns. Apply 8 milliamperes d.c. to the coil observing correct polarity, and then screw in the left hand shunt screw until the armature moves to the right at a value of current less than 8 milliamperes, screw the left hand shunt out until the armature moves to the right at 8 milliamperes. Check the dropout point by reducing the d.c. current. The armature should move to the left between the limits of 4 and 6 milliamperes. If it fails to do so, adjust the right hand shunt screw until it does. It will then be necessary to recheck the pickup and dropout points again and make any minor adjustments to the shunt screws that may be necessary until correct calibration is obtained.

In general, screwing in the left hand shunt screw reduces the pickup current of the relay. Screwing in the right hand shunt screw increases the dropout current. This will in turn cause a change in the pickup current, making necessary several slight readjustments of both shunt screws to obtain the desired calibration. The armature as finally calibrated should pickup and dropout with a snappy action.

Operation Indicator

The operation indicator should pick up and drop the indicator target when the current is between 1 and 1.2 amperes d-c. To increase the pick-up current, remove the molded cover and bend the springs out or away from the cover. To decrease the pick-up current, bend the springs in toward the cover.

Make sure that the target drops freely when the unit operates.

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.

ENERGY REQUIREMENTS

BURDEN DATA OPERATING CURRENT CIRCUIT - 60 CYCLES

Range Amps	Taps	Volt-Amperes Tap Value Current	Power Factor Angle ¢	Volt Amperes at 5 amperes	Power Factor Angle ¢
	.5	.37	39°	24	46°
	.75	.38	36	13	37
.5-2	1	.39	35	8.5	34
	1.25	.41	34	6.0	32
	1.5	.43	32	4.6	31
	2	.45	30	2.9	28
	1	.41	36°	9.0	36°
	1.5	.44	32	5.0	32
1-4	2	.47	30	3.0	29
	2.5	.50	28	2.1	27
	3	.53	26	1.5	26
	4	.59	24	.93	24

RATINGS OF OVERCURRENT UNIT

Range	Continuous Rating Amps	One Second Rating Amps
.5-2	5	100
1-4	5	140

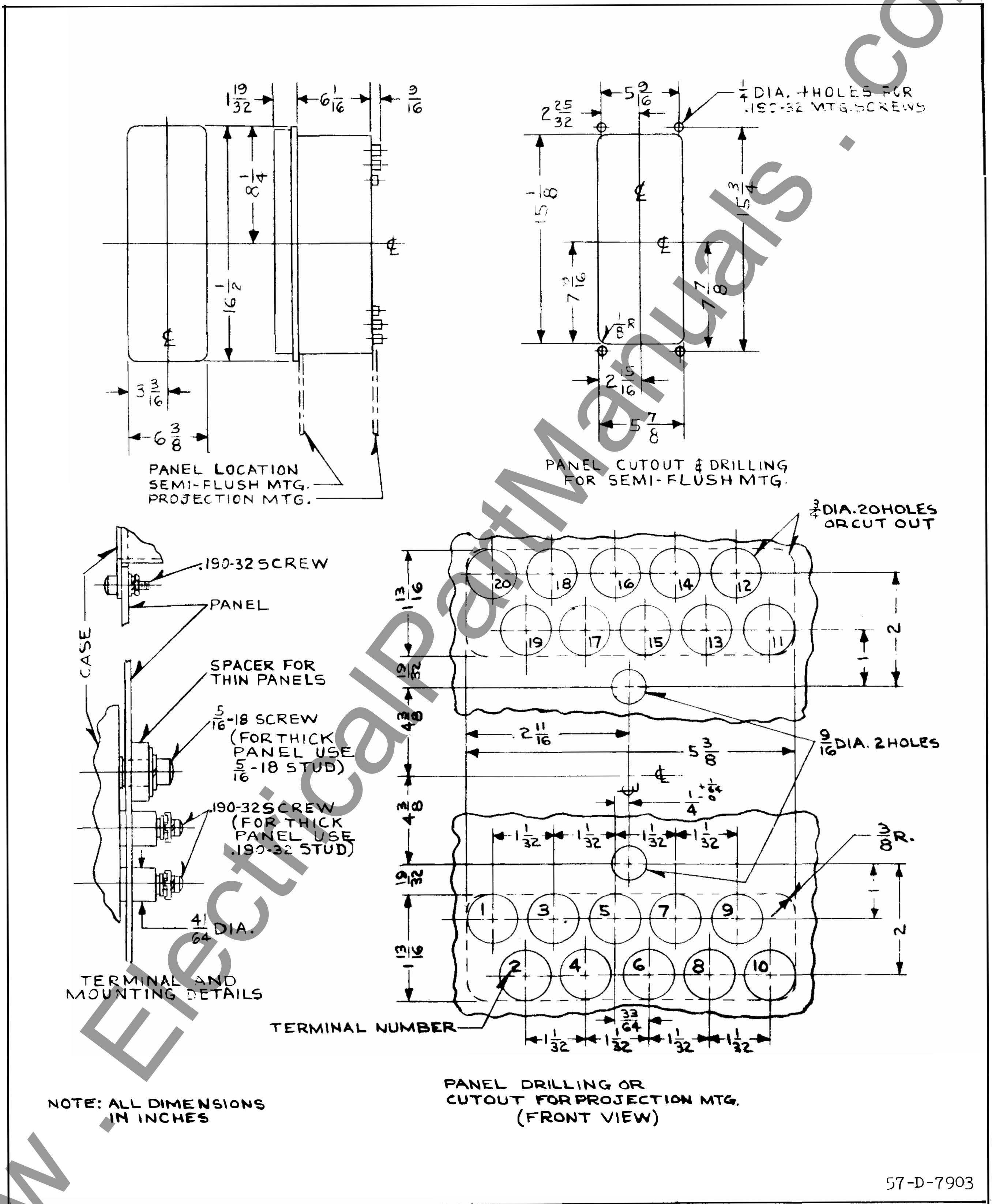


Fig. 5. Outline and Drilling Plan for the type KA Relay in the type FT 32 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY DEPARTMENT **NEWARK, N. J.**

Printed in U. S. A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KA-4 CARRIER AUXILIARY RELAY

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

APPLICATION

The type KA-4 relay is an auxiliary relay used in the distance carrier relaying scheme to block or prevent instantaneous tripping for faults external to the line section to which it is applied, and to permit instantaneous simultaneous tripping for internal faults. The relay is arranged to respond to indications of fault power and direction provided by the phase and ground relays, thereby controlling the transmission of the carrier signals.

CONSTRUCTION AND OPERATION

The Type KA-4 relay consists of directional auxiliary units, receiver and alarm units, phase fault carrier operation indicator and carrier squelch relay. In addition, the type KA-4 relay contains a high speed overcurrent unit used to start carrier transmission for ground faults. The construction and operation of the relay units are described below. Complete details of the operation of this relay in the distance carrier relaying scheme is described in I.L. 41-911.

Overcurrent Unit

The overcurrent unit is a product induction cylinder type unit. The time phase relationship of the two air gap fluxes necessary for the development of torque is achieved by means of a capacitor connected in series with one pair of pole windings.

Mechanically, the overcurrent unit is composed of three basic components: a die-cast alumium frame and electromagnet, a moving element assembly, and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a spring and snap ring. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing, which is threaded into the bridge. The electromagnet is permanently secured to the frame and cannot be separated from the frame.

The moving element assembly consists of a spiral spring, contact carrying member, and an alumium cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearing, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.

With the contacts closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

When the current in the overcurrent unit exceeds the pick-up value the contacts open, allowing positive potential to be applied to the carrier transmitter.

SUPERSEDES I.L. 41-923.4B
*Denotes changes from superseded issue.

EFFECTIVE NOVEMBER 1965

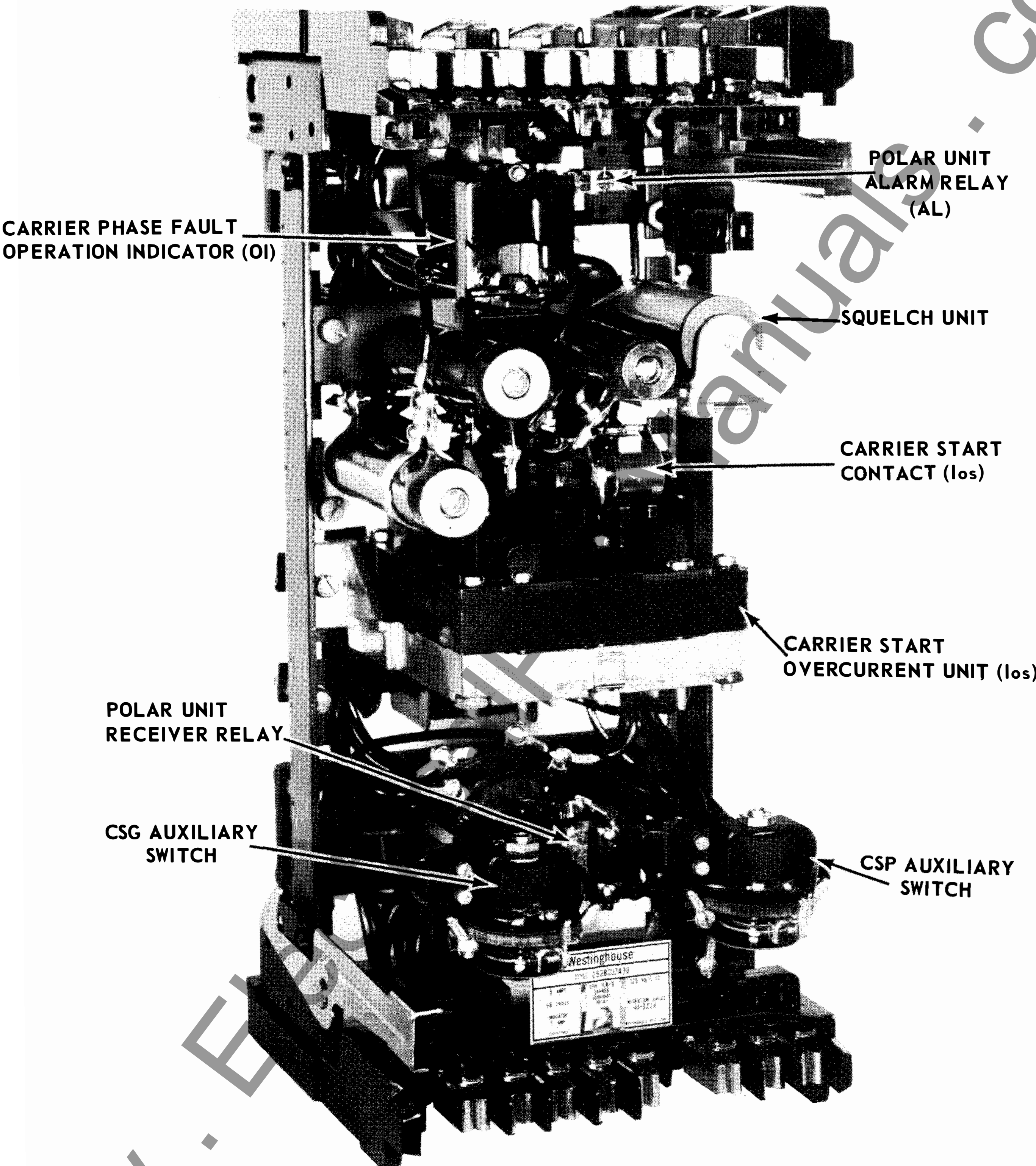


Fig. 1 Type KA-4 Relay Without Case. (Front View)

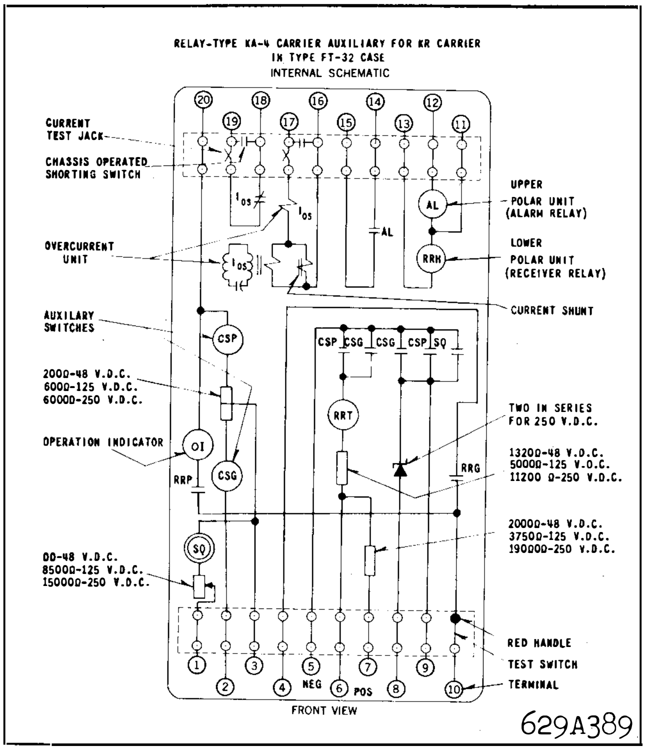


Fig. 2 Internal Schematic of the Type KA-4 Relay for KR carrier set.

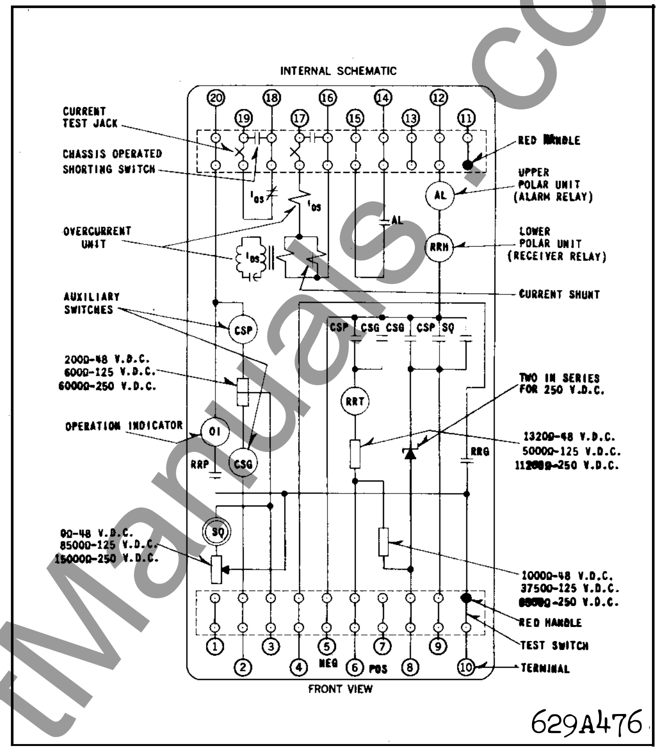


Fig. 3 Internal Schematic of the Type KA-4 Relay for TC carrier set.

A transformer and current limiting reactor is used in conjunction with the overcurrent unit. The transformer and reactor are of the saturating type and limit energy to the overcurrent unit and reduce the burden on the operating CT. This transformer supplies one set of coils on the electromagnet with voltage shifted by approximatly 90° from the residual current supplied directly to another set of coils.

Directional Auxiliary Units

These are two solenoid-type contactor switches designated as CSP and CSG. The plunger of the contactor switch has a circular conducting disc mounted on its lower end and as the plunger travels upward, the disc bridges three silver stationary contacts. The CSP switch is energized by the operation * of the second zone unit of the KD-4 distance relay, and the CSG switch, by the operation of the directional and overcurrent units of the ground relay. The contacts of the two switches are connected in parallel as shown in the internal schematic. The operation of either of these switches connects the carrier control circuit to negative to stop carrier, and energizes the RRT operating coil of the receiver relay unit.

Receiver Unit

The polarized relay consists of an armature and contacts mounted on a leaf spring supported symmetrically within a magnet frame. The armature rides in the front air gap of the frame with the contacts projecting outside. The poles of a permanent magnet clamp directly to each side of the frame. Two adjustable shunts are located across the rear air gaps. These change the reluctance of the magnetic path as shown in Fig. 5 so as to force some of the flux thru the moving armature which is fastened to the frame midway between the two rear air gaps. Flux in the armature polarizes it and creates a magnetic bias, causing it to move towards either the left or right, depending upon the adjustment.

Two stationary contact screws are mounted to the left (front view) of the moving contact assembly and adjusted for normally open contacts. These contacts are designated, RRP and RRG, and are connected in the phase and ground trip circuit respectively. These contacts are operated by two concentric coils, RRT and RRH, which are placed around the armature and within the magnetic frame. RRT is the operating coil and receives its energy from the local battery

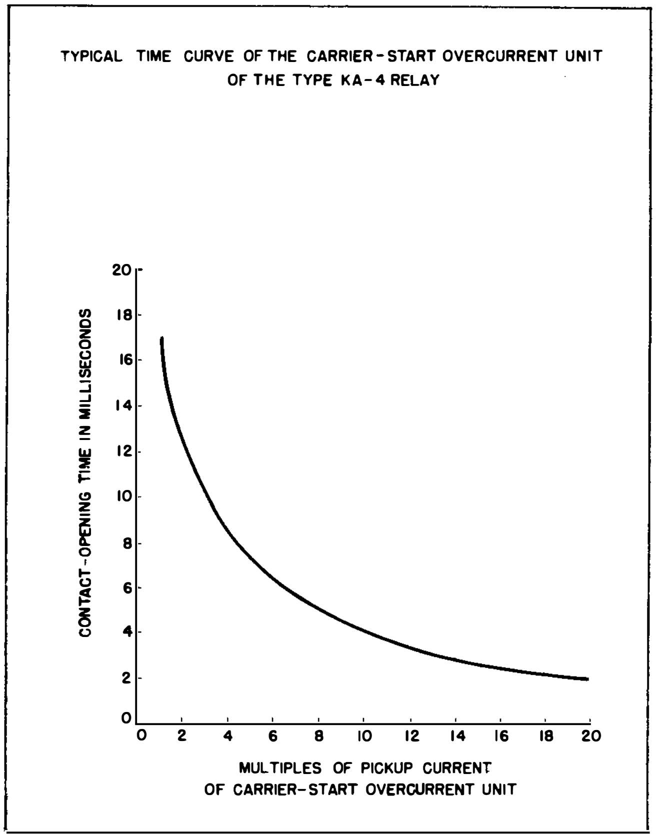


Fig. 4 Typical Time Characteristics of carrier start overcurrent unit of the type KA-4 Relay.

when either CSP or CSG is closed. RRH is the holding coil and receives its energy from the carrier transmitted either from the local transmitter or the one at the end of the line section. These two coils are connected to oppose each other with the operating coil, RRT operating to close the RRP and RRG contacts and trip; and the holding coil, RRH to hold the RRP and RRG contacts open and block tripping. The restraining torque of the RRH coil is sufficient to overcome the operating torque of the RRT coil. Consequently, RRP and RRG contacts cannot close as long as RRH is energized.

Alarm Unit

The alarm element is similar in construction to the receiver element except that it is energized by a single coil and operates a single set of contacts. The coil is energized by the received carrier to close the contacts and give an alarm. This element has a higher-pick-up than that of the receiver element in order to obtain a direct check on the sensitivity of the carrier transmitter-receiver. The failure of the alarm relay to pick-up when carrier is started indicates insufficient output from the transmitter receivers.

Squelch Unit

The function of the squelch unit is to hold off the carrier for a period of 150 milliseconds after the Breaker "a" contact opens. This is to insure that all other terminals of the line are tripped before allowing carrier to be transmitted for any functions.

The squelch unit is a telephone type unit of slow release type.

In these relays, an electromagnet attracts a
* right angle iron bracket which in turn operates one normally open contact. The slow release is obtained by a copper slug located at the end opposite from the armature. When the coil becomes de-energized, the change in flux through the slug results in an electromotive force and associated current in it. This current produces a flux which aids the main flux and delays the release of the armature when the coil is energized, the operation of the relay is not appreciably delayed because the armature is operated by flux not linking the slug.

Operation Indicator

The operation indicator gives a visual indication of a carrier tripping operation for phase faults by the distance relay through the RRP contacts. For a ground fault carrier relaying operation, the indicating contactor switch (ICS) located in the ground relay will drop a target.

CHARACTERISTICS

The characteristics of the various elements of the relays are as follows:

For Use With KR-Set	48V Avg. Ohms	125 Avg. Ohms	250 Avg. Ohms
CSP or CSG Coil	27	27	435
CSP & CSG Tapped Resistor	200	200	6000
Carrier Resistor	2000	3750	19000
RRT Operating Coil	1100	1100	1100
RRT Coil Resistor	1320	5000	11200
RRH Holding Coil	1700	1700	1700
AL Alarm Coil	500	500	500
Operation Indicator (1 amp.)	0.1	0.1	0.1
Squelch Unit Coil	3300	3300	3300
* Squelch Unit Adj. Resistor	—	8500	15000

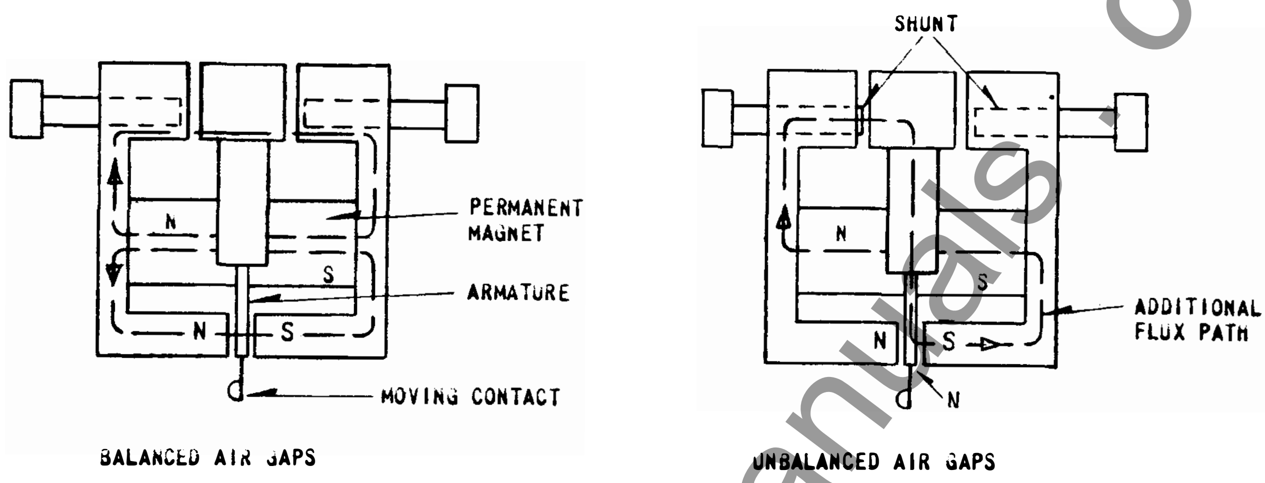


Fig. 5 Polar Unit Permanent Magnet Flux Paths.

For Use With TC-Set

CSP or CSG Coil	27	27	435
CSP & CSG Tapped Resistor	200	600	6000
Carrier Resistor	1000	3750	–
RRT Operating Coil	1100	1100	1100
RRT Coil Resistor	1320	5000	11200
RRH Holding Coil	20	20	20
AL-Alarm Coil	4	4	4
Operation Indicator (1 amp.)	0.1	0.1	0.1
Squelch Unit Coil	3300	3300	3300
* Squelch Unit Adj. Resistor	–	8500	15000

The pick-up and operating values of these units are given under "Adjustments and Maintenance".

The time characteristic of the overcurrent unit is shown in Fig. 4.

The pick-up value of the over-current unit can be changed from the factory adjusted value of 0.5 amperes to any value up to 1 amp. by increasing spring restraint.

SETTINGS

There are no settings to be made.

INSTALLATION

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

The carrier relaying schematic (supplied with the carrier order) should be consulted for details of the external connections of these relays.

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Check

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

Overcurrent Unit

Pass 0.5 amperes of alternated current through relay terminals the contact should pick-up within .475 and .525 amp.

Directional Auxiliary Units (CSP and CSG).

Each contactor switch has a section of a tapped resistor in series with it, and will pick up positively when rated control voltage is applied across the coil and its section of the resistor.

These units should operate at 24 volts for the 48-volt relay, 60 volts for the 125-volt relay, and 120 volts for 250-volt relay. These units have an intermittent rating, and should not be energized for more than a few seconds.

Operation Indicator (OI)

With the polar unit contacts closed, apply direct current to the operation indicator relay terminals. The operation indicator should pick-up and drop the indicator target between 1 ampere and 1.2 amperes d-c.

Squelch Unit (SQ)

Apply rated D.C. voltage to relay terminals that will energize the squelch unit and note contact operation.

Blocking Zener Diode

Apply rated D.C. voltage in series with 10,000 ohms resistors across terminals 8 and 9 with positive on 9, the current leakage flow should not exceed .25 ma. Reverse polarity of the applied voltage; the current flow should be equal to the applied voltage divided by the series resistance.

FOR RELAYS TO BE USED WITH TC-TYPE CARRIER

Polar Unit (Receiver Relay)

Connect a jumper between the middle and left hand contact connection of the CSG or CSP switch. The CSG switch is located on the left-hand pedestal and CSP is located on the right-hand pedestal on the relay (front view). Apply rated voltage across the RRT coil and the RRT coil resistor, observing polarity as shown in the internal schematic. The armature should move to the left.

To the holding coil (RRH) relay terminals, apply direct current observing correct polarity. Increase the current until the armature moves to the right.

The armature should move to the right at approximately 60 ma. Now reduce the current and the armature should move to the left at approximately 40 ma.

Alarm Unit (AL)

Connect direct current to the alarm unit relay terminals. Increase the current until the contacts pick-up. The contacts should pick up at approximately 80 ma. Now reduce the current and the contacts should open at 40 to 60 ma.

FOR RELAYS TO BE USED WITH TYPE KR CARRIERS

Polar Unit (Receiver Relay)

Connect a jumper between the middle and left hand contact connection of the CSG or CSP switch. The CSG switch is located on the left-hand pedestal and CSP is located on the right-hand pedestal on the relay (front view). Apply rated voltage across the RRT coil and the RRT coil resistor, observing polarity as shown in the internal schematic. The armature should move to the left.

To the holding coil (RRH) relay terminals, apply direct current observing correct polarity. Increase the current until the armature moves to the right. The armature should move to the right at approximately 6 ma. Now reduce the current and the armature should move to the left at approximately 4 ma.

Alarm Unit (AL)

Connect direct current to the alarm unit relay terminals. Increase the current until the contacts pick up. The contacts should pick up at approximately 8 ma. Now reduce the current and the contacts should open at 4 to 6 ma.

ROUTINE MAINTENANCE

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

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

CALIBRATION

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

Overcurrent Unit

The upper bearing screw should be screwed down until there is approximately 1/64" clearance between it and the top of the shaft bearing. Securely lock in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

With the moving contact in the normally closed position, i.e., against the right side of the bridge, screw in the stationary contact until both contacts just close. Then screw in the stationary contact approximately one-quarter turn farther to provide the correct amount of follow.

The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

Pass 0.5 amp. of a.c. through relay terminals.

The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver or similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

Adjust the spring until the contact just open. In a similar manner the pick-up value can be adjusted for any value between .5 – 1.0 amp.

Directional Auxiliary Units (CSP and CSG)

The two contactor switches, CSP and CSG, have adjustable plunger travel. Adjust the stationary core and the moving core of 1/64" when the switch is picked up. This can be done by turning the relay upside-down and screwing up the core screw of the switch until the contacts just separate. Then back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for approximately 1/32" by means of the two small nuts on either side of the Micarta disc.

Each contactor switch has a section of a tapped resistor in series with it, and will pick up positively when rated trip circuit voltage is applied across the coil and its section of the resistor.

The units should operate at 24 volts for the 48-volt relay, 60 volts for the 125-volt relay and 120 volts for 250-volt relay. These units have an intermittent rating, and should not be energized for more than a few seconds.

Squelch Unit

Check operation with timer. Adjust series resistor to measure approximately 5000 ohms for 125 v.d.c. relays and for 13000 ohms for 250 v.d.c. relay. With armature closed adjust the residual air gap to be .002" – .003". Contact gap should measure from .020" to .035". Check for dropout time between .140–.160 seconds. If necessary dropout time can be adjusted by changing the residual air gap. After final adjustment the gap should be at least .002". The pick up time should be below 16 milliseconds at –20% rated D.C. voltage. If necessary readjust series resistor.

Operation Indicator

The operation indicator should pick up and drop the indicator target when the current is between 1 and 1.2 amperes d-c.

Make sure that the target drops freely when the unit operates.

ZENER DIODE TEST

Forward Characteristics

Pass 200 milliamperes of d.c. current through terminals 8 and 9 with positive on terminal 8. Measure voltage drop across terminals 8 and 9. The voltage drop should not exceed 3.5 volts.

Reverse Characteristics – Breakdown Voltage

The breakdown voltage is determined by increasing voltage across terminals 8 and 9 with positive on 9. Place 10,000 ohm resistor in series with amp. meter. Increase voltage until current reads .25 milliamperes. Measure d.c. voltage across terminals 8 and 9. The voltage should be between 160 and 240 volts for 48 and 125 v.d.c. * rated relays; and 320 to 480 volts for 250 v.d.c. rated relays. Do not exceed 3.0 ma. current in the circuit.

FOR RELAY TO BE USED WITH TC-TYPE CARRIER

Polar Receiver Unit

Back off contact screws so that they do not make contact. Screw magnetic shunts into the all-out position (5 or 6 screw threads showing.) The armature should remain against whichever side it is pushed with this adjustment.

Adjust the stationary contacts for a contact gap of approximately .020''. This perhaps can best be done by inserting a .010'' steel thickness gage between the large rivet head on the moving armature and the right hand pole face (a .010'' travel of the rivet head is equal to .020'' travel of the moving contacts). Using an indicating light in each contact circuit, adjust the upper and lower stationary contacts to touch the moving contact at the same time. With the feeler gauge removed the contact gap is .020'' and the moving contacts close simultaneously.

Connect a jumper between the middle and left hand contact connection of the CSG or CSP switch. The CSG switch is located on the left-hand pedestal and CSP is located on the right hand pedestal of the relay (front view). Apply rated voltage across the RRT coil and the RRT coil resistor observing polarity as shown in the internal schematic diagram. The armature should move to the left.

To the holding coil, RRH, apply 100 to 200 milliamperes d.c. current observing correct polarity. The armature should now move to the right. De-energize both coils and see that the armature stays up against the right hand side.

Run both shunt screws all the way in, and then back out the left hand shunt screw approximately 6 turns. Back out the right hand shunt screw approximately 9 turns.

Re-energize the operating coil with rated voltage and the holding coil with 40 milliamperes d.c. Adjust the right hand shunt screw until the armature moves to the left. If the armature moves to the left, at a value of holding coil current greater than 40 milliamperes, the right hand shunt screw should be turned out to lower this value to the correct 40 milliampere point.

Increase the holding coil current to 60 milliamperes and adjust the left hand shunt screw until the armature resets, or moves to the right. If the armature resets at a value of current less than 60 milliamperes, the left hand shunt screw should be turned out. This will increase the reset value of the armature and provide for the correct 60 milliampere reset value.

Minor adjustments of both shunt screw must be made several times until the desired operating points are obtained, since the adjustments of one shunt screw affect the adjustment on the other shunt screw.

Polar Alarm Unit

The contacts should close with 80 milliamperes d-c ± 5% applied to the alarm coil. Adjust the contact screws to obtain an .050'' contact gap such that the armature motion between the left and right hand contacts is in the central part of the air gap between the pole faces. Tighten the contact locking nuts. Approximate adjustments of the two magnetic shunt screws are as follows:

Turn both shunt screws all the way in. Then back out both shunt screws approximately seven turns. Apply 80 milliamperes d.c. to the coil observing correct polarity, and then screw in the left hand shunt screw until the armature moves to the right at a value of current less than 80 milliamperes, screw the left hand shunt out until the armature moves to the right at 80 milliamperes. Check the dropout point by reducing the d.c. current. The armature should move to the left between the limits of 40 and 60 milliamperes. If it fails to do so, adjust the right hand shunt screw until it does. It will then be necessary to recheck the pickup and dropout points again and make any minor adjustments to the shunt screws that may be necessary until correct calibration is obtained.

In general, screwing in the left hand shunt screw reduces the pickup current of the relay. Screwing in the right hand shunt screw increases the dropout current. This will in turn cause a change in the pickup current, making necessary several slight readjustments of both shunt screws to obtain the desired calibration. The armature as finally calibrated should pickup and dropout with a snappy action.

FOR RELAYS TO BE USED WITH KR-TYPE CARRIER

Polar Receiver Unit

Calibrate as outlined above except apply 15 ma. d-c current for polarity check. The pickup value should be 4 milliamperes d.c. (armature moves to left) instead of 40 ma. The reset calibration (armatures moves to the right) should be done at 6 milliamperes instead of 60 ma.

Alarm Unit

Calibrate as outlined above. Except check pick-up at 8 milliamperes ±5% instead of 80 ma. Dropout should be between 4 and 6 ma. instead of 40 and 60 ma.

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.

ENERGY REQUIREMENTS

Current Burden at 60 Cycles.

*

CURRENT AMPERES	VOLT-AMPERES	POWER FACTOR ANGLE
0.5	2.2	33° †
5	43	70° †
20	394	49° ††
40	1240	39.2° ††
60	2760	32.5° ††

† Current lagging voltage
†† Current leading voltage

Rating of Overcurrent Unit

Continuous rating 5 amperes. One second rating 100 amps.

WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE SKAU-3 CHANNEL AUXILIARY BLOCKING RELAY

CAUTION: It is recommended that the user of this equipment become acquainted with the information in these instructions and the systems Instruction Leaflet 40-203.2 before energizing this relay. Failure to observe this precaution may result in damage to the equipment. Before putting the relay into service, operate the relay to check the electrical connections.

Do not remove or insert printed circuit boards while the SKAU-3 relay is energized. This may result in breaker tripping or component damage.

APPLICATION

The type SKAU-3 relay is a solid state directional comparison blocking auxiliary relay for use with on-off type TC carrier or a tone channel. This relay will prevent tripping for faults external to the protected line section to which it is applied, and permit high speed simultaneous tripping for internal faults. The SKAU-3 relay will respond to inputs indicative of fault direction, distance and power thereby controlling the transmission of a blocking signal for an external fault or high speed tripping for an internal fault.

The SKAU-3 may be applied to two or multi-terminal lines. A weak feed option permits the SKAU-3 to be used at terminals that fail to deliver a meaningful amount of fault current. Another option, checkback, permits a single station check of all SKAU-3 terminals and channels.

CONSTRUCTION

The SKAU-3 relay is mounted on a 19 inch wide panel 5¼ inches high (3 rack units) with edge slots for mounting on a standard relay rack or panel. For the outline dimensions of the relay refer to Fig. 29.

A hinged and removable door on the front of the chassis covers the printed circuit boards. The photograph in Fig. 1 shows the front view of the relay with the door open. A sealing post at the top center in front may be used to lock and seal the relay when in service.

The rear panel consists of a hinged door which may be opened to expose the relay harness wiring and the four (4) power supply resistors.

All of the circuitry suitable for mounting on printed circuit boards are contained in an enclosure behind the front door. The printed circuit boards slide into position in slotted guides at the top and bottom of the enclosure, and engage a terminal block at the rear of the compartment. Each board and terminal block are keyed so that they cannot be accidentally inserted into the wrong slot location. A handle mounted on the front end of the board is used for identification and for removing and inserting the circuit. In addition the handles also serve as a bumper with the front door to prevent the board from becoming disconnected from its terminal block. The boards may be removed for replacement purposes or for use in conjunction with printed circuit board extender (Style No. 849A534G01) which permits access to the boards test points and terminals for making measurements while the relay is energized.

The SKAU-3 relay contains eight (8) printed circuit boards for the basic system, two (2) more with the checkback option, and two (2) more with the weak feed option. The location and title of the printed circuit boards are shown on the relay component location drawing, Fig. 2.

Printed Circuit Boards

Following is a description of all the printed circuit boards used in the SKAU-3 relay. Refer to the functional relay logic shown in Fig. 3 and 4. The internal schematics associated with the printed circuit boards contain a detailed NOR logic diagram to simplify understanding of the transistor circuits.

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-923.9A, dated April 1974
✪Denotes change from superseded issue.

EFFECTIVE JUNE 1977

For those users not generally acquainted with logic circuit notation or with device symbols of those components used in the SKAU-3 drawings, it is recommended that a copy of Westinghouse instruction leaflet I.L. 41-000.1 entitled "Symbols for Solid State Protective Relaying" be consulted.

A. Power Supply Board

The Power Supply (PWR SUPPLY) board located in slot A contains two 20 volt transistor regulators: These voltage regulators will operate from a nominal battery supply of 48 to 125 V.D.C. by varing resistors RA, RB, RC and RD mounted in the rear of the chassis.

Location of components on this board is shown in Fig. 5 and the internal schematic in Fig. 6.

B. Protective Relay Interface Board

The Protective Relay Interface (P.R. Intr) board located in slot B contains the buffered interface logic for the phase, ground, and overcurrent supervising tripping protective relays.

Two front mounted adjustable timers, 2-20/0 milliseconds, are used for independently delaying the output of the phase or ground relays in order to provide coordination with the remote line terminal. The AND's block an output at T1 and T2, the two red front mounted terminals, for a non trip condition.

Location of components on this board is shown in Fig. 7, and the internal schematic in Fig. 8.

C. Loss of ac Potential Board

The loss of ac Potential (Loss of Pot.) board located in slot C contains a 500/500 millisecond time delay and a buffered input and output. If an input to this timer is obtained, as for an ac potential fuse failure, then 500 milliseconds later a voltage output will be present.

A link on this board may be removed to prevent block of trip due to an output from this timer.

Location of components on this board is shown in Fig. 9, and the internal schematic in Fig. 10.

D. Weak Feed Logic 1 Board

The weak feed logic 1 (W.F. Logic 1) board located in slot D contains logic and timing, and is used only for those SKAU-3 relays with the weak feed option. The primary purpose of the logic here is to determine if a weak feed trip is required, or if it is to be blocked.

Three buffered inputs for the voltage relays and 21S are included on this board. This is accomplished with the three input AND whose output is at TP4 of The Weak Feed board. A 10/0 millisecond timer is associated with a 21S memory circuit for external bolted three phase faults.

Location of components on this board is shown in Fig. 11, and the internal schematic in Fig. 12.

E. Weak Feed Logic 2 Board

The Weak Feed Logic 2 (W.F. Logic 2) board located in slot E contains logic and timing, and is used only for those SKAU-3 relays with the weak feed option.

One buffered input for 52b, two timers, and logic are included on this board. The primary purpose of this board is to block a trip output at the weak feed terminal when bus potentials are used and the supply breaker is open and 27 is operated, and to block tripping at remote terminals when energizing a faulted bus. The 0/50 millisecond timer allows sufficient time for the 27 to reset and the 6/150 millisecond timers provide the necessary carrier transmission delays.

Location of components on this board is shown in Fig. 13, and the internal schematic in Fig. 14.

F. Receiver Interface Board

The Receiver Interface (RCVR INTR) board located in slot F contains the buffered channel interface inputs, buffered channel output, and appropriate AND and OR logic for initiation of transient blocking.

Location of components on this board is shown in Fig. 15, and the internal schematic in Fig. 16.

G. Transmitter Stop Control Board

The Transmitter Stop Control (XMTR STOP) board located in slot G contains buffered inputs and an output, logic, and timing to stop transmitter keying.

Buffered inputs for a high set overcurrent unit, a spare input and a ground relay, and a buffered output for transmitter stop are included on this board. A 1.5/150 millisecond timer is used to squelch transmitter start for 150 milliseconds after a 50 (I_H) unit reset or a pilot trip signal is removed.

Location of components on this board is shown in Fig. 17, and the internal schematic in Fig. 18.

H. Transmitter Start Control Board

The Transmitter Start Control (XMTR START) board located in slot H contains buffered inputs and an output, logic, and timing to start transmitter keying.

Buffered inputs for an overcurrent unit 50 (Ios), carrier start unit 21S and a test switch for checkback, and a buffered output for transmitter start are included on this board. A 10/10 millisecond timer is used to continue transmitter keying for 10 milliseconds to provide blocking while relays reset at the clearing of an external fault.

Location of components on this board is shown in Fig. 17, and the internal schematic in Fig. 18.

I. Checkback - Board

The checkback-1 board located in slot I contains logic and timing, and is used only for those SKAU-3 relays with the checkback option.

One buffered input for a test switch, a flip flop for locking out a station after it checksback, and various control logic are included on this board. The 2000/10 millisecond timer is used to delay committment to a checkback for transmissions up to 2 seconds. After completion of checkback, the 15 sec./25 timer will reset the flip flop.

Location of components on this board is shown in Fig. 19, and the internal schematic in Fig. 20.

J. Checkback 2 Board

The Checkback 2 (CK BK-2) board located in slot J contains a front adjustable 5 to 10 second timer which is the check-in time of the checkback scheme. Output of this timer starts transmitter keying. The transmitter will remain keyed for approximately 2.5 seconds after an input to the timer is lost.

Location of components on this board is shown in Fig. 21, and the internal schematic in Fig. 22.

K. Block/Unblock Control Board

The Block/Unblock Control (BLK/UNBLK) board contains logic and timers for the control of the transient blocking and unblocking 18/18 timer on the TRIP OUTPUT board. In addition, an input buffer, AND, and OR are included on this board as part of the checkback scheme.

The transient block and unblock control logic has two timers: a 0/2 millisecond timer to continue transient block timing for a momentary loss of input, and a 0/1000 millisecond timer to hold transient blocking in effect during adjacent line high speed reclosing.

Location of components on this board is shown in Fig. 23, and the internal schematic in Fig. 24.

L. Trip Output Board

The TRIP OUTPUT board located in slot L contains the final tripping logic and timing of the relay. This board utilizes the intelligence supplied by the P.R. INTR. board for tripping or the BLK/UNBLK board for either transient blocking or unblocking. A buffered pilot trip output is included on this board.

Two timers are used on this board: a 4/0 millisecond timer for delaying the pilot trip output, and a 18/18 millisecond timer for transient blocking/unblocking.

Location of components on this board is shown in Fig. 25, and the internal schematic in Fig. 26.

OPERATION

The type SKAU-3 relay is used in a directional comparison blocking relay system for power line protection. High speed tripping is obtained for two or multiterminal applications for faults anywhere on the protected line.

System Operation

In a directional comparison blocking system, tripping occurs when the local phase or ground distance relays operate and no blocking signal is received from the remote end. Normally the communication equipment is off and is only transmitted as a blocking signal for an external fault.

Optional SKAU-3 logic is available for a functional test channel checkback scheme and for weak feed terminal relaying.

Refer to system I.L. 40-203.2 on the directional comparison system for further system operation.

Relay Operation

Refer to the logic diagrams shown in Fig. 3 and 4 to understand the operation of the SKAU-3 relay.

1. Normal Condition

The logic voltage "0" and "1" states shown in Fig. 3 or Fig. 4 for the weak feed system refer to the normal operating condition of the SKAU-3 relay.

2. Internal Fault

For an internal fault either the ground protective relay (21NP or 67N) or the phase protective relay (21P) and the 50(Ia/Ic) overcurrent unit will operate and start timing either one or both of the 2-20/0 ms timers on the Protective Relay Interface Board. After a time delay as set on the 2-20/0 timers, a logic "1" signal will be obtained at T1 or T2. This logic "1" will start timing the 4/0 ms timer on the Trip Output board and in four (4) milliseconds a logic "1" pilot trip signal will be obtained. With a pilot trip signal, the 18/18 ms transient blocking timer is stopped, and an input is applied to the XMTR STOP CONTROL board to insure that there is no keying.

3. External Fault - Reverse

For a reverse external fault, the reverse reaching relays 21S or the overcurrent relay 50(Ios) will operate to start keying the local transmitter. This keyed signal will be received at the remote end causing it to block.

At the local terminal, the transmitter start output will satisfy the lower two (2) input AND on the RECEIVER INTERFACE board, thereby causing a logic "1" at TP8. This signal will satisfy the three (3) input OR on the block/unblock control board causing a logic "1" at TP12, which, in turn, will pickup the 18/18 ms transient blocking timer on the TRIP OUTPUT board. This causes TP7 to become a logic "1" to both block the pilot trip output, and to pickup the 0/1000 ms timer on the block/unblock control board. Transient blocking is established to insure against any misoperation due to fault power flow reversals caused by unequal breaker reclosing times on parallel lines.

The 1000 millisecond reset time of the 0/1000 ms timer holds transient blocking intact to prevent misoperation during adjacent line high speed sequential reclosing.

The 0/2 timer on the block/unblock control board prevents loss of transient block timing if the signal at TP8 (Receiver Interface Board) is momentarily (less than 2 milliseconds) lost.

4. External Fault - Forward

For a forward external fault, the overreaching tripping relays which saw the internal fault may see the external fault. If they do see the fault then the remote reverse reaching relays 21S or 50(Ios) will see the fault since they reach farther than the tripping relays. This causes the remote transmitter to key, which is locally received as a logic "1" signal at the CH. BLOCK input. This signal causes a "1" at TP4 of the RECEIVER INTERFACE board, which will block both AND's on the PROTECTIVE RELAY INTERFACE BOARD. Therefore no output will occur at T1 or T2, and thus no pilot trip output will appear.

If the forward reach tripping relay sees the external fault, then a transmitter stop signal together with the CH. BLOCK signal will satisfy the upper AND on the RECEIVER INTERFACE board to initiate transient blocking as for the reverse external fault.

5. Sequential Fault

Occasionally an external fault will be followed by an internal fault before the former is cleared. In order to prevent a long delay in clearing a sequential fault, 18 millisecond transient unblocking time is provided. Although transient blocking has been initiated by the external fault, the presence of an internal fault will stop signal transmission at the remote end to remove the CH. BLOCK input at the local terminals. This will stop blocking the two (2) AND's on the PROTECTIVE RELAY INTERFACE board allowing an output at T1 or T2 for an internal fault. This output will pickup the 4/0 ms timer on the TRIP OUTPUT board but will not cause tripping as it is blocked by transient blocking. However, the output from T1 and T2 is also connected to the negative input of the two (2) input AND following the 0/1000 ms timer on the BLOCK/UNBLOCK OUTPUT BOARD. This blocks output from the AND, even though the 1000 milliseconds timer is still dropping out.

The three (3) input OR will no longer be satisfied since transient blocking initiation from the RECEIVER INTERFACE board has stopped for an internal fault, thereby allowing the 18/18 ms timer to dropout, removing blocking and allowing pilot tripping.

6. Channel Transmitter Control

Two separate transmitter control buffered outputs are provided: one for transmitter start, the other for transmitter stop, Within the transmitter, stop must have priority over start.

Transmitter start is controlled by the reverse reaching relays 21S or 50(Ios), in order to send a signal to the remote terminal indicating an external fault. The 10/10 ms timer on the XMTR START CONTROL board is used to continue blocking for relay reset coordination to take care of any condition where transient blocking had not had a chance to set up. Transmitter start will initiate transient block timing through the lower AND on the RECEIVER INTERFACE board, provided there is no transmitter stop signal. There is also provision on the XMTR START CONTROL board for starting the transmitter with either a test switch test (CBI) or with the output of the checkback circuit. The transmitter is stopped for an internal fault condition. Operation of a phase (21P), ground (21NP or 67N (Z × Ios)) or high set overcurrent 50(I_H) unit will stop keying. The 21NP/67N unit is supervised externally by Ios to stop keying and prevent Ios block of trip for a low current internal fault. When a pilot trip occurs, its output will hold keying stopped, and after both the pilot trip and 50(I_H) signals are removed, keying will remain squelched for another 150 milliseconds. This squelched signal is provided by the dropout of the 1.5/150 ms timer on the XMTR STOP CONTROL board in order to prevent a block of tripping being set up. A SPARE input is provided and OR'ed with the 50 (I_H) input.

In addition to stopping transmission, a XMTR stop signal will prevent XMTR start from initating transient block timing, but permits transient block timing, for an external fault where a CH. BLOCK signal would be received. This is accomplished by the upper and lower AND's respectively on the RECEIVER INTERFACE board.

7. Loss of ac Potential

Since tripping of circuit breakers is undesirable for loss of ac potential as for fuse failure, the SKAU-3 relay provides a voltage output and optional block of tripping for this situation. This is accomplished by the 500/500 ms. timer on the LOSS OF ac POTENTIAL board. In 500 milliseconds after a loss of potential input, a logic "1" signal will be produced at TP4 on this board. A buffered "1" output will be obtained at the J1 connector. A LINK in the LOSS OF ac POTENTIAL board, when in, allows this logic "1" signal to block the two AND'S on the PROTECTIVE RELAY INTERFACE board through a two (2) input OR on the RECEIVER INTERFACE board, thereby blocking trip. When the loss of potential condition has cleared, the 500/500 ms timer will reset in 500 milliseconds to remove the block of trip.

8. Channel Checkback Scheme

(Information in this section pertains only to those SKAU-3 relays having the CHECKBACK option, and covers only that portion of the checkback test concerning the SKAU-3 relay.)

At the local terminal, the test (CBI) switch will be closed causing the local transmitter to be started through the 3 input OR of the XMTR START CONTROL board. The transmitted signal will be received at all terminals (local and remote) as a logic "1" at the CH. BLOCK input. This logic "1" will cause terminal 12 of the CHECKBACK-1 board of all the remote terminals to become a logic "1" satisfying the 2 input AND, except at the local terminal where the closing of TEST (CBI) switch caused TP9, of the CHECKBACK-1 board, to change from 1 to 0 blocking the AND. Therefore, at the remote terminals only, the 2000/10 ms timer will pickup in approximately 2 seconds satisfying the 2 input OR and one input of the AND following it, thereby committing the SKAU-3 to a checkback transmission.

Now, the test (CBI) switch is opened stopping signal transmission, and causing the CH BLOCK signal to change from "1" to "0" at all terminals. This removes the logic "1" from terminal 12 of CHECKBACK-1 board satisfying the negated input of the 2 input AND following the OR, and at the remote terminals only, the other input of this AND is satisfied while the 2000/10 ms timer is dropping out, thereby causing a logic "1" at TP5, which is fed back to the 2 input OR to hold this logic "1" until the negated input of the AND is changed to a logic "1". When TP5 becomes a logic "1", the 5-10 sec. adjustable timer in CHECKBACK-2 board starts timing, and after the set time will cause that remote transmitter to key to all terminals, and also set its flip flop to lock out this station. The transmitted signal at the remote terminal will also be received at the same terminal, and causing CH. BLOCK "0" to "1", and the negated input of the 2 input AND on CHECKBACK-1 board to become a "1", disabling the AND and causing TP5 to become a logic "0". This will dropout the 5-10 sec./2.5 sec. timer causing the signal to be transmitted for only 2.5 seconds.

For systems with more than one remote terminal, each terminal is set for a different check in time so that an operator at the local terminal can distinguish which terminal is operating. Operation for a multiterminal system is as follows. When the first remote terminal (the one with the lowest 5 to 10 sec. setting) started keying its checkback signal to the local terminal, this signal would also be received at the remainder of the remote terminals causing TP5 on CHECKBACK-1 board to change from "1" to "0". This will prevent the 5-10 sec. timer on CHECKBACK-2 board from timing any further. When the check in signal stops, after approx. 2.5 seconds as mentioned earlier, then the remote terminals not checked in will again be committed to checkback, and that remote terminal with the next lowest time will check in. (note that the output of the flip flop of the first remote terminal becomes zero, and removes logic "1" from the two input AND on the CHECKBACK-1 board, in which this terminal will not operate when the other remote terminals are transmitting a signal). This process will continue until all remote terminals have checked in, after which time the 15 sec. timer on CHECKBACK-1 board resets the flip flop.

To check that the relay is blocking properly with the blocking signal transmitted from the remote terminal, the TEST (For) switch on the functional test unit, where supplied, is closed. This will circulate test current in the tripping relays, simulate a $50(I_H)$ input to the SKAU-3 and satisfy one input of the 2 input AND connected to the buffer on the BLOCK/UNBLOCK CONTROL board. With the blocking signal being received, tripping will be blocked. The SKAU-3 will go into transient blocking and be held there by the TEST (FOR) switch and AND ckt. on the BLK/UNBLK board, preventing tripping following loss of the CH BLOCK signal after the 2.5 seconds of check-in stops.

9. Weak Feed Operation

(Information in this section applies only for those SKAU-3 relays having the Weak Feed option).

For those SKAU-3 relays for use at a weak feed terminal where fault current may not be adequate to operate the phase and ground distance relays, the logic in Fig. 4 applies.

Either the under or overvoltage, 27 or 59N, relay would operate for an internal fault causing a logic "1" at TP4 of Weak Feed Logic 1 board. This signal causes a logic "1" to appear at terminal 6 of the PROTECTIVE RELAY INTERFACE board, and after a time delay, causes a logic "1" at T2 to set up pilot trip.

For an external fault, the reverse reaching 21S relay will operate to start keying to the remote terminals to block. If either of the voltage relays 27 or 59N also operate for this fault, then no trip signal will be initiated as for an internal fault, since operation of 21S blocks the 3 input AND whose output is TP4 on WEAK FEED LOGIC 1 board.

A 21S memory circuit consisting of a three (3) input AND 10/0 ms timer, and OR is included on WEAK FEED LOGIC-1 board. When 21S operates, TP7 on WEAK FEED LOGIC-1 board becomes a logic "1", which is fed back to satisfy one input of the three (3) input, AND preceding the 10/0 ms timer. If 27 also operates, then the three (3) input AND will be satisfied and the 10/0 ms timer will pickup in 10 milliseconds, thereby holding TP7 as logic "1", even if 21S resets. This circuit is required to hold a sustained transmitter blocking signal for the remote terminal for an external bolted close in three phase fault, a condition where 21S may reset. The blocking signal will remain transmitted until either 27 resets, or the weak feed terminal breaker opens.

WEAK FEED LOGIC 2 board contains logic and timing for 52b control. When the weak feed breaker opens, 52b closes and picks up the 0/50 ms timer on WEAK FEED LOGIC 2 board causing a logic "1" at terminals 10 and 11. This logic "1" causes any 21S memory to reset, and also blocks the three (3) input voltage trip AND and TP4 on WEAK FEED LOGIC 1 board blocking an output on potential circuit deenergization.

The 0/50 ms and 6/150 ms timers provide coordination where bus potentials are used to supply the 27 and 59 relays. They block trip locally when closing into a sound bus and block trip remotely when closing into a bus fault. After closing in, the 52b input will drop from "1" to "0" and the 0/50 ms timer will start to drop out. If a fault exists, 27 will stay operated, and the AND on WEAK FEED LOGIC 2 board will be satisfied, then, in 6 milliseconds and for 150 milliseconds after the 50 millisecond dropout time, TP9 will change from "0" to "1" to key a blocking signal to the remote terminal to block trip. After 50 milliseconds the weak feed terminal will trip when closing into a 3 phase bus fault because the 21S SDU-1 will not operate with no voltage applied to it prior to the fault and will therefore be unable to block the undervoltage trip.

CHARACTERISTICS

Control Voltage:	48VDC (42 to 56 volts) or 125VDC (105 to 140 volts)
Current Drain:	without weakfeed or checkback options nominal = 70mA maximum =130mA either the weakfeed or checkback option adds 20 mA drain
Temperature Range:	−20°C to +55°C around chassis
Inputs:	
52b contact	48/125VDC control voltage buffered 48V - 1.5mA max. current 125V - 2.5mA max. current
All other inputs	15 to 20 VDC buffered 2mA max. current
Outputs:	15 to 20VDC buffered 10mA max. current
Time Delays:	
Protective Relay Intr Bd.	2 -20/0 timers pickup ±10% dropout - less than 1 ms
Loss of AC Potential Bd.	500/500 timer pickup 400 to 600 ms dropout 400 to 600 ms
XMTR Stop Control Bd.	1.5/150 timer pickup - 0 to 2 ms dropout - 120 to 180 ms
XMTR Start Control Bd.	10/10 timer pickup - 9 to 11 ms dropout - 10 to 16 ms
BLK/UNBLK Control Bd.	0/2 timer pickup - less than 1 ms dropout - 1.7 to 2.3 ms 0/1000 timer pickup - less than 2 ms dropout - 1000 to 1650 ms
Trip Output Bd.	4/0 timer pickup - 3.6 to 4.4 ms dropout - less than 1 ms 18/18 timer pickup - 16.2 to 19.8 ms dropout - 16.2 to 19.8 ms
Checkback 1 Bd.	2000/10 timer pickup - 1500 to 2250 ms dropout - 5 to 15 ms 15sec/25 timer pickup - 15 to 24 sec. dropout - 10 to 50 ms
Checkback 2 Bd.	5-10sec/2.5sec. timer pickup - ±10% dropout - 2.5 to 4 sec.
Weak Feed Logic 1 Bd.	10/0 timer pickup - 8 to 12 ms dropout - less than 1 ms
Weak Feed Logic 2 Bd.	0/50 timer pickup - less than 1 ms dropout - 50 to 80 ms 6/150 timer pickup 3.9 to 6 ms dropout - 150 to 240 ms
DIMENSIONS:	height - 5.25 in. (3 rack units) width - 19 in. depth - 14 in.
WEIGHT:	approximately 17 lbs.

SETTINGS

The two 2-20/0 millisecond adjustable timers on the PROTECTIVE RELAY INTERFACE board must be set for the proper system coordinating time. Refer to IL 40-203.2.

When the checkback option is used, the 5-10/2.5 second adjustable timer on the CHECKBACK 2 board must be set for the proper check in time.

A link on the LOSS OF AC POTENTIAL board can be removed if blocking of trip due to loss of ac potential is not desired.

Refer to the system instruction leaflet 40-203.2 for information pertaining to the proper timer settings. After making the timer setting, lock the knob by tightening the screw on the knob lock assembly.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. The maximum ambient temperature around the chassis must not exceed 55°C. Mount the relay be means of the four slotted holes on the front of the case. Additional support should be provided toward the rear of the relay in addition to the front panel mounting. This will protect against warping of the front panel due to the extended weight within the relay case. Ground relay chassis with No. 12 AWG copper wire to grounding post.

The outline of the SKAU-3 relay is shown in Fig. 29.

ADJUSTMENTS AND MAINTENANCE

Acceptance Check

It is recommended that an acceptance check be applied to the SKAU-3 relay to verify that the circuits are functioning properly. The following procedure can be used for this purpose.

Connect the SKAU-3 relay to the test circuit of Fig. 28. Apply rated dc to J1 terminals 3 and 4 as shown, and use an auxiliary 20 volt regulator or the internal 20 volts of the SKAU-3 relay for the inputs to the switches.

When reference is made to TP, this refers to the test points toward the front of the printed circuit board and slot location mentioned. T1 and T2 refer to the red terminals at the front of the Protective Relay Interface board.

All voltages are to be measured with respect to negative, TP3 (Pwr. supply Bd.-A), and may vary by ±10%. Time delays shown may vary by ±20% except as otherwise described under "Characteristics". Fig. 27 shows location of the test points as well as voltage values for the "0" and "1" logic states.

A. Internal Fault -

Pilot trip operation - 4/0 timer trip output Bd.

Xmtr - stop control - 1.5/150 timer XMTR Stop Bd.

2-20/0 T1 and T2 timer - P.R. INTR. Bd.

1. Close 21NP(I_0) Switch
   T1: Voltage rise from 0 to 13 volts after a time delay (2-20MS) depending on the T1 timer setting.

   TP10 (Trip Output Bd.-L): Voltage rise from 0 to 20 volts 4 milliseconds after the voltage at T1 rises.

   TP4 (XMTR STOP Bd.-G): Voltage rise from 0 to 20 volts the same time TP10 changes.

2. Open 21NP(I_0) Switch
   T1: Voltage drop from 13 to zero volts.

   TP10 (Trip Output Bd.-L): Voltage drop from 20 to zero volts.

   TP4 (XMTR STOP Bd.-G): Voltage drop from 20 to 0 in 150 milliseconds.

3. Close 21P Switch
   T2: Voltage must remain zero.

   TP4 (XMTR STOP Bd.-G): Voltage rise from 0 to 20 volts.

4. Open 21P Switch, then close 50 (I_a/I_c) Switch
   T2: Voltage must remain zero.

   TP4 (XMTR STOP Bd.-G): Voltage drop from 20 to zero volts.

5. Close 21P Switch
   T2: Voltage rise from 0 to 13 volts after a time delay (2-20MS) depending on the T2 timer setting.

   TP10 (Trip Output Bd.-L): Voltage rise from 0 to 20 volts 4 milliseconds after the voltage at T2 rises.

   TP4 (XMTR STOP Bd.-G): Voltage rise from 0 to 20 volts the same time TP10 changes.

6. Open 50(I_A/I_C) Switch
   TP10 (Trip Output Bd.-L): Voltage drop from 20 to 0 volts.

TP4 (XMTR STOP Bd.-G): Voltage must remain 20 volts.

7. Open 21P Switch
   TP4 (XMTR STOP Bd.-G): Voltage drop from 20 to zero volts.

B. Reverse External Fault -

Xmtr start control-10/10 timer XMTR START BD..

0/1000 and 0/2 timer - Blk. Unblk. Bd.

18/18 Transient Blk/Unblk timer-Trip Output Bd.

1. Close 50 (I_{OS}) or 67NS Switch
   TP2 (XMTR Start Bd.-H): Voltage rise from 0 to 20 volts.
   TP4 (XMTR Start Bd.-H): Voltage rise from 0 to 20 volts.
   TP8 (RCVR Intr. Bd.-F): Voltage rise from 0 to 13 volts.
   TP7 (Trip Output Bd.-L): Voltage rise from 0 to 11 volts in 18 milliseconds.
2. Open 50 (I_{OS}) or 67NS Switch
   TP12 (Blk/Unblk Bd.-K): Voltage drop from 16 to 0 volts in 1350 milliseconds.
   TP4 (XMTR Start Bd.-H): Voltage drop from 20 to 0 volts in 10 milliseconds.
   TP7 (Bd-L): Voltage drop from 11 to 0 volts in 1.3 second.
3. Close 21S Switch
   TP7 (Trip Output Bd.-L): Voltage rise from 0 to 11 volts in 18 milliseconds.
4. Close 21NP (I_{OS}) Switch
   TP7 (Trip Output Bd.-L): Voltage drop from 11 to 0 volts in 1350 milliseconds.
5. Open 21NP (I_{OS}) Switch
   TP7 (Trip Output Bd.-L): Voltage rise from 0 to 11 volts in 18 milliseconds.
6. Close 21NP (I_0) Switch
   TP10 (Trip Output Bd.-L): Voltage must remain zero.
7. Open 21S Switch
   TP12 (BLK UNLBK Bd.-K): Voltage drop from 16 to 0 volts in 2 milliseconds.
   TP7 (TRIP OUTPUT Bd.-K): Voltage drop from 11 to 0 volts in 22 milliseconds.
   TP10 (TRIP OUTPUT Bd.-K): Voltage rise from 0 to 20 volts in 22 milliseconds.
8. Close 50 (I_{OS}) or 67NS Switch
   TP7 (TRIP OUTPUT Bd.L): Voltage remain zero.
9. Open 50 (I_{OS}) or 67NS and 21NP (I_0) Switches
   TP10 (TRIP OUTPUT Bd.-L): Voltage drop from 20 to 0 volts.

C. Forward External Fault -

Channel Rcvr. Control transient blk/unblk 18/18 timer - trip output Bd.

Remove checkback 1 and 2 boards (slots I and J) for the following tests if used.

1. Close NOISE Switch
   TP2 (RCVR INTR BD.-F): Voltage rise from 0 to 20 volts.
   TP4 (RCVR INTR. BD.-F): Voltage rise from 0 to 13 volts.
2. Close 21NP (I_0) Switch
   TP1: Voltage must remain zero.
3. Open 21NP (I_0) Switch, then close 21P Switch
   TP8 (RCVR INTR. BD.-F): Voltage rise from 0 to 13 volts.
   TP7 (TRIP OUTPUT BD.-L): Voltage rise from 0 to 11 volts in 18 milliseconds.
4. Close 50 (I_A/I_C) Switch
   T2: Voltage must remain zero.
5. Open NOISE Switch
   T2: Voltage rise from 0 to 13 volts.
   TP7 (Trip Output Bd.-L): Voltage drop from 11 to 0 volts in 22 milliseconds.
   TP10 (Trip Output Bd.-L): Voltage rise from 0 to 22 milliseconds.
6. Open 21P and 50 (I_a/I_c) Switches
   TP10 (Trip Output Bd.-L): Voltage drop from 20 to 0 volts.
7. Close CH block Switch
   TP2 (RCVR Intr. Bd.-F): Voltage rise from 0 to 20 volts.
8. Close 21NP (I_{OS}) Switch
   TP4 (XMTR Stop Bd.-G): Voltage rise from 0 to 20 volts.
   TP7 (Trip Output Bd.-L): Voltage rise from 0 to 11 volts in 18 milliseconds.

9. Open Ch Block Switch
   TP7 (Trip Output Bd.-L): Voltage drop from 11 to 0 volts in 1350 milliseconds.

10. Open 21NP (I_{os}) Switch
    TP4 (XMTR Stop Bd.-G): Voltage drop from 20 to 0 volts.

11. Close either 50 (I_h) or spare switch
    TP2 (XMTR Stop Bd.-G): Voltage rise from 0 to 20 volts.

    TP4 (XMTR Stop Bd.-G): Voltage rise from 0 to 20 volts.

12. Open 50 (I_h) or SPARE Switch, whichever was closed.
    TP2 (XMTR Stop Bd.-G): Voltage drop from 20 to 0 volts.

    TP4 (XMTR Stop Bd.-G): Voltage drop from 20 to 0 volts in 150 milliseconds.

Reinsert checkback 1 and 2 boards into board slots I and J respectively.

D. Loss of AC Potential Control

Loss of Potential 500/500 timer - Loss of Pot Bd.-C.

Pilot Trip Operation

(Note: Link on Loss of Pot. Board to be "in" for test)

1. Close 21NP (I_0) Switch
   T1: Voltage rise from 0 to 13 volts.

   TP10 (Trip Output Bd.-L): Voltage rise from 0 to 20 volts, in 4 MS.

2. Close LOSS OF POTENTIAL Switch
   TP4 (Loss of Pot. Bd.-C): Voltage rise from 0 to 20 volts in 500 milliseconds.

   TP10 (Trip Output Bd.-L): Voltage drop from 20 to 0 volts in 500 milliseconds.

3. Open LOSS OF POTENTIAL Switch
   TP4 (Loss of Pot. Bd.-L): Voltage drop from 20 to 0 volts in 500 milliseconds.

   TP10 (Trip Output Bd.-L): Voltage rise from 20 to 0 volts in 500 milliseconds.

4. Open 21NP (I_0) Switch
   TP10 (Trip Output Bd.-L): Voltage drop from 20 to 0 volts.

E. Checkback Operation -

Logic and timers on Checkback 1 and Checkback 2 boards test logic on blk/unblk bd.

The following test is required only for those SKAU-3 relays having the checkback option.

1. Close test (for) switch
   TP12 (Blk/Unblk Bd.-K): Voltage must remain zero.

2. Open Test (for) switch, then close 50 (I_{os}) or 67NS switch.
   TP7 (Trip Output Bd.-L): Voltage rise from 0 to 11 volts in 18 milliseconds.

3. Close Test (for) switch, then open 50 (I_{os}) or 67NS switch.
   TP7 (Trip Output Bd.-L): Voltage must remain 11 volts.

4. Open Test (for) switch
   TP7 (Trip Output Bd.-L): Voltage must drop from 11 to 0 volts in 18 milliseconds.

5. Close Test (CBI) switch
   TP9 (Checkback 1 Bd.-I): Voltage drop from 13 to 0 volts.
   TP4 (XMTR Start Bd.-H): Voltage rise from 0 to 20 volts.

6. Open Test (CBI) switch
   TP9 (Checkback 1 Bd.-I): Voltage rise from 0 to 13 volts.

   TP4 (XMTR Start Bd.-H): Voltage drop from 20 to 0 volts.

7. Close CH Block switch, then after 5 seconds, open it again.
   TP5 (Checkback 1 Bd.-I): Voltage rise from 0 to 13 volts.

   Red Jack (Ck. Bk. 2 Bd.-I): Voltage rise from 0 to 13 volts after a time delay (5 to 10 sec.) depending on the adjustable timer setting.

   TP4 (XMTR Start Bd.-H): Voltage rise from 0 to 20 volts the same time the RED JACK changes.

8. Close CH. Block Switch
   Red Jack (Ch. Bk. 2 Bd.-J): Voltage drop from 13 to 0 volts in 3.3 seconds.

   TP4 (XMTR Start Bd.-H): Voltage drop from 20 to 0 volts in 3.3 seconds.

TP9 (Checkback 1 Bd.-I): Voltage must remain zero.

9. Open CH. Block switch
   TP5 (Checkback 1 Bd.-I): Voltage must remain zero.

   TP9 (Checkback 1 Bd.-I): Voltage rise from 0 to 13 volts in 20 seconds.

10. Close CH. Block switch, then open it in less than 1.5 seconds.
    TP5 (Checkback 1 Bd.-I): Voltage must remain zero.

    NOTE: To recheck steps 7 and 8, reset circuit with the procedure in steps 9 and 10.

F. Weak Feed Operation -

Logic and timers on W.F. logic 1 and 2 Bds.

The following test is required only for those SKAU-3 relays with the weak feed option.

1. Close 59N or 27 switch
   TP4 (W.F. Logic 1 Bd.-D): Voltage rise from 0 to 13 volts.

   TP10 (Trip Output Bd.-L): Voltage rise from 0 to 20 volts after a time delay of the T1 timer plus 4 milliseconds.

2. Close 50 (I_{OS}) or 67NS switch
   TP4 (W.F. Logic 1Bd.-D): Voltage drop from 13 to 0 volts.

3. Open 50 (I_{OS}) or 67NS switch
   TP4 (W.F. Logic 1 Bd.-D): Voltage rise from 0 to 13 volts.

4. Open 59N or 27 switch, whichever was closed.
   TP4 (W.F. Logic 1 Bd.-D): Voltage drop from 13 to 0 volts.

   TP10 (Trip Output Bd.-L): Voltage drop from 20 to 0 volts.

5. Close 52B switch, then close 27 switch.
   TP4 (W.F. Logic 1 Bd.-D): Voltage must remain zero.

6. Open 52B switch
   TP9 (W.F. Logic 2 Bd.-E): Voltage rise from 0 to 16 volts in 4.7 milliseconds then TP4 (XMTR Start Bd.-H): drop from 16 to 0 volts in 270 milliseconds.

   TP4 (W.F. Logic 1 Bd.-D): Voltage rise from 0 to 13 volts in 67 milliseconds.

   TP10 (Trip Output Bd.-L): Voltage rise from 0 to 20 volts 22 milliseconds after TP4 (XMTR Start Bd.-H) drops.

7. Close 21S switch
   TP7 (W.F. Logic 1 Bd.-D): Voltage rise from 0 to 13 volts.

   TP9 (W.F. Logic 2 Bd.-E): Voltage rise from 0 to 16 volts.

   TP10 (Trip Output Bd.-L): Voltage drop from 20 to 0 volts.

8. Open 21S switch
   TP7 (W.F. Logic 1 Bd.-D): Voltage must remain 13 volts.

9. Close 52B switch
   TP7 (W.F. Logic 1 Bd.-D): Voltage drop from 13 to 0 volts

   TP4 (W.F. Logic 1 Bd.-D): Voltage must remain zero.

10. Open 27 switch, then open 52B switch
    TP9 (W.F. Logic 1 Bd.-D): Voltage must remain zero.

Recommended Routine Maintenance

Periodic checks of the relaying system are desirable to indicate impending failure so that equipment can be taken out of service for correction. Any accumulated dust should be removed at regular maintenance intervals.

CALIBRATION

The proper adjustments to insure correct operation of the relay have been made at the factory and should not be disturbed after receipt by the customer. However, if the adjustments or if the components or printed circuit boards which affect timer calibration have been changed, then the SKAU-3 relay should be rechecked per the acceptance check information.

All time delays are either fixed or adjustable. All the adjustable timers can be adjusted from the front except for the two timers on the TRIP OUTPUT board: 4/0MS pilot trip timer, and 18/18MS transient block and unblock timer which are located on the board. These two timers can be recalibrated as follows using an auxiliary timer or oscilloscope.

1. Pilot trip 4/0 MS timer - TRIP OUTPUT BD.

Start timer on T1 timer terminal (positive pulse)
End timer on TP10 (TRIP OUTPUT Bd.-L)

(positive pulse).

Close 21NP (Io) switch and the voltage at TP10 must rise from 0 to 20 volts in 4 milliseconds.

This time can be adjusted with trimpot R7 on the TRIP OUTPUT Bd., clockwise for more time or counterclockwise for less time.

2. Transient block/unblock 18/18MS timer - TRIP OUTPUT BD.

Start timer on TP12 (Blk/Unblk Bd.-K)
(positive pulse for pickup, negative pulse for dropout)

End timer on TP7 (Trip Output Bd.-L)
(positive pulse for pickup, negative pulse for dropout)

For pickup, close 50 (Ios) switch and the voltage at TP7 must rise from 0 to 11 volts in 18 milliseconds. This time can be adjusted with trimpot R19 on the TRIP OUTPUT Bd., clockwise for more time or counterclockwise for less time.

For dropout, open 50 (Ios) switch and the voltage at TP7 must drop from 11 to 0 volts 18 milliseconds after the voltage at TP12 drops to zero. Note that triggering of the dropout time will occur approximately 1.3 seconds after opening 50 (Ios) switch. The dropout time can be adjusted with trimpot R24 on the TRIP OUTPUT Bd., clockwise for more time, or counter clockwise for less time.

Trouble shooting

The components of the SKAU-3 relay are operated well within their ratings and normally will give long and troublefree service. However, if a relay has given indication of trouble in service or during routine checks, then using "0" and "1" logic notation, the faulty printed circuit board can be identified using the logic diagram in Fig. 3 or 4. In turn, the faulty component, connection, or circuit can be found using the individual schematics of the printed circuit boards which show the detailed NOR logic.

Each NOR logic block, shown by an AND with negated inputs, or an OR with a negated output, represents a transistor on the internal circuit board schematic. The output of each individual logic block is the collector of the transistor which represents that block. Each collector is either connected to a test point or a printed circuit terminal. A box around the transistor indicates that it is conducting for the normal condition of the relay.

Voltage levels for the "0" and "1" logic states at the test points shown on the Fig. 3 and 4 logic drawings are shown in Fig. 27. For the remainder of the test points, a logic "0" is equivalent to less than 0.5 volts and a logic "1" is equivalent to 8 to 20 volts, thereby representing positive logic.

A board extender, Style No. 849A534G01 is available for facilitating circuit voltage measurements. After withdrawing anyone of the circuit boards, the extender is inserted into that slot. The board is then inserted into the terminal block on the front of the extender to restore all circuit connections. Do not remove or insert printed circuit boards while the SKAU-3 is energized as damage may result.

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, and style numbers from the Electrical Parts List.

ELECTRICAL PARTS LIST

CIRCUIT SYMBOL	REFERENCE	STYLE
POWER SUPPLY BOARD – STYLE 202C465G01		
Capacitors		
C1, C2	6.8 MFD, 35 VDC	184A661H10
C3, C4	0.1 MFD, 200 VDC	188A669H03
Transistors		
Q1, Q2	2N4063 ✪	878A432G01
Heat Sink for Q1, W2		849A517H01
Zener Diodes		
Z1, Z3	1N3050B, 180 V, 1W	187A936H17
Z2, Z4	1N4747A, 20 V, 1W	849A487H01
PROTECTIVE RELAY (P.R.) INTERFACE BOARD-STYLE 6265D37G01		
Capacitors		
C1, C2, C4	.047MFD, 200 VDC	849A437H04
C3, C5	.47MFD, 35VDC	837A241H21
Diodes		
D1 to D10	1N645A	837A692H03
Potentiometers		
R20, R38	100K ohm, 0.5W, ±10%	880A687H04
Resistors		
R1, R2, R7, R8, R29, R30	4.7K ohm, ½W, ± 2%	629A531H48
R3, R9, R31	82K ohm, ½W, ± 2%	629A531H78
R4, R10, R14, R17, R24, R27, R32, R35, R42, R44	10K ohm, ½W, ± 2%	629A531H56
R5, R11, R13, R16, R23, R25, R26, R34, R41, R43	27K ohm, ½W, ±2%	629A531H66
R6, R12, R15, R18, R28, R33, R36, R45	6.8K ohm, ½W, ± 2%	629A531H52
R19, R37	470 ohm, ½W, ±2%	629A531H24
R21, R39	1K ohm, ½W, ±2%	629A531H32
R22, R40	20K ohm, ½W, ±2%	629A531H63
Thermistors		
TH1, TH2	1K ohm, @25°C. ± 10%	185A211H02
Transistors		
Q1 to Q10	2N3417	848A851H02
Zener Diodes		
Z1, Z3, Z6	1N3686B, 20 V, ±5%	185A212H06
Z2, Z4, Z5, Z7, Z8	1N957B, 6.8V, ±5%	186A797H06
Miscellaneous		
SUB BASE		862A273G01
DIAL		199P670H01
KNOB		187A967H03
KNOB LOCK		629A980H01
TIP JACK		187A332H01

ELECTRICAL PARTS LIST

CIRCUIT SYMBOL	REFERENCE	STYLE
LOSS OF AC POTENTIAL BOARD – STYLE 265C954G01		
Capacitors		
C1	.045 MFD, 200V	849A437H04
C2, C3	22 MFD, .35V	184A661H16
C4	100 MFD, 35V	880A363H01
C5	.27 MFD, 200V	188A669H05
Diodes		
D1 to D5	1N645A	837A692H03
Resistors		
R1, R2	4.7K ½W, ±2%	629A531H48
R3, R15, R21	82K ½W, ±2%	629A531H78
R4, R9, R11, R13, R14, R18, R20	10K, ½W, ±2%	629A531H56
R6, R19	6.8K, ½W, ±2%	629A531H52
R7, R17	27K, ½W, ±2%	629A531H66
R5, R8	47K, ½W, ±2%	629A531H72
R10, R12	470 Ω ½W, ±2%	629A531H24
R16	270K, ½W, ±2%	629A531H90
R22	150 Ω 3W,	762A679H01
Transistors		
Q1 to Q5	2N3417	848A851H02
Q6	2N3645	849A441H01
Zener Diodes		
Z1	1N3686B	185A212H06
Z1 to Z5	1N957B	186A797H06
Z6	1N3688A	862A288H01
WEAK FEED (W.F.) LOGIC 1 BOARD – STYLE 6265D33G01		
Capacitors		
C1, C2, C4, C5	.047 MFD, 200VDC	849A437H04
C3	.47 MFD, 35VDC	837A241H21
Diodes		
D1, D2, D3, D4	1N645A	837A692H03
Resistors		
R1, R2, R9, R10, R26, R27, R34, R35	4.7 K ½W, ±2%	629A531H48
R5, R8, R14, R19, R30, R33	6.8 K ½W, ±2%	629A531H52
R4, R7, R13, R18, R23, R29, R32	10 K ½W, ±2%	629A531H56
R6, R12, R15, R16, R17, R20, R21, R22, R31	27 K ½W, ±2%	629A531H66
R3, R11, R28, R36	82 K ½W, ±2%	629A531H78
R24	43 K ½W, ±2%	629A531H71
R25	470 Ω ½W, ±2%	629A531H24
Transistors		
Q1 to Q7	2N3417	848A851H02
Zener Diodes		
Z1, Z3, Z5, Z8	1N3686B	185A212H06
Z2, Z4, Z6, Z7, Z9	1N957B	186A797H06

ELECTRICAL PARTS LIST

CIRCUIT SYMBOL	REFERENCE	STYLE
WEAK FEED (W.F.) LOGIC 2 – BOARD STYLE 6265D35G01		
Capacitors		
C1	.047MFD, 200VDC	849A437H04
C2	1.5MFD, 35VDC	187A508H09
C3	.47MFD, 35VDC	837A241H21
C4	3.3MFD, 35VDC	862A530H01
Diodes		
D1, D2, D3, D4, D5	1N645A	837A692H03
Resistors		
R1	47K ohm, ½W, ±2%	629A531H72
R2	4.7K ohm, ½W, ±2%	629A531H48
R3	82K ohm, ½W, ±2%	629A531H78
R4, R6, R9, R12, R17, R20, R22, R26, R29	10K ohm, ½W, ±2%	629A531H56
R5, R10, R13, R21, R27, R30	6.8K ohm, ½W, ±2%	629A531H52
R7, R23	2K ohm, ½W, ±2%	629A531H39
R8	12K ohm, ½W, ±2%	629A531H58
R11, R14, R15, R16, R25, R28	27K ohm, ½W, ±2%	629A531H66
R18, R24	20K ohm, ½W, ±2%	629A531H63
R19	470 ohm, ½W, ±2%	629A531H24
Thermistors		
TH1, TH2	1K ohm, @ 25°C, ±10%	185A211H02
Transistors		
Q1, Q3, Q4, Q5, Q6, Q8, Q9	2N3417	848A851H02
Q2, Q7	2N3645	849A441H01
Zener Diodes		
Z1	1N3686B, 20V, ±5%	185A212H06
Z2, Z3	1N957B, 6.8V, ±5%	186A797H06
RCVR INTERFACE BOARD – STYLE 6265D39G01		
Capacitors		
C1	.047MFD, 200VDC	849A437H04
C2	.27MFD, 200VDC	188A669H05
Diodes		
D1	1N645A	837A692H03
Resistors		
R1, R2, R3	4.7K ohm, ½W, ±2%	629A531H48
R4, R8	82K ohm, ½W, ±2%	629A531H78
R5, R7, R12, R15, R19, R22, R26, R30	10K ohm, ½W, ±2%	629A531H56
R6, R13, R16, R20, R23, R27, R31	6.8K ohm, ½W, ±2%	629A531H52
R9	150 ohm, 3W, ±5%	762A679H01
R10, R11, R14, R17, R18, R21, R24, R25, R28, R29	27K ohm, ½W, ±2%	629A531H66
Transistors		
Q1, Q3, Q4, Q5, Q6, Q7, Q8	2N3417	848A851H02
Q2	2N3645	849A441H01
Zener Diodes		
Z1, Z2, Z5	1N3688A, 24V, ±10%	862A288H01
Z3	1N3686B, 20V, ±5%	185A212H06
Z4	1N957B, 68V, ±5%	186A797H06

ELECTRICAL PARTS LIST

CIRCUIT SYMBOL	REFERENCE	STYLE
XMTR STOP BOARD – STYLE 6265D41G01 XMTR START BOARD – STYLE 6265D41G02		
Capacitors		
C1, C3	.047MFD, 200VDC	849A437H04
C2 (XMTR Stop Board)	6.8 MFD, 35VDC	184A661H21
C2 (XMTR Start Board)	1.5 MFD, 35VDC	187A508H18
C4	.27 MFD, 200VDC	188A669H05
Diodes		
D1 to D7	1N645A	837A692H03
Resistors		
R1, R2, R3, R10, R11 (R10 for XMTR Stop Board)	4.7K ohm ½W, ±2%	629A531H48
R4, R12, R18	82K ohm, ½W, ±2%	629A531H78
R5, R8, R13, R14, R17, R20	10K, ohm, ½W, ±2%	629A531H56
R6, R15	27K ohm, ½W, ±2%	629A531H66
R7, R16	6.8K ohm, ½W, ±2%	629A531H52
R9 (XMTR Stop Board)	2K ohm, ½W, ±2%	629A531H39
R19	150 ohm, 3W, ±5%	762A679H01
R9 (XMTR Start Board)	12K ohm, ½W, ±2%	629A531H58
R10 (XMTR Start Board)	47K ohm, ½W, ±2%	629A531H72
Thermistor		
TH1	1K ohm, @25°C, ±10%	185A211H02
Transistors		
Q1, Q3	2N3417	848A851H02
Q2, Q4	2N3645	849A441H01
Zener Diodes		
Z1, Z2, Z3, Z8	1N3688A, 24V, ±10%	862A288H01
Z4, Z6	1N3686B, 20V, ± 5%	185A212H06
Z5, Z7, Z9 (Z9 for XMTR Start Board)	1N957B, 6.8V, ± 5%	187A797H06
CHECKBACK 1 BOARD – STYLE 6265D43G01		
Capacitors		
C1	100MFD, 30VDC	184A761H04
C2, C3	150MFD, 30VDC	849A007H01
C4	.047MFD, 200VDC	849A437H04
C5	.27MFD, 200VDC	188A669H05
Diodes		
D1 to D7	1N645A	837A692H03
Resistors		
R1, R4, R7, R8, R12, R15, R16, R19, R21, R27, R30, R33, R37, R40	27K ohms, ½W, ±2%	629A531H66
R2, R5, R9, R13, R17, R20, R28, R31, R34, R35	10K ohm, ½W, ±2%	629A531H56
R3, R6, R14, R18, R29, R32, R36,	6.8K ohm, ½W, ±2%	629A531H52
R10	33K ohm, ½W, ±2%	629A531H68
R11	3.9K ohm, ½W, ±2%	629A531H46
R22	100K ohm, ½W, ±2%	629A531H80
R23	3.3K ohm, ½W, ±2%	629A531H44
R24, R25	4.7K ohm, ½W, ±2%	629A531H48
R26	82K ohm, ½W, ±2%	629A531H78
R38	1K ohm, ½W, ±2%	629A531H32
R39	20K ohm, ½W, ±2%	629A531H63

ELECTRICAL PARTS LIST

CIRCUIT SYMBOL	REFERENCE	STYLE
CHECKBACK 1 BOARD – STYLE 6265D43G01 (Continued)		
Thermistor		
TH1	1K ohm, @25°C, ±10%	185A211H02
Transistor		
Q1 to Q10	2N3417	848A851H02
Zener Diodes		
Z1, Z3, Z4	1N957B, 6.8V, ±5%	186A797H06
Z2	1N3686B, 20V, ±5%	185A212H06
CHECKBACK 2 BOARD – STYLE 6683D58G01		
Capacitors		
C1, C3	47MFD, 35VDC	187A508H13
C2	150MFD, 30VDC	849A007H01
C4	1MFD, 200VDC	187A624H04
Diodes		
D1, D2, D3, D4	1N645A	837A692H03
Potentiometer		
R8	100K ohm, 0.5W, ±10%	880A687H04
Resistors		
R1, R4, R17, R14	27K ohm, ½W, ±2%	629A531H66
R2, R5, R10, R12, R15, R18	10K ohm, ½W, ±2%	629A531H56
R3, R11, R16, R19, R21	6.8K ohm, ½W, ±2%	629A531H52
R6	47K ohm, ½W, ±2%	629A531H72
R9	1K ohm, ½W, ±2%	629A531H32
R13	200 ohm, ½W, ±2%	629A531H15
R7	470 ohm, ½W, ±2%	629A531H24
Thermistors		
TH1, TH2	1K ohm, @25°C, ±10%	185A211H02
Transistors		
Q1, Q2, Q3, Q5, Q6	2N3417	848A851H02
Q4	2N3645	849A441H01
Zener Diode		
Z1	1N957B, 6.8V, ±5%	186A797H06
Miscellaneous		
SUB BASE		862A372G01
DIAL		199P669H01
KNOB		187A967H03
KNOB LOCK		629A980H01
TIP JACK (RED)		187A332H01
TIP JACK (BLACK)		187A332H02

ELECTRICAL PARTS LIST

CIRCUIT SYMBOL	REFERENCE	STYLE
BLOCK/UNBLOCK BOARD – STYLE 6265D47G01		
Capacitors		
C1	.047 MFD, 200VDC	849A437H04
C2	68 MFD, 35VDC	187A508H02
C3	.27 MFD, 200VDC	188A669H05
Diodes		
D1, D2, D3	1N645A	837A692H03
Resistors		
R1, R2	4.7K ohm, ½W, ±2%	629A531H48
R3	82K ohm, ½W, ±2%	629A531H78
R4, R8, R12, R15, R18, R22, R25, R29, R32, R35, R40, R43	10K ohm, ½W, ±2%	629A531H56
R5, R9, R13, R16, R19, R23, R30, R36, R41, R44	6.8K ohm, ½W, ±2%	629A531H52
R6, R7, R10, R11, R14, R17, R20, R21, R24, R28, R31, R37 R38, R39, R42	27K ohm, ½W, ±2%	629A531H66
R26	39K ohm, ½W, ±2%	629A531H70
R27, R34	470 ohm, ½W, ±2%	629A531H24
R33	15K ohm, ½W, ±2%	629A531H60
Transistors		
Q1,to Q12	2N3417	848A851H02
Zener Diodes		
Z1	1N3686B, 20V, ±5%	185A212H06
Z2, Z3, Z4	1N957B, 6.8V, ±5%	186A797H06
TRIP OUTPUT BOARD – STYLE 6265D49G01		
Capacitors		
C1, C4	.27 MFD, 200VDC	188A669H05
C2, C3	1.0 MFD, 35 VDC	837A241H15
Diodes		
D1 to D10	1N645A	837A692H03
Potentiometers		
R7, R19, R24	20K ohm, ½W, ±10%	862A406H02
Resistors		
R1, R4, R12, R15, R16, R18, R23, R29, R30, R33	27K ohm, ½W, ±2%	629A531H66
R2, R5, R10, R13, R17, R22, R27, R31, R34, R36	10K ohm, ½W, ±2%	629A531H56
R3, R11, R14, R28, R32, R35	6.8K ohm, ½W, ±2%	629A531H52
R6	15K ohm, ½W, ±2%	629A531H60
R8, R20, R25	470 ohm, ½W, ±2%	629A531H24
R9, R21, R26	1K ohm, ½W, ±2%	629A531H32
R37	82K ohm, ½W, ±2%	629A531H78
R38	150 ohm, 3W, ±5%	762A679H01
Thermistors		
TH1, TH2, TH3	1K ohm, @ 25° C, ±10%	185A211H02
Transistors		
Q1 to Q9	2N3417	848A851H02
Q10	2N3645	849A441H01
Zener Diodes		
Z1, Z5	1N3688A, 24V, ±10%	862A288H01
Z2, Z3, Z4	1N957B, 6.8V, ±5%	186A797H06

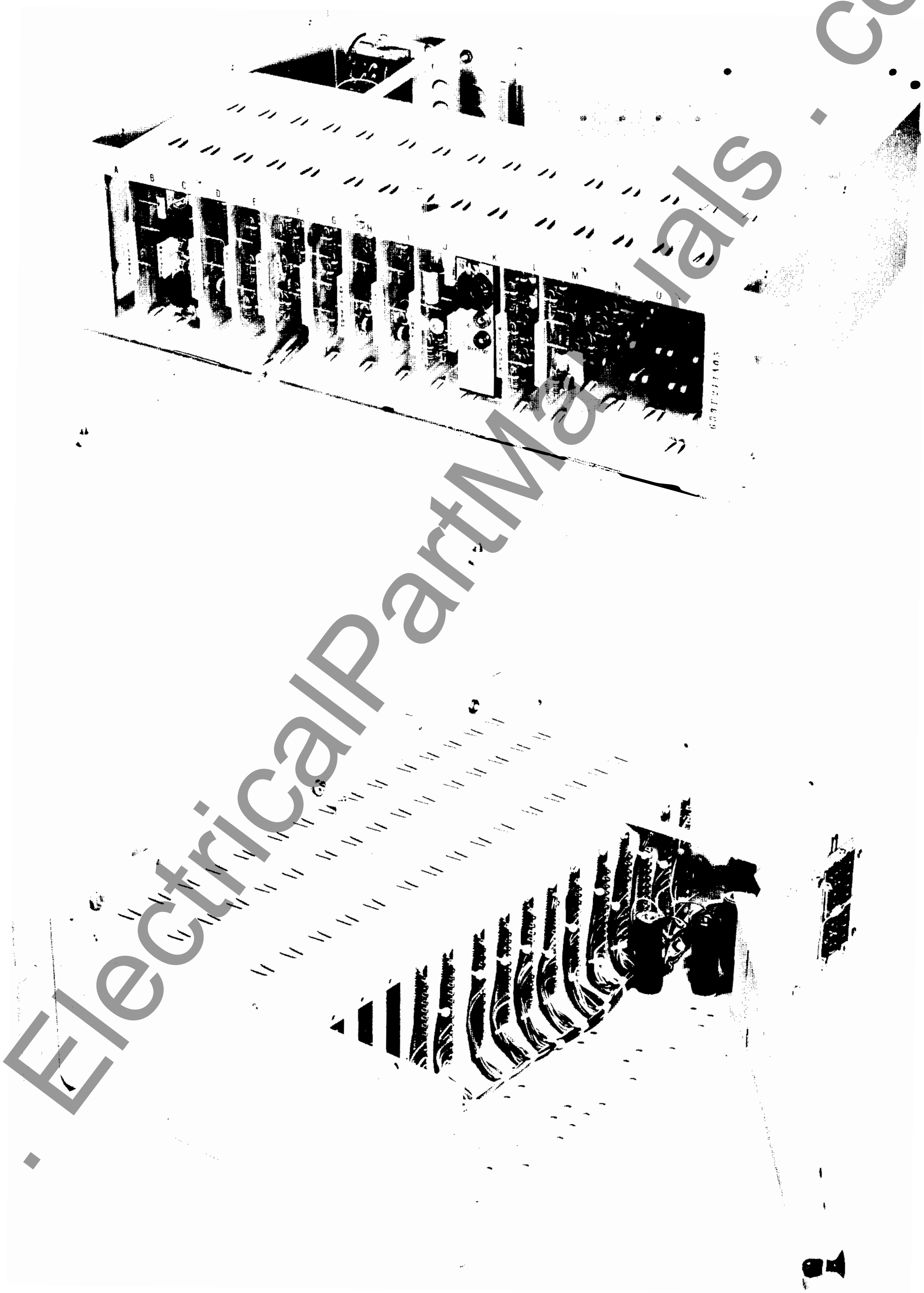
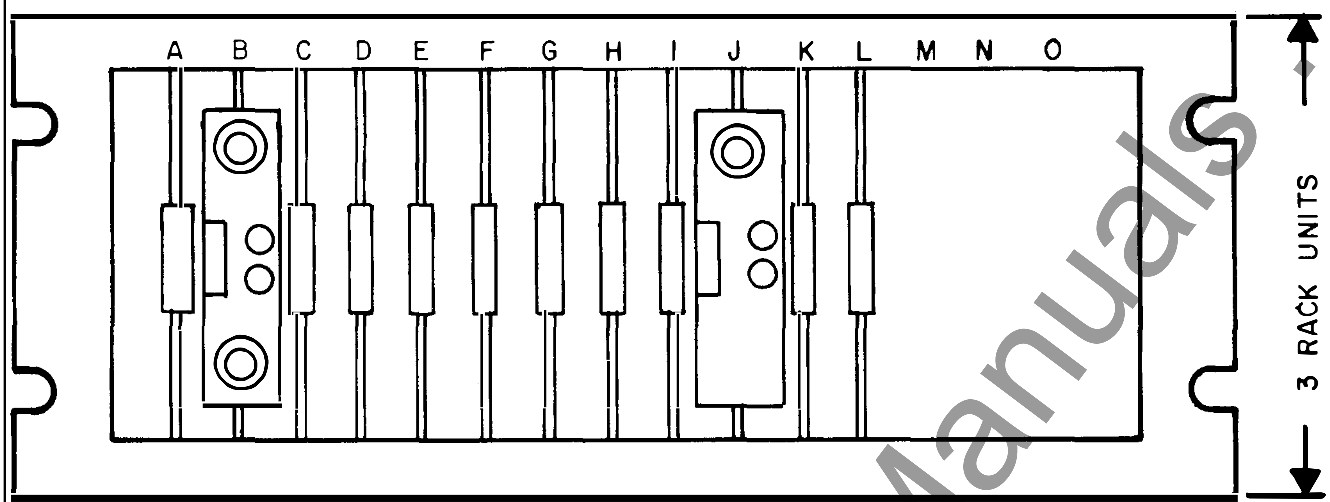


Fig. 1. Photograph Front View — Rear View.

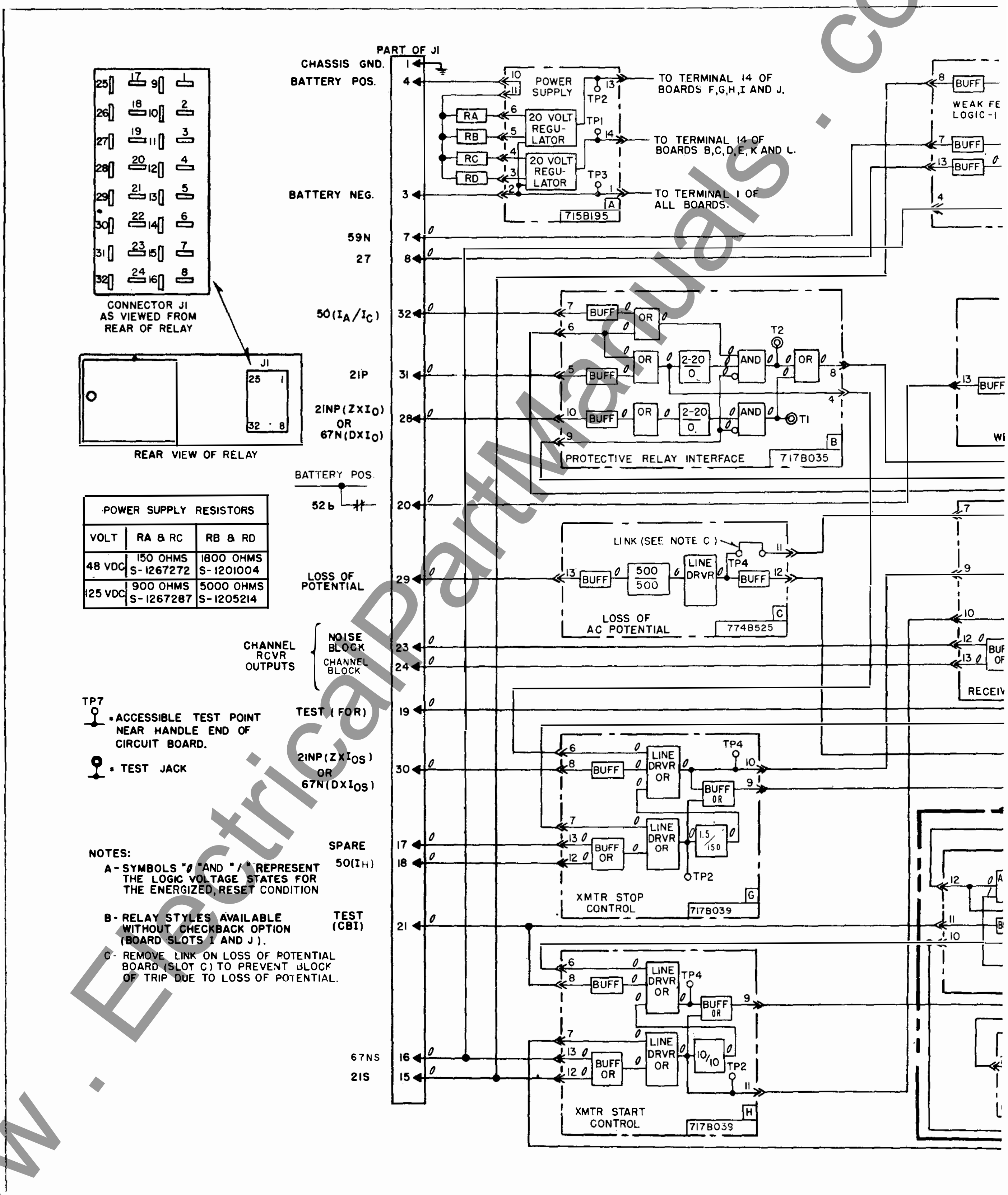


FRONT VIEW
(COVER REMOVED)

BOARD POSITION	BOARD DESCRIPTION
A	POWER SUPPLY
B	PROTECTIVE RELAY INTERFACE
C	LOSS OF AC POTENTIAL
D	WEAK FEED LOGIC - 1
E	WEAK FEED LOGIC - 2
F	RCVR INTERFACE
G	XMTR STOP CONTROL
H	XMTR START CONTROL
I	CHECKBACK - 1
J	CHECKBACK - 2
K	BLOCK/UNBLOCK CONTROL
L	TRIP OUT PUT
M	
N	
O	

878A568

Fig. 2 Relay Component Location



POWER SUPPLY RESISTORS		
VOLT	RA & RC	RB & RD
48 VDC	150 OHMS S-1267272	1800 OHMS S-1201004
125 VDC	900 OHMS S-1267287	5000 OHMS S-1205214

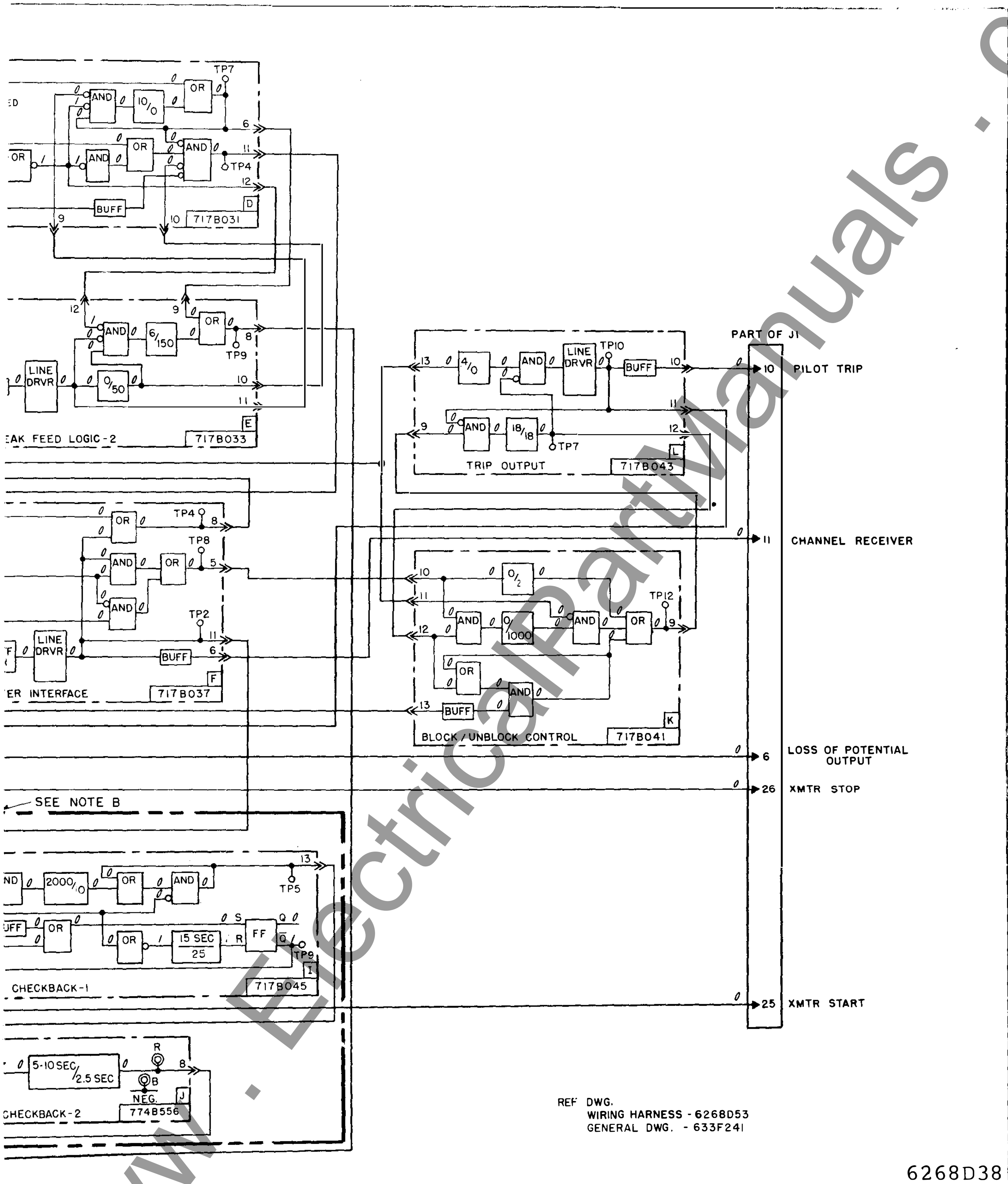
NOTES:

A - SYMBOLS "0" AND "/" REPRESENT THE LOGIC VOLTAGE STATES FOR THE ENERGIZED, RESET CONDITION

B - RELAY STYLES AVAILABLE WITHOUT CHECKBACK OPTION (BOARD SLOTS I AND J).

C - REMOVE LINK ON LOSS OF POTENTIAL BOARD (SLOT C) TO PREVENT BLOCK OF TRIP DUE TO LOSS OF POTENTIAL.

Fig. 4. SKAU-3 Logi



: for a Weak Feed Terminal

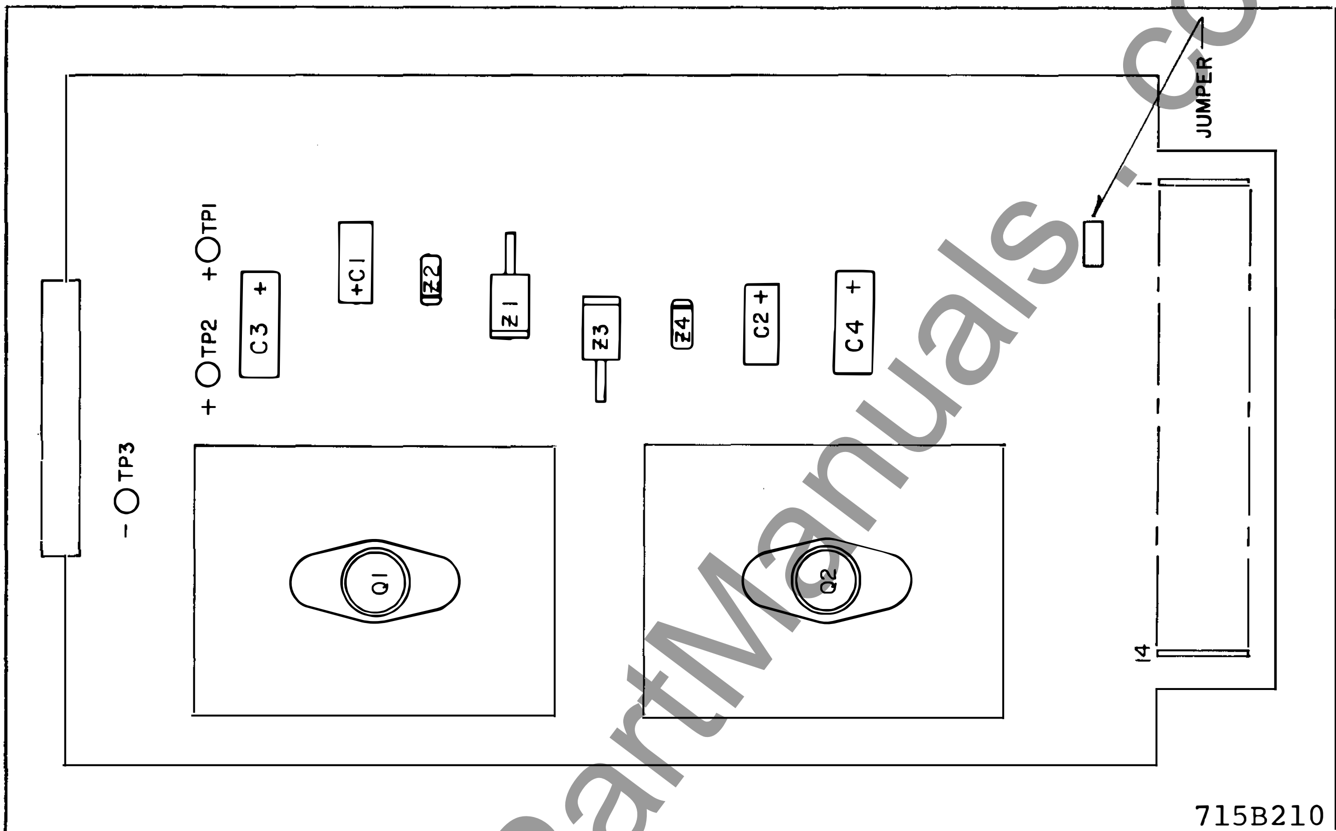


Fig. 5. Component Location – Power Supply Board

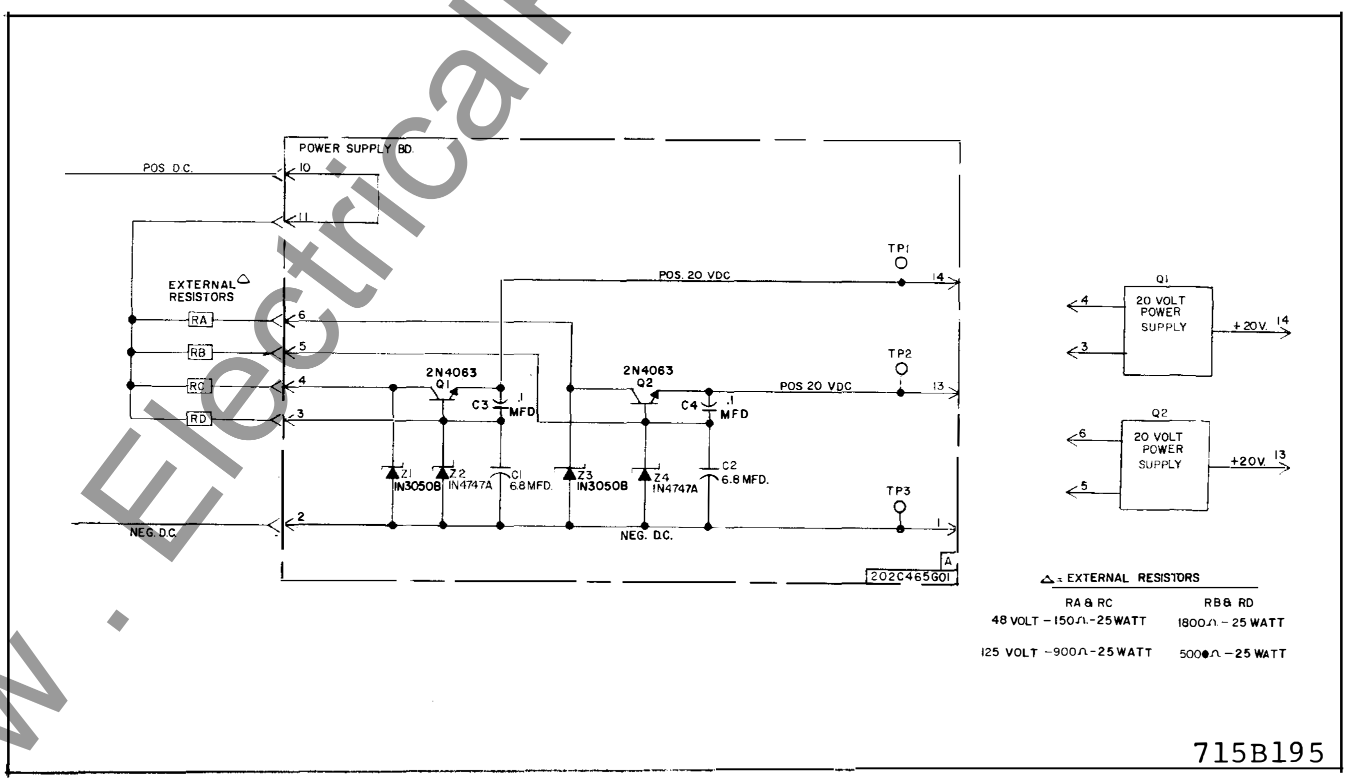


Fig. 6. Internal Schematic – Power Supply Board

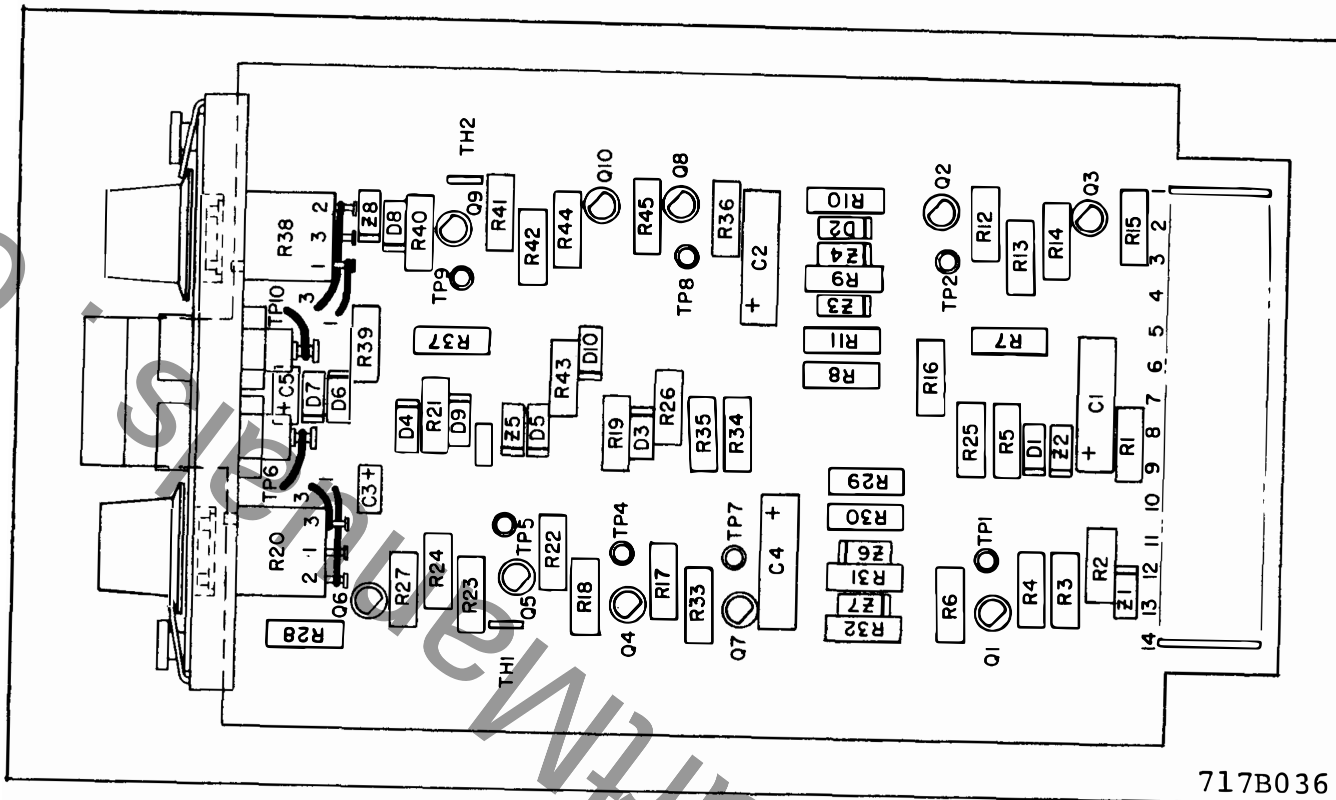


Fig. 7. Component Location – Protective Relay Interface Board

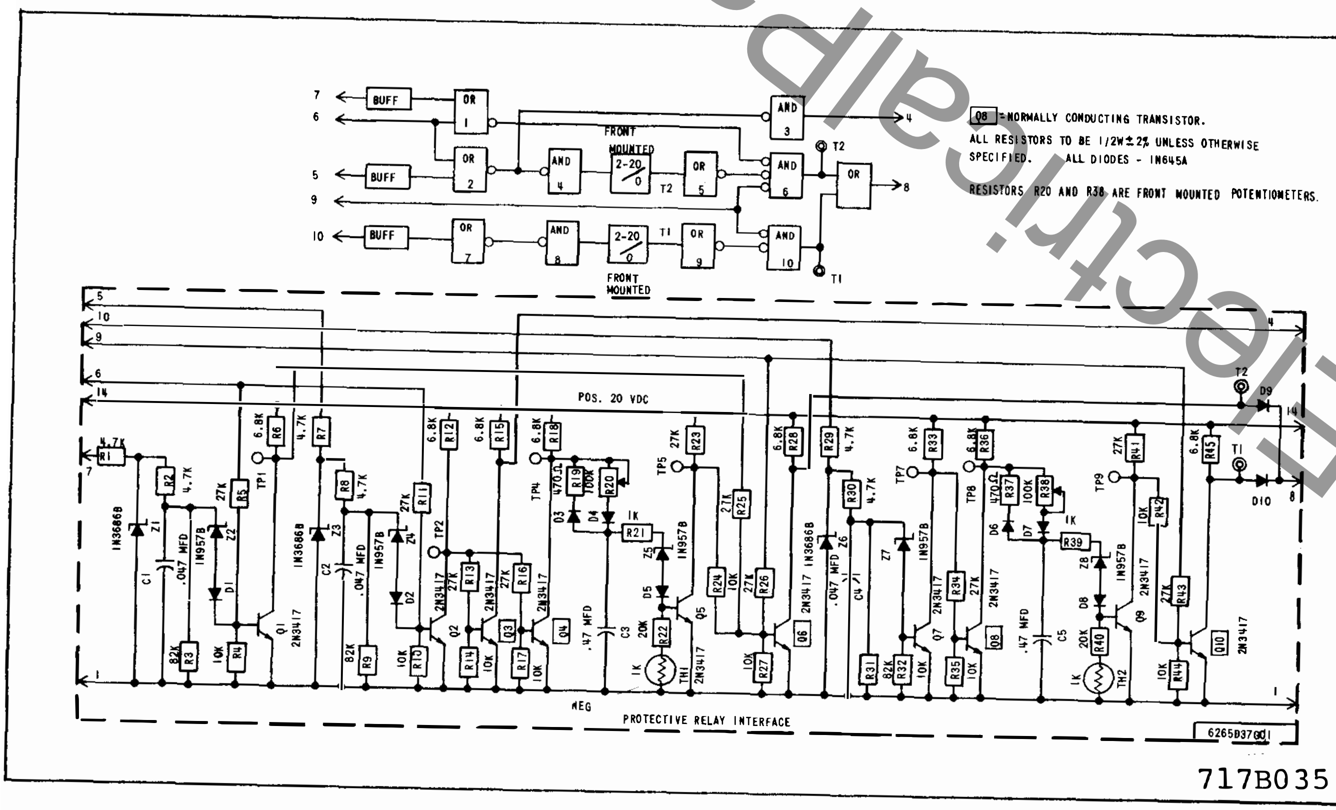


Fig. 8. Internal Schematic – Protective Relay Interface Board

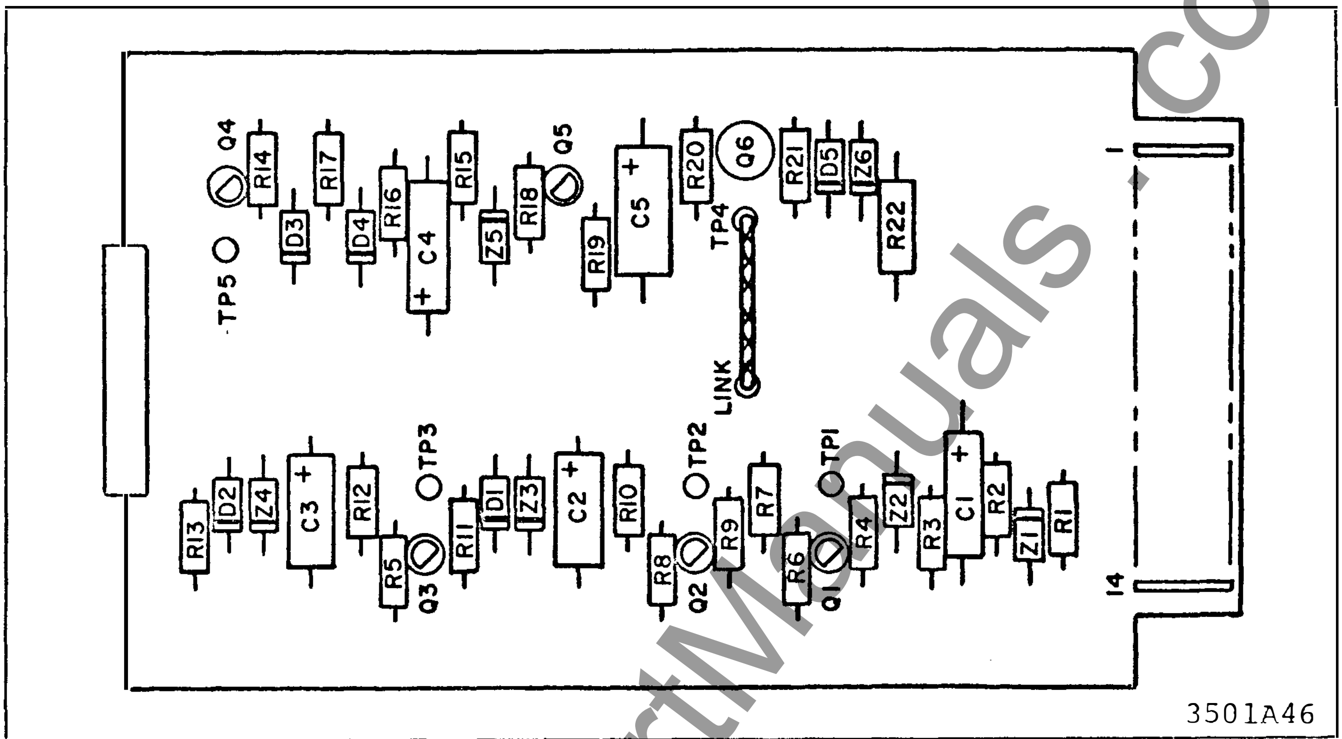


Fig. 9. Component Location – Loss of Potential Board

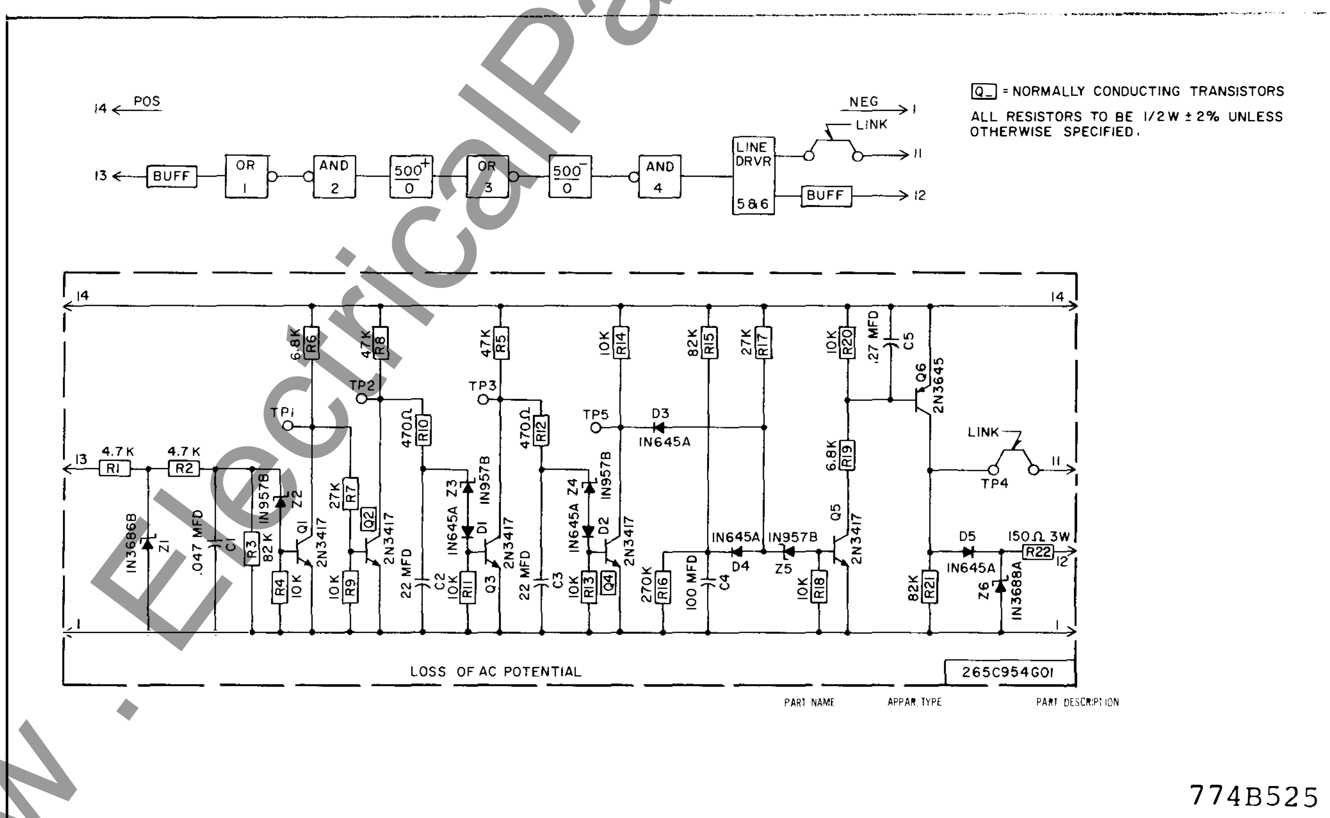


Fig. 10. Internal Schematic – Loss of Potential Board

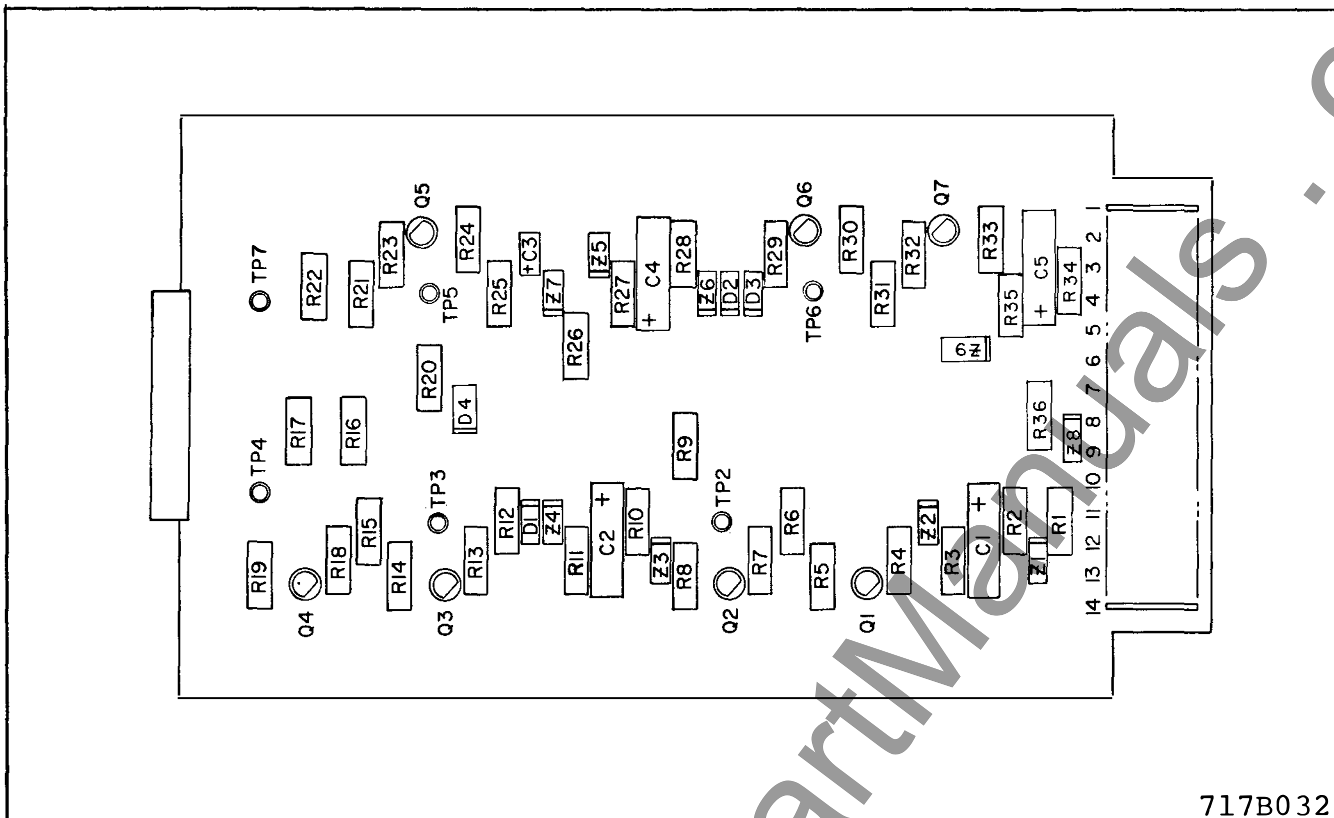


Fig. 11. Component Location – Weak Feed Logic-1 Board

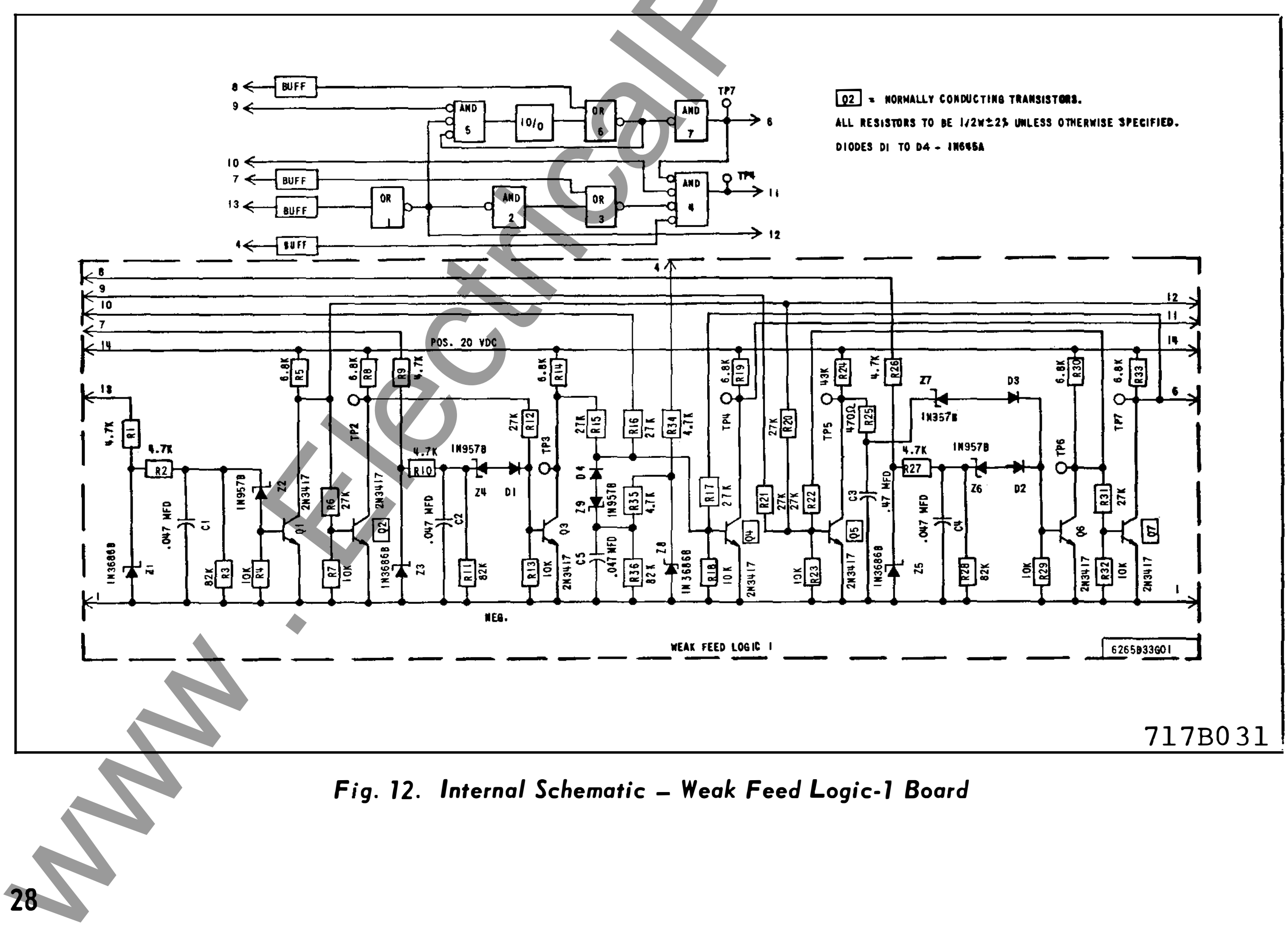


Fig. 12. Internal Schematic – Weak Feed Logic-1 Board

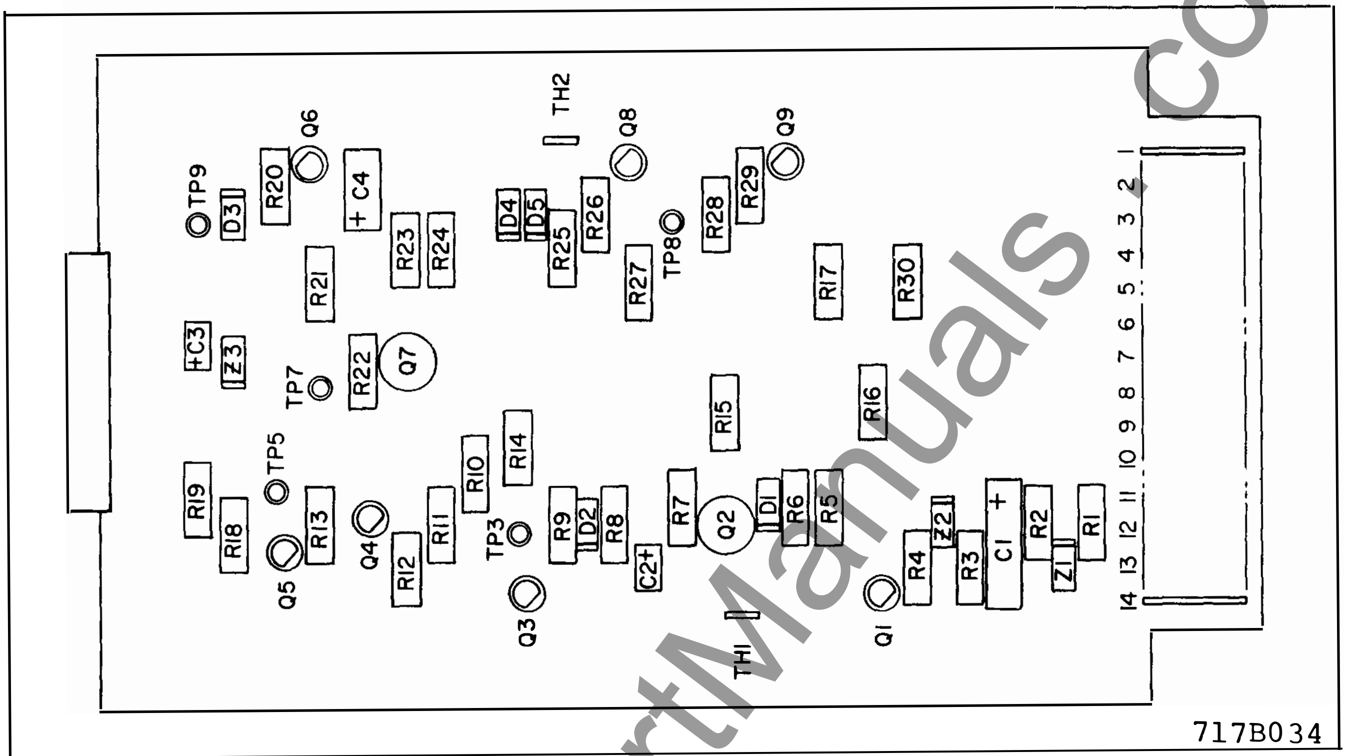


Fig. 13. Component Location – Week Feed Logic-2 Board

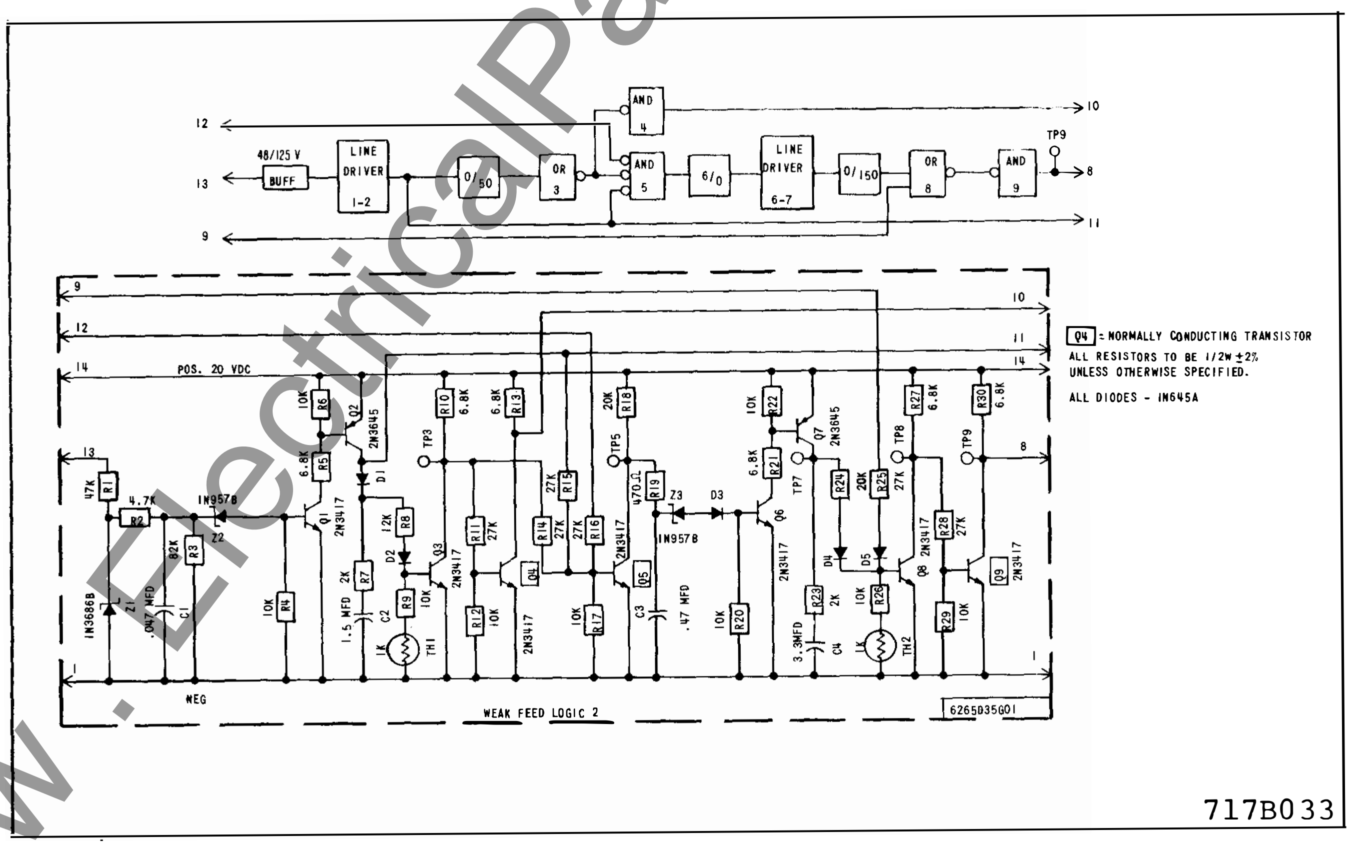


Fig. 14. Internal Schematic – Weak Feed Logic-2 Board

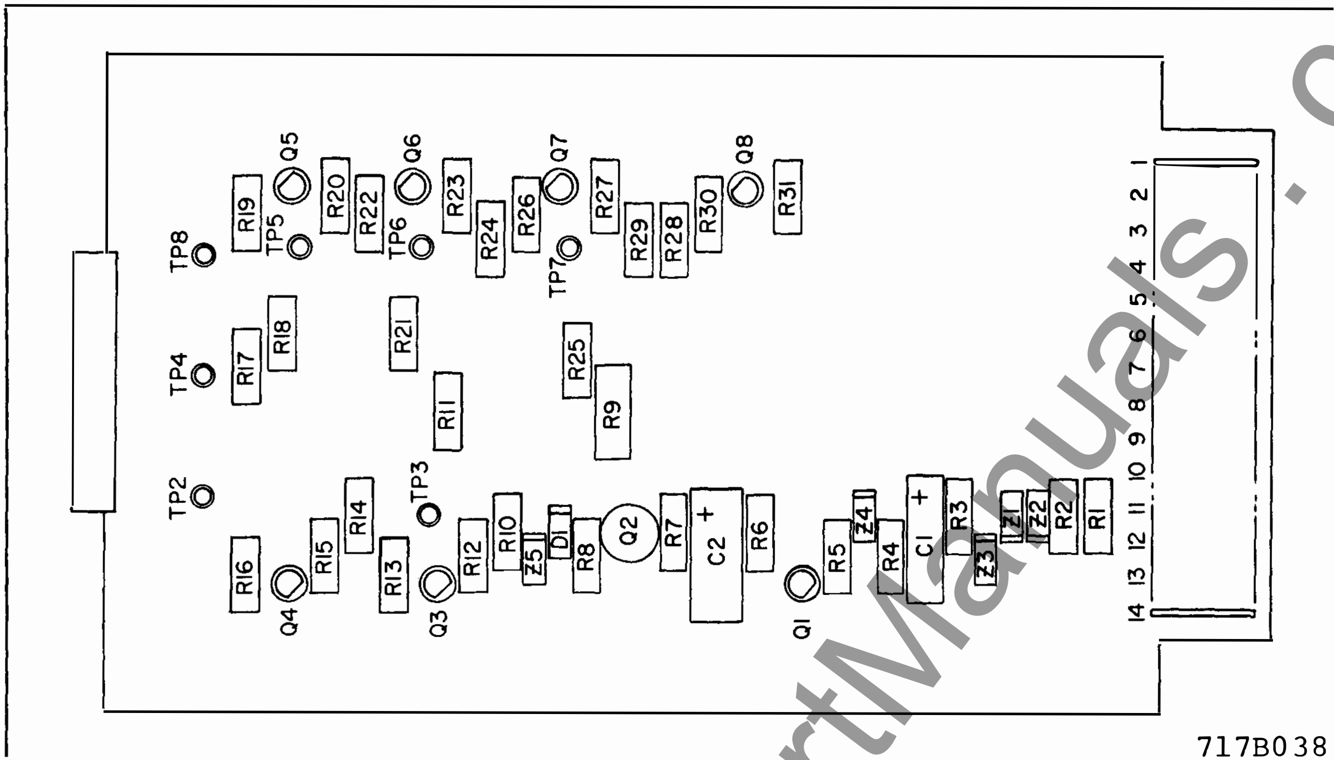


Fig. 15. Component Location – Receiver Interface Board

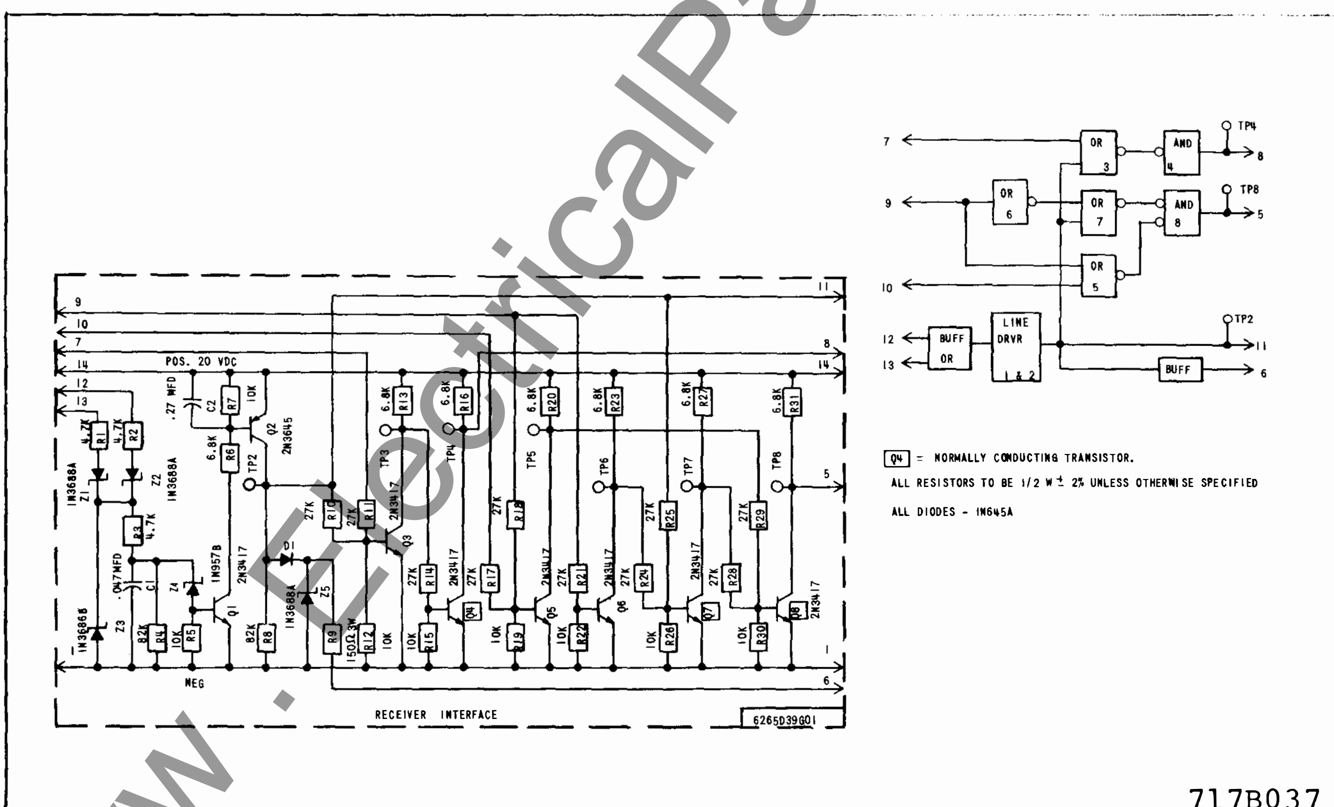


Fig. 16 Internal Schematic – Receiver Interface Board

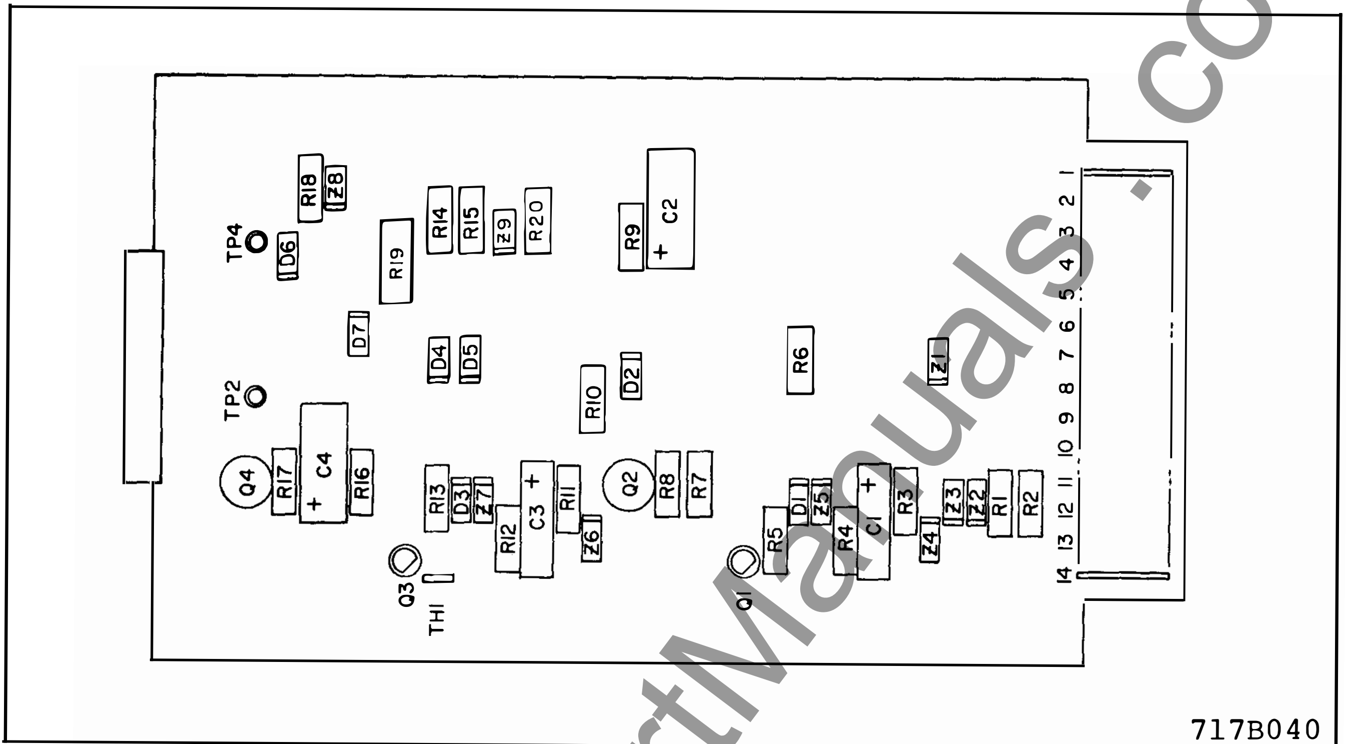
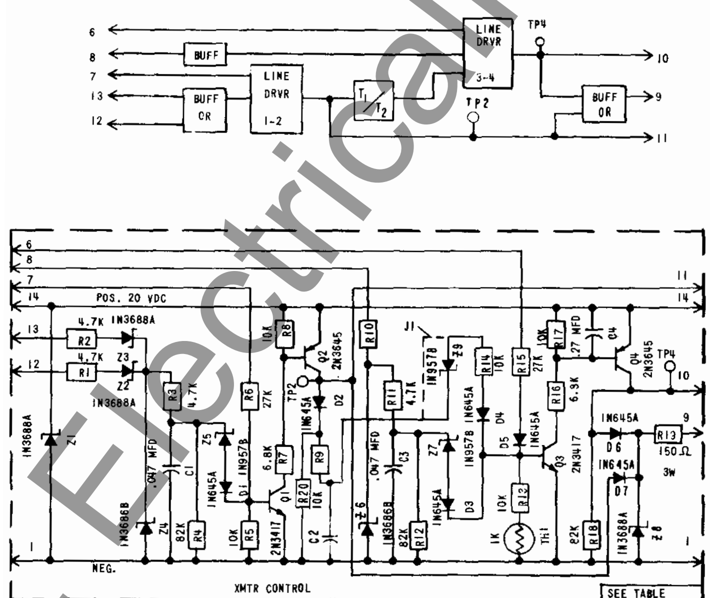


Fig. 17. Component Location – XMTR Control Boards



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

STYLE NO.	R9	C2	Z9	T_1/T_2	R10	FUNCTION
6265D41G01	2K	6.8 MFD	JUMPER(J1)	1.5/150	4.7K	XMTR STOP
6265D41G02	12K	1.5 MFD	6.8 V	10/10	47K	XMTR START

717B039

Fig. 18. Internal Schematic – XMTR Control Boards

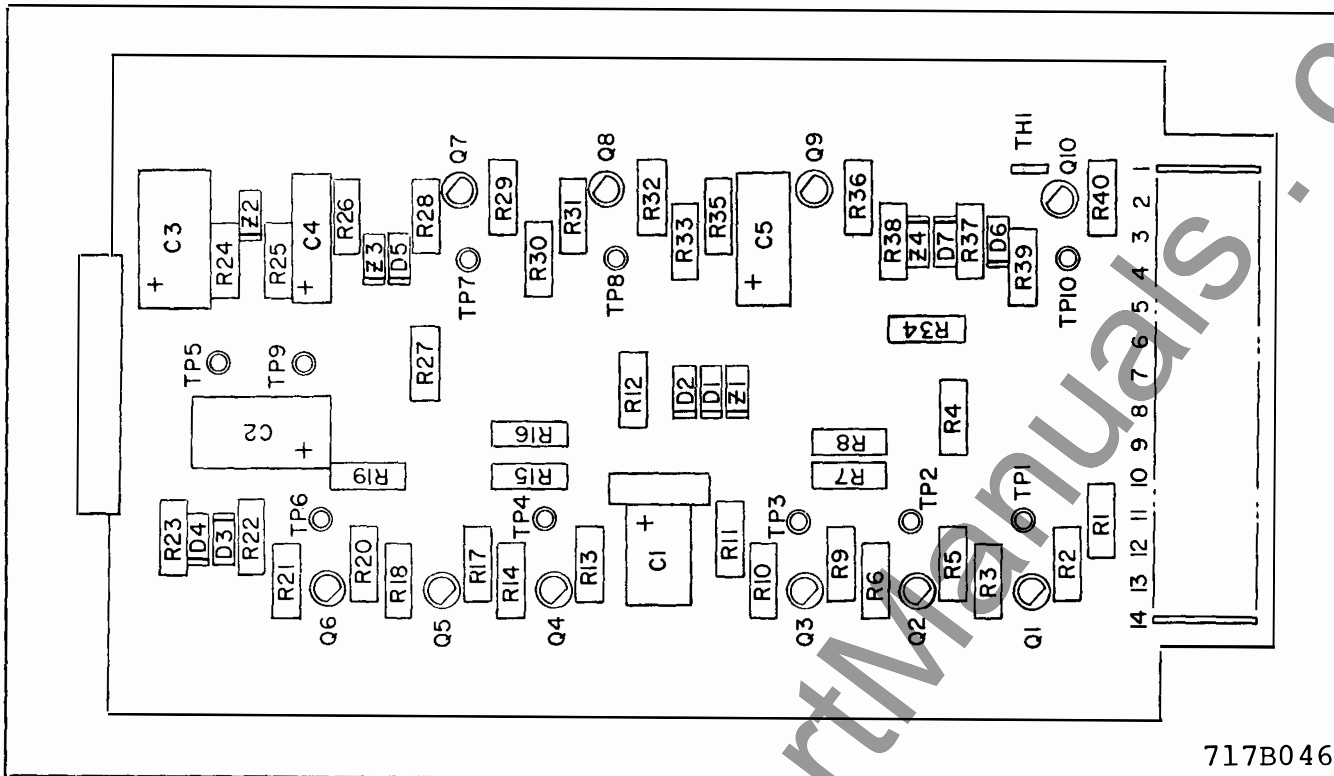


Fig. 19. Component Location – Checkback-1 Board

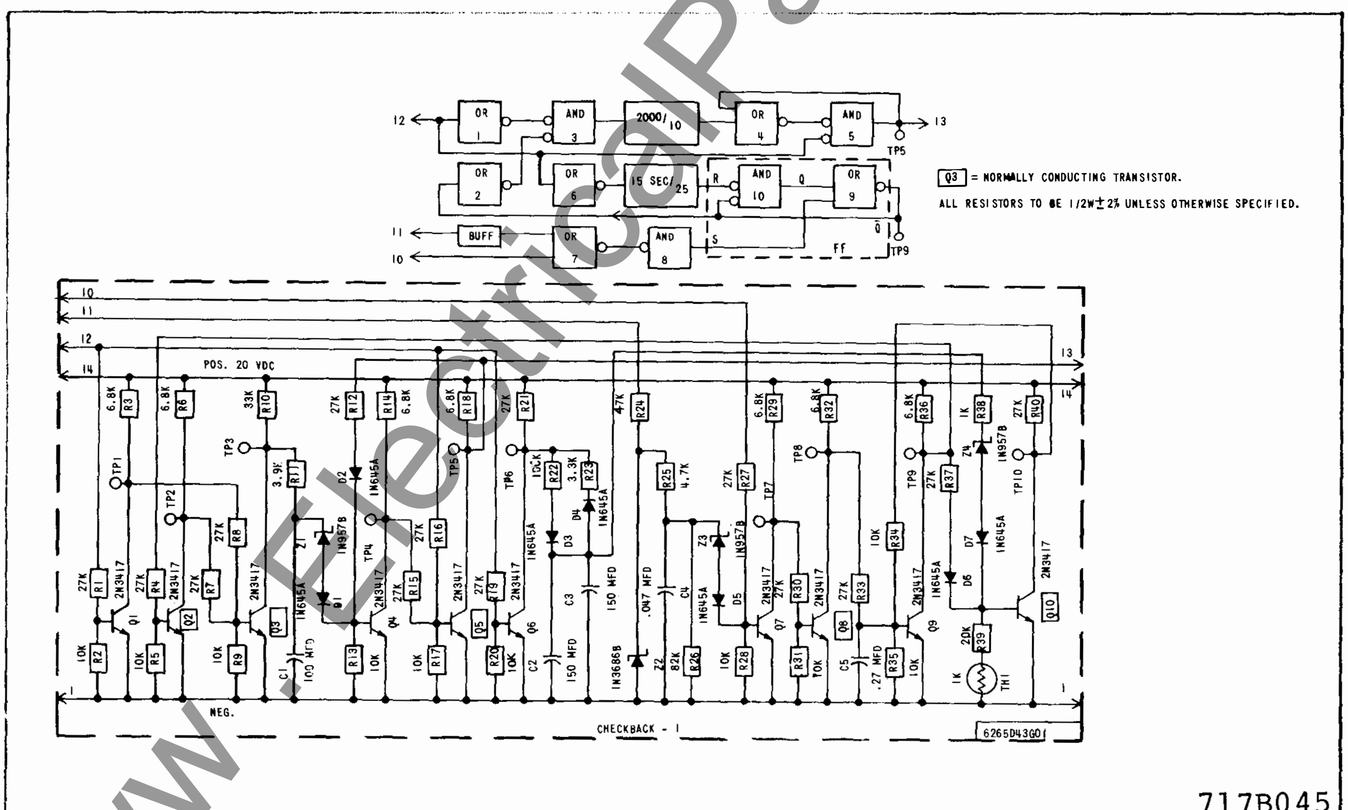


Fig. 20. Internal Schematic – Checkback-1 Board

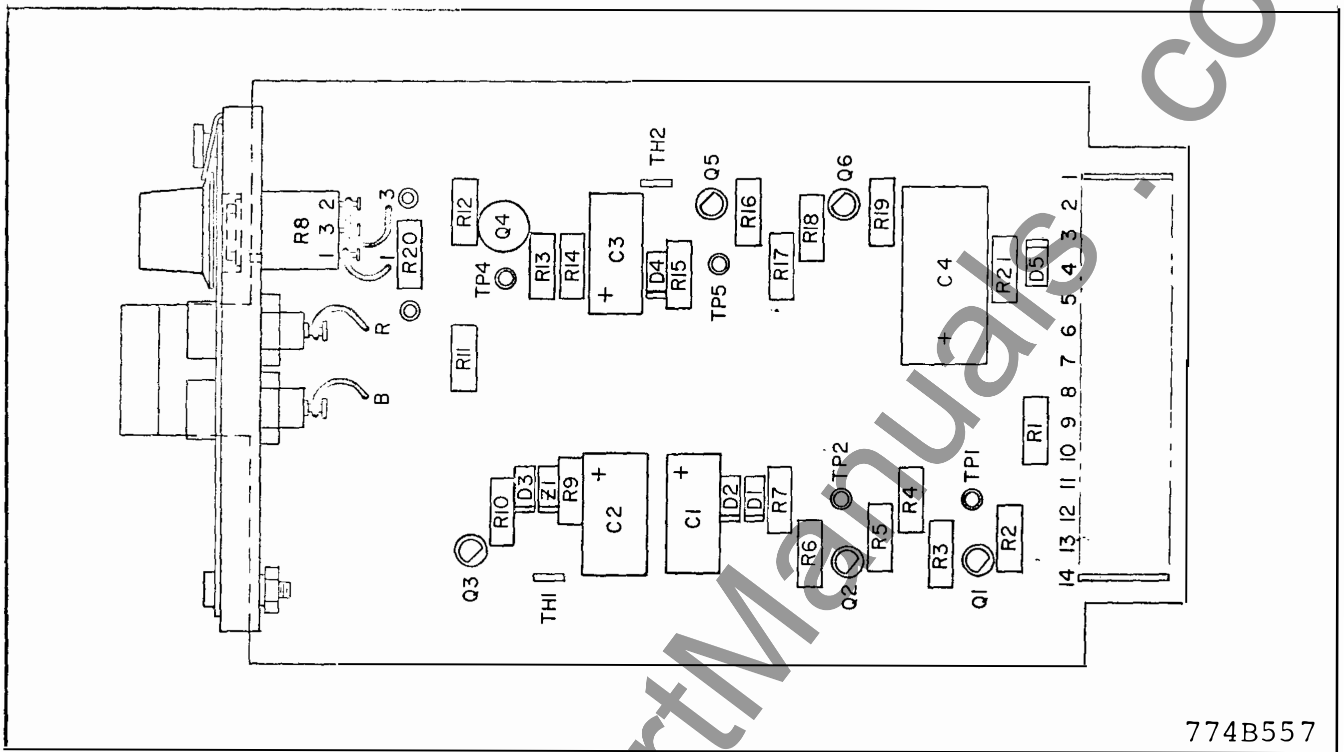


Fig. 21. Component Location – Checkback-2 Board

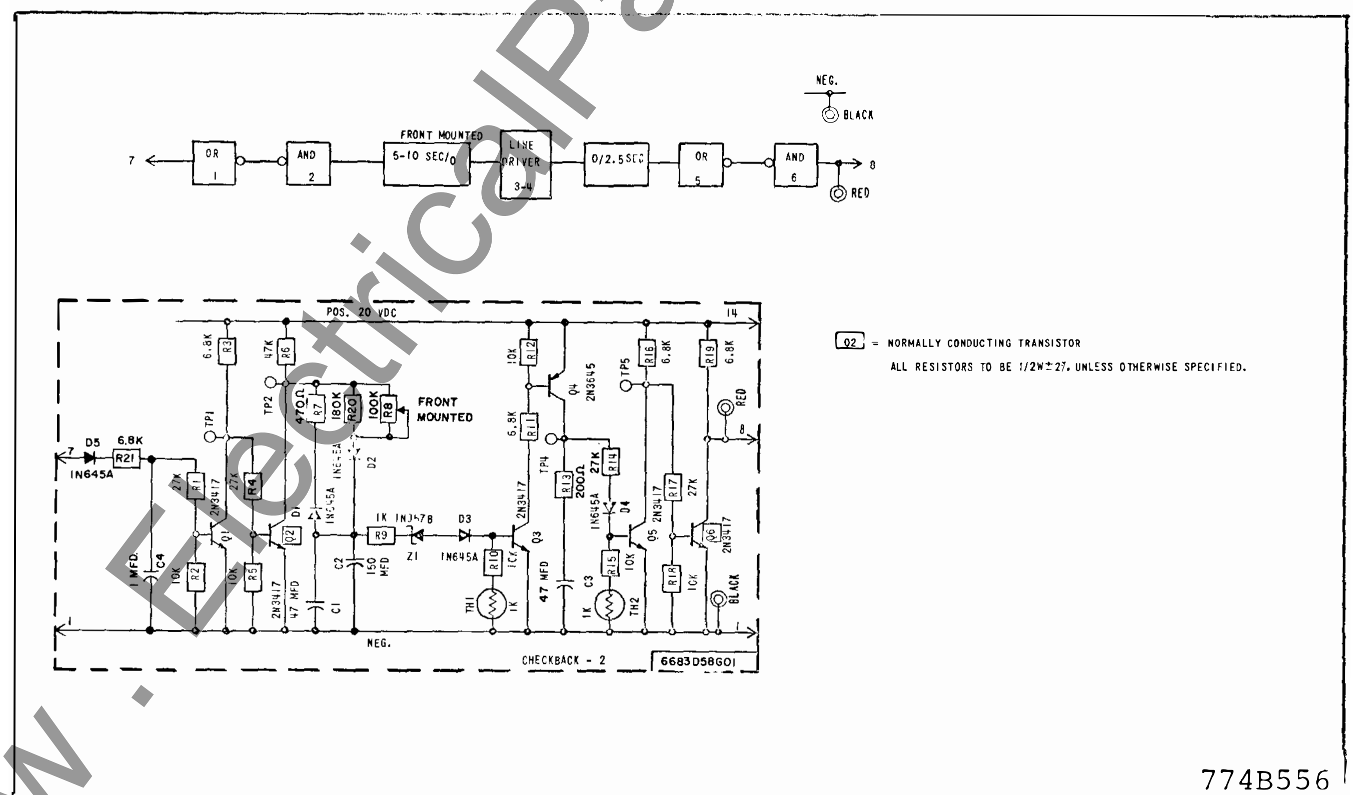


Fig. 22 Internal Schematic – Checkback-2 Board

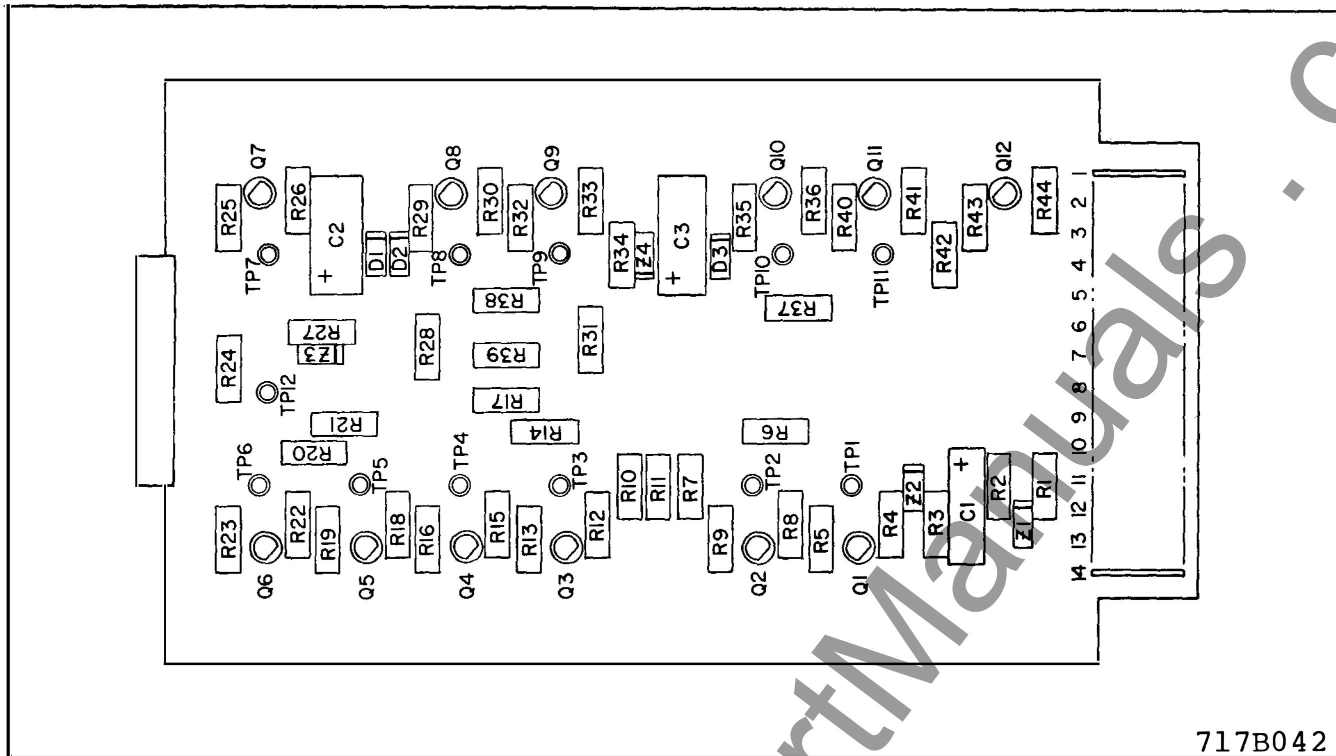


Fig. 23. Component Location – Block/Unblock Control Board

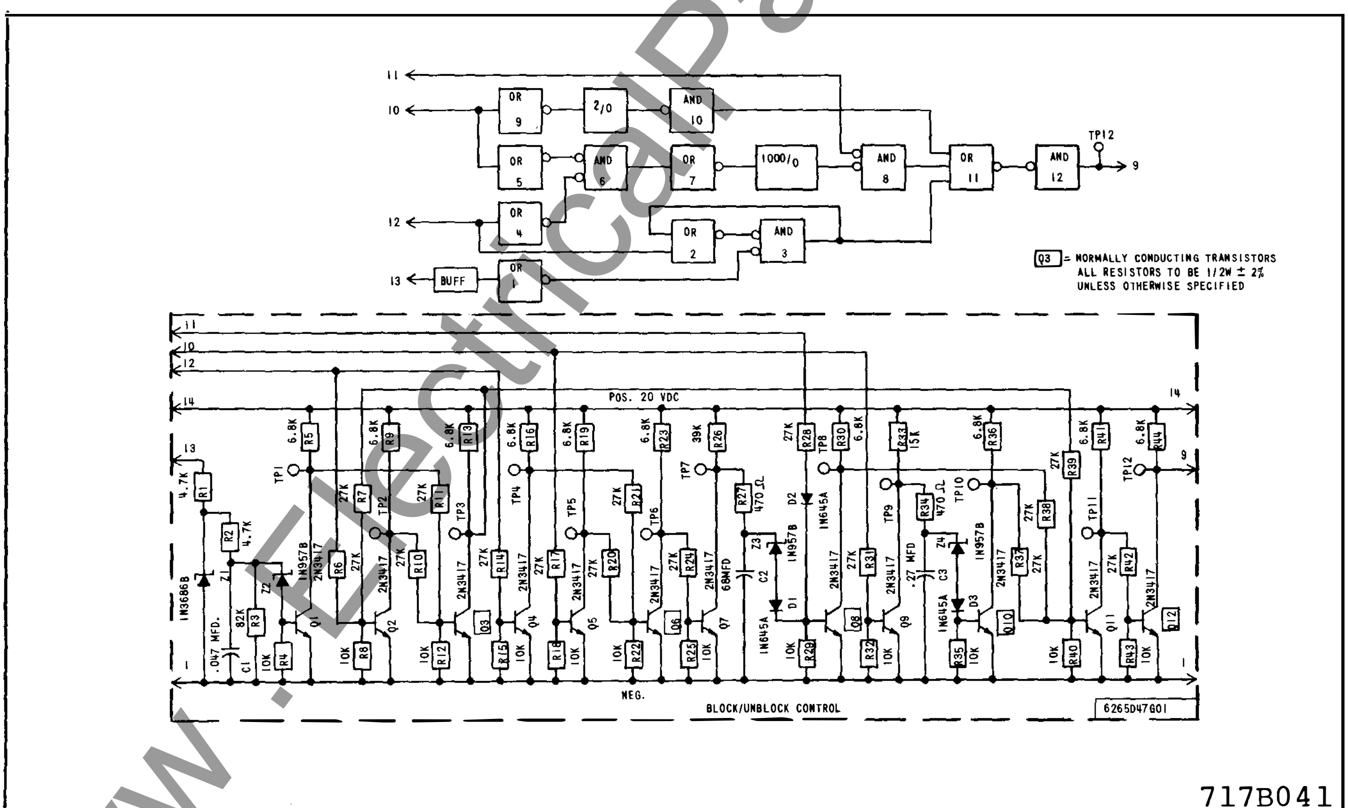


Fig. 24 Internal Schematic – Block/Unblock Control Board

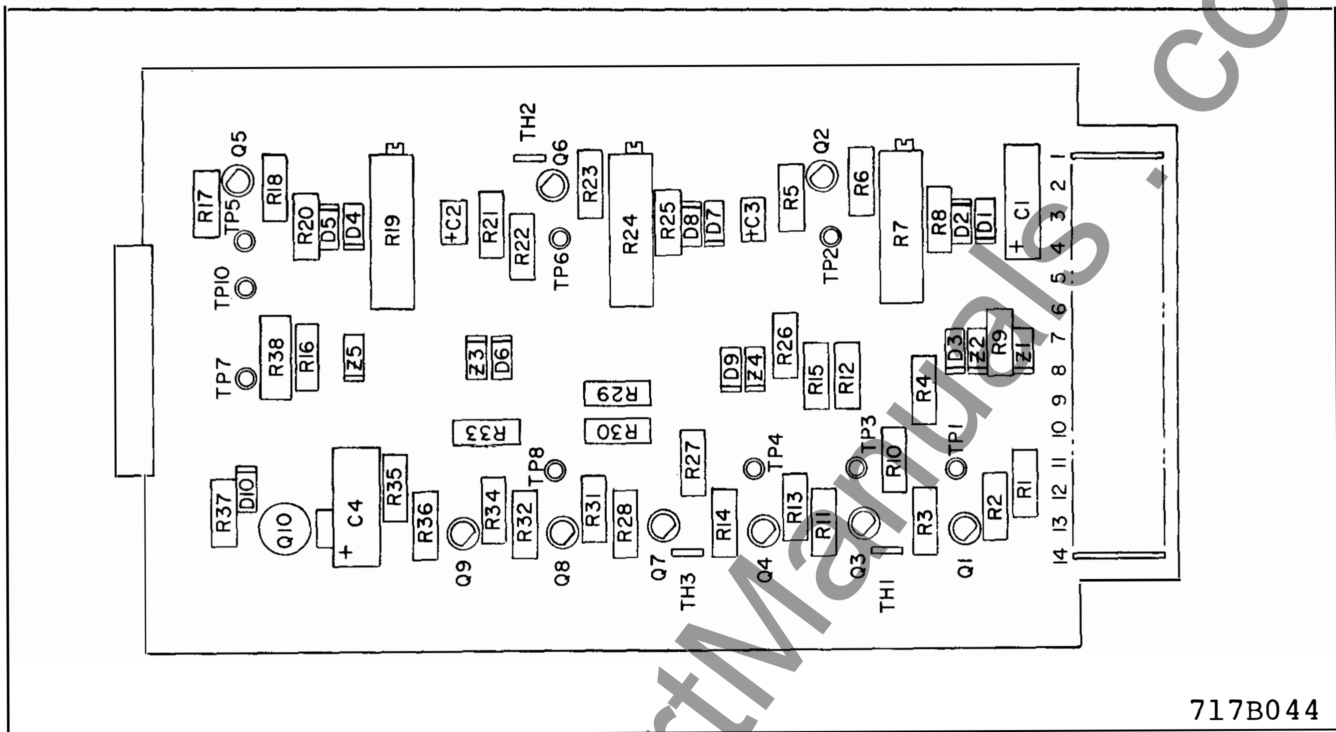


Fig. 25. Component Location – Trip Output Board

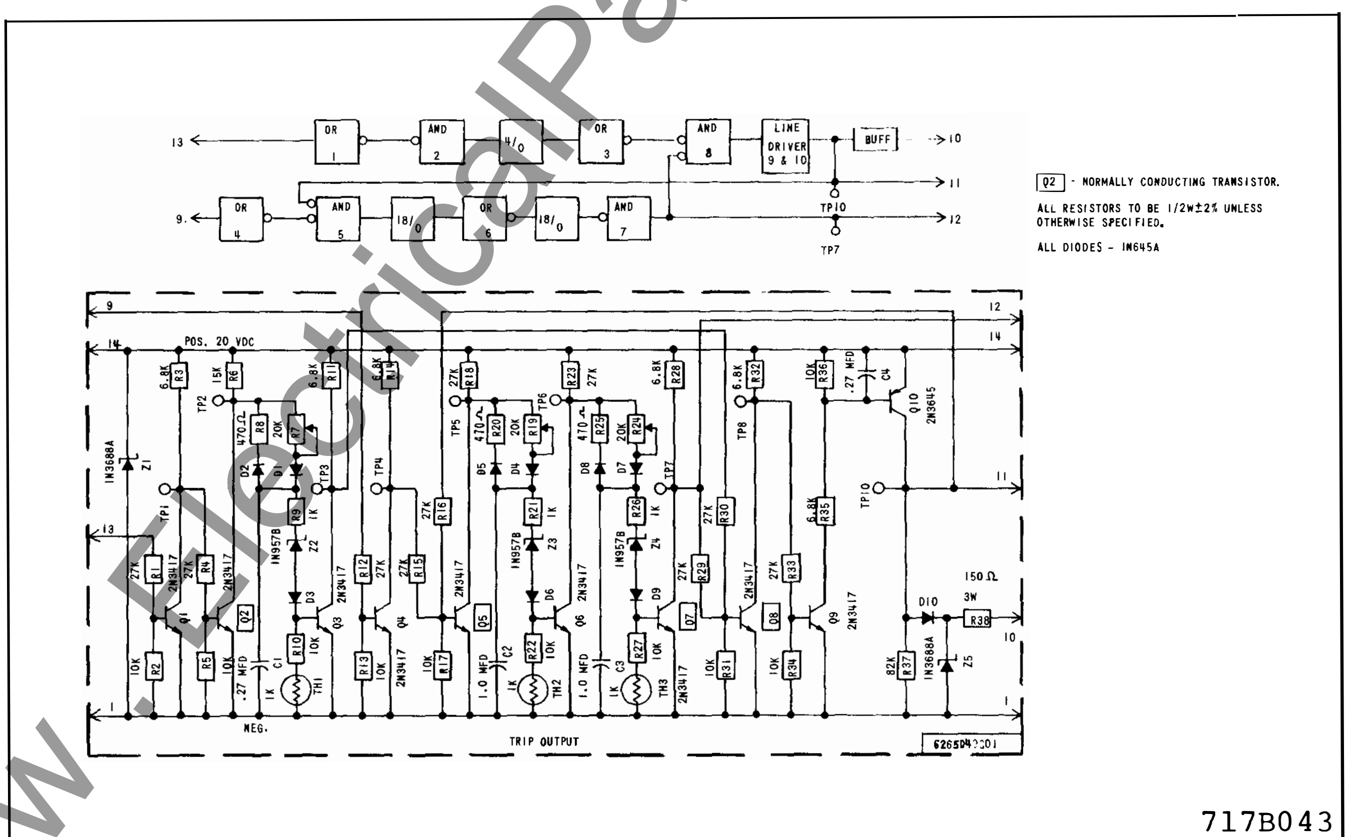
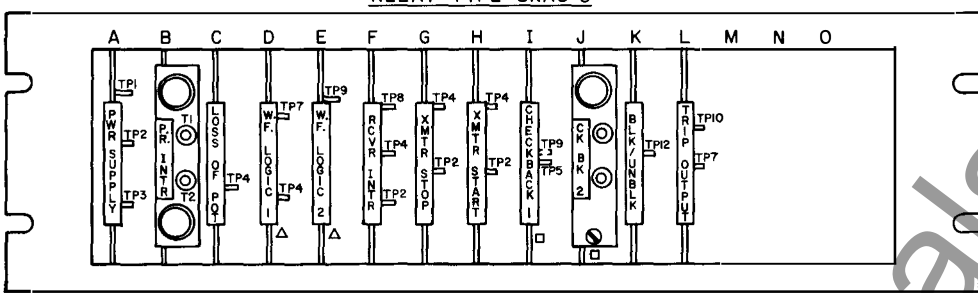


Fig. 26. Internal Schematic- Trip Output board

RELAY TYPE SKAU-3

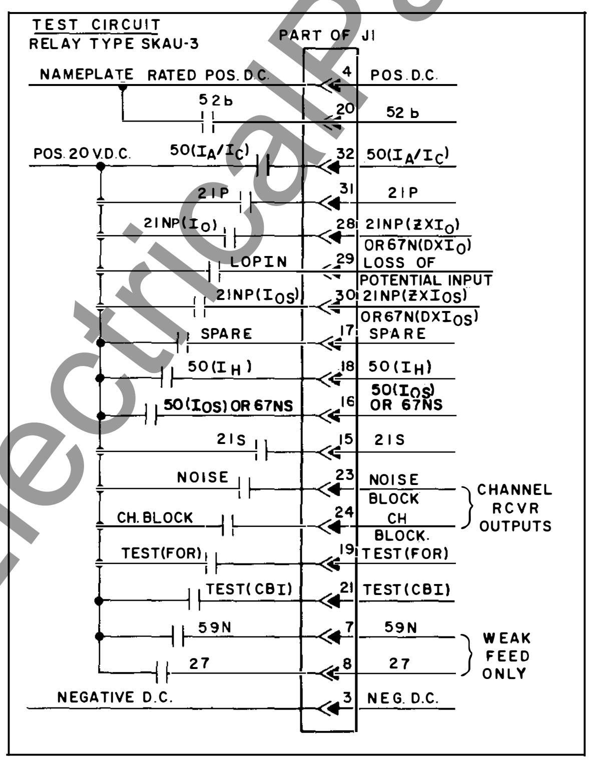


BOARD	SLOT	TEST POINT VOLTAGES (±10%) TO NEG.	BOARD	SLOT	TEST POINT VOLTAGES (±10%) TO NEG.
PWR. SUPPLY	A	TP1 = +20 , TP2 = +20 , TP3 = NEG.	XMTR STOP	G	TP4 : 0 = 0, 1 = 20 TP2 : 0 = 0, 1 = 20
P.R. INTR	B	T1 : 0 = 0, 1 = 13 T2 : 0 = 0, 1 = 13	XMTR START	H	TP4 : 0 = 0, 1 = 20 TP2 : 0 = 0, 1 = 20
LOSS OF POT	C	TP4 : 0 = 0, 1 = 20	CHECKBACK 1 □	I	TP5 : 0 = 0, 1 = 13 TP9 : 0 = 0, 1 = 13
W.F. LOGIC 1 △	D	TP7 : 0 = 0, 1 = 13 TP4 : 0 = 0, 1 = 13	CK BK 2 □	J	RED 0 = 0, 1 = 13 BLACK = NEG.
W.F. LOGIC 2 △	E	TP9 : 0 = 0, 1 = 16	BLK / UNBLK	K	TP12 : 0 = 0, 1 = 16
RCVR INTR	F	TP8 : 0 = 0, 1 = 13 TP4 : 0 = 0, 1 = 13 TP2 : 0 = 0, 1 = 20	TRIP OUTPUT	L	TP10 : 0 = 0, 1 = 20 TP7 : 0 = 0, 1 = 11

△ – OPTIONAL: FOR WEAK FEED SYSTEM ONLY
□ – OPTIONAL: FOR CHANNEL CHECKBACK ONLY

717B230

Fig. 27. Test Point Voltages



878A571

Fig. 28. Test Circuit

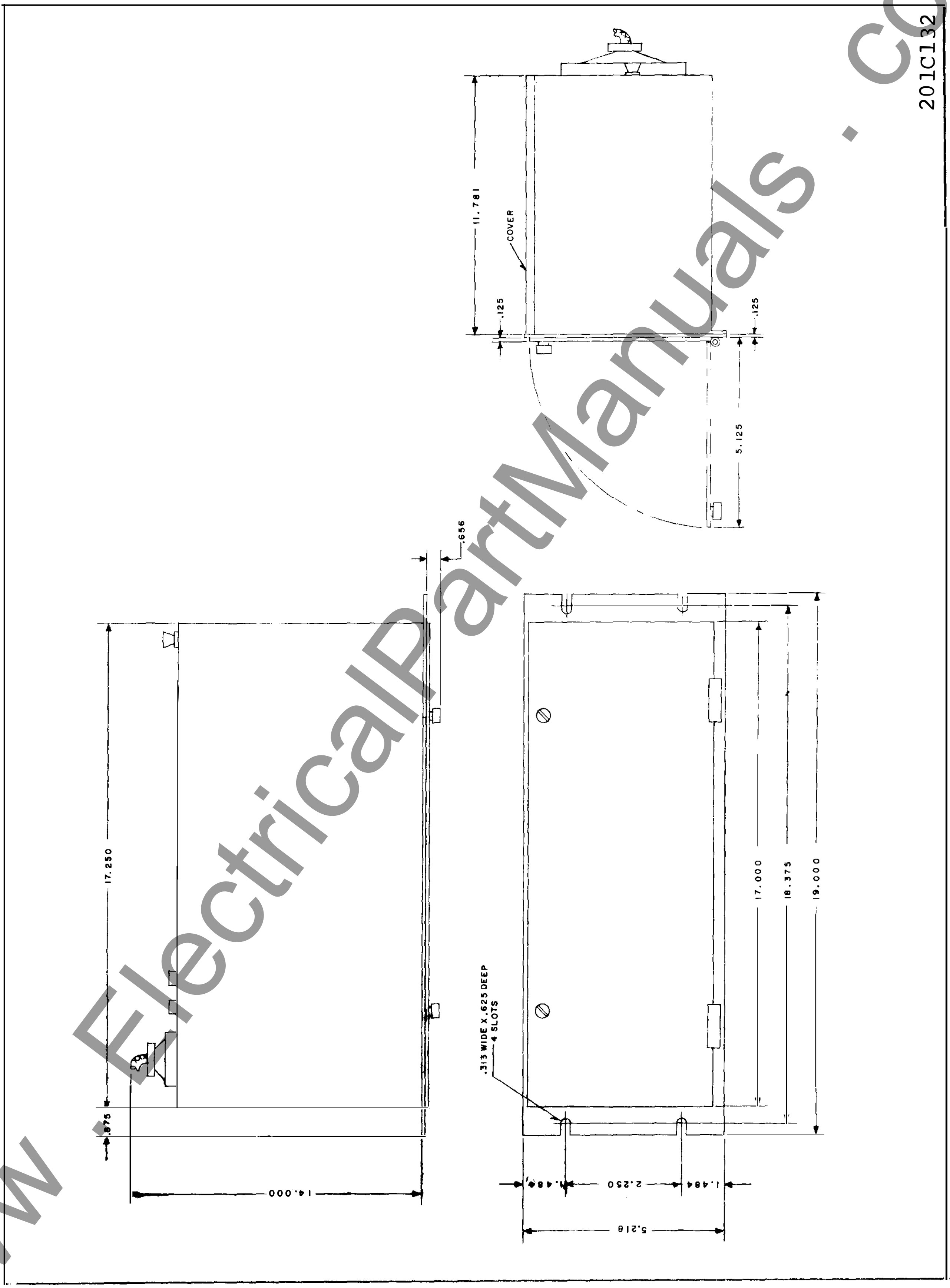


Fig. 29. Outline and Drilling Plan

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION NEWARK, N. J.

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE KA-4 CARRIER AUXILIARY RELAY

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

APPLICATION

The type KA-4 relay is an auxiliary relay used in a distance carrier relaying scheme to block or prevent instantaneous tripping for faults external to the line section to which it is applied, and to permit instantaneous simultaneous tripping for internal faults. The relay is arranged to respond to indications of fault power and direction provided by phase and ground relays, thereby controlling the transmission of the carrier signals.

CONSTRUCTION AND OPERATION

The Type KA-4 relay consists of two auxiliary units, receiver and alarm units, phase fault carrier operation indicator and carrier squelch relay. In addition, the type KA-4 relay contains a high speed overcurrent unit used to start carrier transmission for ground faults. The construction and operation of the relay units are described below. Complete details of the operation of this relay in the distance carrier relaying scheme is described in I.L. 40-208.

Overcurrent Unit

The overcurrent unit consists of a transformer, current limiting reactor, and a product induction cylinder type unit. The time phase relationship of the two air gap fluxes necessary for the development of torque of the cylinder unit is achieved by means of a capacitor connected in series with one pair of pole windings.

Mechanically, the cylinder unit is composed of three basic components: a die-cast aluminum frame and electromagnet, a moving element assembly and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a spring and snap ring. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two pairs of coils. The coils of each pair are mounted diametrically opposite one another. In addition, there are two locating pins. The locating pins are used to accurately position the lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing, which is threaded into the bridge. The electromagnet is permanently secured to the frame and cannot be separated from the frame.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-923.4K, DATED SEPT. 1978
✪ DENOTES CHANGED SINCE PREVIOUS ISSUE.
EFFECTIVE NOVEMBER 1980

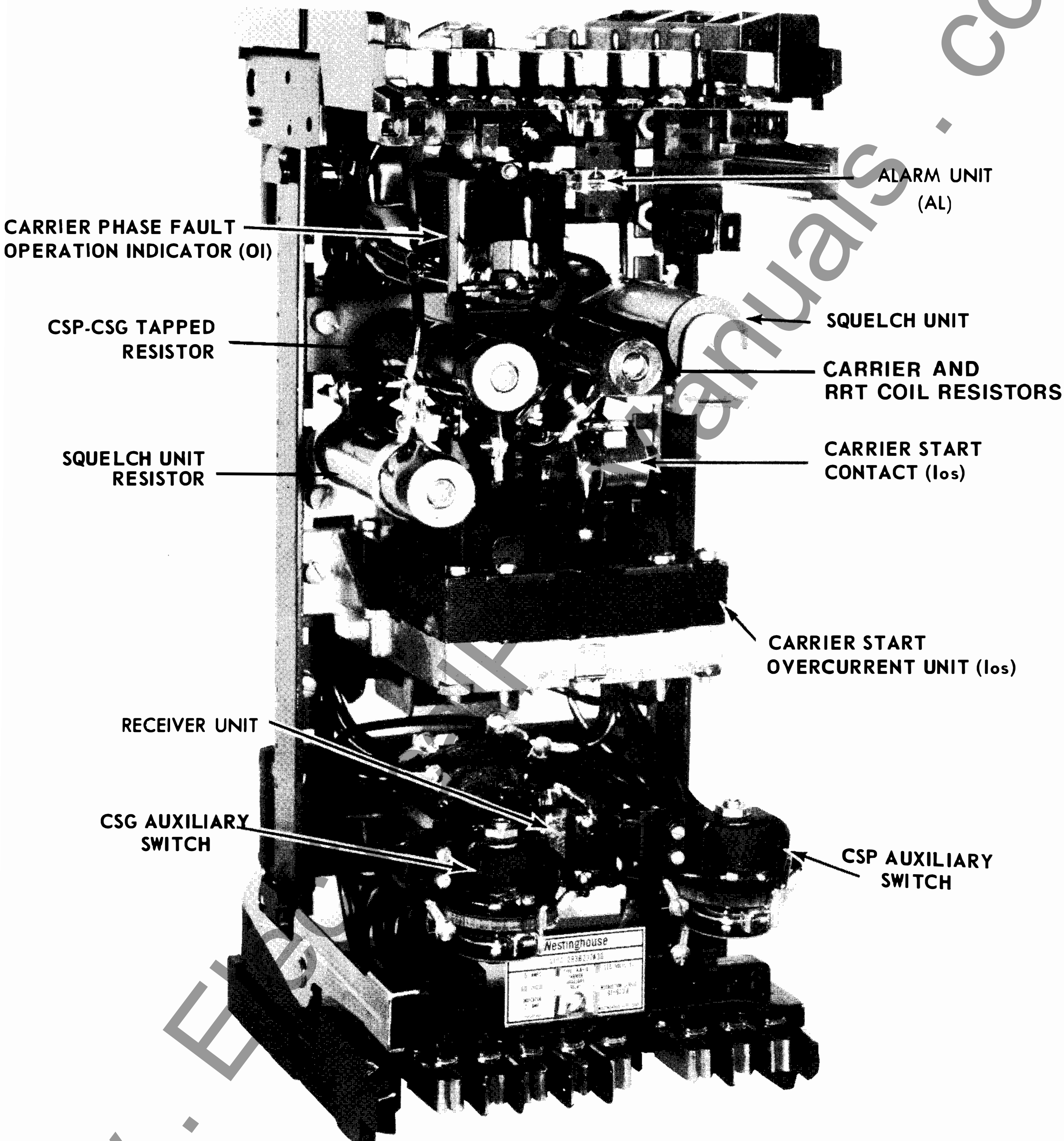


Fig. 1. Type KA-4 Relay Without Case. (Front View)

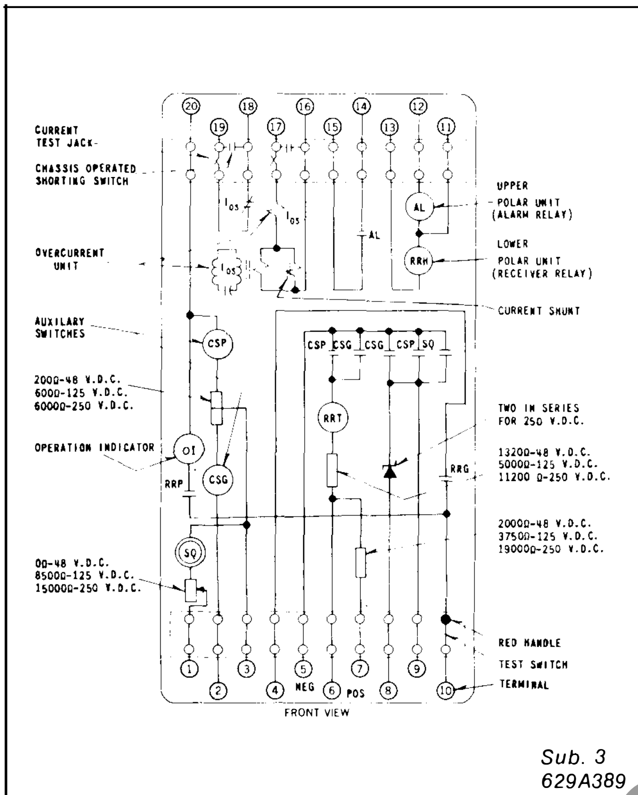


Fig. 2. Internal Schematic of the Type KA-4 Relay for KR carrier set.

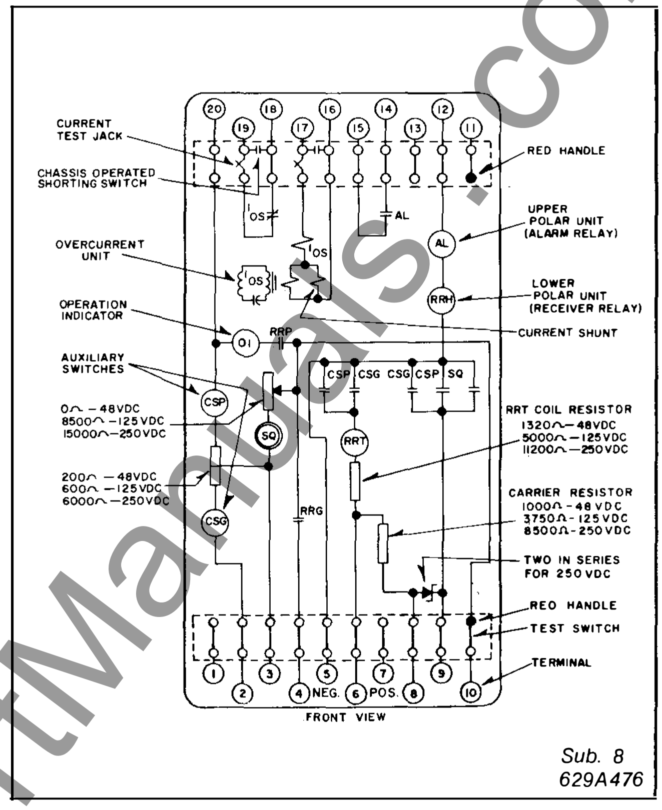


Fig. 3. Internal Schematic of the Type KA-4 Relay for TC carrier set.

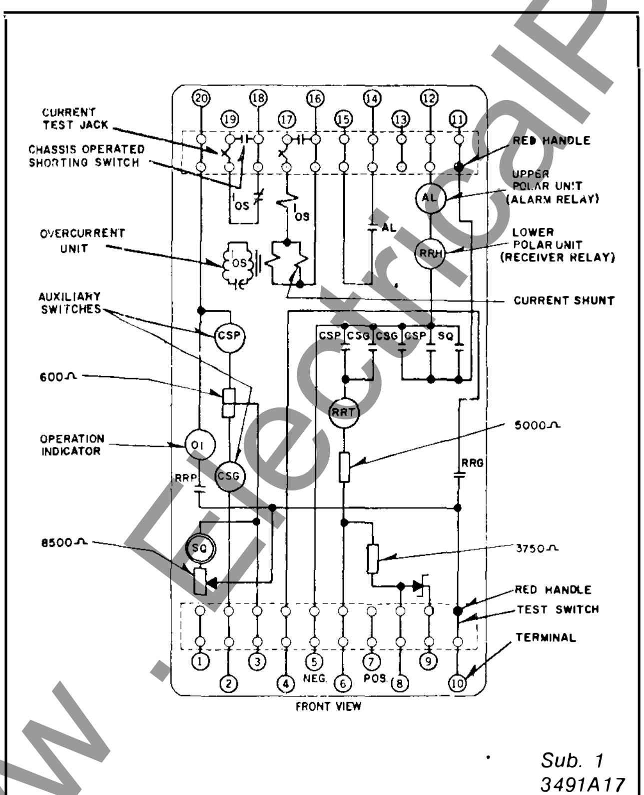


Fig. 4. Internal Schematic of the Type KA-4 Relay with Modified Carrier Stop to Terminal 11 for TC carrier set.

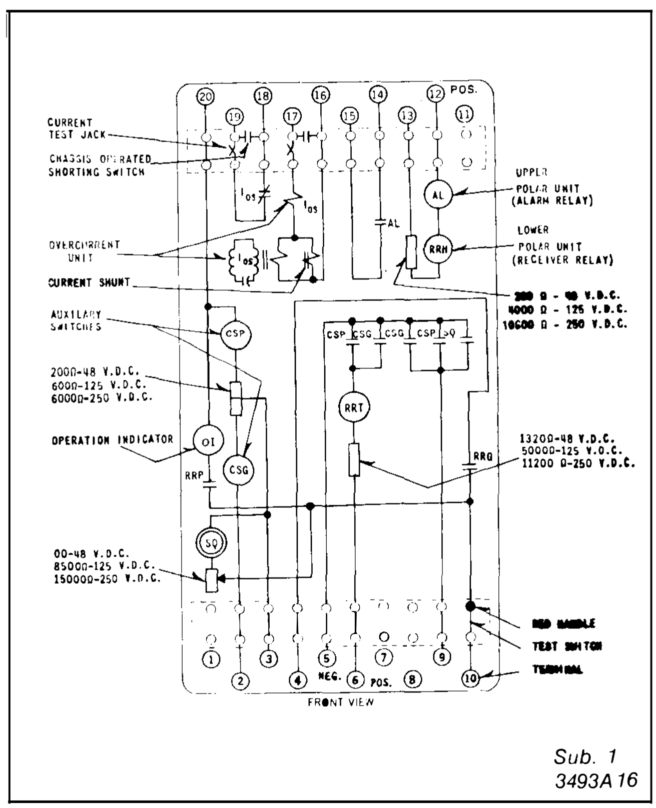


Fig. 5. Internal Schematic of the Type KA-4 Relay for the TA-3 Tones.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearing, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.

With the contacts closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

When the current in the overcurrent unit exceeds the pick-up value the contacts open, allowing positive potential to be applied to the carrier transmitter.

A transformer and current limiting reactor is used in conjunction with the cylinder unit. The transformer supplies one set of coils on the cylinder unit with voltage shifted by approximately 90° from the residual current supplied directly to another set of coils. The transformer and reactor are of the saturating type which limits energy to the cylinder unit and reduces the burden on the transmission line CT.

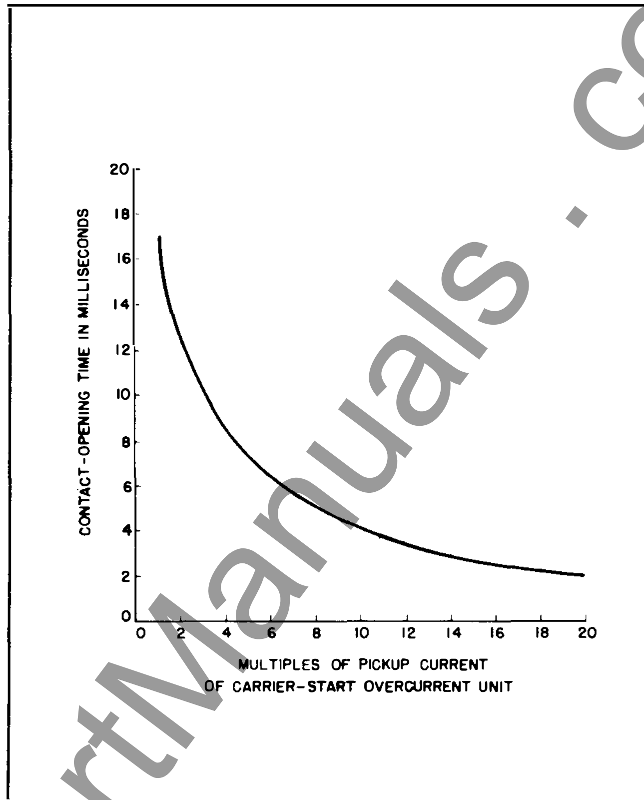
Auxiliary Units

These are two solenoid-type contactor switches designated as CSP and CSG. The plunger of the contactor switch has a circular conducting disc mounted on its lower end and as the plunger travels upward, the disc bridges three silver stationary contacts. The CSP switch is energized by the operation of the second zone or KD-10 distance relay, and the CSG switch, by the operation of the directional and overcurrent units of the KRD-4 ground relay. The contacts of the two switches are connected in parallel as shown in the internal schematic. The operation of either of these switches connects the carrier control circuit to negative to stop carrier, and energizes the RRT operating coil of the receiver relay unit.

Receiver Unit

The receiver unit consists of an armature and contacts mounted on a leaf spring supported symmetrically within a magnet frame. The armature rides in the front air gap of the frame with the contacts projecting outside. The poles of a permanent magnet clamp directly to each side of the frame. Two adjustable shunts are located across the rear air gaps. These change the reluctance of the magnetic path as shown in Fig. 7 so as to force some of the flux thru the moving armature which is fastened to the frame midway between the two rear air gaps. Flux in the armature polarizes it and creates a magnetic bias, causing it to move towards either the left or right, depending upon the adjustment.

Two stationary contact screws are mounted to the left (front view) of the moving contact assembly and adjusted for normally open contacts. These contacts are designated, RRP and RRG, and are connected in the phase and ground trip circuit respectively. These contacts are operated by two concentric coils, RRT and RRH, which are placed around the armature and within the magnetic frame. RRT is the operating coil and



✪ *Fig. 6. Typical Time Characteristics of carrier start overcurrent unit of the type KA-4 Relay.*

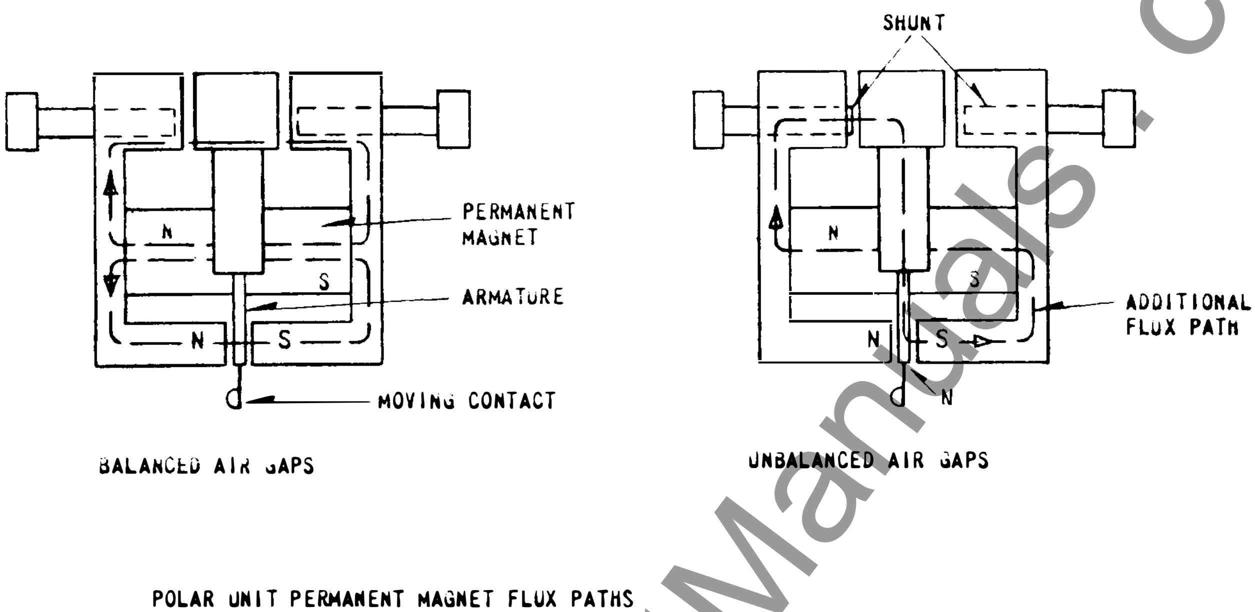


Fig. 7. Permanent Magnet Flux Paths of Receiver and Alarm Units.

receives its energy from the local battery when either CSP or CSG is closed. RRH is the holding coil and receives its energy from the carrier transmitted either from the local transmitter or the one at the end of the line section. These two coils are connected to oppose each other with the operating coil, RRT operating to close the RRP and RRG contacts and trip; and the holding coil, RRH to hold the RRP and RRG contacts open and block tripping. The restraining torque of the RRH coil is sufficient to overcome the operating torque of the RRT coil. Consequently, RRP and RRG contacts cannot close as long as RRH is energized.

Alarm Unit

The alarm unit is similar in construction to the receiver unit except that it is energized by a single coil and operates a single set of contacts. The coil is energized by the received carrier to close its contacts and give an alarm. This unit has a higher-pick-up than that of the receiver unit in order to obtain a direct check on the sensitivity of the carrier transmitter-receiver. The failure of the alarm unit to pick-up when carrier is started indicates insufficient output from the transmitter receivers.

Squelch Unit

The function of the squelch unit is to hold off the carrier for a period of 150 milliseconds after the Breaker "a" contact opens. This is to insure that all other terminals of the line are tripped before allowing carrier to be transmitted for any functions.

The squelch unit is a telephone type unit of slow release type.

In these relays, an electromagnet attracts a right angle iron bracket which in turn operates one normally open contact. The slow release is obtained by a copper slug located at the end opposite from the armature. When the coil becomes de-energized, the change in flux through the slug results in an electromotive force and associated current in it. This current produces a flux which aids the main flux and delays the release of the armature. When the coil is energized, the operation of the relay is not appreciably delayed because the armature is operated by flux not linking the slug.

Operation Indicator

The operation indicator gives a visual indication of a carrier tripping operation for phase faults by the distance relay through the RRP contacts. For a ground fault carrier relaying operation, the indicating contactor switch (ICS) located in the ground relay will drop a target.

CHARACTERISTICS

The characteristics of the various elements of the relays are as follows:

For Use With KR-Set	48V Avg. Ohms	125 Avg. Ohms	250 Avg. Ohms
CSP or CSG Coil	27	27	435
CSP & CSG Tapped Resistor	200	600	6000
Carrier Resistor	2000	3750	19000
RRT Operating Coil	1100	1100	1100
RRT Coil Resistor	1320	5000	11200
RRH Holding Coil	1700	1700	1700
AL Alarm Coil	500	500	500
Operation Indicator (1 amp.)	0.1	0.1	0.1
Squelch Unit Coil	3300	3300	3300
Squelch Unit Adj. Resistor	–	8500	15000

For Use With TC-Set			
CSP or CSG Coil	27	27	435
CSP & CSG Tapped Resistor	200	600	6000
Carrier Resistor	1000	3750	–
RRT Operating Coil	1100	1100	1100
RRT Coil Resistor	1320	5000	11200
RRH Holding Coil	20	20	20
AL-Alarm Coil	4	4	4
Operation Indicator (1 amp.)	0.1	0.1	0.1
Squelch Unit Coil	3300	3300	3300
Squelch Unit Adj. Resistor	–	8500	15000

For Use With TA-3 Tones	48V Avg. Ohms	125V Avg. Ohms	250V Avg. Ohms
CSP or CSG Coil	27	27	435
CSP & CSG Tapped Resistor	200	600	6000
AL & RRH Resistor	200	4000	10600
RRT Operating Coil	1100	1100	1100
RRT Coil Resistor	1320	5000	11200
RRH Holding Coil	1700	1700	1700
AL Alarm Coil	500	500	500
Operating Indicator (1 amp.)	0.1	0.1	0.1
Squelch Unit Coil	3300	3300	3300
Squelch Unit Adj. Resistor	–	8500	15000

The pick-up and operating values of these units are given under "Adjustments and Maintenance".

The time characteristic of the overcurrent unit is shown in Fig. 6.

The pick-up value of the over-current unit can be changed from the factory adjusted value of 0.5 amperes to any value up to 1 amp. by increasing spring restraint.

SETTINGS

There are no settings to be made.

INSTALLATION

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

The carrier relaying schematic (supplied with the carrier order) should be consulted for details of the external connections of these relays.

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Check

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

Overcurrent Unit

Pass 0.5 amperes of alternated current through relay terminals 16 and 17, the contact should pick-up within .475 and .525 amp.

Auxiliary Units (CSP and CGS)

Each contactor switch has a section of a tapped resistor in series with it, and will pick up positively when rated control voltage is applied across the coil and its section of the resistor.

These units should operate at 24 volts for the 48-volt relay, 60 volts for the 125-volt relay, and 120 volts for 250-volt relay. These units have an intermittent rating, and should not be energized for more than a few seconds.

Operation Indicator (OI)

With the polar unit contacts closed, apply direct current to the operation indicator relay terminals. The operation indicator should pick-up and drop the indicator target between 1 ampere and 1.2 amperes dc.

Squelch Unit (SQ)

Apply rated D.C. voltage to relay terminals that will energize the squelch unit and note contact operation.

Blocking Zener Diode

Apply rated D.C. Voltage in series with 10,000 ohms resistors across terminals 8 and 9 with positive on 9, the current leakage flow should not exceed .25 ma. Reverse polarity of the applied voltage; the current flow should be equal to the applied voltage divided by the series resistance.

FOR RELAYS TO BE USED WITH TC-TYPE CARRIER

Receiver Unit

Connect a jumper between the middle and left hand contact connection of the CSG or CSP switch. The CSG switch is located on the left-hand pedestal and CSP is located on the right-hand pedestal on the relay (front view). Apply rated voltage across the RRT coil and the RRT coil resistor, observing polarity as shown in the internal schematic. The armature should move to the left.

To the holding coil (RRH) relay terminals, apply direct current observing polarity. Increase the current until the armature moves to the right.

The armature should move to the right at approximately 60 ma. Now reduce the current and the armature should move to the left at approximately 40 ma.

Alarm Unit (AL)

Connect direct current to the alarm unit relay terminals. Increase the current until the contacts pick-up. The contacts should pick up at approximately 80 ma. Now reduce the current and the contacts should open at 40 to 60 ma.

✪ FOR RELAYS TO BE USED WITH TYPE KR CARRIER OR TA-3 TONES

Receiver Unit

Connect a jumper between the middle and left hand contact connection of the CSG or CSP switch.

CSG switch is located on the left-hand pedestal and CSP is located on the right-hand pedestal on the relay (front view). Apply rated voltage across the RRT coil and the RRT coil resistor, observing polarity as shown in the internal schematic. The armature should move to the left.

To the holding coil (RRH) relay terminals, apply direct current observing correct polarity. Increase the current until the armature moves to the right. The armature should move to the right at approximately 6 ma. Now reduce the current and the armature should move to the left at approximately 4 ma.

Alarm Unit (AL)

Connect direct current to the alarm unit relay terminals. Increase the current until the contacts pick up. The contacts should pick up at approximately 8 ma. Now reduce the current and the contacts should open at 4 to 6 ma.

ROUTINE MAINTENANCE

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

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

CALIBRATION

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

Overcurrent Unit

The upper bearing screw should be screwed down until there is approximately 1/64" clearance between it and the top of the shaft bearing. Securely lock in position with the lock nut. The lower bearing position is fixed and cannot be adjusted.

With the moving contact in the normally closed position, i.e., against the right side of the bridge, screw in the stationary contact until both contacts just close. Then screw in the stationary contact approximately one-quarter turn farther to provide the correct amount of follow for KR & TC type carrier, one-half turn for TA-3 tones.

The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver or similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

Pass 0.5 amp. of a.c. through relay terminals 16 and 17. Adjust the spring until the contact just opens. In a similar manner the pick-up value can be adjusted for any value between .5 to 1.0 amp.

Auxiliary Units (CSP and CSG)

The two contactor switches, CSP and CSG, have adjustable plunger travel. Adjust the stationary core and the moving core of 1/64" when the switch is picked up. This can be done by turning the relay upside-down and screwing up the core screw of the switch until the contacts just separate. Then back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for approximately 1/32" by means of the two small nuts on either side of the Micarta disc.

Each contactor switch has a section of a tapped resistor in series with it, and will pick up positively when rated trip circuit voltage is applied across the coil and its section of the resistor.

The units should operate at 24 volts for the 48-volt relay, 60 volts for the 125-volt relay and 120 volts for 250-volt relay. These units have an intermittent rating, and should not be energized for more than a few seconds.

Squelch Unit

Check operation with timer. Adjust series resistor to measure approximately 5000 ohms for 125 v.d.c. relays and for 13000 ohms for 250 v.d.c. relay. With armature closed adjust the residual air gap to be .002" − .003". Contact gap should measure from .020" to .035". Check for dropout time between .140−.160 seconds. If necessary dropout time can be adjusted by changing the residual air gap. After final adjustment the gap should be at least .002". The pick up time should be below 16 milliseconds at −20% rated dc voltage. If necessary readjust series resistor.

Operation Indicator

The operation indicator should pick up and drop the indicator target when the current is between 1 and 1.2 amperes dc.

Make sure that the target drops freely when the unit operates.

ZENER DIODE TEST

Forward Characteristics

Pass 200 milliamperes of dc current through terminals 8 and 9 with positive on terminal 8. Measure voltage drop across terminals 8 and 9. The voltage drop should not exceed 3.5 volts.

Reverse Characteristics – Breakdown Voltage

The breakdown voltage is determined by increasing voltage across terminals 8 and 9 with positive on 9. Place 10,000 ohm resistor in series with ammeter. Increase voltage until current reads .25 milliamperes. Measure dc voltage across terminals 8 and 9. The voltage should be between 160 and 240 volts for 48 and 125 v.d.c. rated relays; and 320 to 480 volts for 250 v.d.c. rated relays. **Do not** exceed 3.0 ma. current in the circuit.

FOR RELAY TO BE USED WITH TC-TYPE CARRIER

Receiver Unit

Back off contact screws so that they do not make contact. Screw magnetic shunts into the all-out position (5 or 6 screw threads showing.) The armature should remain against whichever side it is pushed with this adjustment.

Adjust the stationary contacts for a contact gap of approximately .020". This can be done by inserting a .010" steel thickness gage between the large rivet head on the moving armature and the right hand pole face (a .010" travel of the rivet head is equal to .020" travel of the moving contacts). Using an indicating light in each contact circuit, adjust the upper and lower stationary contacts to touch the moving contact at the same time. With the feeler gauge removed the contact gap is .020" and the moving contacts close simultaneously.

Connect a jumper between the middle and left hand contact connection of the CSG or CSP switch. The CSG switch is located on the left-hand pedestal and CSP is located on the right hand pedestal of the relay (front view). Apply rated voltage across the RRT coil and the RRT coil resistor observing polarity as shown in the internal schematic diagram. The armature should move to the left.

To the holding coil, RRH, apply 100 to 200 milliamperes dc current observing correct polarity. The armature shoud now move to the right. De-energize both coils and see that the armature stays up against the right hand side.

Run both shunt screws all the way in, and then back out the left hand shunt screw approximately 6 turns. Back out the right hand shunt screw approximately 9 turns.

Re-energize the operating coil with rated voltage and the holding coil with 40 milliamperes dc. Adjust the right hand shunt screw until the armature moves to the left. If the armature moves to the left, at a value of holding coil current greater than 40 milliamperes, the right hand shunt screw should be turned out to lower this value to the correct 40 milliampere point.

Increase the holding coil current to 60 milliamperes and adjust the left hand shunt screw until the armature resets, or moves to the right. If the armature resets at a value of current less than 60 milliamperes, the left hand shunt screw should be turned out. This will increase the reset value of the armature and provide for the correct 60 milliampere reset value.

Minor adjustments of both shunt screws must be made several times until the desired operating points are obtained, since the adjustments of one shunt screw affect the adjustment on the other shunt screw.

Alarm Unit

The contacts should close with 80 milliamperes dc ±5% applied to the alarm coil. Adjust the contact screws to obtain an .050" contact gap such that the armature motion between the left and right hand contacts is in the central part of the air gap between the pole faces. Tighten the contact locking nuts. Approximate adjustments of the two magnetic shunt screws are as follows:

Turn both shunt screws all the way in. Then back out both shunt screws approximately seven turns. Apply 80 milliamperes dc to the coil observing correct polarity, and the screw in the left hand shunt screw until the armature moves to the right. If the armature moves to the right at a value of current less than 80 milliamperes, screw the left hand shunt out until the armature moves to the right at 80 milliamperes. Check the dropout point by reducing the dc current. The armature should move to the left between the limits of 40 and 60 milliamperes. If it fails to do so, adjust the right hand shunt screw until it does. It will then be necessary to recheck the pickup and dropout points again and make any minor adjustments to the shunt screws that may be necessary until correct calibration is obtained.

In general, screwing in the left hand shunt screw reduces the pickup current of the relay. Screwing in the right hand shunt screw increases the dropout current. This will in turn cause a change in the pickup current, making necessary several slight readjustments of both shunt screws to obtain the desired calibration. The armature as finally calibrated should pickup and dropout with a snappy action.

FOR RELAYS TO BE USED WITH ✪ KR-TYPE CARRIER OR TA-3 TONES

Receiver Unit

Calibrate as outlined under TC Type Carrier. Apply 15 ma. dc current for polarity check. The pickup value should be 4 milliamperes dc (armature moves to left) instead of 40 ma. The calibration of reset (armature moves to the right) should be done at 6 milliamperes instead of 60 ma.

Alarm Unit

Calibrate as outlined under TC-Type Carrier. Check pick-up at 8 milliamperes ±5% instead of 80 ma. Dropout should be between 4 and 6 ma. instead of 40 and 60 ma.

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.

ENERGY REQUIREMENTS

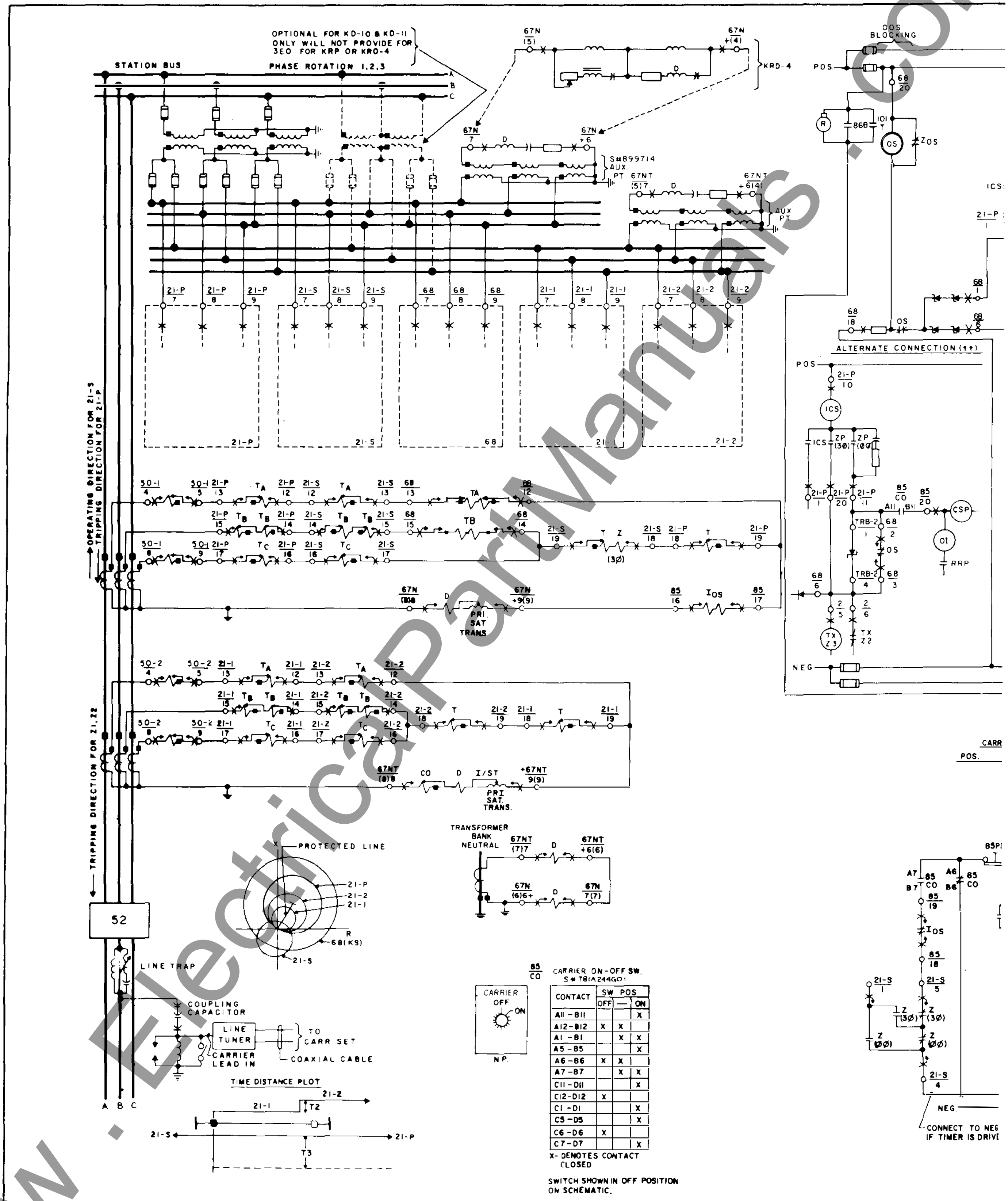
Current Burden at 60 Cycles.

CURRENT AMPERES	VOLT-AMPERES	POWER FACTOR ANGLE
0.5	2.2	33° †
5	43	70° †
20	394	49° ††
40	1240	39.2° ††
60	2760	32.5° ††

† Current lagging voltage
†† Current leading voltage

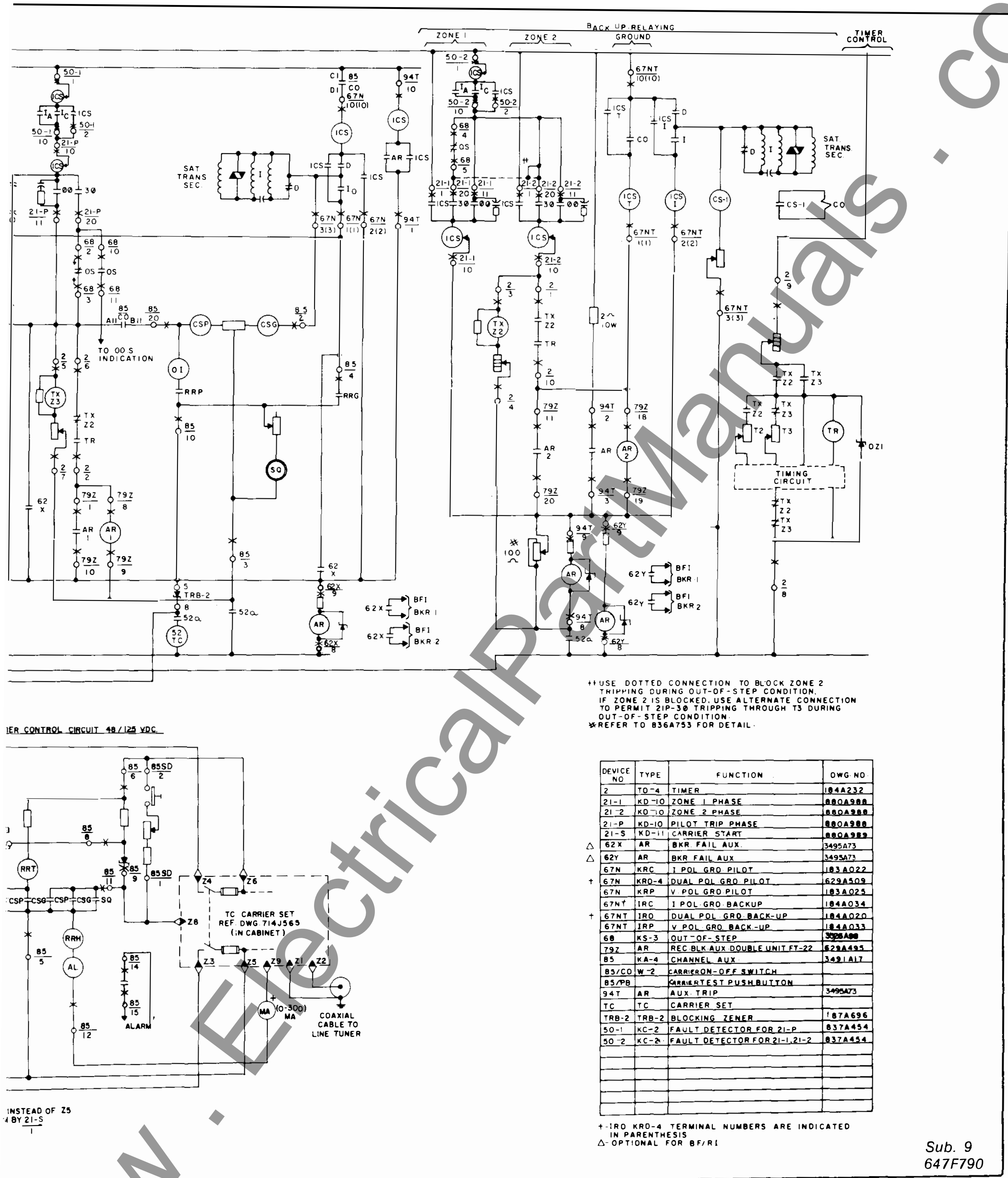
Rating of Overcurrent Unit

Continuous rating 5 amperes. One second rating 100 amps.



CONTACT	SW POS OFF	—	ON
A11-B11			X
A12-B12	X	X	
A1-B1		X	X
A5-B5			X
A6-B6	X	X	
A7-B7		X	X
C11-D11			X
C12-D12	X		
C1-D1			X
C5-D5			X
C6-D6	X		
C7-D7			X

✪ *Fig. 9. Typical External Sc*
KD-10/TC Blocking S



‡ USE DOTTED CONNECTION TO BLOCK ZONE 2 TRIPPING DURING OUT-OF-STEP CONDITION. IF ZONE 2 IS BLOCKED, USE ALTERNATE CONNECTION TO PERMIT 21P-30 TRIPPING THROUGH T3 DURING OUT-OF-STEP CONDITION.

✲ REFER TO 836A753 FOR DETAIL.

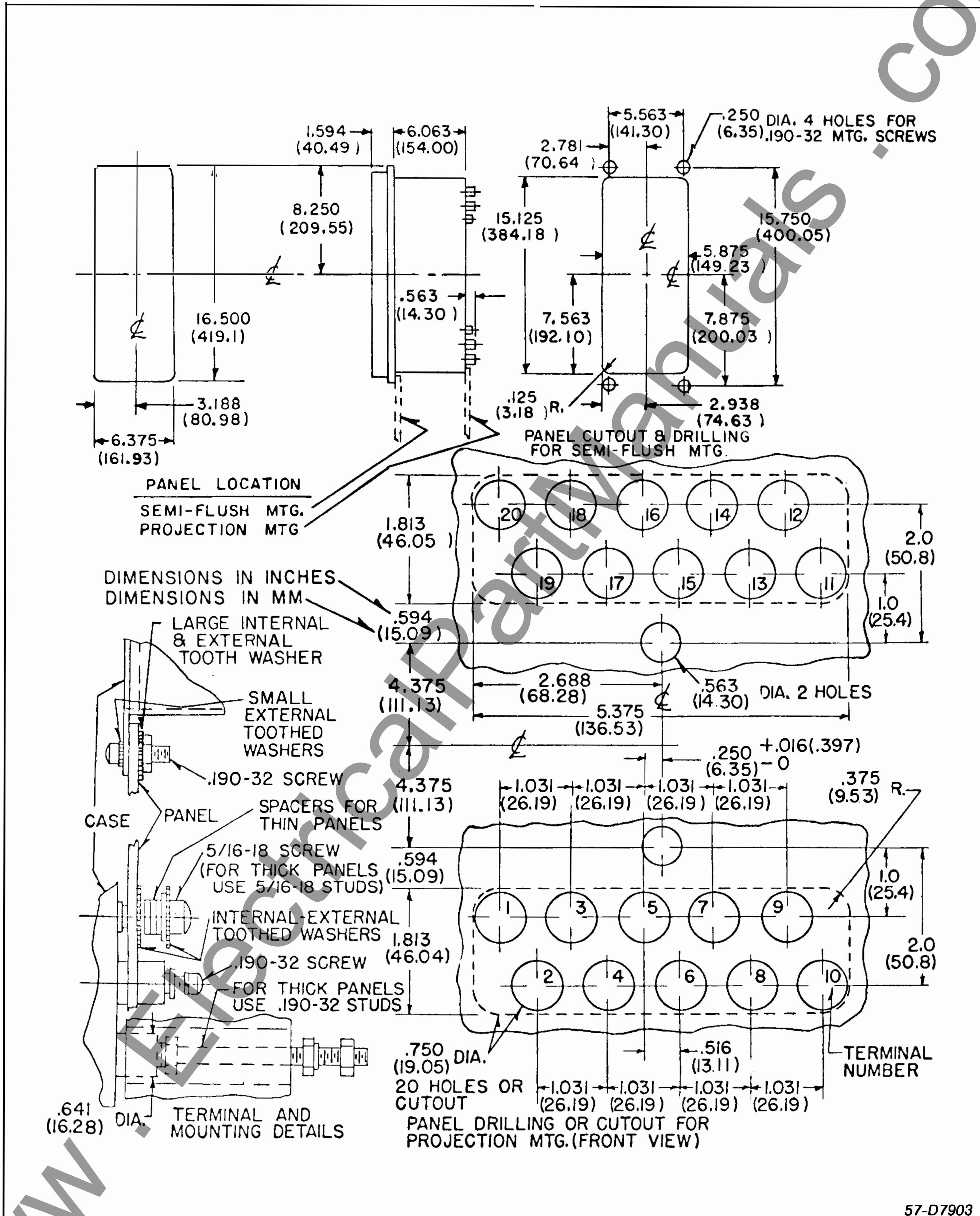
DEVICE NO	TYPE	FUNCTION	DWG NO
2	TO-4	TIMER	184A232
21-1	KD-10	ZONE 1 PHASE	880A988
21-2	KD-10	ZONE 2 PHASE	880A988
21-P	KD-10	PILOT TRIP PHASE	880A988
21-S	KD-11	CARRIER START	880A989
△ 62X	AR	BKR. FAIL AUX.	3495A73
△ 62Y	AR	BKR FAIL AUX	3495A73
67N	KRC	I POL GRD PILOT	183A022
† 67N	KRD-4	DUAL POL GRD PILOT	629A509
67N	KRP	V POL GRD PILOT	183A025
67NT	IRC	I POL GRD BACKUP	184A034
† 67NT	IRD	DUAL POL GRD BACK-UP	184A020
67NT	IRP	V POL GRD BACK-UP	184A033
68	KS-3	OUT-OF-STEP	3526A98
79Z	AR	REC BLK AUX DOUBLE UNIT FT-22	629A495
85	KA-4	CHANNEL AUX	3491A17
85/CO	W-2	CARRIER ON-OFF SWITCH	
85/PB		CARRIER TEST PUSHBUTTON	
94T	AR	AUX TRIP	3495A73
TC	TC	CARRIER SET	
TRB-2	TRB-2	BLOCKING ZENER	187A696
50-1	KC-2	FAULT DETECTOR FOR 21-P	837A454
50-2	KC-2	FAULT DETECTOR FOR 21-1, 21-2	837A454

† - IRD KRD-4 TERMINAL NUMBERS ARE INDICATED IN PARENTHESIS

△ - OPTIONAL FOR BF/RI

Sub. 9
647F790

...hematic of a KA-4 Relay in a ...ystem.



✪ *Fig. 10. Outline and Drilling Plan for Type KA-4 Relay in Type FT-32 Case.*

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **CORAL SPRINGS, FL.**

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