Instruction Leaflet
41-923.4M

Type KA-4
Carrier Auxiliary Relay

Effective: August 1985
Supersedes I.L. 41-923.4L, dated November 1980

(|) Denotes Changes since previous issue

CAUTION

Before putting the Synchro-Verifier into service, remove all blocking 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 clean and close properly, and operate the relay to check the settings and electrical connections.

1.0 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 indictions of fault power and direction provided by phase and ground relays, thereby controlling the transmission of the carrier signals.

2.0 CONSTRUCTION & OPERATION

The type KA-4 relay consists of two auxiliary units, receivers 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.

2.1. 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

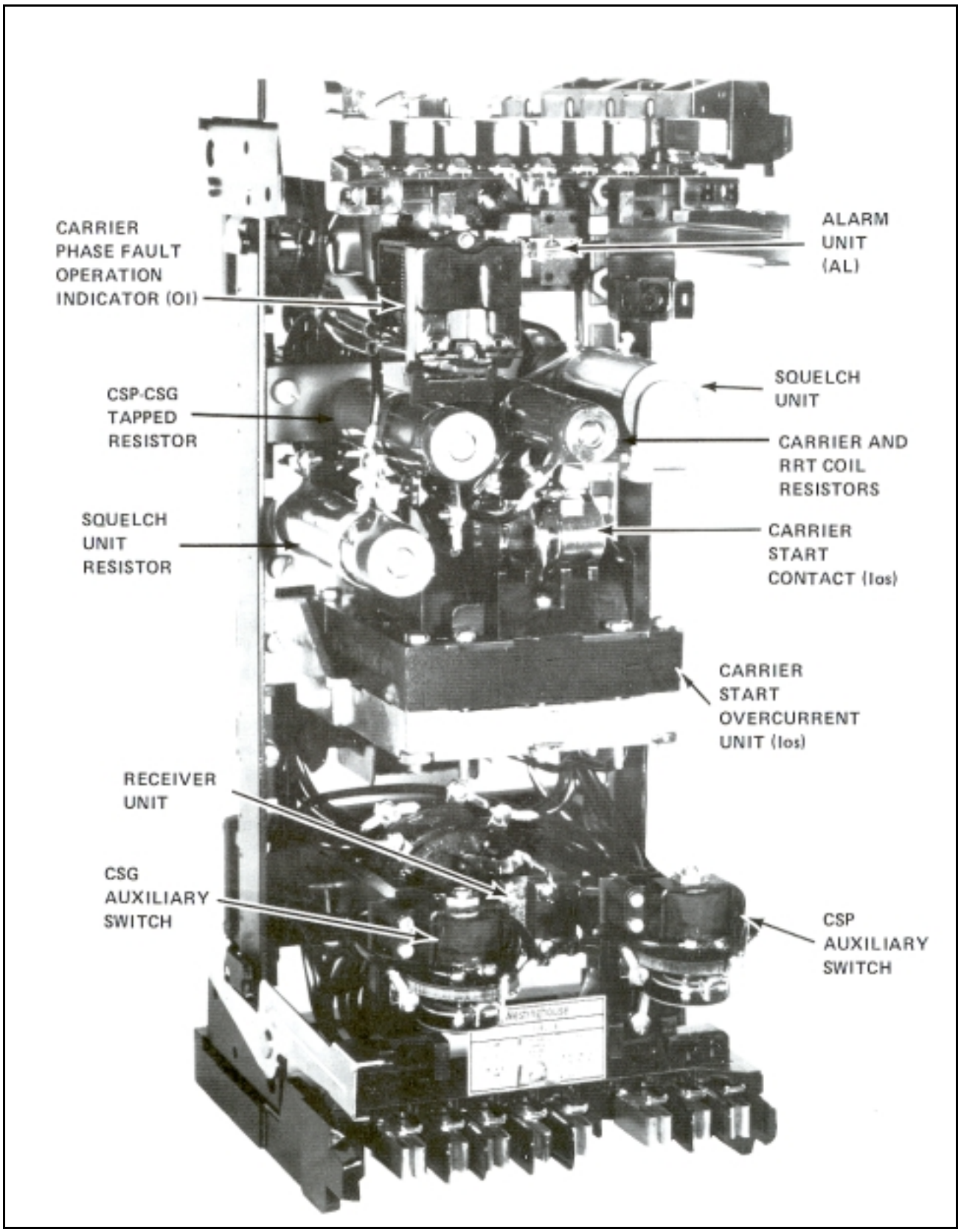

Figure 1. Type KA-4 Relay without case. (Front View)

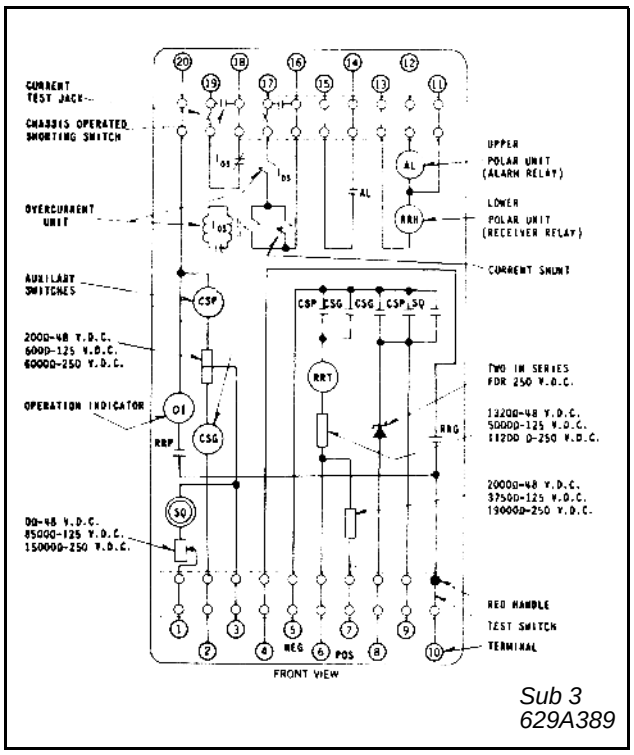

Figure 2. Internal Schematic of the Type KA-4 Relay for KR Carrier Set.

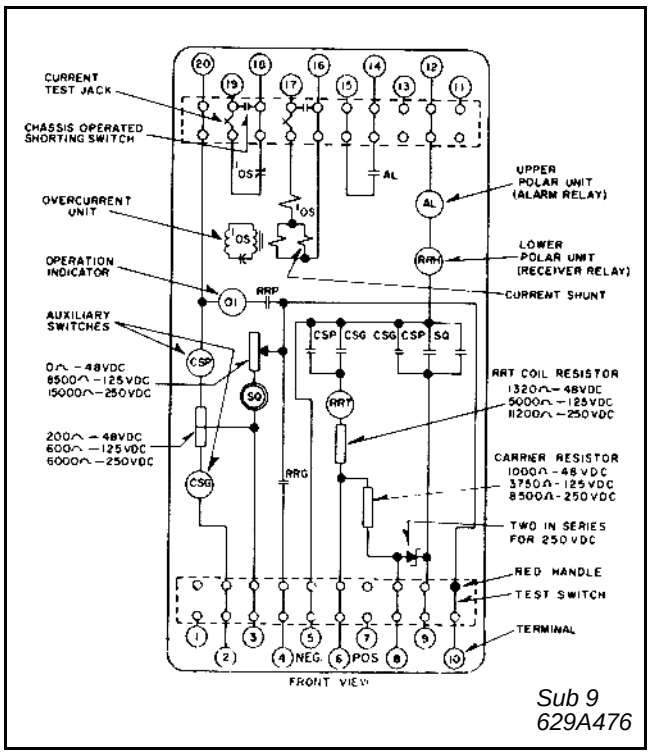

Figure 3. Internal Schematic of the Type KA-4 Relay for TC Carrier Set.

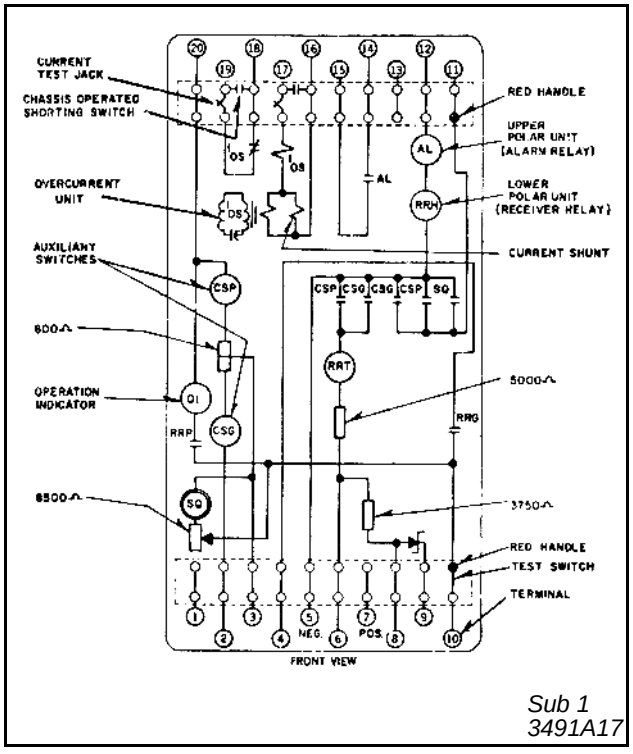

Figure 4. Internal Schematic of the Type KA-4 Relay with Modified Carrier Stop to Terminal 11 for TC Carrier Set.

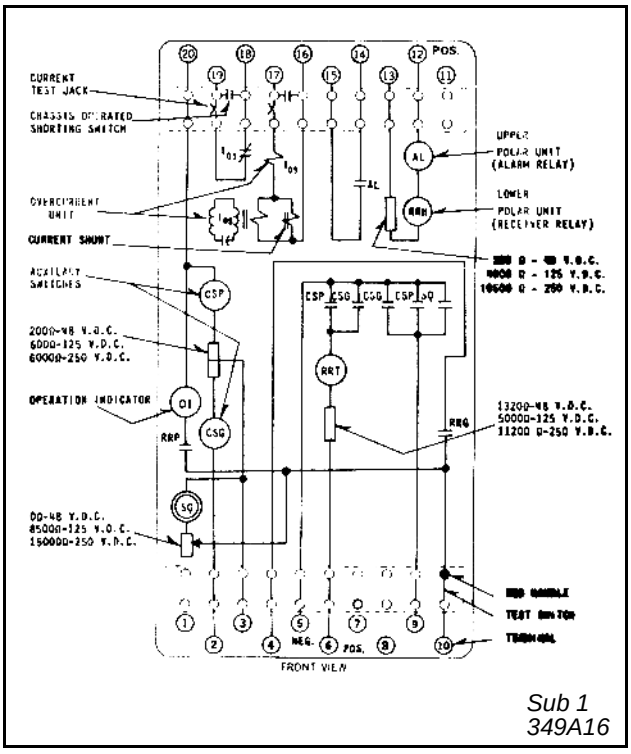

Figure 5. Internal Schematic of the Type KA-4 Relay for the TA-3 tones.

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 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.

2.2. 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.

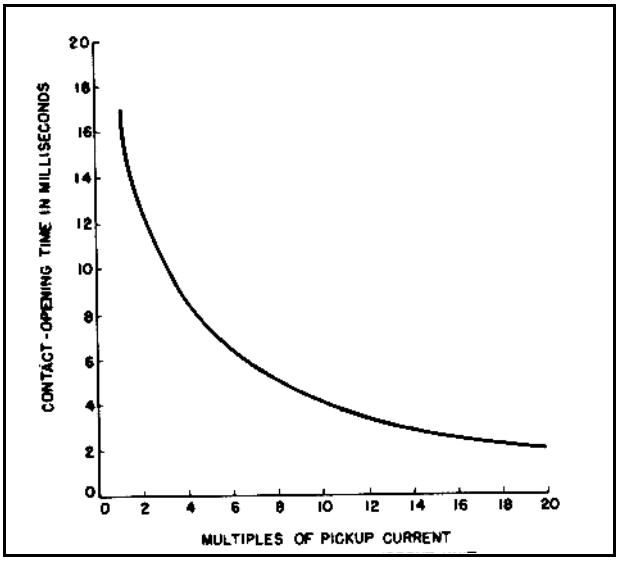

Figure 6. Typical Time Characteristics of carrier start overcurrent unit of the type KA-4 Relay.

2.3. 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 Figure 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 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 in oppose each other with the operating coil, RRT oper-

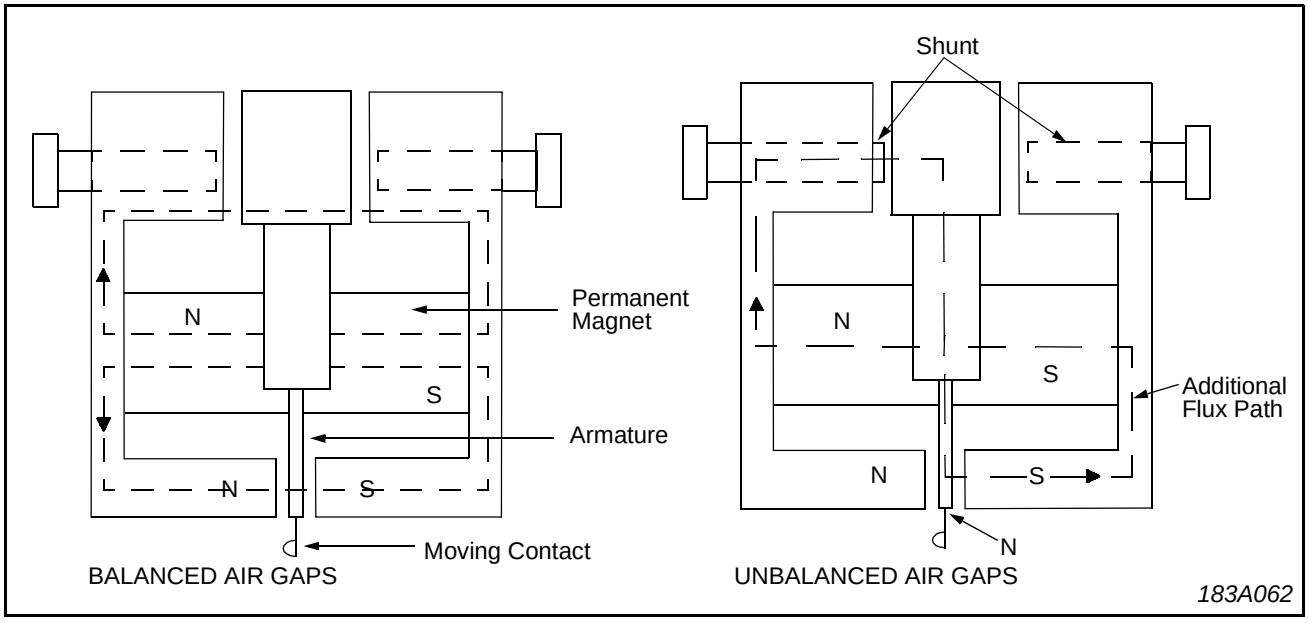

Figure 7. Permanent Magnet Flux Paths of Receiver and Alarm Units

ating 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.

2.4. 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.

2.5. SQUELCH UNIT

The function of the squelch unit is to hold of 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 deenergized, the change in flux through the slug results in an electromotive force and associated current in it. This current produces a flux which aids the main flux and delays the release of the armature. When the coil is energized, the operation of the relay is not appreciably delayed because the armature is operated by flux not linking the slug.

2.6. 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.

3.0 CHARACTERISTICS

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

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

The time characteristic of the overcurrent unit is

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	1500
For Use With TC-Set			
CSP or CSG Coil	27	27	45
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			
CSP or CSG Coil	27	27	435
CSP & CSG Tapped Resistor	200	600	6000
Carrier 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
Operation Indicator (1 amp.)	0.1	0.1	0.1
Squelch Unit Coil	3300	3300	3300
Squelch Unit Adj. Resistor	-	8500	15000

shown in figure 6.

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

4.0 SETTINGS

There are not settings to be made

5.0 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.

6.0 ADJUSTMENTS & 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.

6.1. ACCEPTANCE CHECK

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

6.1.1. Overcurrent Unit

Pass 0.5 amperes of altered current through relay terminals 16 and 17, the contact should pickup within .475 and .525 amp.

6.1.2. 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.

6.1.3. 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.

6.1.4. Squelch Unit (SQ)

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

6.1.5. Blocking Zener Diode

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

6.2. FOR RELAYS TO BE USED WITH TC-TYPE CARRIER

6.2.1. 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.

6.2.2. 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.

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

6.3.1. 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.

6.3.2. Alarm Unit (AL)

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

7.0 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 Style # 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.

7.1. 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”).

7.1.1. 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 ac 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 and 1.0 amp.

7.1.2. 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 voltages 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.

7.1.3. Squelch Unit

Check operation with timer. Adjust series resistor to measure approximately 5000 ohms for 125 Vdc relays and for 13000 ohms for 250 Vdc 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 and .160 seconds. If necessary dropout time can be adjusted by changing the residual air gap. After final adjustment the gap should be at lease .002". The pickup time should be below 16 milliseconds at -20% rated dc voltage. If necessary readjust series resistor.

7.1.4. Operation Indicator

The operation indicator should pickup 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.

7.2. ZENER DIODE TEST

7.2.1. Forward Characteristics

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

7.2.2. 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 mA. Measure dc voltage across terminals 8 and 9. The voltage should be between 160 and 240 volts for 48 and 125 Vdc rated relays; and 320 to 480 volts for 250 Vdc rated relays. **DO NOT** exceed 3.0 mA current in the circuit.

7.3. FOR RELAY TO BE USED WITH TC-TYPE CARRIER

7.3.1. 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 0.20" 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 right-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 should now move to the right. Deenergize 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.

7.3.2. 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 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.

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

7.4.1. 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.

7.4.2. Alarm Unit

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

8.0 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.

9.0 ENERGY REQUIREMENTS

9.1. 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.*

9.2. RATING OF OVERCURRENT UNIT

Continuous rating 5 amperes. One second rating 100 amps.

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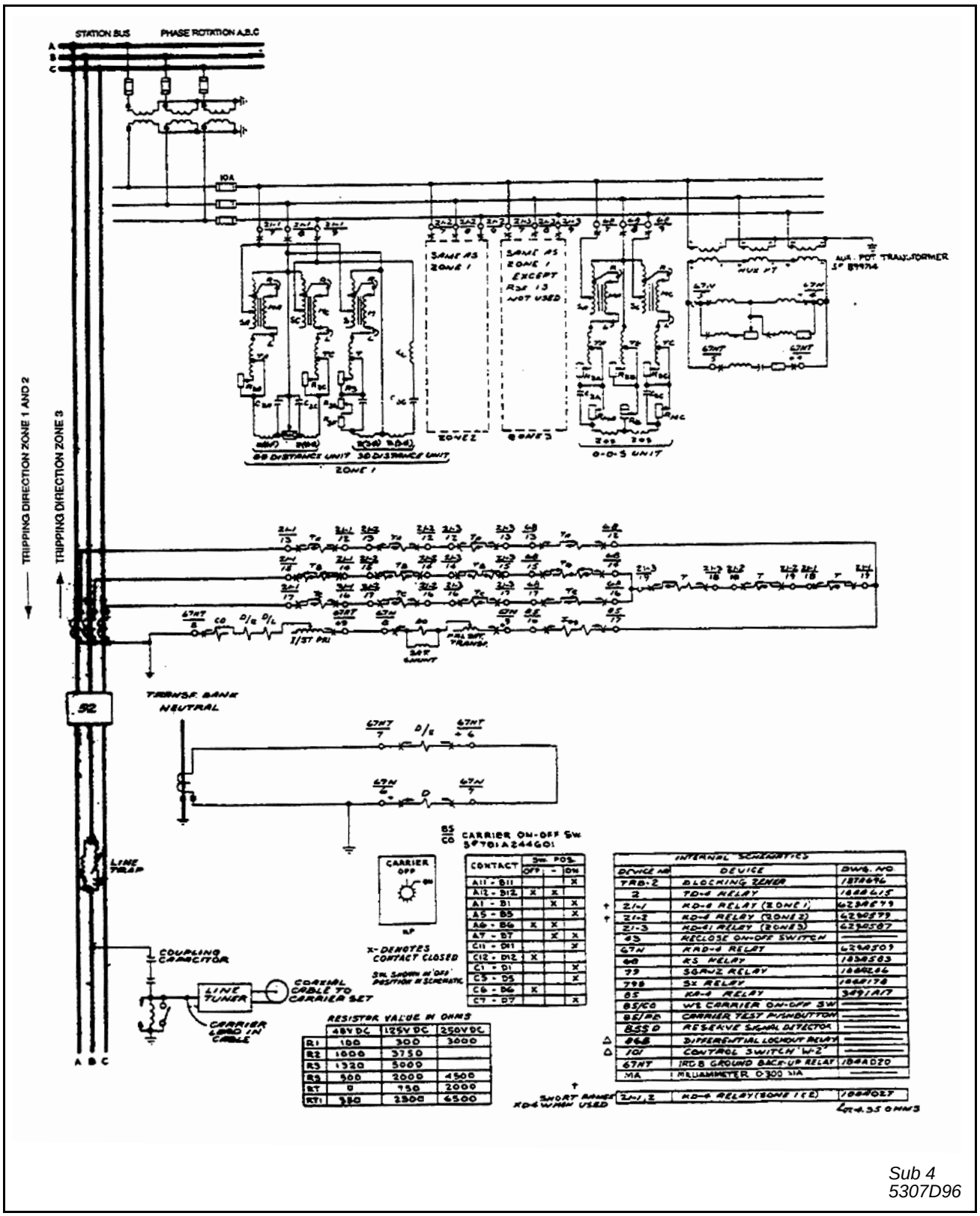


Figure 8. Typical External Schematic of a KA-4 Relay in a KD-4/TC Blocking System

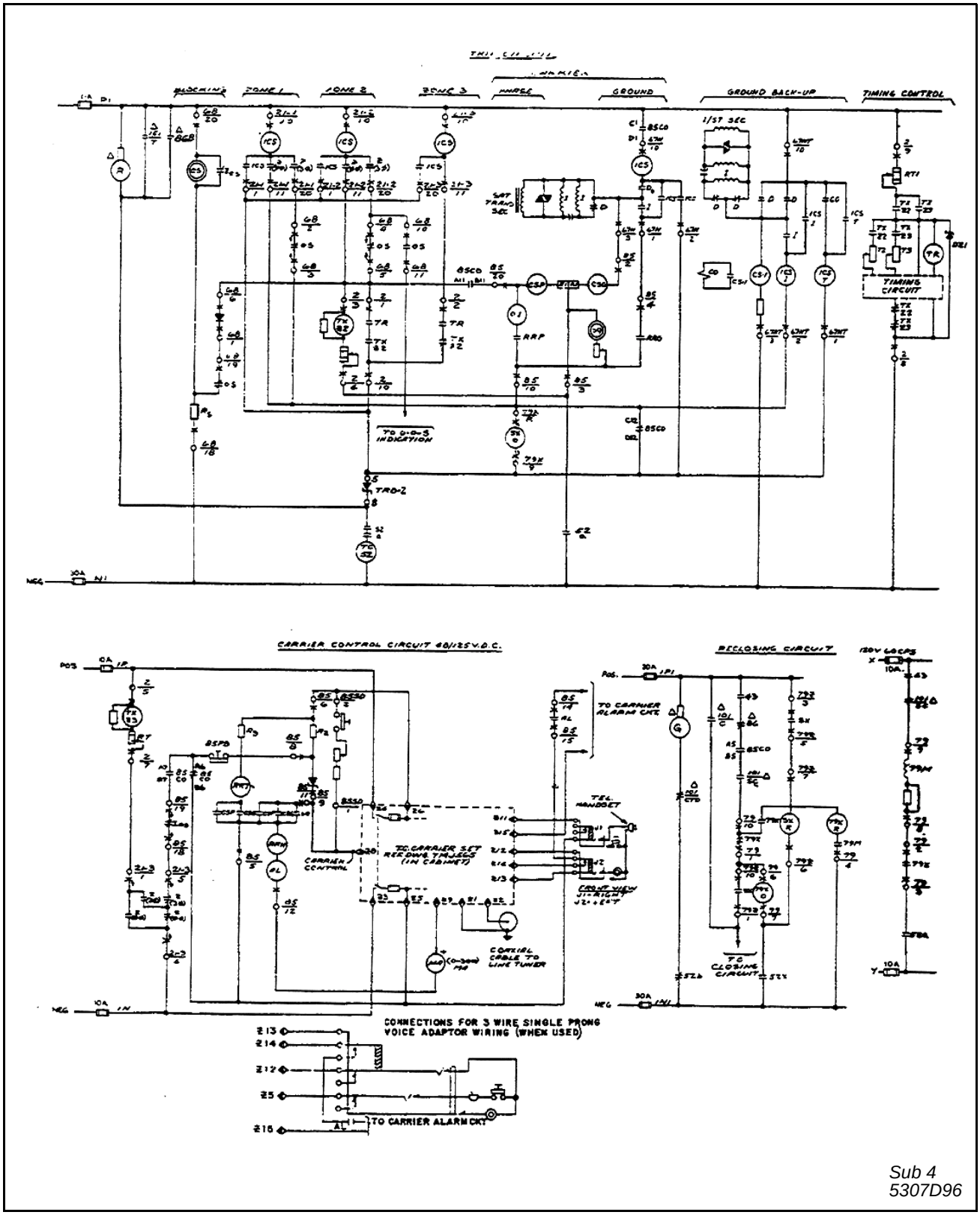


Figure 8. Typical External Schematic of a KA-4 Relay in a KD-4/TC Blocking System

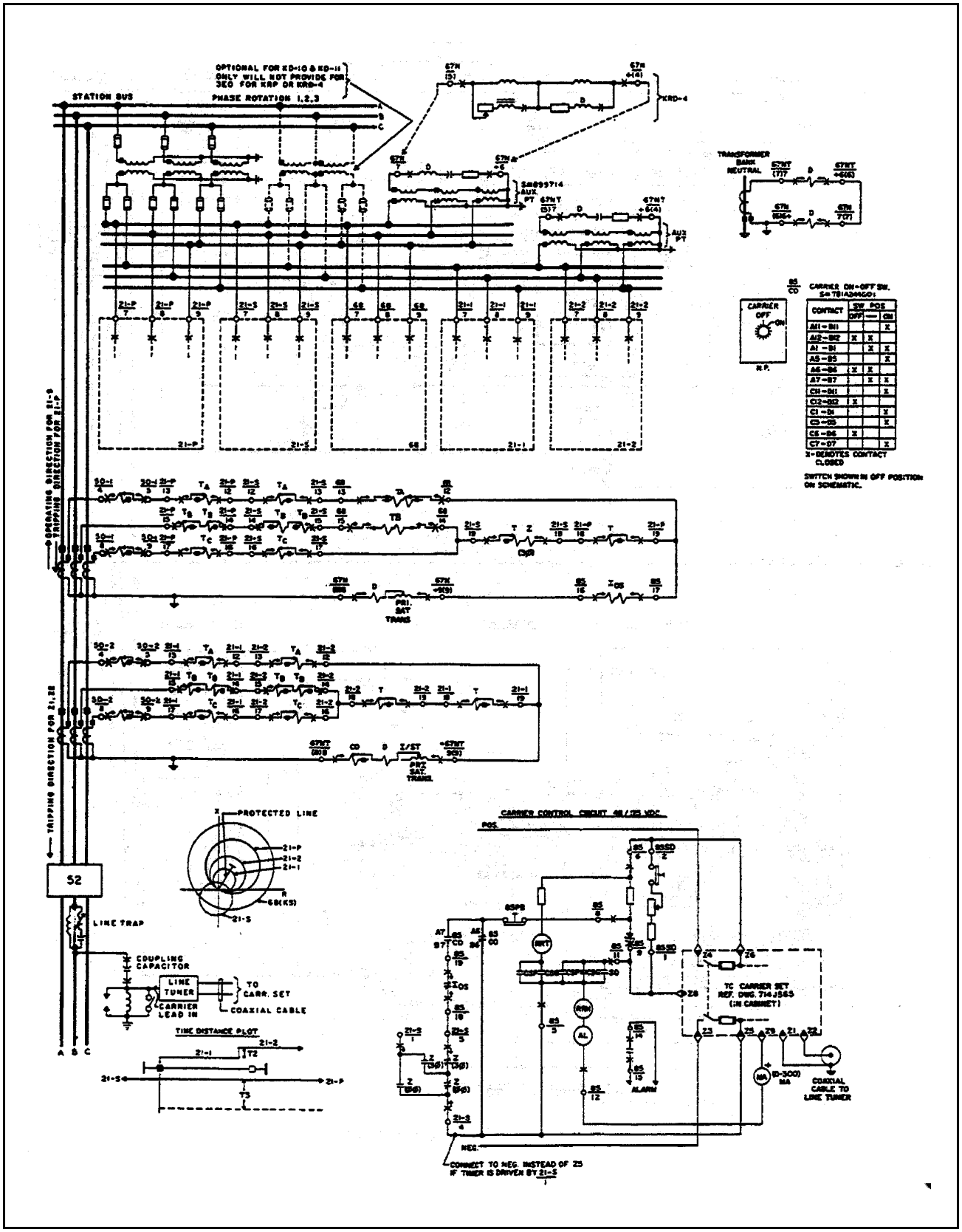
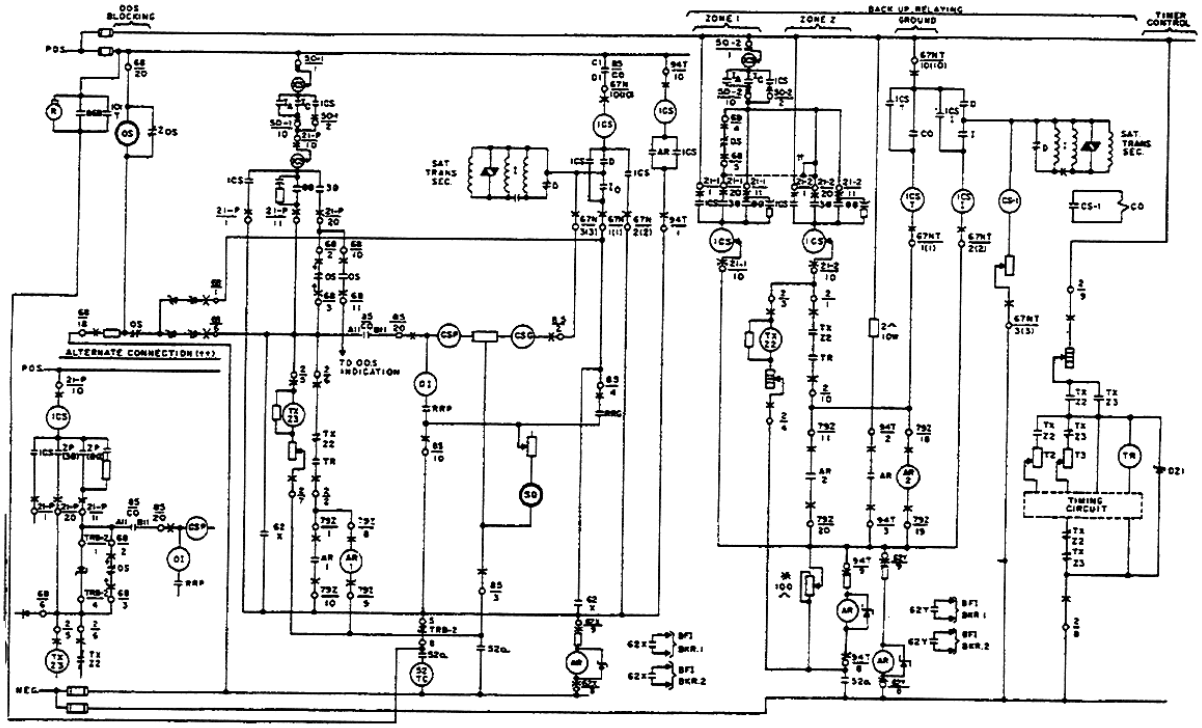


Figure 9A. Typical External Schematic of a KA-4 Relay in a KD-10/TC Blocking System



++USE DOTTED CONNECTION TO BLOCK ZONE 2 TRIPPING DURING OUT-OF-STEP CONDITION. IF ZONE 2 IS BLOCKED, USE ALTERNATE CONNECTION TO PERMIT 21P-3B TRIPPING THROUGH T3 DURING OUT-OF-STEP CONDITION.
*REFER TO 836A753 FOR DETAIL.

	DEVICE NO	TYPE	FUNCTION	DWG. NO.
	2	TD-4	TIMER	1844232
	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
Δ	62X	AR	BKR. FAIL AUX.	3480A73
Δ	62Y	AR	BKR FAIL AUX	3480A73
	67N	KRC	I POL. GRD PILOT	183A022
†	67N	KRD-4	DUAL POL GRD PILOT	629A509
	67N	KRP	V POL. GRD. PILOT	183A023
	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	[illegible]
	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 PUSH BUTTON	
	94T	AR	AUX. TRIP	3480A73
	TC	TC	CARRIER SET	
	TRB-2	TRB-2	BLOCKING ZENER	1874A96
	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
Δ-OPTIONAL FOR BF/RI

Sub. 9
647F790

Figure 9B. Typical External Schematic of a KA-4 Relay in a KD-10/TC Blocking System

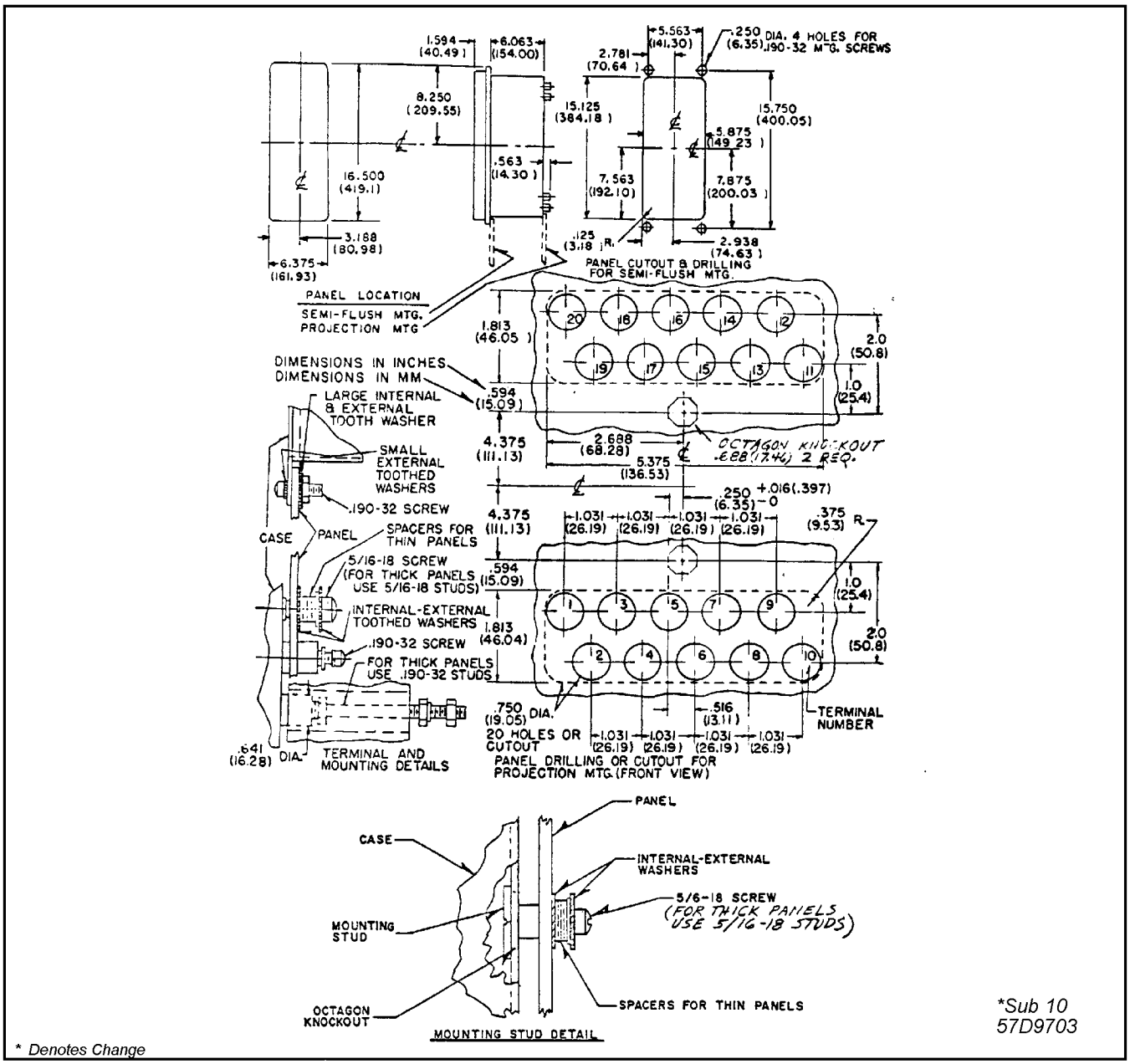


Figure 10. Outline and Drilling Plan for Type KA-4 Relay in Type FT-32 Case.

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