



INSTALLATION • OPERATION • MAINTENANCE I N S T R U C T I O N S

TYPE KA-4 CARRIER AUXILIARY RELAY FOR COMMONWEALTH EDISON COMPANY

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, X_1 unit, 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. These components are connected as shown in Fig. 1. The construction and operation of the relay units are described below.

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 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

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*Denotes Change from superseded issue.

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.

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 pickup 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 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 approximately 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. 2 so as to force some of the flux through 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 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 the 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.

X₁ Unit

The function of the X₁ relay is to delay carrier stop for 1.5/2.0 cycles. This is to insure proper coordination of all terminals of a three terminal line with a weak in-feed.

The X₁ unit is a double winding telephone type unit of fast release type.

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 style numbers of relays available for various types of carrier sets and d.c. supply voltage are as follows:

<u>Type Carrier</u>	<u>D.C. Supply Voltage</u>	<u>Relay Style Number</u>
KR-JY	48	292B237A38
KR-JY	125	292B237A37
KR-JY	250	1963009
TC	48	*670B233A19
TC	125	*670B233A18
TC	250	*670B233A17
CS-27	48	*670B233A27
CS-27	125	*670B233A26
CS-27	250	*670B233A25
CS-17	48	*670B233A35
CS-17	125	*670B233A34
CS-17	250	*670B233A33

The major difference in the KA-4 relay for various carrier sets is the pickup and dropout of the alarm and receiver units. These pickup and dropout values are as follows:

Type Carrier	KR	TC	CS-17	CS-27
Receiver Unit				
Pickup	4 MA	40 MA	24 MA	36 MA
Dropout	6 MA	60 MA	36 MA	54 MA
Alarm Unit				
Pickup	8 MA	80 MA	48 MA *	72 MA
Dropout	5 MA	50 MA	30 MA	45 MA

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

<u>For Use with KR-Set</u>	48V Avg. Ohms	125 Avg. Ohms	250 Avg. Ohms
CSP or CSG Coil	27	27	435
CSP & CSG Tapped Resistor (R ₄)	200	600	6000
Carrier Resistor (R ₂)	2000	3750	19000
RRT Operating Coil	1100	1100	1100
RRT Coil Resistor (R ₁)	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 (R ₃)	15000	10000	15000
X ₁ Coil Unit	500	500	500 (Each Winding)
X ₁ Unit Adj. Resistor (R ₅)	5000	5000	5000
<u>For Use with TC-Set</u>			
CSP or CSG Coil	27	27	435
CSP & CSG Tapped Resistor (R ₄)	200	600	6000
Carrier Resistor (R ₂)	1000	3750	8500
RRT Operating Coil	1100	1100	1100
RRT Coil Resistor (R ₁)	1320	5000	11200
RRH Holding Coil	20	20	20
AL Alarm Coil	5	5	5
Operation Indicator (1 Amp.)	0.1	0.1	0.1
Squelch Unit Coil	3300	3300	3300
Squelch Unit Adj. Resistor (R ₃)	15000	15000	15000
X ₁ Coil Unit	500	500	500 (Each Winding)
X ₁ Unit Adj. Resistor (R ₅)	5000	5000	5000

<u>For Use with CS-27 Set</u>	<u>48</u> Avg. <u>Ohms.</u>	<u>125</u> Avg. <u>Ohms.</u>	<u>250</u> Avg. <u>Ohms.</u>
CSP or CSG Coil	27	27	435
CSP & CSG Tapped Resistor (R ₄)	200	600	6000
Carrier Resistor (R ₂)	2000	3750	19000
RRT Operating Coil	1100	1100	1100
RRT Coil Resistor (R ₁)	1320	5000	11200
RRH Holding Coil	20	20	20
AL Alarm Coil	5	5	5
Operation Indicator (1 Amp.)	0.1	0.1	0.1
Squelch Unit Coil	3300	3300	3300
Squelch Unit Adj. Resistor (R ₃)	15000	15000	15000
X ₁ Coil Unit	500	500	500(Each Winding)
X ₁ Unit Adj. Resistor (R ₅)	5000	5000	5000

For Use with CS-17 Set

CSP or CSG Coil	27	27	435
CSP & CSG Tapped Resistor (R ₄)	200	600	6000
Carrier Resistor (R ₂)	2000	3750	19000
RRT Operating Coil	900	900	900
RRT Coil Resistor (R ₁)	1320	5000	11200
RRH Holding Coil	23	23	23
AL Alarm Coil	5.2	5.2	5.2
Operation Indicator (1 Amp.)	0.1	0.1	0.1
Squelch Unit Coil	3300	3300	3300
Squelch Unit Adj. Resistor (R ₃)	15000	15000	15000
X ₁ Coil Unit	500	500	500(Each Winding)
X ₁ Unit Adj. Resistor (R ₅)	5000	5000	5000

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 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.

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.

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.

Tripping Zener Diode

Pass 10 amp d-c through the terminals 8 and 9 with positive on 8. Measure the voltage drop V_{F1} across the terminals 8 and 9 with a high resistance voltmeter.

It should not exceed the following limits:

250V d-c	Max. V_{F1}	3.5 Volts
125V d-c	Max. V_{F1}	1.75 Volts

Apply rated voltage (d-c) in series with 10,000 ohms resistor across terminals 8 and 9 with positive on 9. Measure leakage current--it should be less than 5 milliamperes.

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 and should reset to the left at the approximate current values specified in Table I.

TABLE I

<u>TYPE CARRIER</u>	<u>PICK-UP CURRENT</u>	<u>RESET CURRENT</u>
KR-JY	4 MA	6 MA
TC	40 MA	60 MA
CS-27	* 36 MA	* 54 MA
CS-17	24 MA	36 MA

ALARM UNIT (AL)

Connect direct current to the alarm unit relay terminals. Increase the current until the contacts pick up. Then reduce the current until the contact resets. The unit should pick up and reset at the approximate current values specified in Table II.

TABLE II

<u>TYPE CARRIER</u>	<u>PICK-UP CURRENT</u>	<u>RESET CURRENT</u>
KR-JY	8 MA	4 to 6 MA
TC	80 MA	40 to 60 MA
CS-17	48 MA	24 to 36 MA
CS-27	72 MA	36 to 54 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 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 contact just opens. 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 13,000 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 .160 - .170 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.

X1 - Relay

Adjust series resistance for 5000 ohms for 250V d-c relay or for 2200 ohms for 125V d-c relay. Apply rated d-c voltage across terminals 3 & 15. Check pickup time, it should be .035 - .040 seconds.

If necessary, readjust the series resistance. Check dropout time--it should be below .006 seconds. If necessary, readjust residual gap for dropout adjustment. Check for visible contact follow and for visible residual gap.

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.

Tripping Zener Diode

Pass 10 amp d-c through the terminals 8 and 9 with positive on 8. Measure the voltage drop V_{F1} across the terminals 8 and 9 with a high resistance voltmeter.

It should not exceed the following limits:

250V d-c	Max. V_{F1}	3.5 volts
125V d-c	Max. V_{F1}	1.75 volts

Apply rated voltage (d-c) in series with 10,000 ohms resistor across terminals 8 and 9 with positive on 9. Measure leakage current--it should be less than 5 milliamperes.

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 gage 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 polarity current of Table III 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 pickup current of Table III. 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 pickup, the right hand shunt screw should be turned out to lower this value to the correct pickup point.

Increase the holding coil current to dropout current of Table III 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 reset value, the left hand shunt screw should be turned out. This will increase the reset value of the armature and provide for the correct 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 affects the adjustment on the other shunt screw.

TABLE III

<u>TYPE CARRIER</u>	<u>POLARITY CURRENT</u>	<u>PICKUP CURRENT</u>	<u>DROPOUT CURRENT</u>
KR-JY	15 MA	4 MA	6 MA
TC	100 to 200 MA	40 MA	60 MA
CS-27	100 to 200 MA	36 MA	54 MA
CS-17	100 to 150 MA	24 MA	36 MA

Polar Alarm Unit

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 pickup current of Table IV 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 pickup current, screw the left hand shunt out until the armature moves to the right at pickup current. Check the dropout point by reducing the d.c. current. The armature should move to the left between the limits of dropout current of Table IV. 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 pick up and drop out with a snappy action.

TABLE IV

<u>TYPE CARRIER</u>	<u>PICKUP CURRENT</u>	<u>DROPOUT CURRENT</u>
KR-JY	8 MA \pm 5%	4 to 6 MA
TC	80 MA \pm 5%	40 to 60 MA
CS-27	72 MA \pm 5%	36 to 54 MA
CS-17	* 48 MA \pm 5%	24 to 36 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.

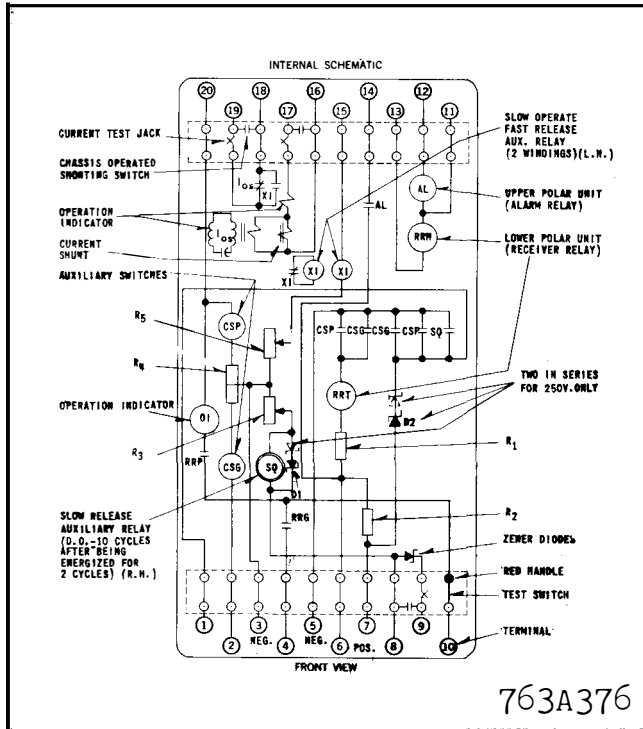


Fig. 1. Internal Schematic of KA-4 Relay for Commonwealth Edison Co.

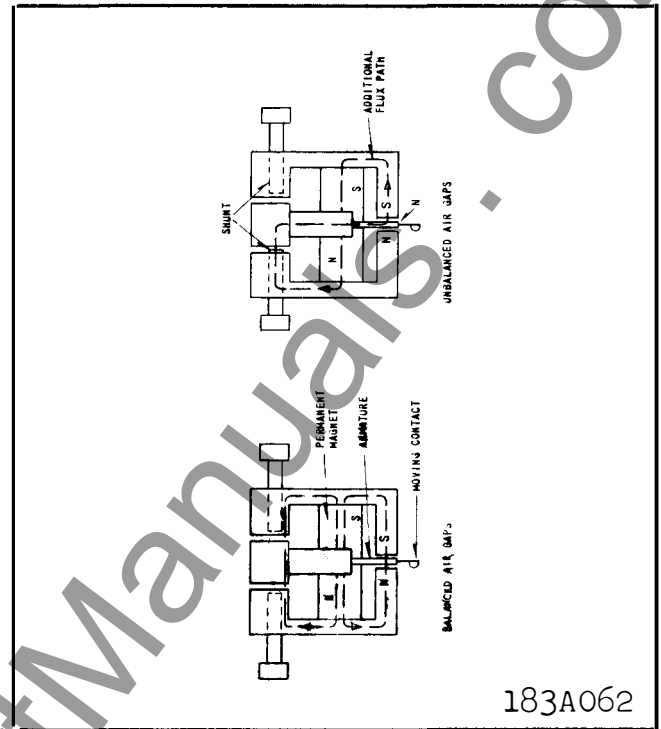


Fig. 2. Polar Unit Permanent Magnet Flux Paths.

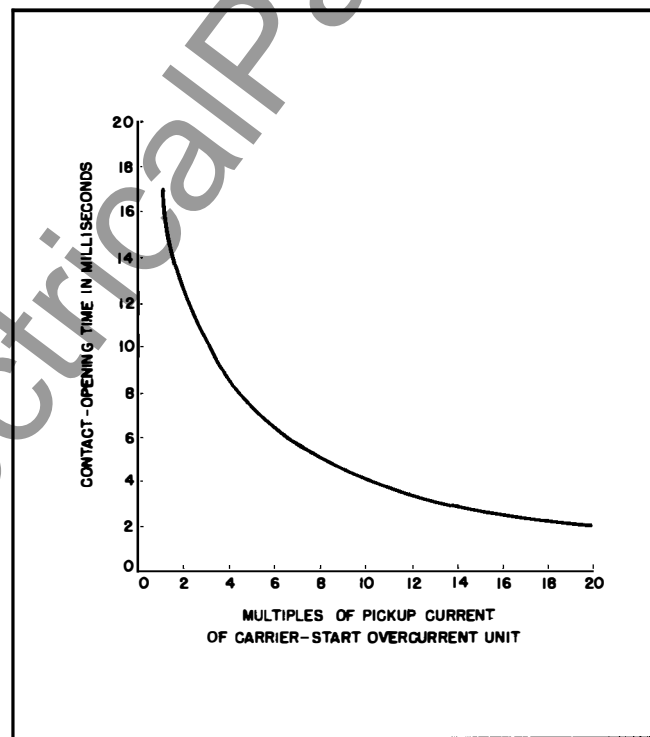


Fig. 3. Typical Time Characteristics of Carrier Start Overcurrent Unit of KA-4 Relay.

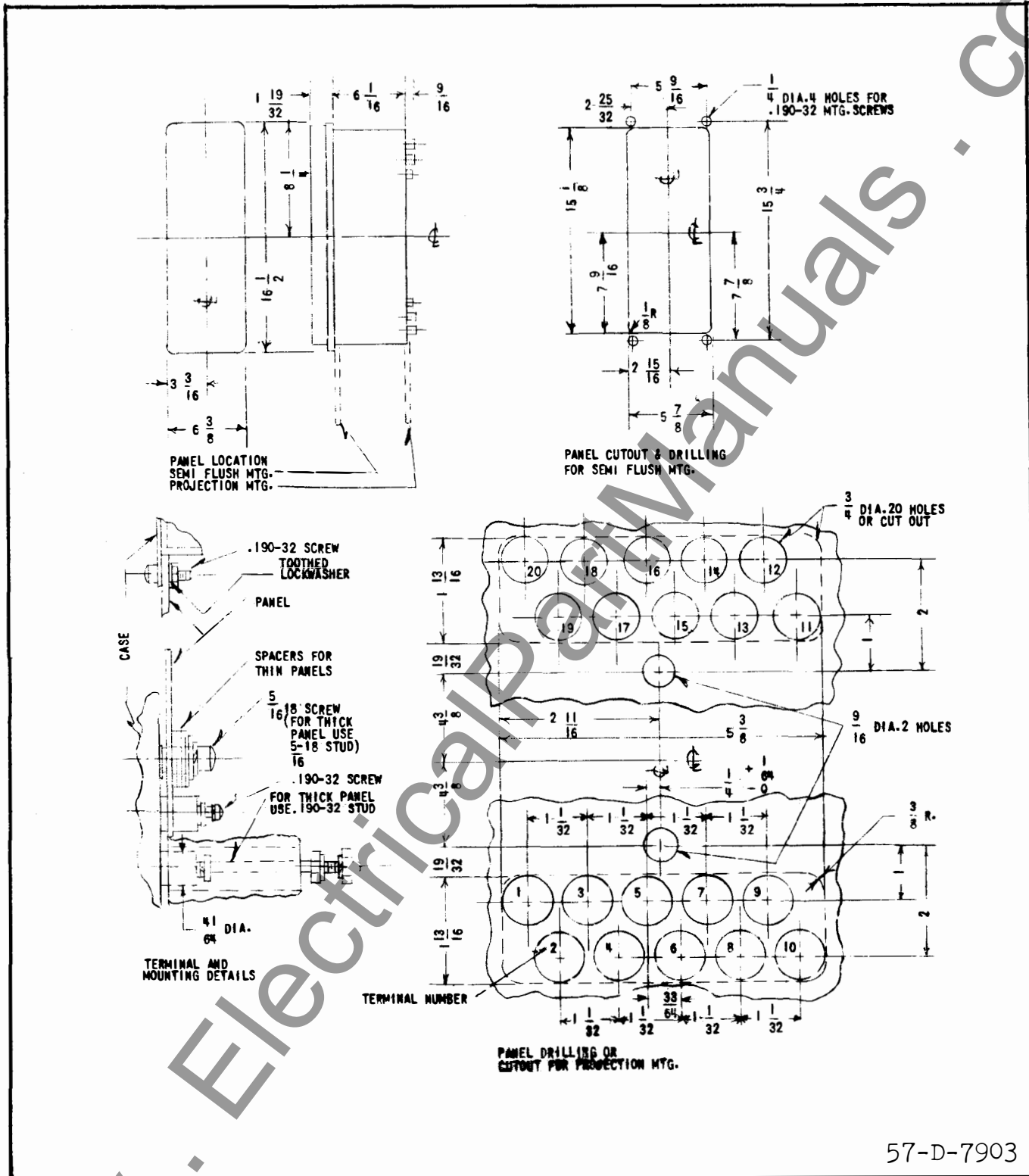


Fig. 4. Outline and Drilling Plan for the KA-4 Relay in FT-32 Case.

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