INSTRUCTIONS

PHASE DIRECTIONAL OVERCURRENT RELAYS

WITH VOLTAGE RESTRAINT

TYPES

IBCV51M

IBCV51M(-)Y1A

IBCV52M

IBCV53M

IBCV53M(-)Y1A

IBCV54M

IBCV77M

IBCV78M

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CONTENTS

PHASE DIRECTIONAL OVERCURRENT RELAYS WITH VOLTAGE RESTRAINT

TYPES

IBCV51M	IBCV53M(1)Y1A
IBCV51M(-)Y1A	IBCV54M
IBCV52M	IBCV77M
IBCV53M	IBCV78M

DESCRIPTION

The Type IBCV relays are phase directional overcurrent relays with voltage restraint. They are used primarily for the protection of feeders and transmission lines. They are available with inverse, very-inverse or extremely-inverse-time characteristics.

All the IBCV relays contain a time-overcurrent unit of the induction-disk type and an instantaneous-directional unit of the induction-cup type. The directional unit is quadrature polarized and it directionally controls the operation of the time-overcurrent unit. Because the directional unit is voltage restrained, the IBCV relays are suitable for use in those applications where the maximum load current can be greater than the minimum available fault current.

A target seal-in unit is provided in each of the relays. The operating coil for this unit is connected in series with the contacts of the time-overcurrent unit so that it will pick up whenever the time-overcurrent unit operates. The contacts of the seal-in unit are connected in parallel with the contacts of the time-overcurrent unit to provide protection for them and the associated control spring.

Those relays having the designation Y1A following the model number also contain a High-Seismic instantaneous overcurrent unit of hinged-armature construction. This unit has a self contained hand-reset target that will show whenever the unit has operated.

All the IBCV relays are mounted in standard M1-size drawout cases, the outline and panel-drilling dimensions for which are shown in Figure 24. Internal connections for the relays are given in Figures 5, 6, 7, 8, 9, and 10. Typical external connections are shown by Figure 11.

Table I lists the various models and ranges that are available.

TABLE I

EXTENDED RANGE IBCV RELAYS

RELAY MODEL	TIME CHARACTERISTIC	INSTANTANEOUS UNIT	PICKUP RANGE INSTANTEOUS	PICKUP RANGE TIME	INTERNAL CONNECTIONS
IBCV51M(-)A	Inverse	No	-	2-16	Fig. 5
IBCV51M9-)Y1A	Inverse	Yes	6-150	2-16	Fig. 6
IBCV52M(-)A	Inverse	No	-	2-16	Fig. 7
IBCV53M(-)A	Very Inverse	No	-	1.5-12	Fig. 5
IBCV53M(-)Y1A	Very Inverse	Yes	6-150	1.5-12	Fig. 6
IBCV54M(-)A	Very Inverse	No	-	1.5-12	Fig. 8
IBCV77M(-)A	Extremely Inv.	No	-	1.5-12	Fig. 9
IBCV78M(-)A	Extremely Inv.	No	-	1.5-12	Fig. 10

APPLICATION

The Type IBCV relays are phase directional overcurrent relays that may be used as phase fault detectors in a transmission line protective-relaying scheme.

IBCV relays are used for phase fault protection when it is necessary to distinguish between fault conditions and maximum load. The relay is prevented from tripping on heavy load currents because the directional unit will be restrained due to the system voltage being maintained. When a fault occurs, the restraining torque in the directional unit will collapse as the voltage drops, thus permitting the relay to trip, even at fault currents below the maximum load current.

Each relay contains a time-overcurrent unit that is torque controlled by the instantaneous directional overcurrent unit. The directional unit for each phase uses quadrature polarization; i.e., the "A" phase relay uses "A" phase current and "B-C" voltage, etc. The angle of maximum torque of the directional unit is approxmately 45^{o}, i.e., maximum torque will occur for relay current lagging the unity-power-factor position by 45^{o}, or conversely, leading the quadrature voltage by 45^{o}.

The differences between the various models covered by this instruction book are shown in Table I. Inverse-time relays should be used on systems where the fault current flowing through a given relay is influenced largely by the system generating capacity at the time of the fault. Very-inverse-time and extremely-inverse-time relays should be used in cases where the fault-current magnitude is dependent mainly upon the location of the fault in relation to the relay, and only slightly or not at all upon the system generating setup.

The reason for this is that relays must be set to be selective with maximum fault current flowing. For fault currents below this value, the operating time becomes greater as the current is decreased If there is a wide range in generating capacity, together with variation in short-circuit current with fault position, the operating time with minimum fault current may be exceedingly long with very-inverse-time relays and even longer with extremely-inverse-time relays. For such cases the inverse time relay is more applicable.

The choice between very-inverse and extremely-inverse-time relays is more limited than between them and the inverse-time relay, as they are more nearly alike in their time-current characteristic curves. For grading with fuses, the extremely-inverse-time relay should be chosen, as the time-current curves more nearly match the fuse curve. Another advantage of the extremely-inverse relay is that it is better suited than both the inverse and very-inverse relays for picking up cold load. For any given cold-load-pickup capability, the resulting settings will provide faster protection at high-fault currents with the extremely-inverse relay than with the less-inverse relays.

The operating time of the time-overcurrent unit for any given value of current and tap setting is determined by the time-dial setting. The operating time is inversely proportional to the current magnitude, as illustrated by the time curves in Figures 13, 14, and 15. Note that the current values on these curves are given as multiples of the tap setting. That is, for a given time-dial setting, the time will be the same for 80 amperes on the 8 ampere tap as for 50 amperes on the 5 amp tap, since in both cases, the current is 10 times the tap setting.

If selective action of two or more relays is required, determine the maximum possible short-circuit current of the line and then choose a time value for each relay that differs sufficiently to ensure the proper sequence in the operation of the several circuit breakers. Allowance must be made for the time involved in opening each breaker after the relay contacts close.

The YlA relays contain a High-Seismic instantaneous overcurrent unit. This unit may be set high to provide direct tripping for faults some distance down the transmission line. In determining the setting for this unit, it will be necessary to consider faults directly behind the relay as well as at the remote terminal, because the unit is non-directional. The unit should be set with a suitable margin above the maximum external-fault current, taking into account the effects of transient overreach as illustrated in Figure 17.

RATINGS

The IBCV relays described in this instruction are available in 50 and 60 Hz models. The TOC (time-overcurrent) units have extended (8 to 1) range similar to the 800 series IAC relays. The IOC (instantaneous-overcurrent) units also have extended (25 to 1) range.

Ratings of the operating-current circuits of the TOC, the IOC and the directional unit are shown individually. However, since all operating-current circuits are normally connected in series, the operating coil rating of all units should be considered in determining the rating of the entire operating circuit.

TIME-OVERCURRENT UNIT

The one second (1 sec.) ratings of the TOC units are all 260 amperes. The available taps and the continuous ratings are shown in Tables II, III, IV. Note that separate tables are given for the IBCV51, IBCV53 and IBCV models.

TABLE II

CONTINUOUS RATING OF INVERSE-TIME OVERCURRENT UNIT

2.0 - 16.0 AMP. RANGE IBCV51											
TAP	2.0	2.5	3.0	4.0	5.0	6.0	7.0	8.0	10.0	12.0	16
RATING	8.0	9.0	10.0	12.0	14.0	15.0	16.0	17.5	20.0	20.0	20.0

TABLE III

CONTINUOUS RATING OF VERY-INVERSE-TIME OVERCURRENT UNIT

1.5 - 12.0 AMP. RANGE IBCV53											
TAP	1.5	2.0	2.5	3.0	4.0	5.0	6.0	7.0	8.0	10.0	12.0
RATING	10	11.5	13.0	14.5	17.0	19.0	21.0	23.0	23.5	27.5	30.5

TABLE IV

CONTINUOUS RATING OF EXTREMELY-INVERSE-TIME OVERCURRENT UNIT

1.5 - 12.0 AMP. RANGE IBCV77											
TAP	1.5	2.0	2.5	3.0	4.0	5.0	6.0	7.0	8.0	10.0	12.0
RATING	9.5	10.5	11.5	12.5	14.0	15.5	17.0	18.0	19.0	20.0	20.0

DIRECTIONAL UNIT

The directional-unit operating circuit, terminals 4 and 5, has a 6-ampere continuous rating and a 200-ampere one second (1 sec.) rating. The potential polarizing circuit, terminals 7 and 8, and the potential restraint circuit, terminals 9 and 10, are continuously rated.

INSTANTANEOUS UNIT

The instantaneous unit coil is tapped for operation on either one of two ranges (H or L). Selection of the high or low range is determined by the position of leads T and E at terminal 6. See Table V and the applicable internal connections referenced in Table I. For the H range, connect lead T to terminal 6, and lead E to the auxiliary terminal that is mounted on terminal 6. For range L, reverse leads T and E.

TABLE V

CONTINUOUS AND ONE-SECOND RATINGS OF IOC UNIT

Instantaneous Unit (Amps)	Range	+ Range (Amps)	Continuous Rating (Amps)	One Second Rating (Amps)
6 - 150	L	6 - 30	10.2	260
	H	30 - 150	19.6	

\+ The range is approximate, which means that 6-30, 30-150 may be 6-28, 28-150. There will always be at least one ampere overlap between the maxium L setting and the minimum H setting. Whenever possible, be sure to select the higher range, since it has the higher continuous rating.

TARGET AND SEAL-IN UNIT

The rating and impedance of the seal-in unit for the 0.2 and 2 ampere taps are given in Table VI. The tap setting used will depend on the current drawn by the trip coil.

Table VI

SEAL-IN UNIT RATINGS

	TAP 0.2	TAP 2.0
DC RESISTANCE ± 10% (OHMS)	7	0.13
MINIMUM OPERATING (AMPERES) 0+25%	0.2	2.0
CARRY CONTINUOUSLY (AMPERES)	0.3	3.0
CARRY 30 AMPS FOR (SEC.)	0.03	4.0
CARRY 10 AMPS FOR (SEC.)	0.25	30.0
60 HZ IMPEDANCE (OHMS)	52.0	0.53

The 0.2 ampere tap is for use with the trip coils that operate on currents ranging from 0.2 up to 2.0 amperes, at the minimum control voltage. If this tap is used with trip coils requiring more than 2 amperes, there is a possibility that the resistance of 7 ohms will reduce the current to so low a value that the breaker will not be tripped.

The 2-ampere tap should be used with trip coils that take 2 amperes or more at minimum control voltage, provided the current does not exceed 30 amperes at the maximum control voltage. If the tripping current exceeds 30 amperes, the connections should be arranged so that the induction unit contacts will operate an auxilary relay, which in turn energizes the trip coil or coils. On such an application, it may be necessary to connect a loading resistor in parallel with the auxiliary relay coil to allow enough current to operate the target seal-in unit.

CONTACTS

The current-closing rating of the induction-unit contacts is 30 amperes for voltages not exceeding 250 volts. Their current-carrying rating is limited by the tap rating of the seal-in unit.

CHARACTERISTICS

PICKUP

At rated voltage and maximum torque angle, the directional unit will pick up at 9 (-5%, +15%) amperes. At restraint voltages less than rated, the operating current is also less. This relationship is shown by the curve in Figure 12.

Pickup of the TOC units is defined as the current required to close the contacts from the 0.5 time-dial position. The pickup value is within 5% of tap value.

RESET (TIME-OVERCURRENT UNIT)

Inverse time-overcurrent units reset at 90% of the minimum pickup current, very-inverse-time units at 80% and extremely-inverse-time-units at 85%.

When the relay is de-energized, the time required for the disk to completely reset to the number 10 time-dial postion is approximately 6 seconds for inverse-time relays and 60 seconds for very-inverse-time and extremely-inverse-time relays.

OPERATING TIME

The time curves of the TOC units are shown in Figures 13, 14 and 15 respectively for inverse-time, very-inverse-time and extremely-inverse-time relays. For the same operating conditions, the relay will operate repeatedly within 1 or 2% of the same time.

The time-current characteristic of the High-Seismic IOC unit is shown by Figure 16 and its transient-overreach characteristic is shown by Figure 17.

BURDENS

Table VII gives the potential-circuit burdens of the directional unit.

TABLE VII

DIRECTIONAL UNIT POTENTIAL-CIRCUIT BURDENS AT 60 CYCLES AND RATED VOLTS

CIRCUIT	VOLT AMPERES	POWER FACTOR	WATTS
Polarizing	32	0.64	20.5
Restraint	5.9	0.66	3.9

Table VIII gives the combined burdens of the time-overcurrent and the directional-unit current circuits.

TABLE VIII

CURRENT-CIRCUIT BURDENS AT 60 CYCLES (TOC + DIRECTIONAL UNIT)

		Burdens At Minimum Pickup					Ohms Impedance At		
Time Charac- teristic	Tap Range (Amps)	Eff.Res. (Ohms)	React. (Ohms)	+Imped. (Ohms)	++Volt Amperes	Power Factor	3 Times Min.P.U.	10 Times Min.P.U.	# VA At 5 Amperes
Inverse	2-16	0.42	1.56	1.62	6.46	0.26	0.78	0.45	40
Very Inverse	1.5-12	0.28	0.65	0.71	1.59	0.40	0.71	0.49	18
Extremely Inverse	1.5-12	0.135	0.27	0.30	0.67	0.45	0.30	0.39	7.5

\+ The impedance values given are those for the minimum tap of each relay. The impedance for other taps, at pickup current (tap rating), varies inversely approximately as the square of the current rating. Example: for the Type IBCV53 relay, 1.5-12 amperes, the impedance of the 1.5 ampere tap is 0.71 ohms. The impedance of the 3 ampere tap, at 3 amperes, is approximately (1.5/3)2 x 0.71=0.18 ohms.

++ Some companies list relay burdens only as the volt-ampere input to operate at minimum pickup. This column is included so that a direct comparison can be made. It should not be used in calculating volt-ampere burdens in a CT secondary circuit, since the burden at 5 amperes (see last column) is used for this purpose.

\# Calculated from burden at minimum pickup.

Table IX gives the burden of the instantaneous unit.

TABLE IX

BURDEN OF THE INSTANTANEOUS UNIT

Instantaneous Unit (Amps)	Hz	Range	Range (Amps)	Min. Pickup (Amps)	Burdens at Minimum Pickup (Ohms)			Burden Ohms (Z) Times Pickup		
					R	J_X	Z	3	10	20
6-150	60	L	6-30	6	0.110	0.078	0.135	0.095	0.085	0.079
		H	30-150	30	0.220	0.005	0.023	0.022	0.022	0.022

CONSTRUCTION

Type IBCV relays are single-phase, directional-overcurrent relays with voltage restraint. They are available with inverse, very-inverse or extremely-inverse time-current characteristics.

They consist of two main units, a time-overcurrent unit (top) of the induction-disk type, and an instantaneous power-directional unit (bottom) of the induction-cup type. The directional unit is potential polarized and, by means of its closing contacts, directionally controls the operation of the time-over-current unit.

The IBCV relays have a target seal-in unit and models with the YlA suffix, as shown by Table I, have a hinged-armature type instantaneous-overcurrent unit.

The IBCV relays are mounted in the single-ended Ml drawout case.

DIRECTIONAL UNIT

The directional unit is of the induction-cylinder construction, with a laminated stator having eight poles projecting inward and arranged symmetrically around a stationary central core. The cup-like aluminum induction rotor is free to operate in the annular air gap between the poles and the core. The poles are fitted with voltage-restraint, current-operating, and potential-polarizing coils.

The principle by which torque is developed is the same as that of an induction-disk relay with a wattmetric element, although, in arrangement of parts, the unit is more like a split-phase induction motor. The induction-cylinder construction provides higher torque and lower rotor inertia than the induction-disk construction, resulting in a faster and more sensitive relay.

Contacts

The directional-unit contacts, which control the time overcurrent unit, are shown in Figure 18. They are of the low-gradient type, specially constructed to minimize the effects of vibration. Both the stationary and moving contact brushes are made of low-gradient materials that, when subjected to vibration, tend to follow one another, hence, they resist contact separation.

The contact dial (A) supports the stationary contact brush (B) on which is mounted a conical contact tip (C). The moving contact arm (D) supports the moving contact brush (E) on which is mounted a button contact tip (F). The end of the moving contact brush bears against the inner face of the moving contact brush retainer (G). Similarly, the end of the stationary contact brush bears against the inner face of the stationary contact brush retainer (H). The stop screw (J), mounted on the contact dial, functions to stop the motion of the contact arm by striking the moving contact brush retainer after the moving and stationary contact members have made contact. The stationary contact support (K) and the contact dial are assembled together by means of a mounting screw (L) and two locknuts (M).

TIME-OVERCURRENT UNIT

The inverse-time and very-inverse-time overcurrent units consist of a tapped current-operating coil wound on a U-magnet iron structure. The tapped operating coil is connected to taps on the tap block. The U-magnet contains wound shading coils that are connected in series with a directional-unit contact. When power flow is in such a direction as to close the directional unit contacts, the shading coils act to produce a split-phase field that, in turn, develops torque on the operating disk.

The extremely-inverse-time overcurrent unit is of the wattmetric type, similar to that used in watthour meters except as follows: the upper portion of the iron structure has two concentric windings on the middle leg of the magnetic circuit. One of these is a tapped current winding connected to taps on the tap block; the other is a floating winding that is connected in series with the directional-unit contacts, a resistor, a capacitor and the two coils on the lower legs of the magnetic circuit. When power flow is in such a direction as to close a directional-unit contact, the unit develops torque on the operating disk.

The disk shaft carries the moving contact, which completes the trip circuit when it touches the stationary contact or contacts. The shaft is restrained by a spiral spring to give the proper contact-closing current, and its motion is retarded by a permanent magnet acting on the disk to produce the desired time characteristic. The variable retarding force resulting from the gradient of the spiral spring is compensated by the spiral shape of the induction disk, which results in an increased driving force as the spring winds up.

TARGET SEAL-IN UNIT

The seal-in unit is mounted on the left side of the time-overcurrent unit. This unit has its coil in series and its contacts in parallel with the main contacts of the overcurrent unit, arranged in such a manner that when the main contacts close, the seal-in unit picks up and seals in around the main contacts. When the seal-in unit operates, it raises a target into view that latches up and remains exposed until manually released by pressing the button located at the lower-left corner of the cover.

INSTANTANEOUS UNIT

The IOC unit is a small hinged-armature-type instantaneous element and is mounted on the right side of the TOC unit. The IOC element operates over a 25-1 total range obtained by using a tapped coil that has a 5-1 low range and a 5-1 high range; this combination provides the 25-1 total range. When the current reaches a predetermined value, the instantaneous element operates, closing its contact circuit and raising its target into view. The target latches in the exposed position until it is released. The same button that releases the target seal-in unit also releases the target of the instantaneous unit.

RECEIVING, HANDLING AND STORAGE

These relays, when not included as part of a control panel, will be shipped in cartons designed to protect them against damage. Immediately upon receipt of a relay, examine it for any damage sustained in transit. If injury or damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Sales Office.

Reasonable care should be exercised in unpacking the relay, in order that none of the parts are injured, nor the adjustments disturbed.

If the relays are not to be installed immediately, they should be stored in their original cartons in a place that is free from moisture, dust and metallic chips. Foreign matter collected on the outside of the case may find its way inside when the cover is removed and cause trouble in the operation of the relay.

ACCEPTANCE TESTS

Immediately upon receipt of the relay an inspection and acceptance test should be made to make sure that no damage has been sustained in shipment and that the relay calibrations have not been disturbed. If the examination or test indicates that readjustment is necessary, refer to the section on SERVICING.

These tests may be performed as part of the installation or of the acceptance tests, at the discretion of the user. Since most operating companies use different procedures for acceptance and for installation tests, the following section includes all applicable tests that may be performed on these relays.

VISUAL INSPECTION

Check the nameplate stamping to make sure that the model number and rating of the relay agree with the requisition.

Remove the relay from its case and check that there are no broken or cracked molded parts or other signs of physical damage, and that all screws are tight. Check that the shorting bars are in the proper location(s) as shown by the internal-connections diagrams, Figures 5 to 10 inclusive, and that the main brush is properly formed to contact the shorting bar.

MECHANICAL INSPECTION

Top Unit (TOC)

1. The disk shaft end play should be 0.005-0.015 inch.
2. The disk should be centered in the air gaps of both the electromagnet and the drag magnet.
3. Both air gaps should be free of foreign matter.
4. The disk should rotate freely, and should return by itself to the reset position.
5. The moving contact should just touch the stationary contact when the time dial is at the zero (0) time-dial position.

Bottom Unit (DIR)

1. The rotating shaft end play should be 0.015-0.020 inch.
2. The contact gap should be 0.015-0.025 inch on the low-gradient contact.

Target and Seal-in Unit/Instantaneous Unit

1. The armature and contacts should move freely when operated by hand.
2. Both contacts should make at approximately the same time.
3. The target should latch into view just as the contacts make, and should unlatch when the target-release button is operated.
4. The contacts should have approximately 0.030 inch wipe.

DRAWOUT RELAYS, GENERAL

Since all drawout relays in service operate in their cases, it is recommended that they be tested in their cases or an equivalent steel case. In this way, any magnetic effects of the enclosure will be accurately duplicated during testing. A relay may be tested without removing it from the panel by using a 12XLA13A test plug. This plug makes connections only with the relay, and does not disturb any shorting bars in the case. The 12XLA12A test plug may also be used; although this test plug allows greater testing flexiblity, it requires CT shorting jumpers and the exercise of greater care, since connections are made to both the relay and the external circuitry.

POWER REQUIREMENTS, GENERAL

All alternating-current-operated devices (AC) are affected by frequency. Since non-sinusoidal waveforms can be analyzed as a fundamental frequency plus harmonics of the fundamental frequency, it follows that AC devices (relays) will be affected by the applied waveform.

Therefore, in order to test alternating-current relays properly, it is essential to use a sine wave of current and/or voltage. The purity of the sine wave (i.e., its freedom from harmonics) cannot be expressed as a finite number for any particular relay; however, any relay using tuned circuits, RL or RC networks, or saturating electromagnets (such as time-overcurrent relays) is affected by non-sinusoidal wave forms.

TARGET AND SEAL-IN UNIT

The target and seal-in unit has an operating coil tapped at 0.2 and 2.0 amperes.

When used with trip coils operating on currents ranging from 0.2 to 2.0 amperes at the minimum control voltage, the target-and seal-in tap screw should be set in the 0.2 ampere tap. When the trip-coil current ranges from 2 to 30 amperes at the minimum control voltage, the tap screw should be placed in the 2.0 ampere tap.

The seal-in tap screw is the screw holding the right-hand stationary contact of the seal-in unit. To change the tap setting, first remove the connecting plug of the relay. Than take a screw from the left-hand stationary contact and place it in the desired tap. Next, remove the screw from the other (undesired) tap and place it back in the left-hand contact. This procedure is necessary to prevent the right-hand stationary contact from getting out of adjustment. Tap screws should **never** be left in **both** taps at the same time.

Pickup and Dropout Test

1. Connect relay studs 1 and 2 (see internal-connections diagram) to a DC source, ammeter and load box, so that the current can be controlled over a range of 0.1 to 2.0 amperes.
2. Close or jumper the contact(s) that parallel the seal-in-unit contact.
3. Increase the current slowly until the seal-in-unit picks up. See Table X.
4. Open the parallel contact circuit of step 2; the seal-in unit should remain in the picked up postion.
5. Decrease the current slowly until the seal-in-unit drops out. See Table X.

TABLE X

TARGET-AND-SEAL-IN-UNIT OPERATING CURRENTS

TAP	PICKUP CURRENT	DROPOUT CURRENT
0.2	0.115 - 0.195	0.05 OR MORE
2.0	1.15 - 1.95	0.55 OR MORE

TIME-OVERCURRENT UNIT

Rotate the time dial slowly and check, by means of a lamp, that the contacts just close at the zero (0) time-dial setting.

Where the contacts just close can be adjusted by running the stationary contact brush in or out, by means of its adjusting screw. This screw should be held securely in its support.

With the contacts just closing at No. 0 time setting, there should be sufficient gap between the stationary contact brush and its metal backing strip to ensure approximately 1/32 inch wipe.

Current Setting

The minimum current at which the time-overcurrent unit will close its contacts is determined by the position of the plug in the tap block. The tap plate on this block is marked in amperes, as shown in Tables II, III and IV.

When the tap setting is changed with the relay energized in its case, the following procedure must be followed: (1) remove the connecting plug; this de-energizes the relay and shorts the current-transformer secondary winding; (2) remove the tap screw and place it in the tap marked for the desired pickup current; (3) replace the connecting plug.

The minimum current required to rotate the disk slowly and to close the contacts should be within 5% of the value marked on the tap plate for any tap setting and time-dial position. If this adjustment has been disturbed, it can be restored by means of the spring-adjusting ring. The ring can be turned by inserting a screw-driver blade in the notches around the edge. By turning the ring, the operating current of the unit can be brought into agreement with the tap setting employed. This adjustment also permits any desired setting, intermediate between the available tap settings, to be obtained.

Pickup adjustments by means of the control spring applies to the JBCV51 and JBCV53 relays. A different procedure applies to the JBCV77 relays. For the JBCV77 relays, the pickup of the unit for any current tap setting is adjusted by means of the variable resistor in the phase-shifting circuit. This adjustment also permits any desired setting intermediate between the various tap settings to be obtained. The control spring is prewound approximately 660° with the contacts just closed. Further adjustment of this setting is seldom required; if it is required, because of insufficient range of the variable resistor, it should never be necessary to wind up the control spring adjuster more than 30° (one notch) or unwind it more than 90° (three notches) from the factory setting.

Test connections for making pickup and time checks on the time-overcurrent unit are shown in Figures 20 and 21. Use a source of 120 volts or greater, with good wave form and constant frequency. Stepdown transformers or phantom loads should **not** be employed in testing induction relays, since their use may cause a distorted wave form. The contact in the wound-shading-coil circuit marked D (see internal connection diagram) must be blocked closed or jumpered for the pickup test and the time test.

Time Setting

The setting of the time dial determines the length of time the unit requires to close its contacts when the current reaches a predetermined value. The contacts are just closed when the dial is set on zero (0). When the dial is set on 10, the disk must travel the maximum amount to close the contacts, and therefore this setting gives the maximum time setting.

The primary adjustment for the time of operation of the unit is made by means of the time dial. However, further adjustment is obtained by moving the permanent magnet along its supporting shelf; moving the magnet toward the disk shaft decreases the time, while moving it away increases the time. Be sure the magnet never extends out beyond the cutout in the disk.

Pickup Test

Use rated frequency for both the pickup and the time tests.

Set the relay at the 0.5 time-dial position and 2.0 ampere tap. Using the test connections in Figure 20, the main unit should close its contacts within ± 2.0 % of tap value current (1.96-2.04 amps).

Time Test

Set the relay at No. 5 time-dial setting and the 2.0 amp tap. Using the test connection in Figure 21, apply five (5) times tap current (10.0 amp) to the relay. The relay should operate within the limits shown in Table XI.

TABLE XI

TOC UNIT OPERATING LIMITS

	Time in Seconds		
Relay Type	Min.	Midpoint	Max.
IBCV51	1.72	1.78	1.83
IBCV53	1.27	1.31	1.35
IBCV77	0.89	0.92	0.95

DIRECTIONAL UNIT

Polarity Check

The polarity of the external connection to the operating and polarizing circuits of the directional unit may be verified by disconnecting the external connections to the restraint circuit and observing the direction of contact-armature torque when the line is carrying load at unity power factor, or slightly lagging power factor. Note that in most directional-overcurrent relay applications, the desired directions are: contact-closing for power flow away from the bus, and contact-opening for power flow toward the bus.

In case of doubt, refer to Figure 22 for a more accurate method of checking the polarity of the external connections to the operating and polarizing circuits. Note that, during this test, the restraint circuit is automatically disconnected by means of the test plug.

The polarity of the restraint circuit is automatically checked when it is reconnected, or when the test plug is removed and the connection plug is reinserted. With normal load and rated voltage, the restraint circuit should always cause the directional-unit contacts to open, regardless of the direction of power flow.

Figure 23 shows the test connections for checking the polarity of the directional unit itself.

Core Adjustment

Short out the potential circuits (studs 7-8, 9-10). Back off the stationary contact and backstop so that the moving contact can move freely. Adjust the control spring so that the moving contact will be parallel with the sides of the unit.

Apply 30 amperes to studs 4-5 and check to see that the moving contact remains stationary or has a slight opening bias. If there is any significant torque, adjust the core until the moving contact remains in the neutral position with the current on or off.

Restraint Adjustment

With the control spring set as above, apply rated voltage to circuits 7-8 and 9-10 in parallel with stud 7 connected to stud 9. After a 15 minute period of energization, check to see that the moving contact remains in its neutral position. If there is any movement, adjust the slide wire resistor so that the contact arm does not move when potential is applied.

Maximum Torque Angle

Connect the relay per Figure 25. Remove the lead from phase 1 to stud 10. Apply rated voltage to studs 7 and 8. Apply 5 amperes to the current circuit between studs 5 and 6, check the angle of maximum torque. It should be between 35° and 55° lead.

Pickup at Rated Voltage

Set the contact gaps to 0.020 inches. Wind the control spring 1/2 inch in the contact-opening direction, reconnect phase 1 to stud 10 and apply rated voltage to both potential circuits. Adjust the phase shifter to the maximum torque angle.

Gradually increase the current until the contact closes. The contact should close between 8.6 and 10.4 amperes.

INSTANTANEOUS UNIT

Make sure that the instantaneous unit is in the correct range in which it is to operate. See the internal connections diagram and Table V. Whenever possible, use the higher range, since the higher range has a higher continuous rating.

The instantaneous unit has an adjustable core located at the top of the unit. To set the instantaneous unit to a desired pickup, loosen the locknut and adjust the core. Turning the core clockwise decreases the pickup; turning the core counterclockwise increases the pickup. Bring up the current slowly until the unit picks up. It may be necessary to repeat this operation, until the desired pickup value is obtained. Once the desired pickup value is reached, tighten the locknut.

CAUTION

Refer to Table V for the continuous and one-second ratings of the instantaneous unit. Do not exceed these ratings when applying current to the instanteous unit.

The range of the instantaneous unit (see Table V) must be obtained between a core postion of 1/8 of a turn from full clockwise and 20 turns counterclockwise from the full-clockwise position.

INSTALLATION

LOCATION

The location should be clean and dry, free from dust and excessive vibration, and well lighted to facilitate inspection and testing.

MOUNTING

The relay should be mounted on a vertical surface. The outline and panel-drilling diagram is shown in Figure 24.

CONNECTIONS

The internal-connection diagrams for the various relays are shown in Figures 5 to 10. A typical wiring diagram is shown by Figure 11. Since phase sequence is important for the correct operation of Type IBCV relays, the **rotation** specified in Figure 11 **must** be adhered to. Unless mounted on a steel panel that adequately grounds the relay case, it is recommended that the case be grounded through a mounting stud or screw with a conductor not less than #12 B&S gage copper wire or its equivalent.

INSPECTION

At the time of installation, the relay should be inspected for tarnished contacts, loose screws, or other imperfections. If any trouble is found, it should be corrected in the manner described in the section on **SERVICING**.

> **CAUTION**
>
> **Every circuit in the drawout case has an auxiliary brush. It is especially important, on current circuits and other circuits with shorting bars, that the auxiliary brush be bent high enough to engage the connecting plug or test plug before the main brushes do. This will prevent CT secondary circuits from being opened. Refer to Figure 19.**

OPERATION

Before the relay is put into service, it should be given a check to determine that factory adjustments have not been disturbed. The time dial will be set at zero before the relay leaves the factory. If the setting has not been changed, it will be necessary to change this setting in order to open the time-overcurrent unit contacts. The following tests are suggested:

TARGET AND SEAL-IN UNITS

1. Make sure that the tap screw is in the desired tap.
2. Perform pickup and dropout tests as outlined in the **ACCEPTANCE TESTS** section.

TIME-OVERCURRENT UNIT

1. Set tap screw on desired tap. Using the test circuit in Figure 20, apply approximately twice tap value current until the contacts just close. Reduce the current until the light in series with the contacts begins to flicker. This value of current should be within 5% of tap value.
2. Check the operating time at some multiple of tap value. This multiple of tap value may be five (5) times tap rating or the maximum fault current for which the relay must coordinate. The value used is left to the discretion of the user. Use the test circuit of Figure 21.

DIRECTIONAL UNIT

Check directional-unit polarity; see **ACCEPTANCE TESTS.**

INSTANTANEOUS UNIT

1. Select the desired range by making the proper connections at the rear of the relay (see internal-connections diagram). Whenever possible, be sure to select the higher range, since it has a higher continuous rating.
2. Set the instantaneous unit to pick up at the desired current level. See the **ACCEPTANCE TESTS** section.

PERIODIC CHECKS AND ROUTINE MAINTENANCE

In view of the vital role of protective relays in the operation of a power system, it is important that a periodic test program be followed. It is recognized that the interval between periodic checks will vary depending upon environment, type of relay and the user's experience with periodic testing. Until the user has accumulated enough experience to select the test interval best suited to his individual requirements, it is suggested that the points listed below be checked at an interval of from one to two years.

These tests are intended to make sure that the relays have not deviated from their original settings. If deviations are encountered, the relay must be retested and serviced as described in this manual.

TARGET AND SEAL-IN UNIT

1. Check that the unit picks up at the values shown in Table X.
2. Check that the unit drops out at 25% or more of tap value.

TIME-OVERCURRENT UNIT

1. Perform the pickup test for the tap in service, as described in the **ACCEPTANCE TESTS** section.
2. Perform the time tests as described in the **ACCEPTANCE TESTS** section.

DIRECTIONAL UNIT

Check condition and operation of contacts. A polarity check should not be necessary if it was correctly installed and no subsequent wiring changes were made.

INSTANTANEOUS UNIT

Check that the instantaneous unit picks up at the desired current level, as outlined in the **ACCEPTANCE TESTS** sections.

SERVICING

These relays are adjusted at the factory and it is advisable not to disturb the adjustments. If, for any reason, they have been disturbed or it is found during installation or periodic testing that the relay is out of limits, the checks and adjustments outlined in the following paragraphs should be observed. It is suggested that this work be done in the laboratory.

TARGET AND SEAL-IN UNIT

Repeat the visual and mechanical inspections and the pickup and dropout current checks, as outlined in the **ACCEPTANCE TESTS** section.

TIME-OVERCURRENT UNIT

Disk and Bearings

The jewel should be turned until the disk is centered in the air gaps, after which it should be locked in this position by the set screw provided for this purpose. The upper bearing should next be adjusted so that the disk shaft has about 1/64 inch end play.

Contact Adjustment

The contacts should have about 1/32 inch wipe. That is, the stationary contact tip should be deflected about 1/32 inch when the disk completes its travel. Wipe is adjusted by turning the wipe adjustment screw, thereby adjusting the position of the brush relative to the brush stop.

When the time dial is moved to the position where it holds the contacts just closed, it should indicate zero (0) on the time-dial scale. If it does not, and the brushes are correctly adjusted, shift the dial by changing the position of the arm attached to the shaft just below the time dial. Loosen the screw clamping the arm to the shaft, and turn the arm relative to the shaft until the contacts just make for zero time-dial setting. Retighten the screw.

Characteristics Check and Adjustments

Repeat the portions of the ACCEPTANCE TESTS section that apply to the time-overcurrent unit. Also check reset voltage and time against the values listed under RESET in the **CHARACTERISTICS** section; low reset voltages or long reset times may indicate excessive friction caused by a worn bearing or by mechanical interference.

On IBCV77 relays, set the relay on the 2 amp tap with the time dial set so that the contacts are just open. Adjust pickup as close as possible to 2.0 amps, but at least within the limits 1.96 to 2.04 amps. Then move the time dial to the No. 10 position and check the current required to just move the disk away from the top arm. This current should be within the limits 1.88 to 2.12 amp. If the disk moves at the lower limit, check that movement is not over 1/2 inch, measured along the periphery of the disk. This is called a "compensation check". If the current falls outside the 1.88 to 2.12 amp limits, the following steps should be taken: reset the control spring until compensation at No. 10 time dial is within limits. Then restore pickup by adjusting the resistor. Recheck compensation after the resistor adjustment.

DIRECTIONAL UNIT

Bearings

The lower jewel bearing should be screwed all the way in until its head engages the end of the threaded core support. The upper bearing should be adjusted to allow about about 1/64 inch end play in the shaft.

To check the clearance between the iron core and the inside of the rotor cup, press down on the contact arm near the shaft, thus depressing the spring-mounted jewel until the cup strikes the iron. The shaft should move about 1/16 inch.

Cup And Stator

Should it be necessary to remove the cup-type rotor from the directional unit, the following procedure should be followed:

All leads to the unit should first be disconnected and tagged for identification in reconnecting. The unit can then be removed from the cradle with its mounting plate still attached.

The upper of the three flat-head screws holding the unit to the plate should now be removed. On some models, it may be necessary to remove a resistor or capacitor to expose this screw. The four corner screws clamping the unit together should next be removed, and the entire top structure lifted off. This gives access to the cup assembly and exposes the stator assembly, which should be protected to keep it free from dust and metallic particles until the unit is reassembled.

To remove the shaft and rotor from the contact-head assembly, the spring clip at the top of the shaft must be pulled out and the clutch-adjusting screw taken out of the side of the molded contact arm. The shaft and cup can now be pulled out of the molding. The rotor must be handled very carefully while it is out of the unit.

Contact Adjustments

To make contact adjustments, refer to Figure 18 for identification of low-gradient contact parts and proceed as follows:

* Loosen the locknut that secures the backstop screw (located at the right hand corner of the unit) to its support. Unwind the backstop screw so that the moving contact arm is permitted to swing freely. Adjust the tension of each low-gradient contact brush so that one-to-two grams of pressure are required at the stationary contact tip and four-to-five grams of pressure at the moving contact tip in order to cause the end of the brush to separate from the inner face of its respective brush retainer. Adjust the spiral spring until the moving contact arm is in a neutral position, i.e., with the arm pointing directly forward. Loosen the locknut that secures the stationary-contact mounting screw to the stationary-contact support. Wind the mounting screw inward until the stationary and moving contact members just begin to touch. Unwind the mounting screw until the stationary-contact stop lines up with the moving-contact-brush retainer. Wind the backstop screw inward until the moving and stationary contact members again just begin to touch. Loosen the locknut of the stationary-contact stop screw, and advance this screw until it just touches the moving-contact-brush retainer. Unwind the screw 1-1/2 turns to provide contact wipe. Tighten the locknut. Unwind the backstop screw 2/3 turn and tighten the locknut that secures the backstop screw to its support.

* Indicates revision

Torque Adjustment

The directional unit is provided with a notched core that is used to minimize the torque produced on the rotor by current alone in the operating coils with the polarizing circuits de-energized. This adjustment is made at the factory and may be checked as follows:

First, short out the potential-polarizing circuit. Adjust the control spring so that the moving contact structure is balanced between the stationary contact and the stop. This can be done by loosening the hexagonal-head locking screw, which clamps the spring-adjusting ring in position, and turning the ring to the left until the balance point is reached.

Energize the operating circuit with 30 amperes and check that the contact arm does not move. The core should be turned in small steps until a point is reached where there is no "bias" torque from current alone. The core can be turned by loosening the large hexagonal nut on the bottom of the unit and turning the core by means of the slotted bearing screw. This screw should be held securely in position when the nut is retightened.

Keep in mind that currents of these magnitudes will cause the coils to overheat if left on too long. Therefore, leave the test current on only for short intervals, and allow sufficient time between tests for the coils to cool.

After the torque adjustments have been made, the spiral should be set to have barely enough tension to swing the moving-contact arm against the stop screw when the unit is de-energized. Sufficient tension will be obtained if the adjusting ring is rotated in the counterclockwise direction about 1/2 inch from the neutral position, as measured on the periphery of the ring.

lutch Adjustment

e connections shown in Figure 23 for the polarity check can also be used in making he clutch adjustment. The 50 ohm fixed resistor should be replaced with an adjustable resistor capable of controlling the current up to 10 amperes. A screw projecting from the side of the moving contact arm controls the clutch pressure and, consequently, the current value that will cause the clutch to slip. With rated frequency and voltage, set the clutch to slip in the range 5.5 to 8 amperes

The clutch slip is limited to approximately 20° by means of a stop pin in the shaft. It should first be set to slip in the contact-closing direction at the current values listed in the table, with the polarizing circuit energized but with the restraint circuit open. Then check that the clutch will slip to the limit in the contact-opening direction, with the restraint circuit energized at rated volts and the current circuit open.

INSTANTANEOUS UNIT

1. Both contacts should close at the same time.
2. The backing strip should be so formed that the forked end (front) bears against the molded strip under the armature.
3. With the armature against the pole piece, the cross member of the "T" spring should be in a horizontal plane and there should be at least 1/64 inch wipe on the contacts. Check this by inserting a 0.010 inch feeler gage between the front half of the shaded pole and the armature, with the armature held closed. The contacts should close with the feeler gage in place.

CONTACT CLEANING

For cleaning fine silver contacts, a flexible burnishing tool should be used. This consists of a flexible strip of metal with an etched-roughened surface, resembling in effect a superfine file. The polishing action is so delicate that no scratches are left, yet corroded material will be removed rapidly and thoroughly. The flexibility of the tool ensures the cleaning of the actual points of contact.

Fine silver contacts should not be cleaned with knives, files or abrasive paper or cloth. Knives or files may leave scratches, which increases arcing and deterioration of the contacts. Abrasive paper or cloth may leave minute particles of insulating abrasive material in the contacts, thus preventing contact closing.

The burnishing tool described above can be obtained from the factory.

RENEWAL PARTS

It is recommended that sufficient quantities of renewal parts be carried in stock to enable the prompt replacement of any that are worn, broken, or damaged.

When ordering renewal parts, address the nearest Sales Office of the General Electric Company, specify quanitity required, name of part wanted, and give complete nameplate data. If possible, give the General Electric Company requisition number on which the relay was furnished. Refer to renewal parts publication GEF-4085.

Figure 1 (8043462) Type IBCV51M(-)Y1A Relay in Case (Front View)

Figure 2 (8043463) Type IBCV51M(-)Y1A Relay Removed from Case (Front View)

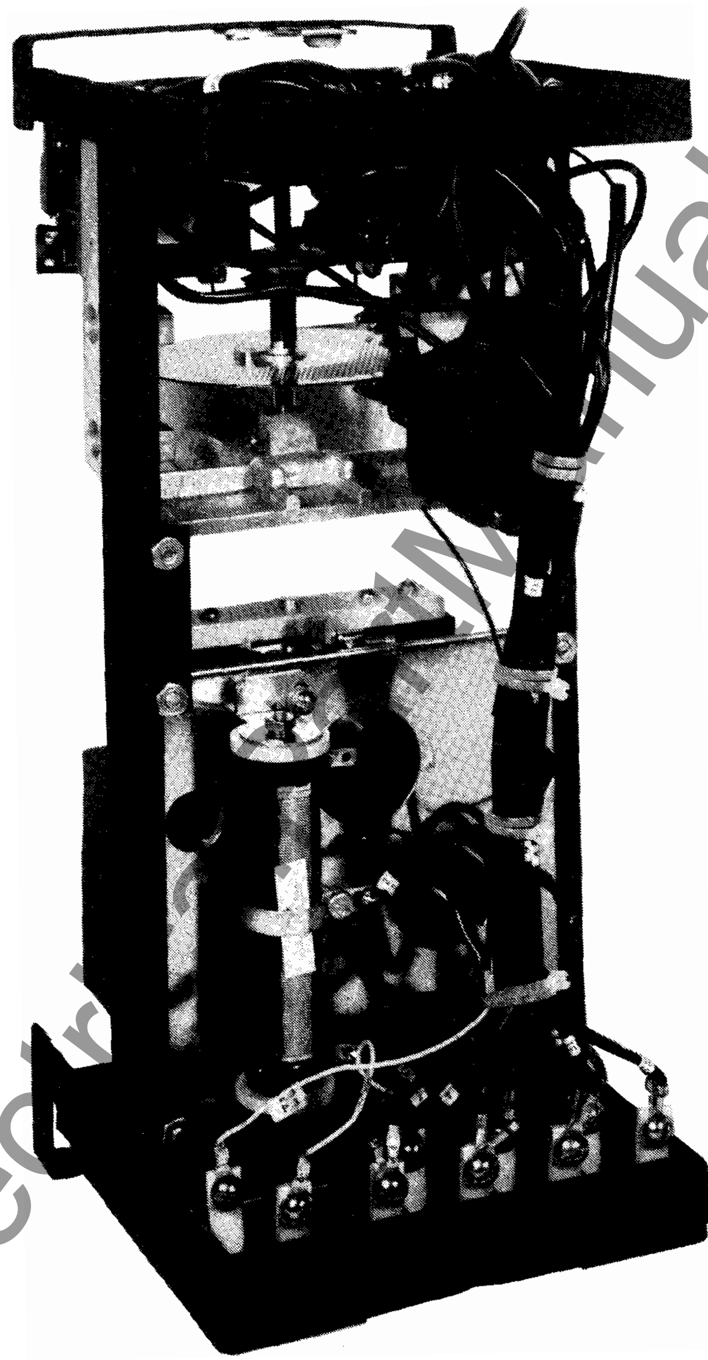


Figure 3 (8043464) Type IBCV51M(-)Y1A Relay Removed from Case (Rear View)

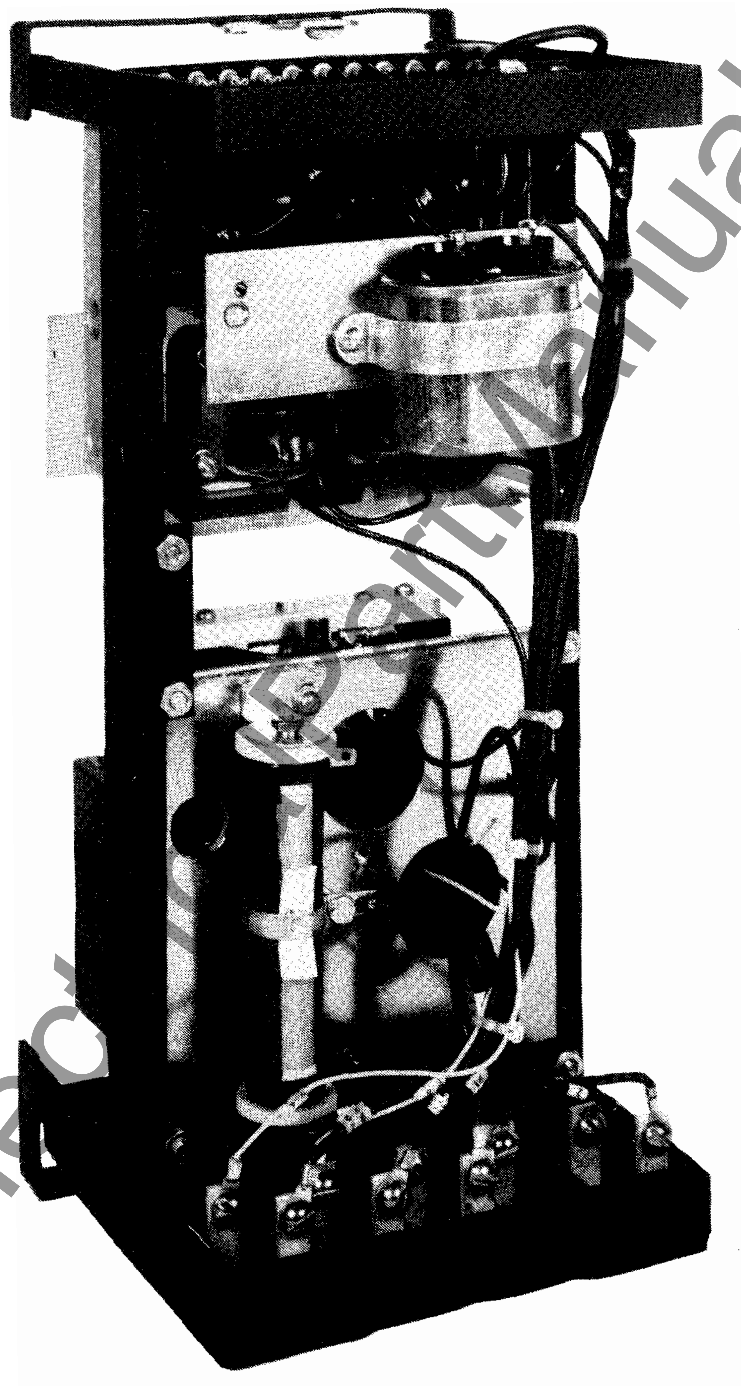


Figure 4 (8043465) Type IBCV77M Relay Removed from Case (Rear View)

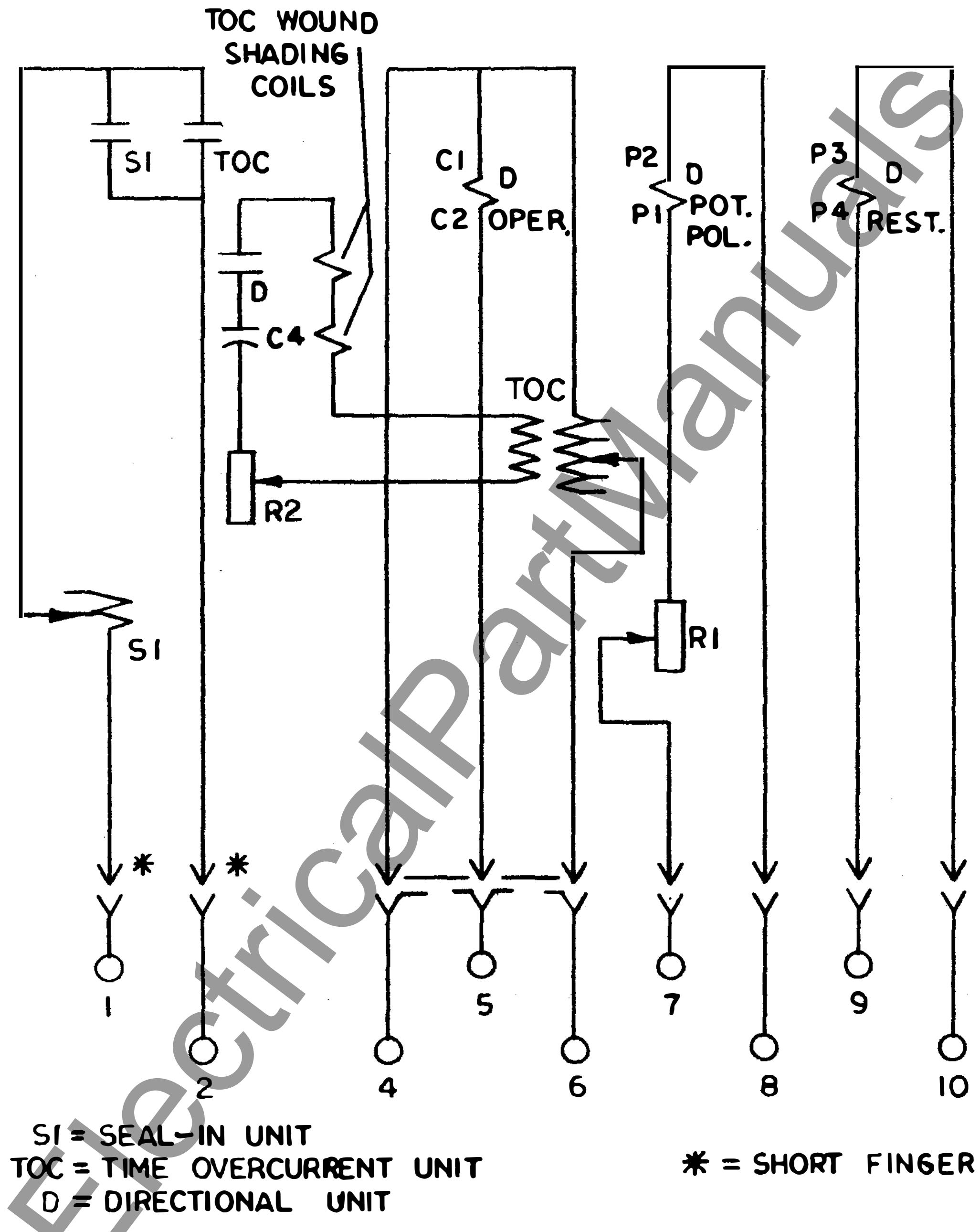


Figure 9 (0257A6167) Internal Connections for IBCV77M Relay (Front View)

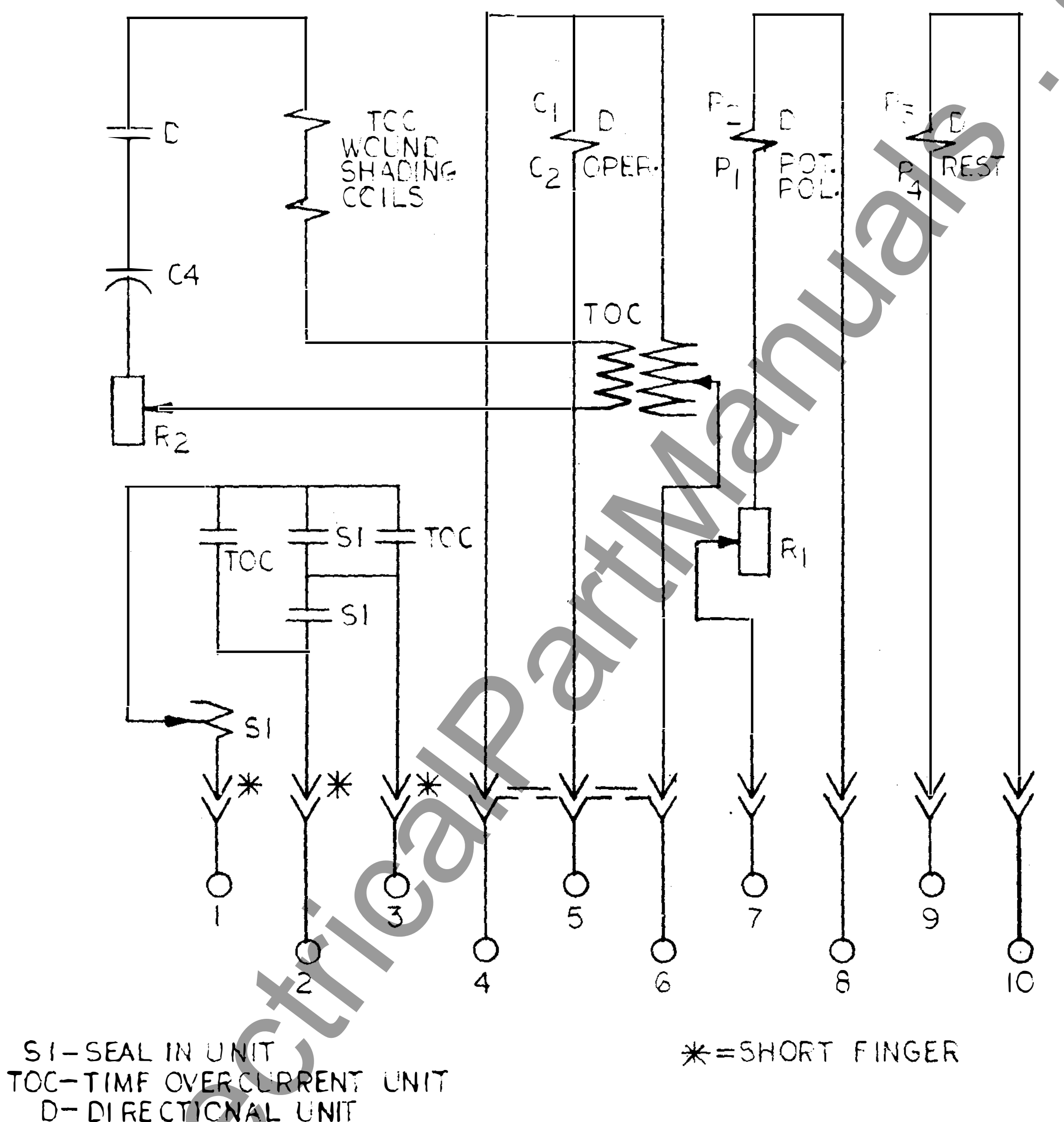
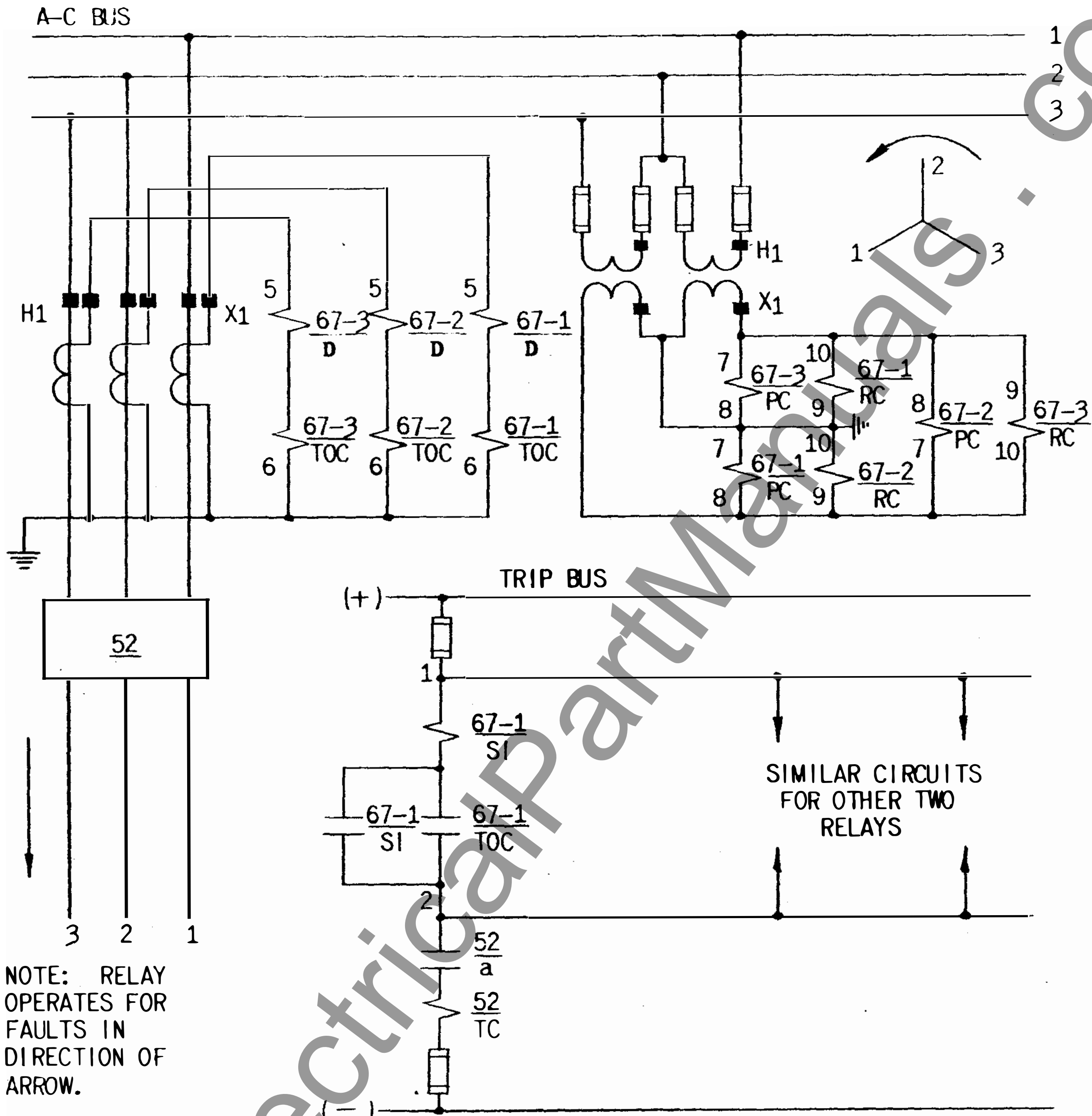


Figure 10 (0273A9197) Internal Connections for IBCV78M Relays (Front View)



67 - PHASE DIRECTIONAL OVERCURRENT RELAY	
TOC - TIME OVERCURRENT UNIT D - DIRECTIONAL UNIT SI - SEAL-IN WITH TARGET	OC - DIRECTIONAL UNIT OPERATING COIL PC - DIRECTIONAL UNIT POLARIZING COIL RC - DIRECTIONAL UNIT RESTRAINT COIL

52 - POWER CIRCUIT BREA ER	
TC - TRIP COIL	a - AUXILIARY SWITCH, CLOSED WHEN BREAKER IS CLOSED

Figure 11 (0418A0933-1) External Connections for Three Single-Phase Type IBCV Relays for Directional Phase Fault Protection of a Single Line

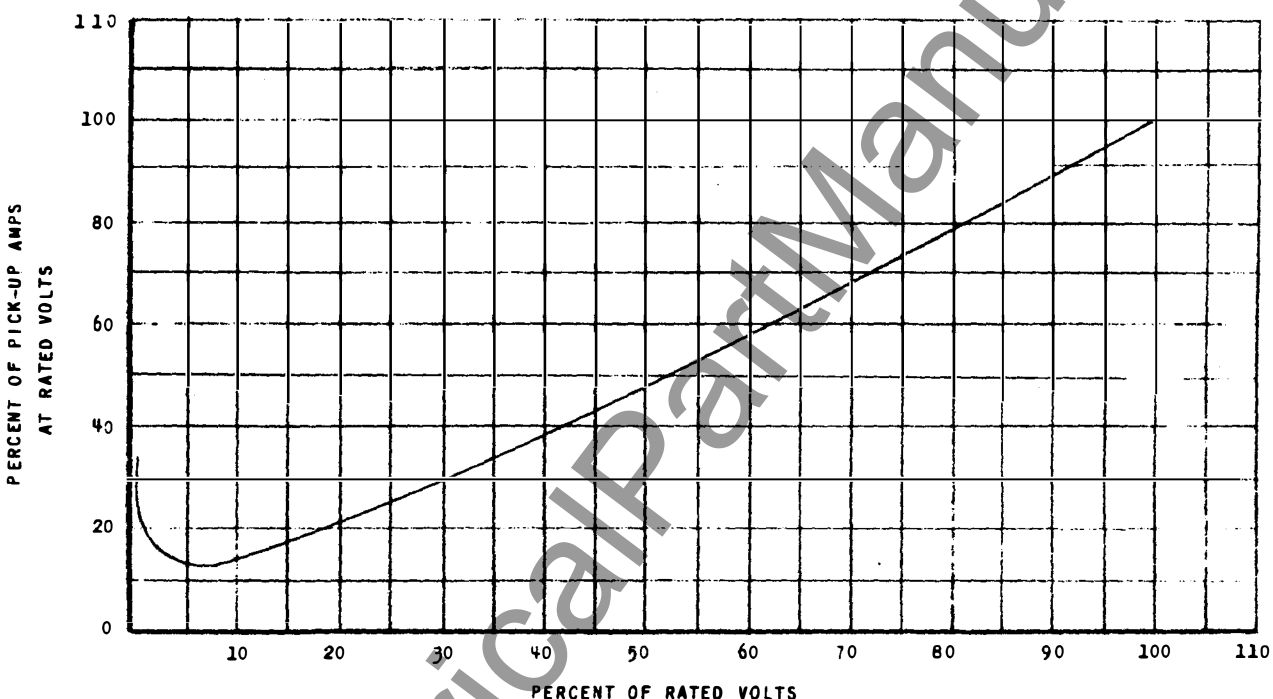


Figure 12 (K-6507958-1) Directional-Unit-Pickup Characteristic with Balanced Voltage and at Maximum Torque Angle

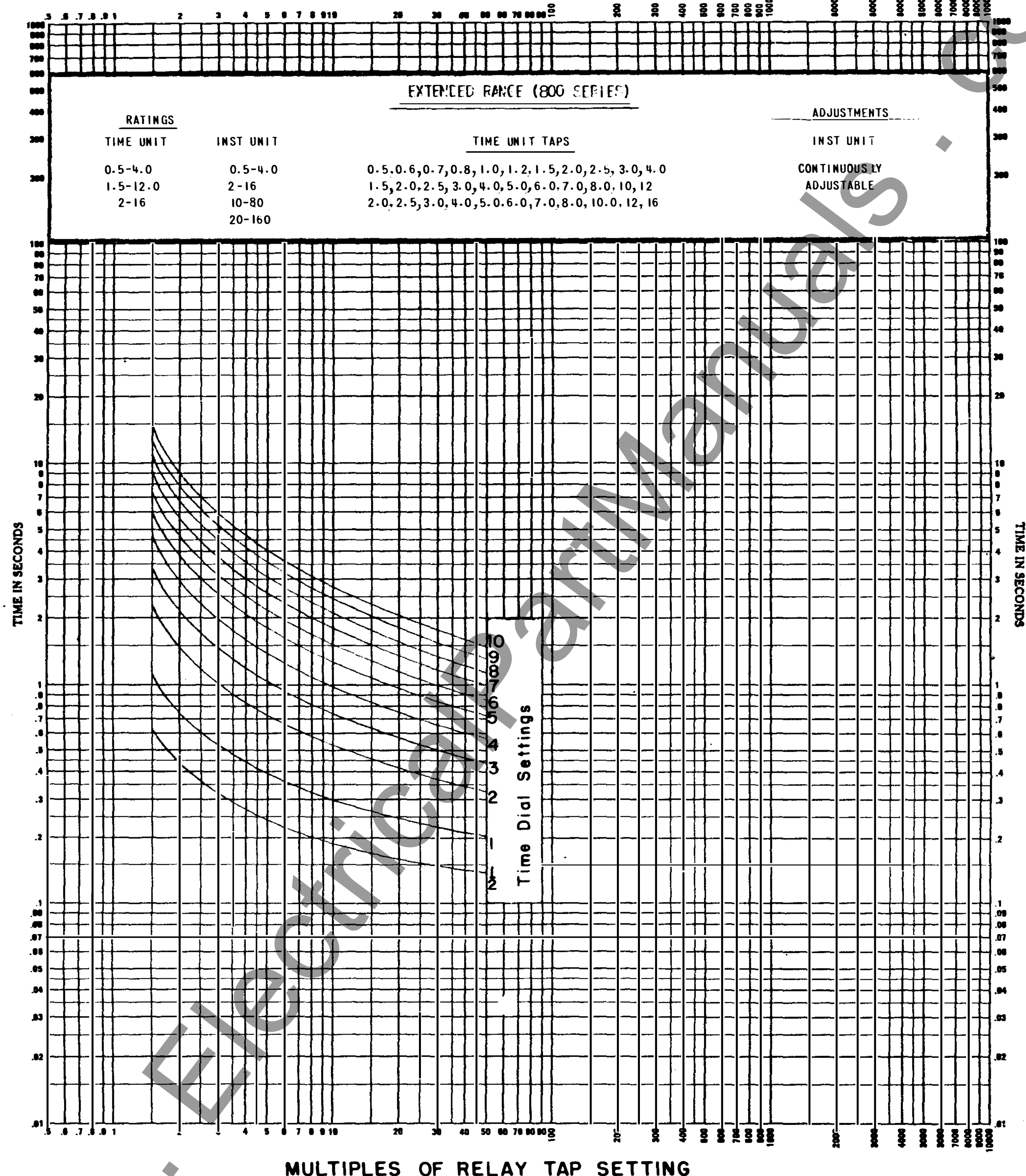


Figure 13 (0888B0269-3) Time-current Characteristic of Inverse-Time Overcurrent Unit

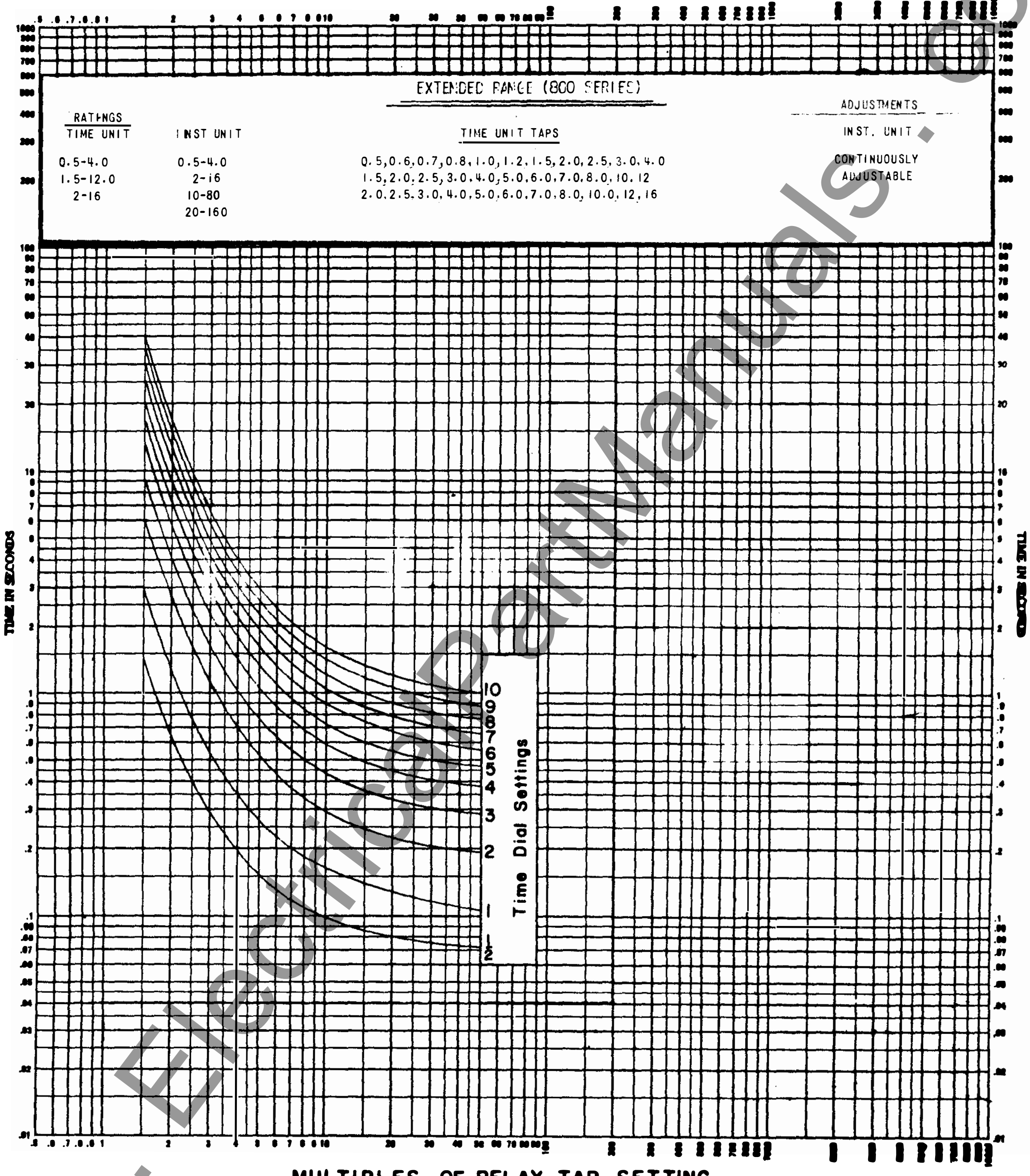


Figure 14 (0888B0270-3) Time-current Characteristics of Very-Inverse-Time Overcurrent Unit

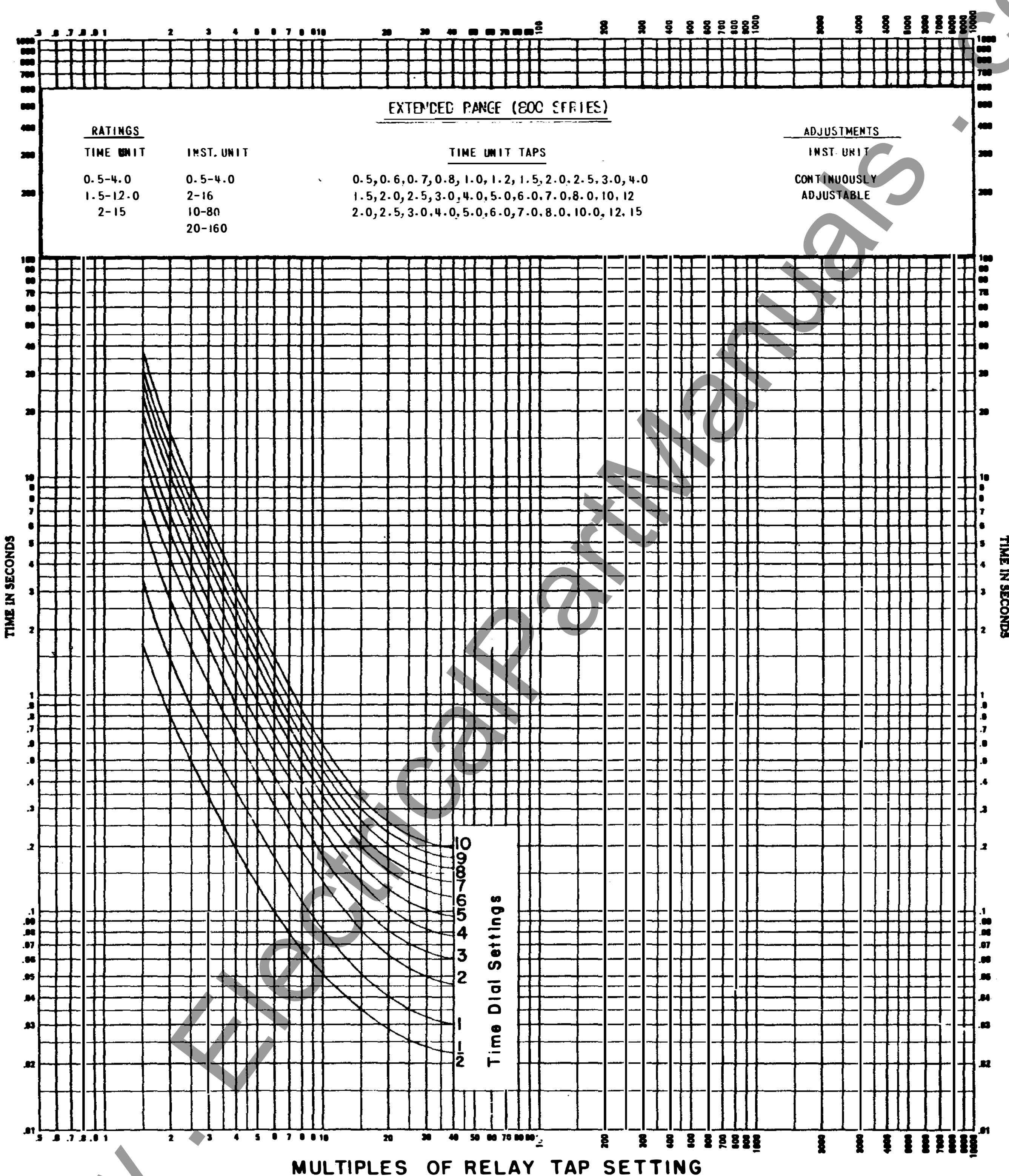


Figure 15 (0888B0274-5) Time-current Characteristic of Extremely-Inverse-Time Overcurrent Unit

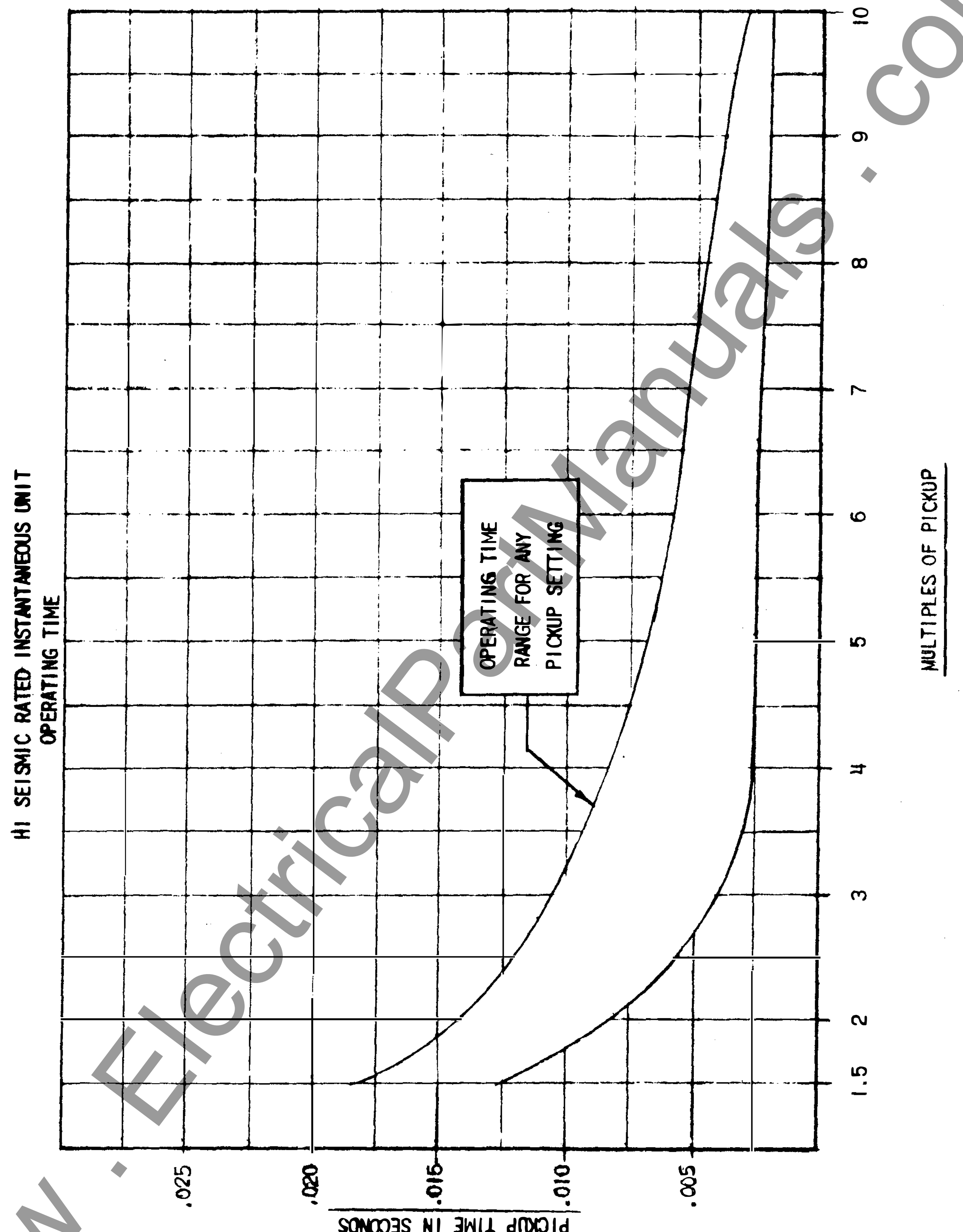


Figure 16 (0208A8695-1) Time-current Characteristics of the High-Seismic Instantaneous Unit

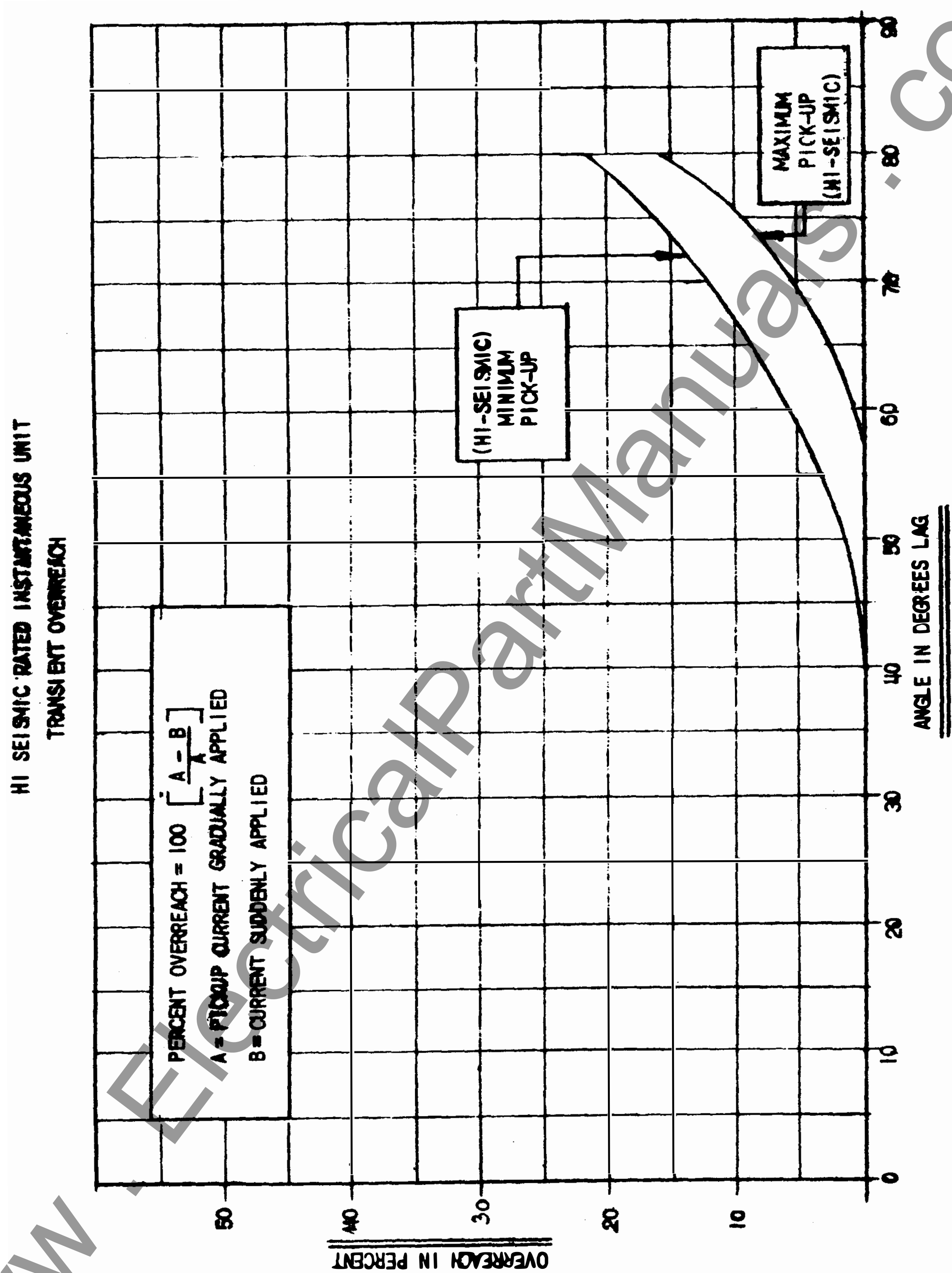
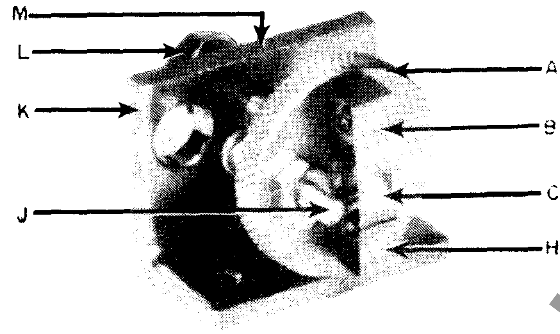
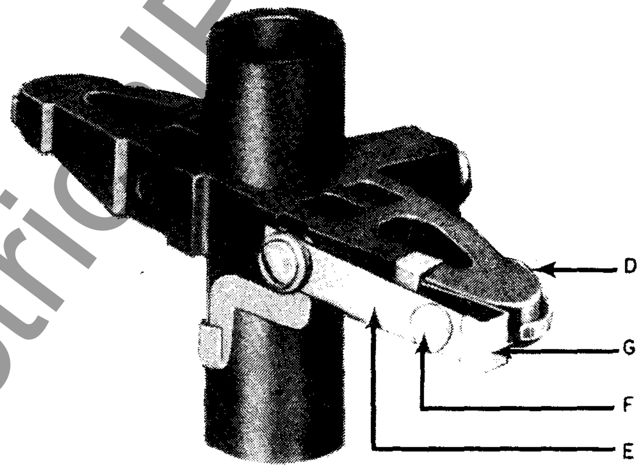


Figure 17 (0208A8694-2) Transient-Overreach Characteristics of the High-Seismic Instantaneous Unit



A - Contact Dial
B - Stationary Contact Brush
C - Contact Tip
H - Stationary Contact Brush Retainer

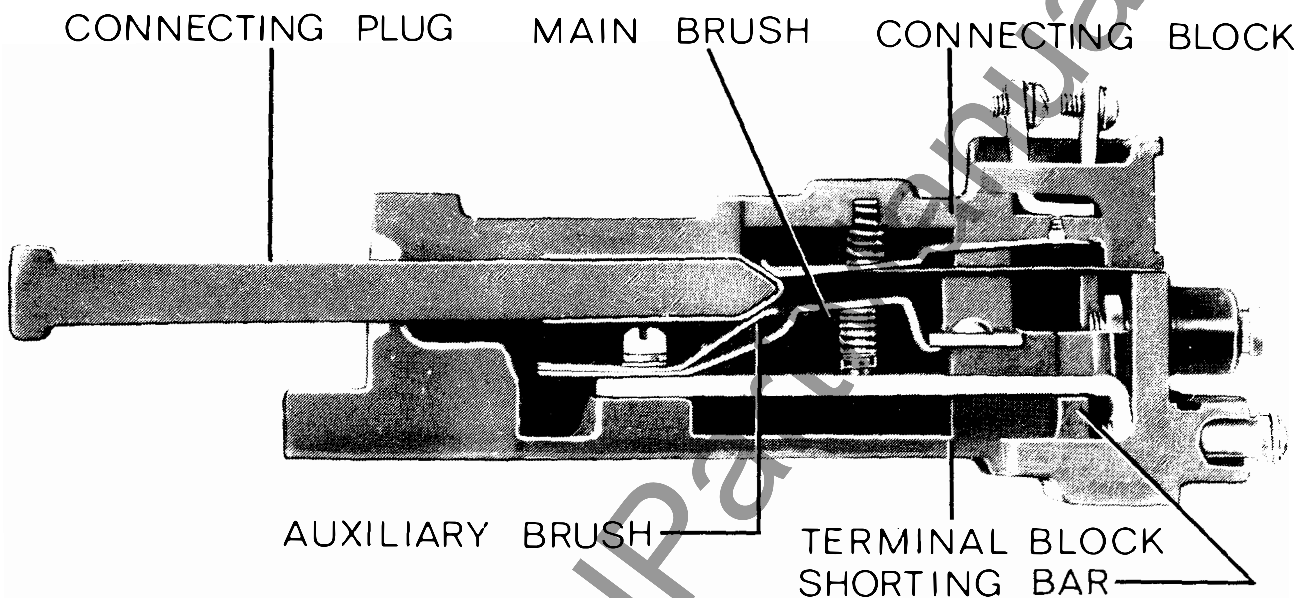
J - Stop Screw
K - Stationary Contact Support
L - Mounting Screw
M - Locknuts



D - Moving Contact Arm
E - Moving Contact Brush

F - Button Contact Tip
G - Moving Contact Brush Retainer

Figure 18 (8027688 and 8023399) Low-Gradient Contact Assembly for the Directional Unit



NOTE: AFTER ENGAGING AUXILIARY BRUSH CONNECTING PLUG TRAVELS 1/4 INCH BEFORE ENGAGING THE MAIN BRUSH ON THE TERMINAL BLOCK

Figure 19 (8025039) Cross Section of Drawout Case Showing Position of Auxiliary Brush

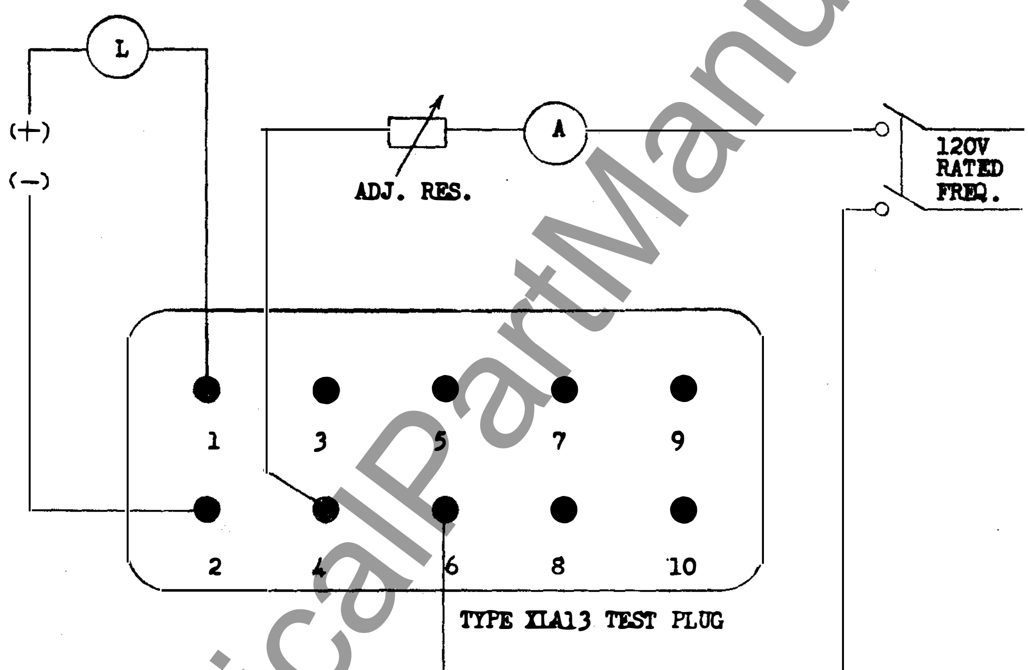


Figure 20 (0195A9179) Test Connections for Checking Pickup of TOC Unit

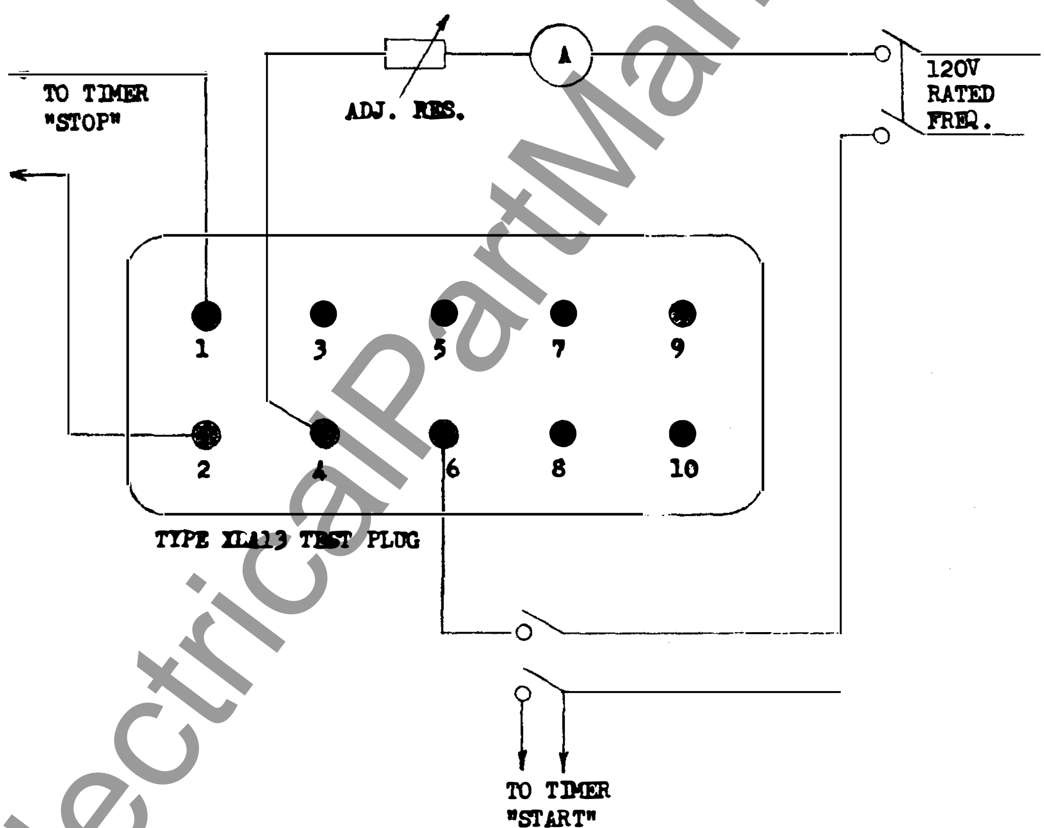
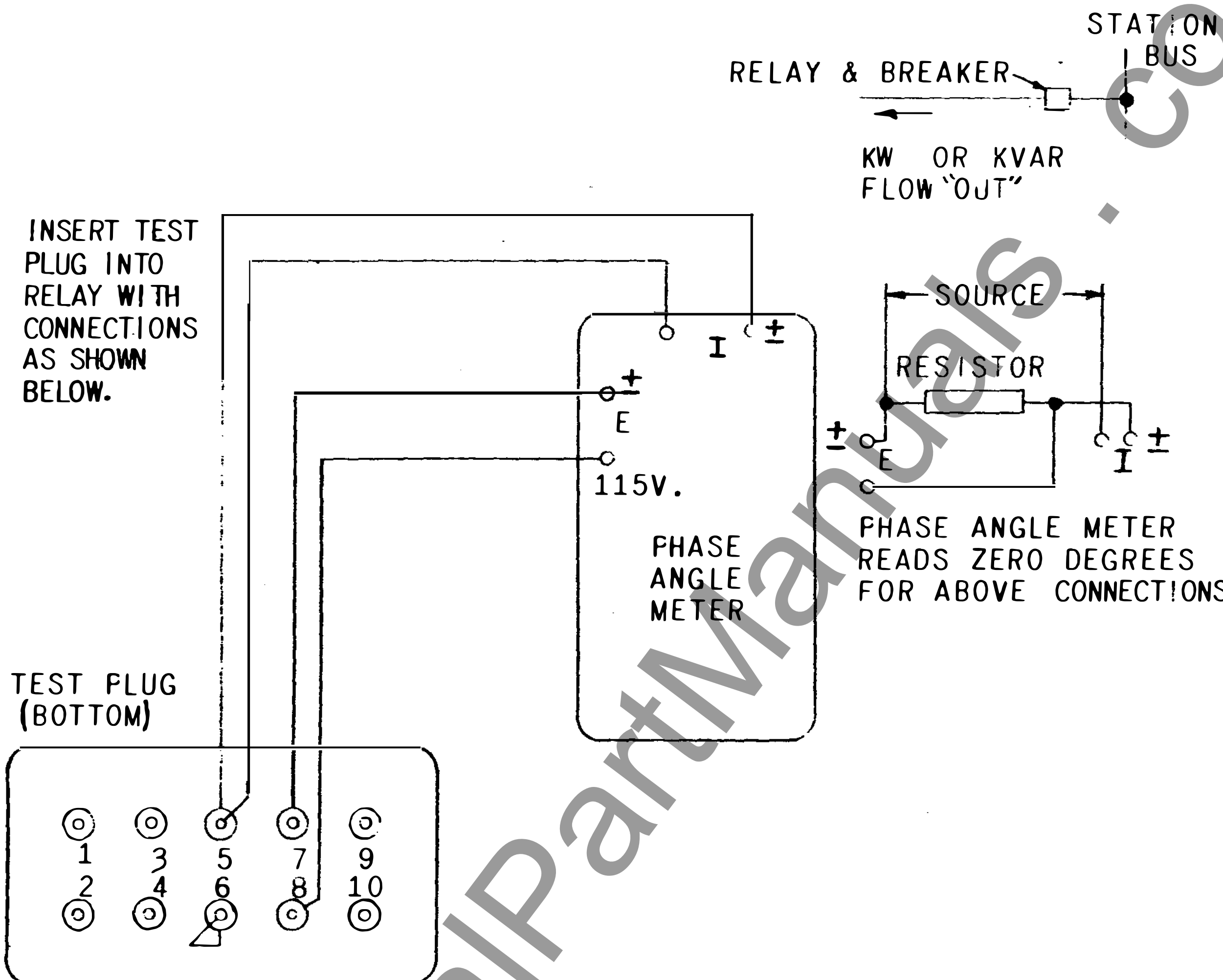


Figure 21 (0195A9180) Test Connections for Checking Operating Time of TOC Unit



POWER FACTOR ANGLE (DEG. LEAD)	0-45	45-90	90-135	135-180	180-225	225-270	270-315	315-360
KW & KVAR DIRECTIONS WITH RESPECT TO THE BUS	KW OUT > KVAR IN	KVAR IN > KW OUT	KVAR IN > KW IN	KW IN > KVAR IN	KW IN > KVAR OUT	KVAR OUT > KW IN	KVAR OUT > KW OUT	KW OUT > KVAR OUT
METER READING WITH PROPER EXT. CONNS.	90-135	135-180	180-225	225-270	270-315	315-360	0 45	45 90

THE ABOVE RANGES OF PHASE ANGLE METER READINGS ARE THE ANGLES BY WHICH THE CURRENT LEADS THE VOLTAGE WITH THE DESCRIBED CONDITIONS OF POWER (KW) AND REACTIVE POWER (KVAR) FLOW WITH THE STATION BUS CONSIDERED AS THE REFERENCE IN ALL CASES. > MEANS GREATER THAN.

CAUTION: MAKE CORRECTIONS FOR METER ERRORS ON LOW CURRENTS, INHERENT IN SOME PHASE-ANGLE METERS.

Figure 22 (0377A195-3) Test Connections for Checking Polarity of the External Wiring to the Directional-Unit Operating and Polarizing Circuits

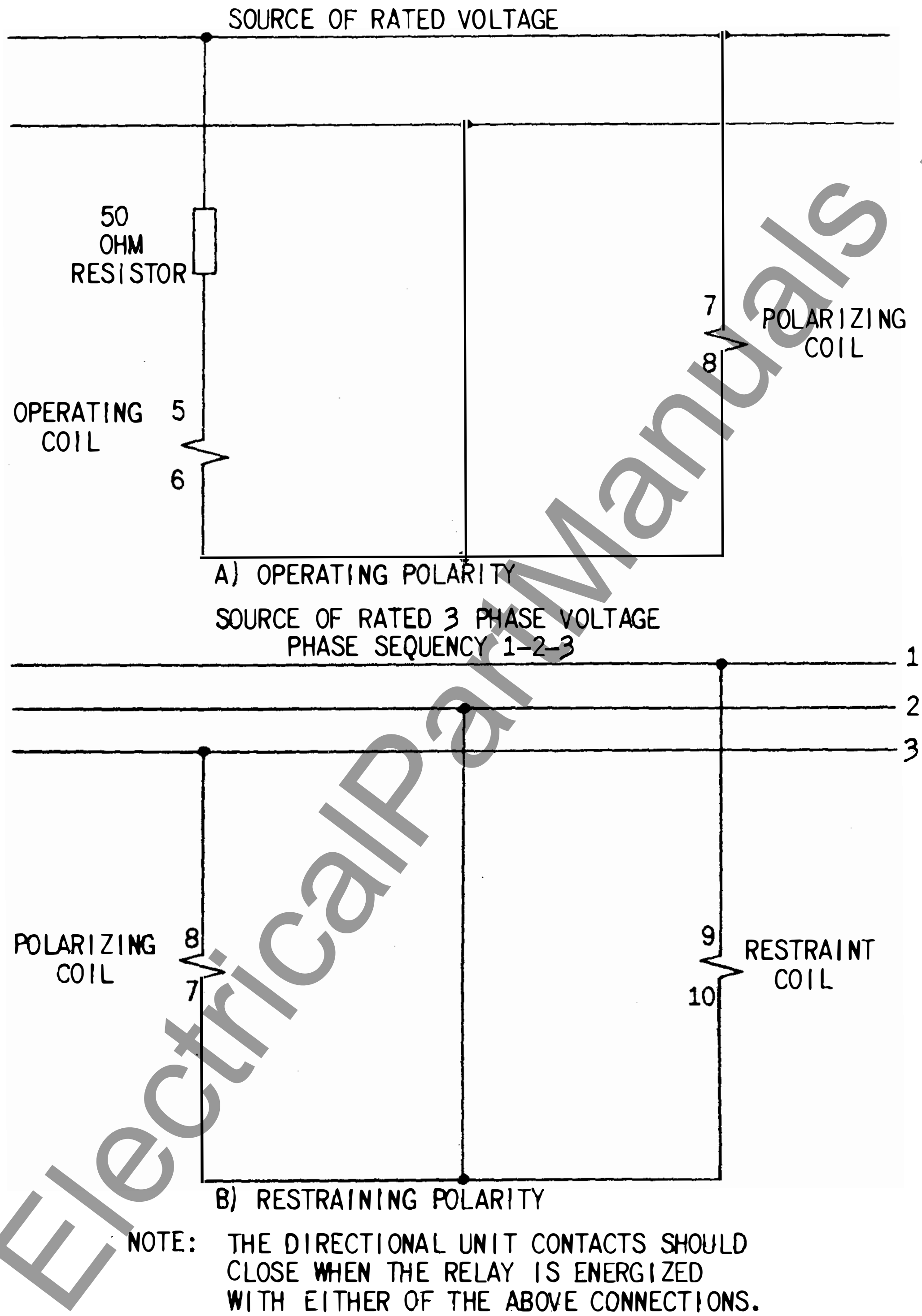
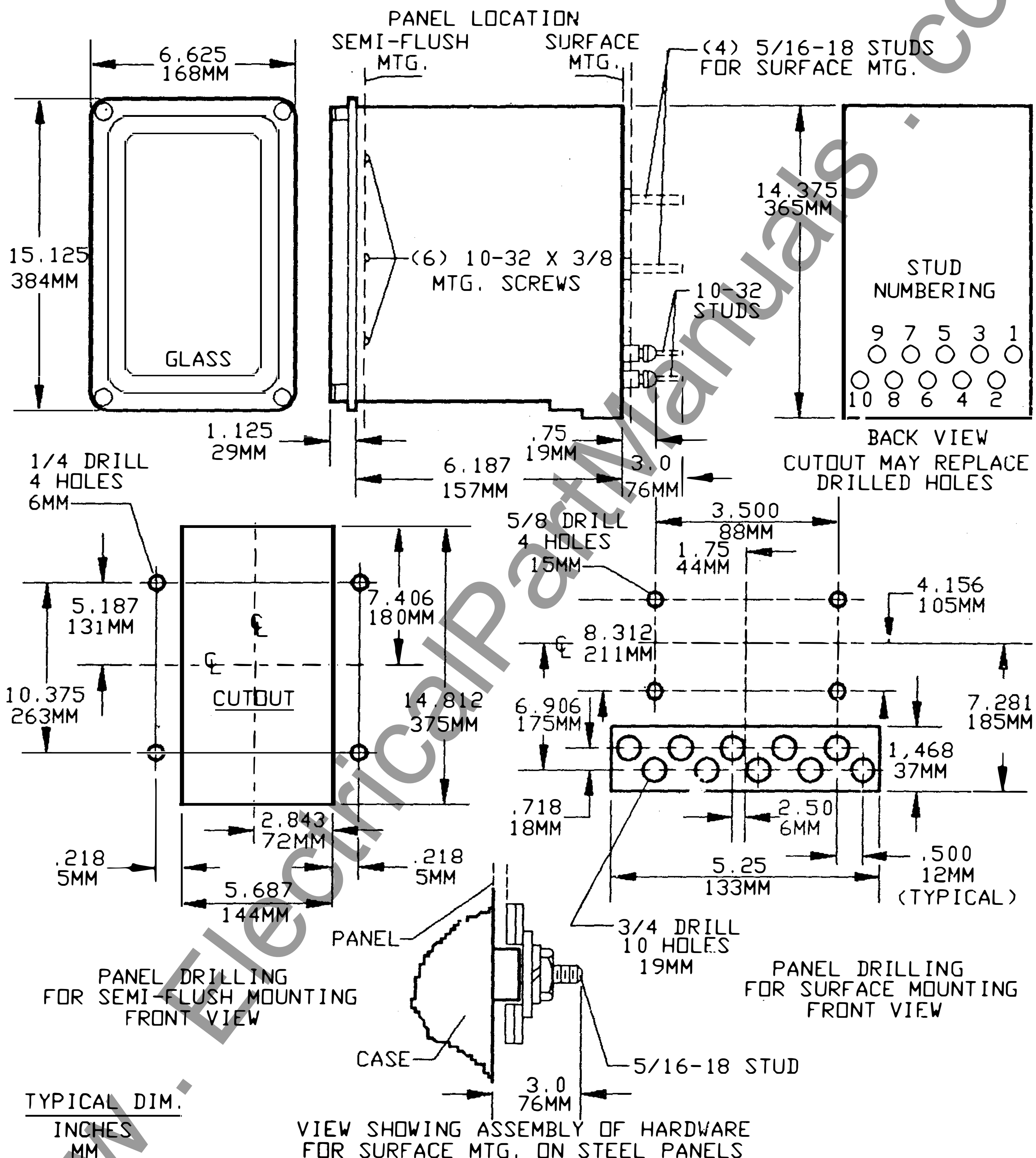
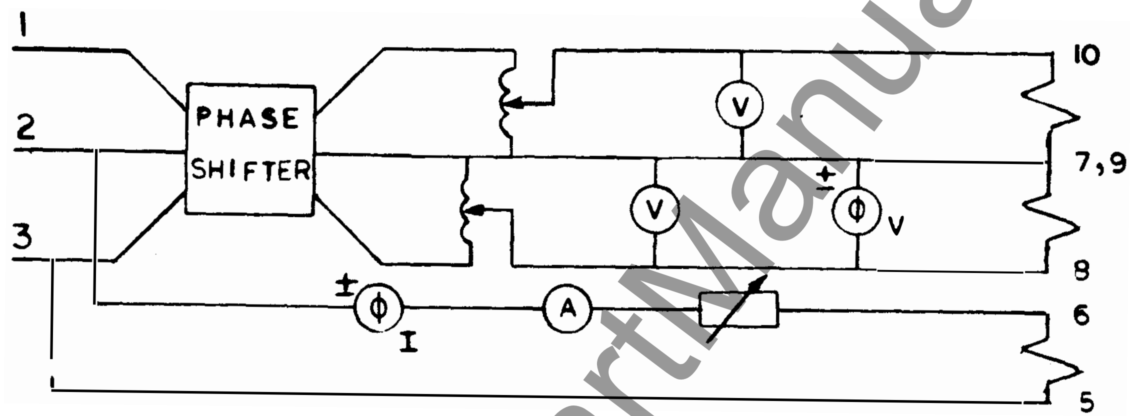


Figure 23 (0418A0971) Test Connections for Checking Polarity of the Directional-Unit Internal Wiring



* **Figure 24 (K-6209273 [5]) Outline and Panel Drilling Dimensions for IBCV Relays**

* Indicates revision



Φ-PHASE ANGLE METER

V-VOLTAGE CONNECTION

I-CURRENT CONNECTION

±-POLARITY MARK

Figure 25 (0285A5178) Test Diagram for Maximum Torque Angle

Meter and Control Business Department

ST-2/94 (300)

General Electric Company
Protection and Control
205 Great Valley Parkway
Malvern, Pennsylvania 19355-0715