INSTRUCTIONS

GEK-49821F

PHASE DIRECTIONAL OVERCURRENT RELAYS

TYPES

IBC51M	IBC51M(-)Y1A	IBC52M
IBC53M	IBC53M(-)Y1A	IBC54M
IBC77M	IBC77M(-)Y1A	IBC78M

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IBC77M	IBC77M(-)Y1A	IBC78M

DESCRIPTION

The Type IBC relays are phase directional overcurrent relays that 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 IBC relays contain an induction disk type time overcurrent unit, and an induction cup type instantaneous directional unit. The directional unit is quadrature polarized; it directionally controls the operation of the time overcurrent unit.

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 hi-seismic instantaneous overcurrent unit with hinged armature construction. This unit has a self-contained hand reset target that will show whenever the unit has operated.

All of the IBC relays are mounted in standard M1 size drawout cases; the outline and panel drilling dimensions for the M1 case are shown in Figure 22. Internal connections for the relays are shown in Figures 5, 6, 7, 8 and 9. Typical external connections are shown in Figure 10.

Table 1 below lists the various models and ranges of IBC relays that are available.

APPLICATION

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

Each relay contains a time overcurrent unit that is torque controlled by the instantaneous of 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 potential polarizing circuit in each relay is equipped with a link that allows the angle of maximum torque to be set at 45 or 70 degrees. With

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

To the extent required the products described herein meet applicable ANSI, IEEE and NEMA standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

TABLE 1

Relay Model	Time Characteristic	Inst. Unit	Pickup Range Inst.	Pickup Range Time	Circuit Closing Contacts	Int. Conns
IBC51M(-)A	INVERSE	NO	-	2-16	ONE	FIG 5
IBC51M(-)Y1A	INVERSE	YES	-	2-16	ONE	FIG 6
IBC52M(-)A	INVERSE	NO	6-150	2-16	TWO	FIG 7
IBC53M(-)A	VERY INVERSE	NO	-	1.5-12	ONE	FIG 5
IBC53M(-)Y1A	VERY INVERSE	YES	6-150	1.5-12	ONE	FIG 7
IBC54M	VERY INVERSE	NO	-	1.5-12	ONE	FIG 6
IBC77M(-)A	EXTREMELY INV.	NO	-	1/5-12	ONE	FIG 8
IBC77M(-)Y1A	EXTREMELY INV.	YES	6-150	1.5-12	ONE	FIG 9
IBC78M	EXTREMELY INV.	NO	-	1.5-12	TWO	FIG 23

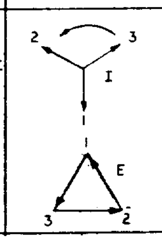
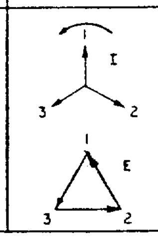
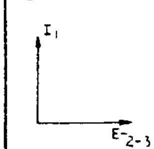
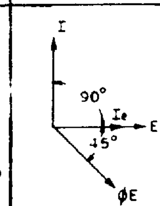
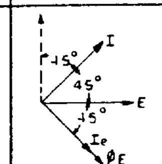
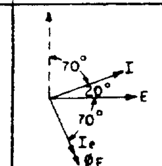
the link open, the angle of maximum torque will be 45 degrees, i.e., maximum torque will occur for relay current lagging the unity power factor condition by 45 degrees, or conversely, leading the quadrature voltage by 45 degrees. The angle of maximum torque and be shifted to 70 degrees by closing the link. For this condition, maximum torque will occur for relay current lagging the unity power condition by 70 degrees, or conversely, leading the quadrature voltage by 20 degrees. Select the link position for each application that will provide an angle of maximum torque that is compatible with existing system conditions.

Sometimes two type IBC phase relays and a ground directional relay, such as an IBCG, are used to implement the protective relay scheme. Where such practices are followed, the phase from which the phase relay is eliminated must be the same throughout the system if protection is to be provided for all fault contingencies.

The difference between the various models covered by this instruction book are shown in Table 1. 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 applications 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 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.

TABLE 2
CONDITIONS FOR MAXIMUM TORQUE USING 90° CONNECTION

CONNECTION (1-2-3 PHASE SEQUENCE - AT 60 CYCLES)	PHASE RELATIONSHIP AT RELAY TERMINALS FOR CURRENT FLOWING IN THE NON-TRIP DIRECTION AT UNITY POWER FACTOR LOAD.	PHASE RELATIONSHIP AT RELAY TERMINALS FOR CURRENT FLOWING IN THE TRIPPING DIRECTION AT UNITY POWER FACTOR LOAD.	VOLTAGE AND CURRENT USED IN PHASE 2 RELAY WITH PHASE RELATIONSHIP AT UNITY P.F. LOAD WHEN CURRENT FLOWS IN TRIPPING DIRECTION.	VECTOR RELATIONSHIP OF EDDY-CURRENTS IN INDUCTION CYLINDER TO FLUX SET UP BY POTENTIAL WINDING AT UNITY P.F. LOAD-SHORTING LINK OFF.	CONDITION FOR MAXIMUM TORQUE WITH SHORTING LINK OFF.	CONDITION FOR MAXIMUM TORQUE WITH SHORTING LINK ON.
QUADRATURE (CURRENT LEADS POTENTIAL 90 DEGREE WHEN FLOWING IN TRIPPING DIRECTION AT UNITY P.F. LOAD)			E_{2-3} AND I_1  I LEADS E BY 90 DEGREES		 MAX. TORQUE OCCURS WHEN I LAGS ITS UNITY P.F. POSITION BY 45 DEGREES.	 MAX. TORQUE OCCURS WHEN I LAGS ITS UNITY P.F. POSITION BY 70 DEGREES.

NOTES: I_e = EDDY-CURRENT IN INDUCTION CUP SET UP BY I.
ϕ = FLUX IN POTENTIAL WINDING.
θ = ANGLE BETWEEN I_e AND ϕ_E.
TORQUE = $K\phi I_e \cos\theta$

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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 11, 12 and 13. 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 eight ampere tap as for 50 amperes on the five amp tap, since in both cases, the current is ten times 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 insure 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 Y1A relays contains a hi-seismic instantaneous overcurrent unit. This unit may be set at high to provide direct tripping for faults some distance down the transmission line. In determining the setting for this unit, faults directly behind the relay must be considered, 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 15.

RATINGS

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

Ratings of the operating current circuits of the TOC, IOC (when used; see Table 1) and the directional units are shown individually. However, since all operating current circuits are normally connected in series, the operating coil ratings of all units should be considered in determining the rating of the entire operating circuit.

TIME OVERCURRENT UNIT

The one second rating of the TOC units are all 260 amperes. The available taps and the continuous ratings are shown in Tables 3, 4 and 5. Note that separate tables are given for the IBC51, IBC53 and IBC77 models.

TABLE 3
CONTINUOUS RATING OF INVERSE TIME OVERCURRENT UNIT

2.0-16.0 Ampere Range IBC51:

TAP	2.0	2.5	3.0	4.0	5.0	6.0	7.0	8.0	10.0	12.0	16.0
RATING	8.0	9.0	10.0	12.0	14.0	15.0	16.0	17.5	20.0	20.0	20.0

* TABLE 4
CONTINUOUS RATING OF VERY INVERSE TIME OVERCURRENT UNIT

1.5-12.0 Ampere Range IBC53:

TAP	1.5	2.0	2.5	3.0	4.0	5.0	6.0	7.0	8.0	10.0	12.0
RATING	10.0	11.5	12.3	13.0	14.5	17.0	19.0	21.0	23.0	23.5	27.5

TABLE 5
CONTINUOUS RATING OF EXTREMELY INVERSE TIME OVERCURRENT UNIT

1.5-12.0 Ampere Range IBC77:

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

* Revised since last issue

DIRECTIONAL UNIT

The directional unit operating circuit, terminals 4 and 5, has a six-ampere continuous rating and a 200-ampere one second rating. The potential polarizing circuit, terminals 7 and 8, is 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 6 and the applicable internal connections referenced in Table 1. 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 6
CONTINUOUS AND ONE SECOND RATINGS OF IOC UNIT

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

**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 maximum L setting and the minimum H setting. Whenever possible, always 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 7. The tap setting used will depend on the current drawn by the trip coil. The 0.2 ampere tap is for use with trip coils which 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 two amperes, there is a possibility that the resistance of seven ohms will reduce the current to so low a value that the breaker will not be tripped.

The two ampere tap should be used with trip coils that take two 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 auxiliary 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.

TABLE 7
SEAL-IN UNIT RATINGS

		Tap	
		0.2	2.0
DC resistance +10%	(ohms)	7	0.13
Minimum Operating (+0, -25%)	(amperes)	0.2	2.0
Carry continuously	(amperes)	0.3	3.0
Carry 30 amps for	(seconds)	0.03	4.0
Carry 10 amps for	(seconds)	0.25	30.0
60 hertz impedance	(ohms)	52.0	0.53

OPERATING CHARACTERISTICS

DIRECTIONAL UNIT

At the maximum torque angle, the directional unit will pick up at one percent of rated voltage with two amperes current. The directional unit has a shorting link connected in parallel with a series resistor located in the potential polarizing circuit. With the link open (potential resistor unshorted), the maximum torque angle is 45 degrees lead (current leads voltage). With the link closed (potential resistor shorted), the maximum torque angle is 20 degrees lead (current leads voltage). See Table 2.

PICKUP (TIME OVERCURRENT UNIT)

Pickup of the TOC unit is defined as the current required to close the contacts from the 0.5 time dial position. The pickup current is within five percent of tap value.

RESET (TIME OVERCURRENT UNIT)

Inverse time overcurrent units reset at 80 percent of the minimum pickup current; very inverse time units at 80 percent; and extremely inverse time units at 85 percent.

When the relay is de-energized, the time required for the disk to completely reset to the number ten time dial position is approximately six 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 11, 12 and 13, respectively for inverse time, very inverse time and extremely inverse time relays. For the same operating conditions, the relay will operate repeatedly within one or two percent of the same time.

The time-current characteristic of the hi-seismic instantaneous unit is shown by Figure 13 and its transient overreach characteristic is shown by Figure 15.

BURDENS

Table 8 gives the burden of the potential circuit.

TABLE 8
POTENTIAL CIRCUIT BURDENS AT 60 CYCLES AND RATED VOLTS

Potential Resistor Shorting Link	Volt Amperes	Power Factor	Watts
Open	16.7	0.71	11.8
Closed	21.9	0.38	8.3

Table 9 gives the combined burdens of the time overcurrent and the directional unit current circuits.

TABLE 9
CURRENT CIRCUIT BURDENS AT 60 CYCLES (TOC + DIRECTIONAL UNIT)

Time Charact.	Tap Range (Amps)	Burdens at Minimum Pickup (Ohms) Eff. Res.	React.	Imp.**	Volt+ Amperes	P.F.	Ohms Impedance at 3 times Min. PU	10 times Min. PU	≠VA at 5 Amps
Inverse	2-16	0.57	1.92	2.00	8.0	0.28	1.17	0.84	50
Very Inverse	1.5-12	0.43	1.01	1.09	2.47	0.39	1.09	0.88	27
Extremely Inverse	1.5-12	0.29	0.63	0.69	1.55	0.41	0.69	0.69	17

**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 IBC53 relay, 1.5/12 amperes, the impedance of the 1.5 ampere tap is 2.00 ohms. The impedance of the three ampere tap, at three amperes, is approximately $(1.5/3)^2 \times 2.00 = 0.50$ ohms.

+Some companies list relay burdens only as the volt-ampere input to operate at minimum pickup. This column is included so 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 five amperes is used for this purpose.

≠Calculated from burden at minimum pickup.

Table 10 gives the burden of the instantaneous unit.

TABLE 10
BURDEN OF THE INSTANTANEOUS UNIT

INST. UNIT (AMPS)	HZ	RANGE	RANGE (AMPS)	MINIMUM PICKUP (AMPS)	BURDEN AT MINIMUM PICKUP (OHMS)			BURDEN OHMS (Z) TIMES PICKUP		
					R	Jx	Z	3	10	20
6-150	60	L	6-30	6	0.110	0.078	0.135	0.095	0.081	0.079
		H	30-150	30	0.022	0.005	0.023	0.022	0.022	0.022

CONSTRUCTION

The IBC relays consist of two units, a time overcurrent unit (top) of the industion disk type, and an instantaneous power-directional unit (bottom) of the induction cup type. The directional unit is potential polarized and directionally controls the operation of the time overcurrent unit by means of its closing contacts. The directional unit has a potential resistor shorting link located on the right-hand molded post which supports the bearing plate. As explained under **OPERATING CHARACTERISTICS,** the link position, either open or closed, determines the maximum torque angle. When the link is left open, it should be attached by the lower screw so that it will not be lost.

The IBC relays have a target seal-in unit, and models with the Y1A siffix, as shown by Table 1, have a hinged armature type instantaneous overcurrent unit.

The IBC relays are mounted in the single-ended M1 drawout case.

DIRECTIONAL UNIT

The directional unit has an 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 alternately with current operating coils and potential polarizing coils.

The principle by which torque is developed is the same as that of an induction disk relay with a watt-metric 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 16. They are low gradient type, specially constructed to minimize the effects of vibration. Both the stationary and moving contact brushes are made of low gradient material which, when subjected to vibration, tend to follow one another; hence, they resist contact separation.

The contact dial (A) supports the stationary contact brush (B) which has a conical contact tip (C) mounted on it. The moving contact arm (D) supports the moving contact brush (E) on which a button contact tip (F) is mounted. 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 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 which are connected in series with a directional unit contact. When as a result of power flow direction, the directional unit contacts close, the shading coils act to produce a split-phase field which, in turn, develops torque on the operating disk.

The extremely inverse time overcurrent unit is of the watt-metric type, similar to watt-hour 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 which 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 conpensated by the spiral shape of the induction disk, which results in an increased driving force as the spring winds up.

TARGET AND SEAL-IN UNIT

A 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 which 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 instantaneous element, mounted on the right side of the TOC unit. The IOC element operates over a 25 to 1 total range that is obtained by using a tapped coil that provides a 5 to 1 low range and a 5 to 1 high range; this combination provides the 25 to 1 total range. When the current reaches a predetermined value, the instantaneous element operates 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 damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Apparatus Sales Office.

Use reasonable care when unpacking the relay in order not to damage any of the parts nor disturb any of the adjustments.

If the relays are not to be installed immediately, they should be stored in their shipping cartons in a place that is moisture-free and where there are neither dust nor metallic chips. If foreign matter collects on the outside of the case, it may find its way inside when the cover is removed, and cause operation problems with the relay.

ACCEPTANCE TESTS

Immediately upon receipt of the relay, perform an inspection and acceptance test to ensure that no damage has been sustained in shipment and the 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 acceptance tests at the discretion of the user.

Since most operating companies use different procedures for acceptance and installation tests, the following section includes all applicable tests that may be performed on these relays.

VISUAL INSPECTION

Check the nameplate stamping to ensure 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 9 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 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 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, they should be tested in either their cases or an equivalent steel case. 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 flexibility, 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 are affected by frequency. Since non-sinusoidal waveforms can be analyzed as a fundamental frequency plus harmonics of the fundamental frequency, it follows that alternating current devices (relays) will be affected by the applied waveform.

Therefore, in order to properly test alternating current relays, 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, R-L 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. Then take a screw from the left-hand stationary contact and place it in the desired tap. Next, remove the screw from the other tap and place it back in the left-hand contact. This prevents 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 11.
4. Open the parallel contact circuit of step 2; the seal-in unit should remain in the picked up position.
5. Decrease the current slowly until the seal-in unit drops out. See Table 11.

TABLE 11
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 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 dial 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 3, 4 and 5.

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 five percent 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 to be obtained intermediately between the available tap settings.

Pickup adjustment by means of the control spring applies to the IBC51 and IBC53 relays. The procedure is different for IBC77 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 setting located intermediately between the various tap settings. The control spring is prewound approximately 660 degrees with the contacts just closed. Further adjustment of this setting is seldom required; if required because of insufficient range of the variable reisitor, it should never be necessary to wind up the control spring adjuster more than 30 degrees (one notch) or unwind it more than 90 degrees (three notches) from the factory setting.

Test connections for making pickup and time checks on the time overcurrent unit are shown in Figures 18 and 19. Use a 120 volts or greater source 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 must be blocked closed or jumpered for both the pickup test and the time test (see internal connection diagram).

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. When the dial is set on 10, the disk must travel the maximum amount to close the contacts and is 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 time tests.

Set the relay at the 0.5 time dial position and 2.0 ampere tap. With test connections as shown in Figure 18, the main unit should close its contacts within plus or minus two percent of tap value current (1.96-2.04 amps).

Time Test

Set the relay at the No. 5 time dial setting and the 2.0 amp tap. With test connections as shown in Figure 19, apply five times tap pickup current to the relay. The relay should operate within the limits given in Table 12. The remainder of the curves should operate within ±7% of the published curve.

TABLE 12
TOC UNIT OPERATING TIME LIMITS

Relay Type	TIME IN SECONDS		
	Minimum	Midpoint	Maximum
IBC51-52	1.69	1.78	1.89
IBC53-54	1.24	1.31	1.38
IBC77-78	0.87	0.92	0.97

DIRECTIONAL UNIT

Polarity Check

The polarity of the external connections to the directional unit may be verified by 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. Refer to Figure 20 for a more accurate method of checking the polarity of the connections.

Figure 21 depicts the test connections to check the polarity of the directional unit itself.

Potential Resistor Shorting Link

The potential resistor shorting link is located on the right-hand molded post which supports the bearing plate and is in parallel with a series resistor located in the potential polarizing circuit. With the link open (potential resistor unshorted), the maximum torque angle is 45 degrees lead (current leads voltage). With the link closed (potential resistor shorted), the maximum torque angle is 20 degrees lead (current leads voltage). When the link is left open, it should be attached by the lower screw so that it will not be lost.

INSTANTANEOUS UNIT

Make sure that the instantaneous unit is in the correct range in which it is to operate (see internal connections diagram and Table 6). Whenever possible, use the higher range because 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 it counterclockwise increases the pickup. Bring the current up 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 6 for the continuous and one second ratings of the instantaneous unit. Do not exceed these ratings when applying current to the instantaneous unit.

The range of the instantaneous unit (see Table 6) must be obtained between a core position of one-eighth of a turn clockwise turn, and 20 turns counterclockwise from the fully 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. See the outline and panel drilling diagram, Figure 22.

CONNECTIONS

The internal connection diagrams for the various relays are shown in Figures 5 through 9. A typical wiring diagram is shown in Figure 10. Since phase sequence is important for the correct operation of Type IBC relays, the rotation must be as specified in Figure 10. Unless the relay case is mounted on a steel panel which adequately grounds it, the case should 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 problems are encountered, they should be corrected as described in the section on servicing.

CAUTION

Every circuit in the drawout case has an auxiliary brush. It is expecially 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 17.

OPERATION

Before putting the relay into service, check to ensure 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 UNIT

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 18, 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 five percent of tap value.
2. Check the operating time at some multiple of tap value. This multiple of tap value may be five 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 19.

DIRECTIONAL UNIT

Check the directional unit polarity and observe that the shorting link is positioned for the desired maximum torque angle. See the **ACCEPTANCE TESTS** section.

INSTANTANEOUS UNIT

1. Select the desired range by making the proper connections at the rear of the relay (see internal connections diagram). Whenever possible, always 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, a periodic test program is important. 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, the points listed below should be checked at an interval of from one to two years.

These tests are intended to ensure 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 11.
2. Check that the unit drops out at 25 percent or more of tap value.

TIME OVERCURRENT UNIT

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

DIRECTIONAL UNIT

Check condition and operation of contacts. A polarity check should not be necessary if the relay 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** and the **INSTALLATION** sections.

SERVICING

The relays have been factory adjusted, and should not be disturbed. If, for any reason, they have been disturbed or are found to be out of limits during installation or periodic testing, then checks and adjustments outlined in the following paragraphs should be made, preferably 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 up until the disk is centered in the air gaps, then locked in this position by the set screw, which is provided for this purpose. The upper bearing pin should 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, i.e., the stationary contact tip should be deflected about 1/32 inch when the disk completes its travel. Adjust the wipe 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 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.

Characteristics Check and Adjustment

Repeat the portions of the **ACCEPTANCE TESTS** section that apply to the time overcurrent unit. Also, check reset voltage and time as outlined 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 IBC77 relays, set the relay on the two amp tap with the time dial set so that the contacts are just open. Adjust pickup within the limits of 1.96 to 2.04 amps, but as close as possible to 2.0 amps. Then move the time dial to the No. 10 position and check the current required to just move the disk away from the stop arm. This current should be within the limits of 1.88 to 2.12 amps. If the disk moves at the lower limit, check that movement is not over one-half 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 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, depressing the spring-mounted jewel until the cup strikes the iron. The shaft should move about 1/16 inch.

Cup and Stator

If necessary to remove the cup-type rotor from the directional unit, use the following procedure:

1. All leads to the unit should first be disconnected and tagged for identification when reconnected. Then remove the unit from the cradle with its mounting plate still attached.

2. 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 provides 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.

3. 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 cluth 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 Adjustment

To make contact adjustments, refer to Figure 16 for identification of low gradient contact parts and proceed as follows:

Loosen the locknut which 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 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 one and a half turns to provide contact wipe. Tighten the locknut. Unwind the backstop screw two-thirds of a turn and tighten the locknut that secures the backstop screw to its support. Finally, adjust the tension on the stationary contact brush so that when the contacts are made and fully wiped in, there is approximately an equal deflection on each brush.

Torque Adjustment

The directional unit is provided with a notched core which 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 contract 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 using 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 applied 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 spring 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 about one-half inch from the neutral position in the counterclockwise direction, as measured on the periphery of the ring.

CLUTCH ADJUSTMENT

The connections shown in Figure 21 for the polarity check can also be used in making the clutch adjustment. The 50 ohm fixed resistor should be replaced with an adjustable resistor capable of controlling the current within 5 to 25 amperes. A screw projecting from the side of the moving contact arm controls the clutch pressure. Use rated frequency and voltage with the shorting link closed and current in phase with the voltage. With suddenly applied current, the clutch must not slip at nine amperes but it must slip at eleven amperes and above.

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 with the armature held closed. The contacts should close with the feeler gage in place.

CONTACT CLEANING

A flexible burnishing tool should be used for cleaning fine silver contacts. This tool is 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 insures cleaning the actual points of contact.

Never clean fine silver contacts with knives, files or abrasive paper or cloth. Knives or files may leave scratches which increase arcing and deterioration of the contacts. Abrasive paper or cloth may leave minute particles of insulating abrasive material in the contacts, 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 qunatity 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-4081.

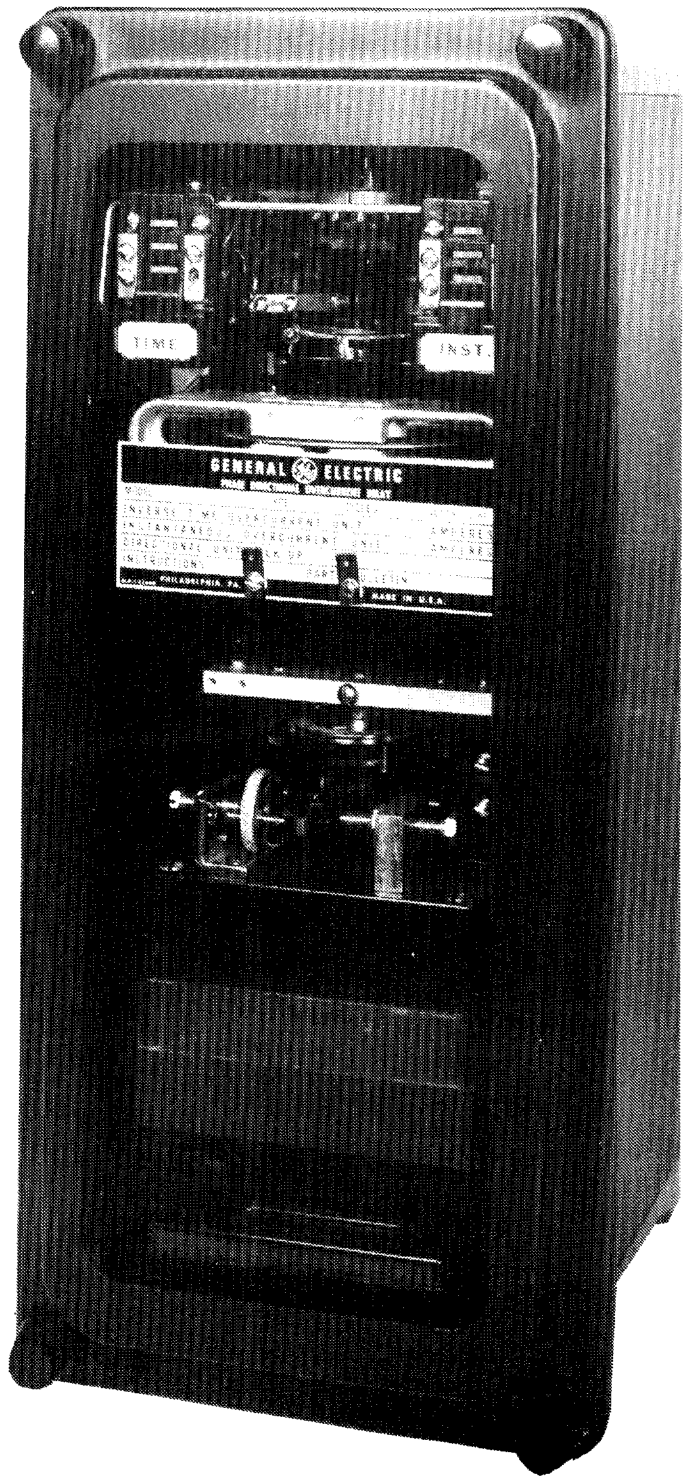


Figure 1 (8043398) Type IBC51M(-)Y1A Relay in Case (Front View)

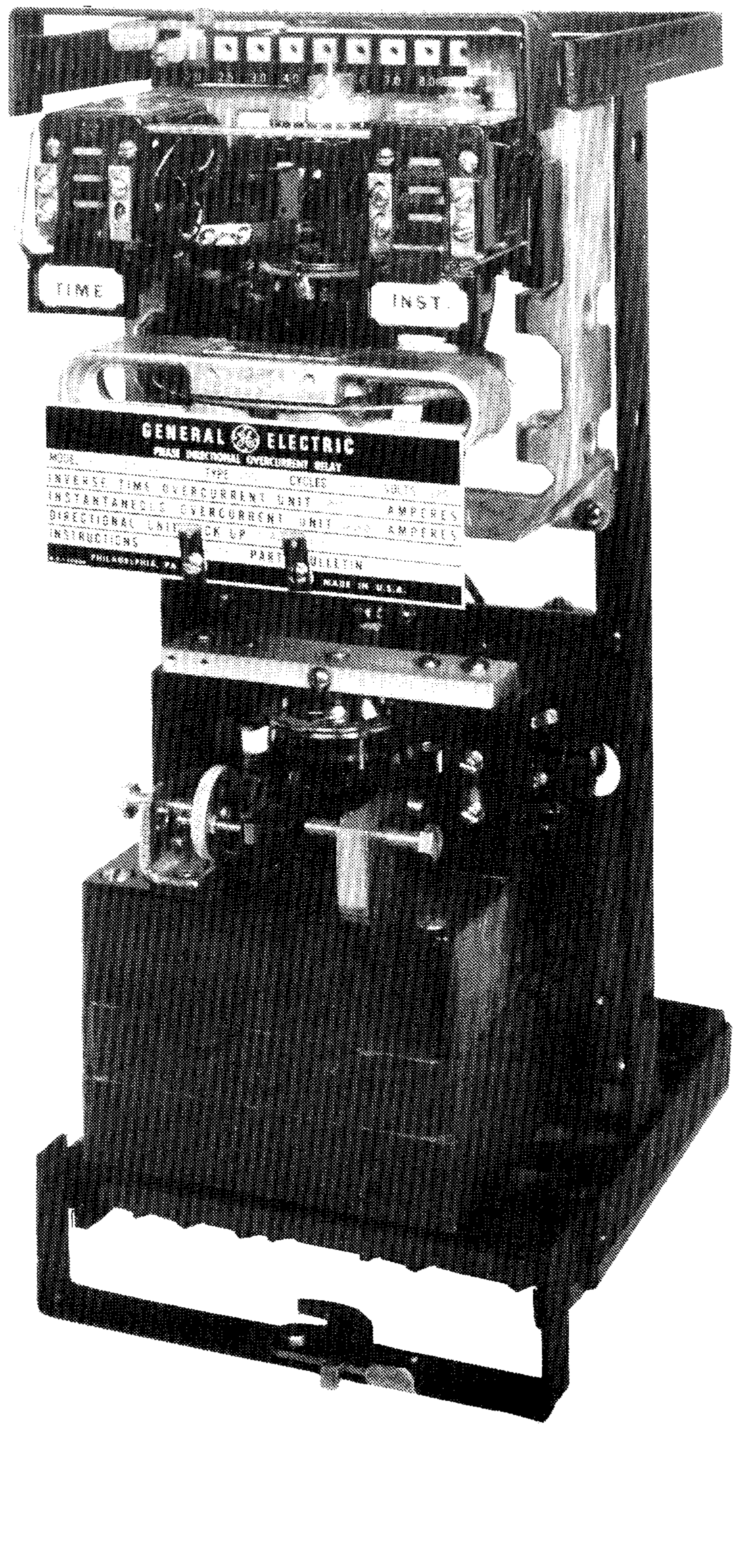


Figure 2 (8043399) Type IBC51M(-)Y1A Relay Removed from Case (Front View)

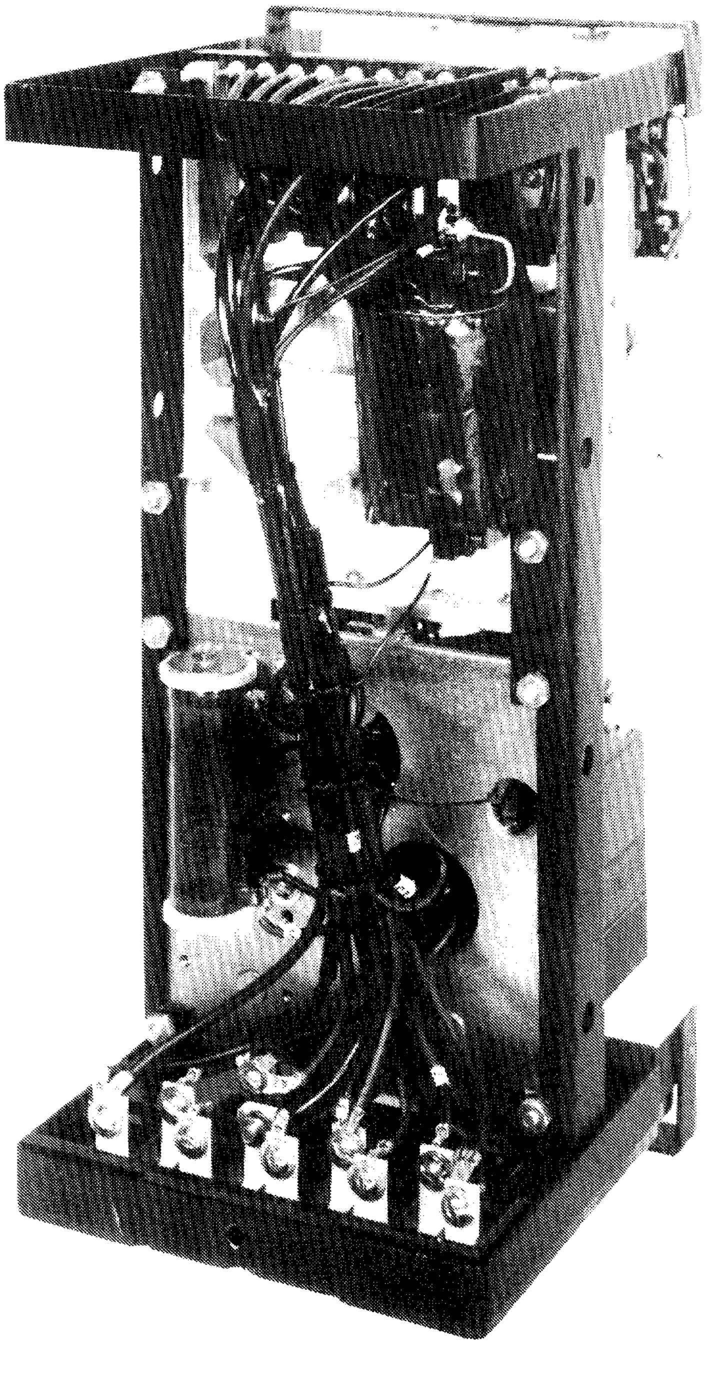


Figure 3 (8043400) Type IBC51M(-)Y1A Relay Removed from Case (Rear View)

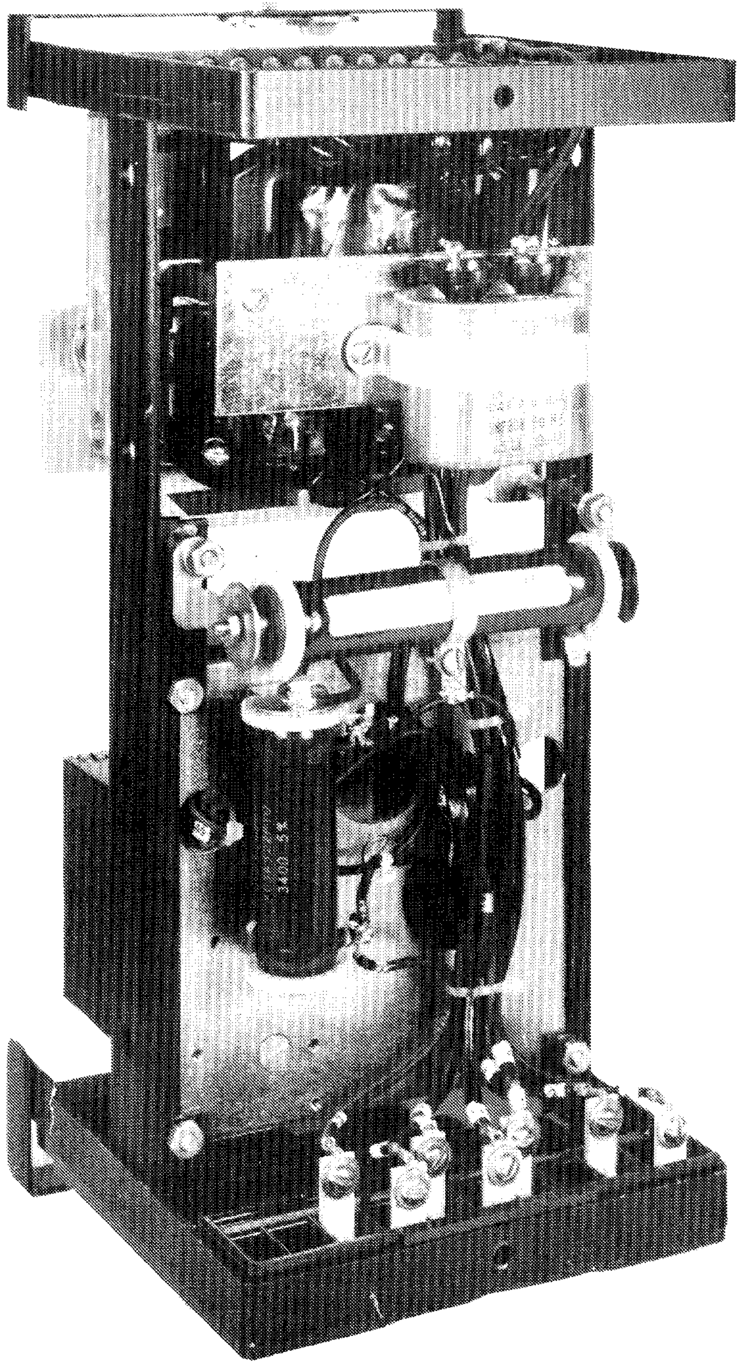


Figure 4 (8043413) Type IBC77M Relay Removed from Case (Rear View)

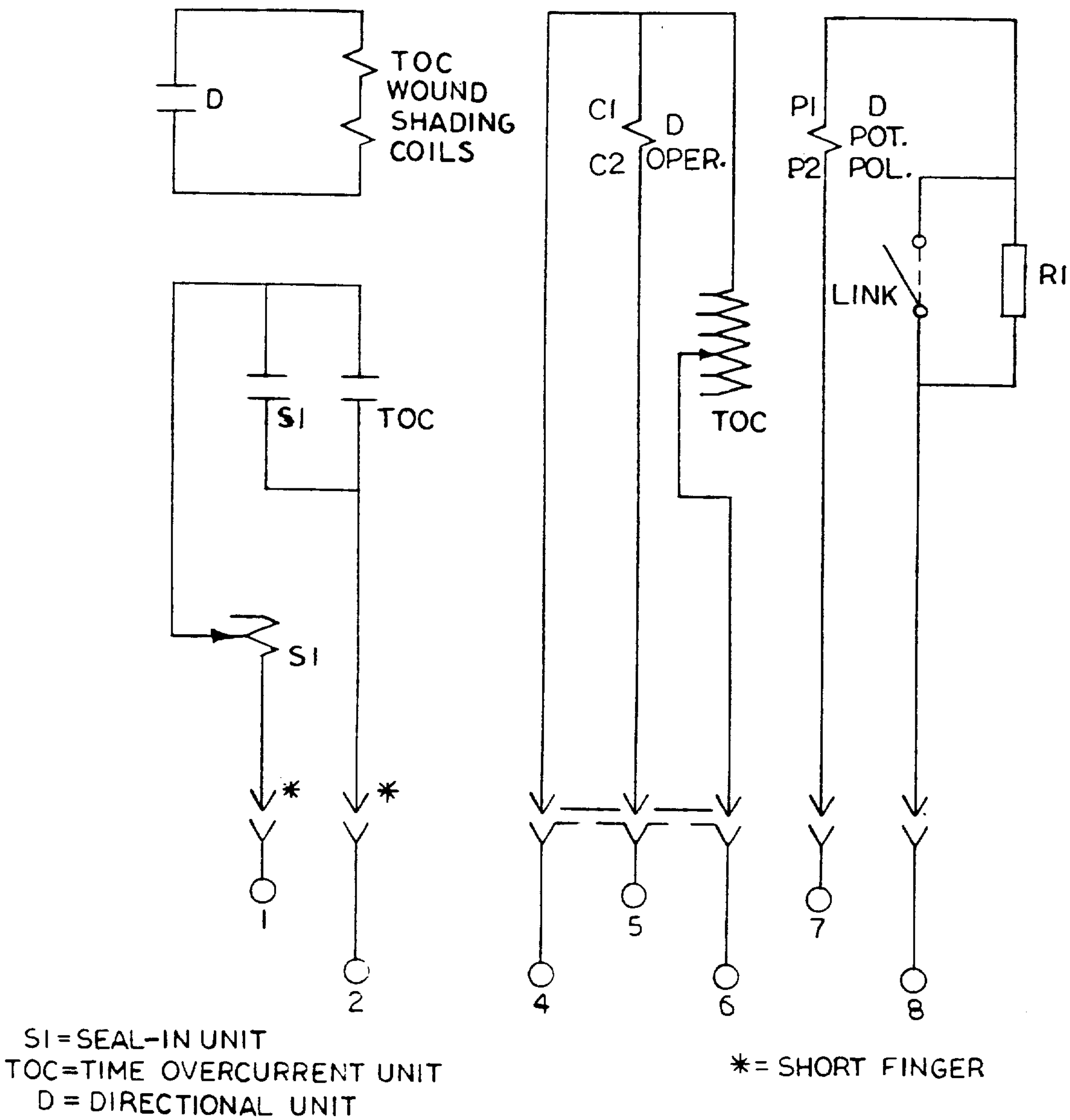
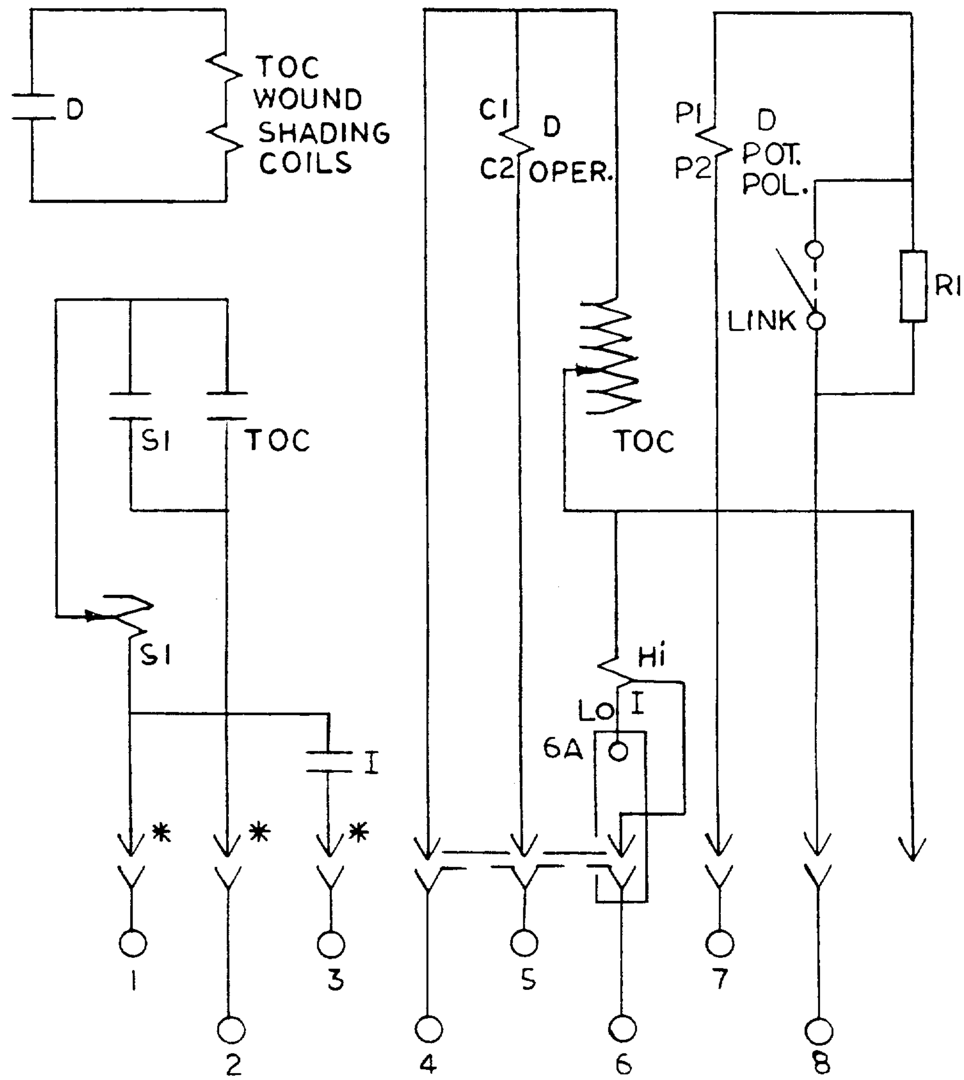


Figure 5 (0269A3057-0) Internal Connections Diagram for IBC51M and IBC53M Relays (Front View)



SI = SEAL-IN UNIT
I = INSTANTANEOUS UNIT
TOC = TIME OVERCURRENT UNIT
D = DIRECTIONAL UNIT

* = SHORT FINGER

Figure 6 (0269A3058-0) Internal Connections Diagram for IBC51M(-)Y1A and IBC53M(-)Y1A Relays (Front View)

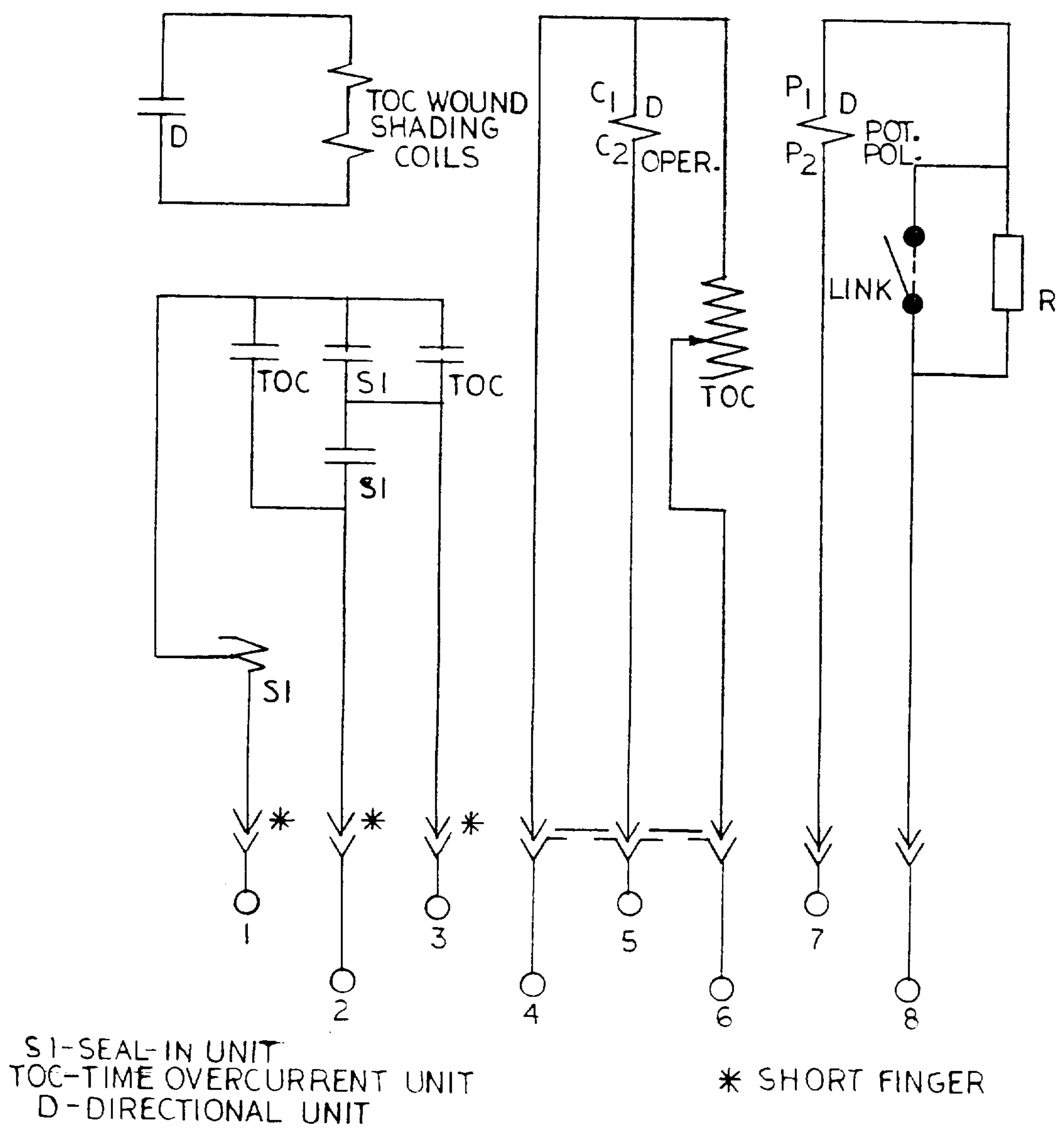


Figure 7 (0273A9135-0) Internal Connections Diagram for IBC52M(-) and IBC54M(-) Relays (Front View)

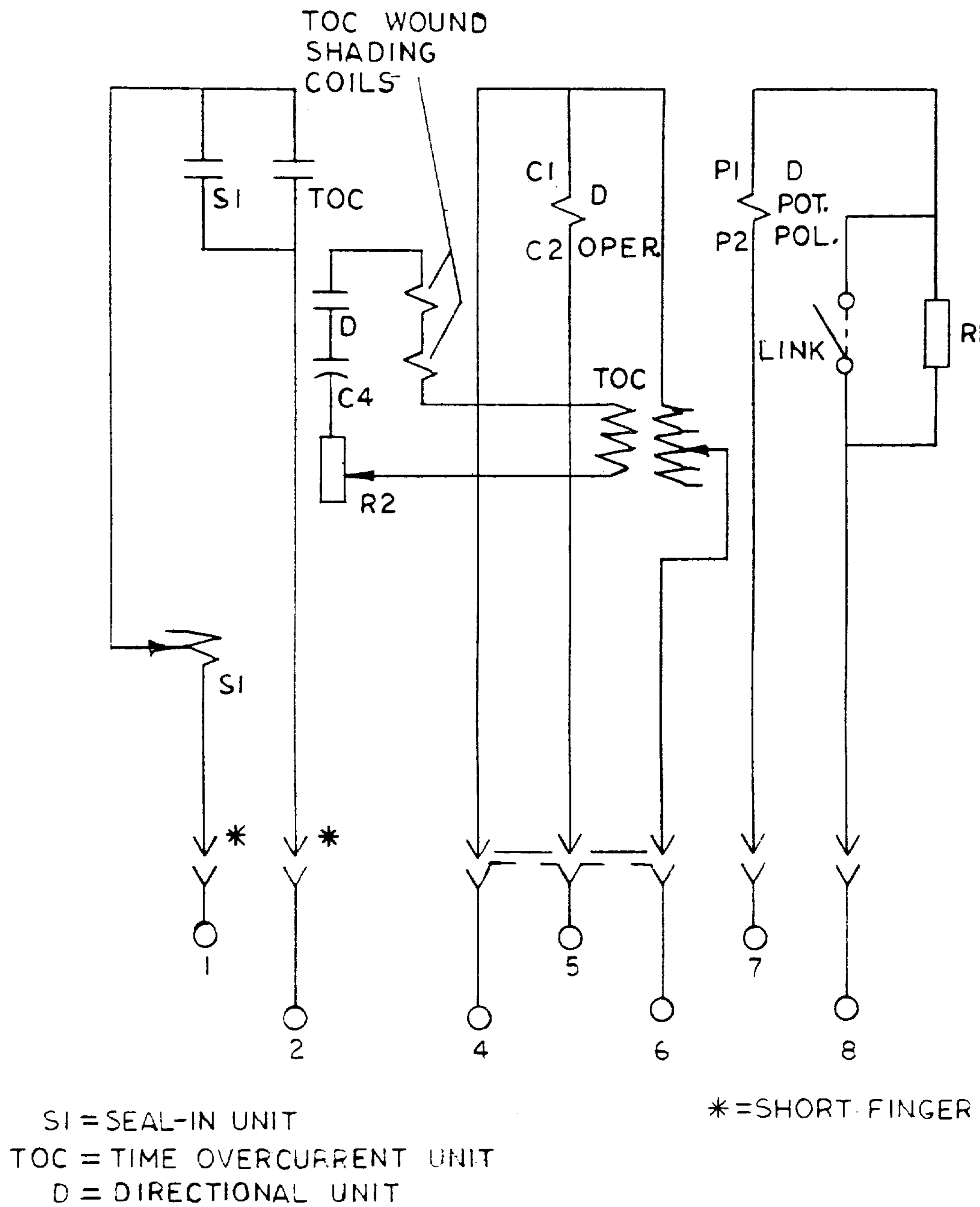
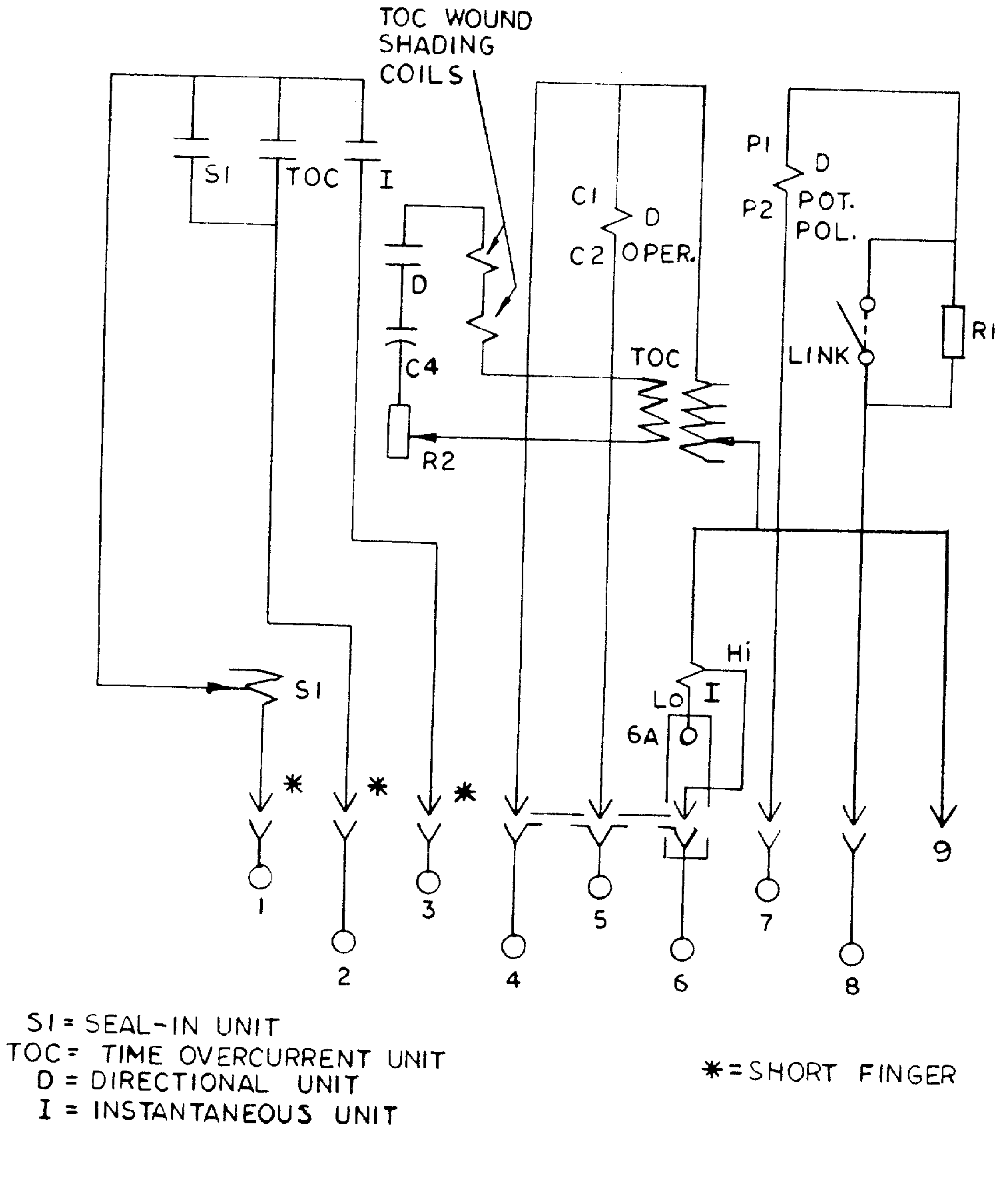
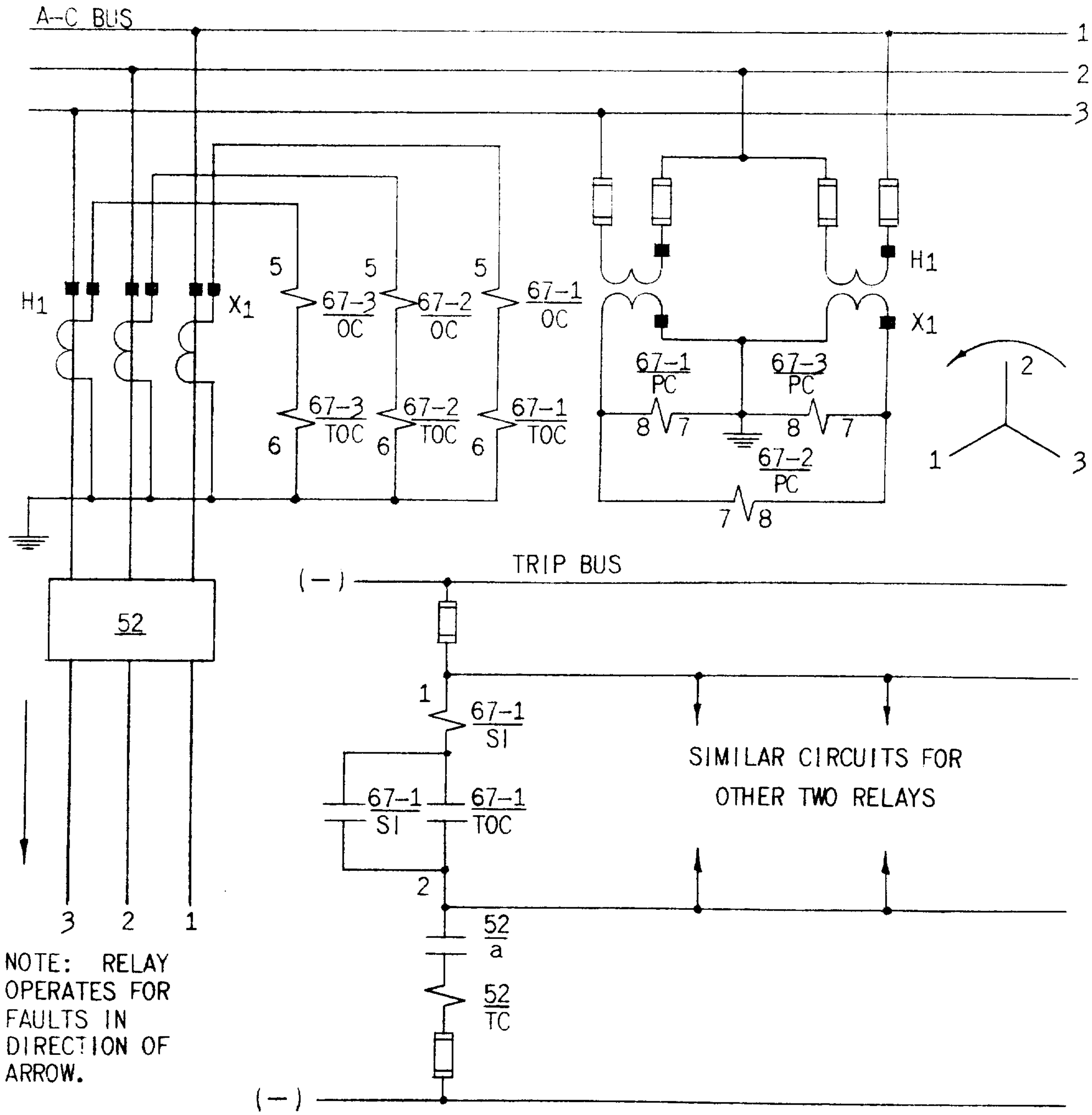


Figure 8 (0269A3059-0) Internal Connections Diagram for the IBC77M Relay (Front View)



* Figure 9 (0269A3060-3) Internal Connections Diagram for the IBC77M(-)Y1A Relay (Front View)

* Revised since last issue



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

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

Figure 10 (0418A0931-0) Quadrature Connection of Three Single Phase IBC Relays for Directional Phase Fault Protection of a Single Line

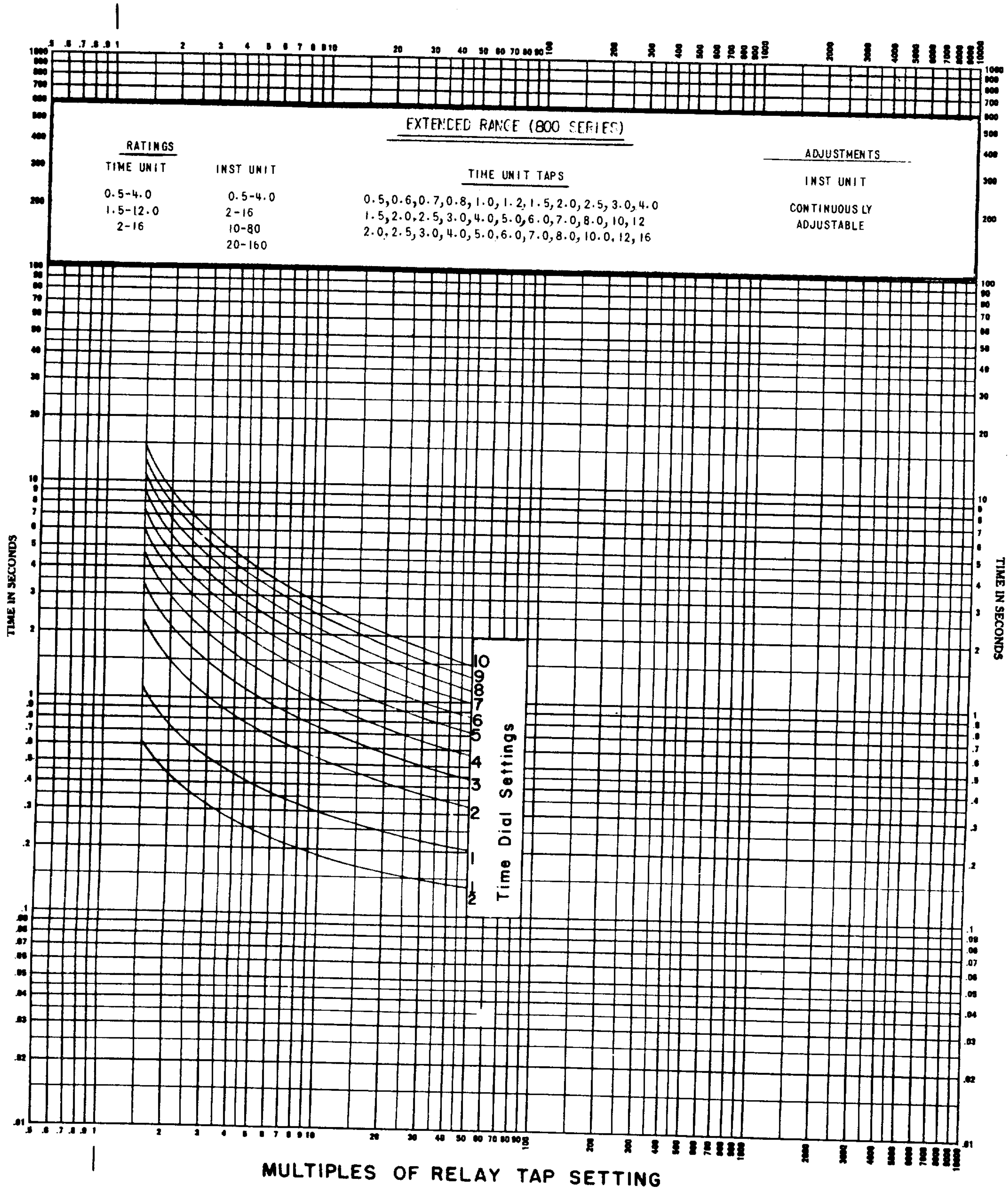


Figure 11 (0888B0269-3) Time Current Characteristic of Inverse Time Overcurrent Unit

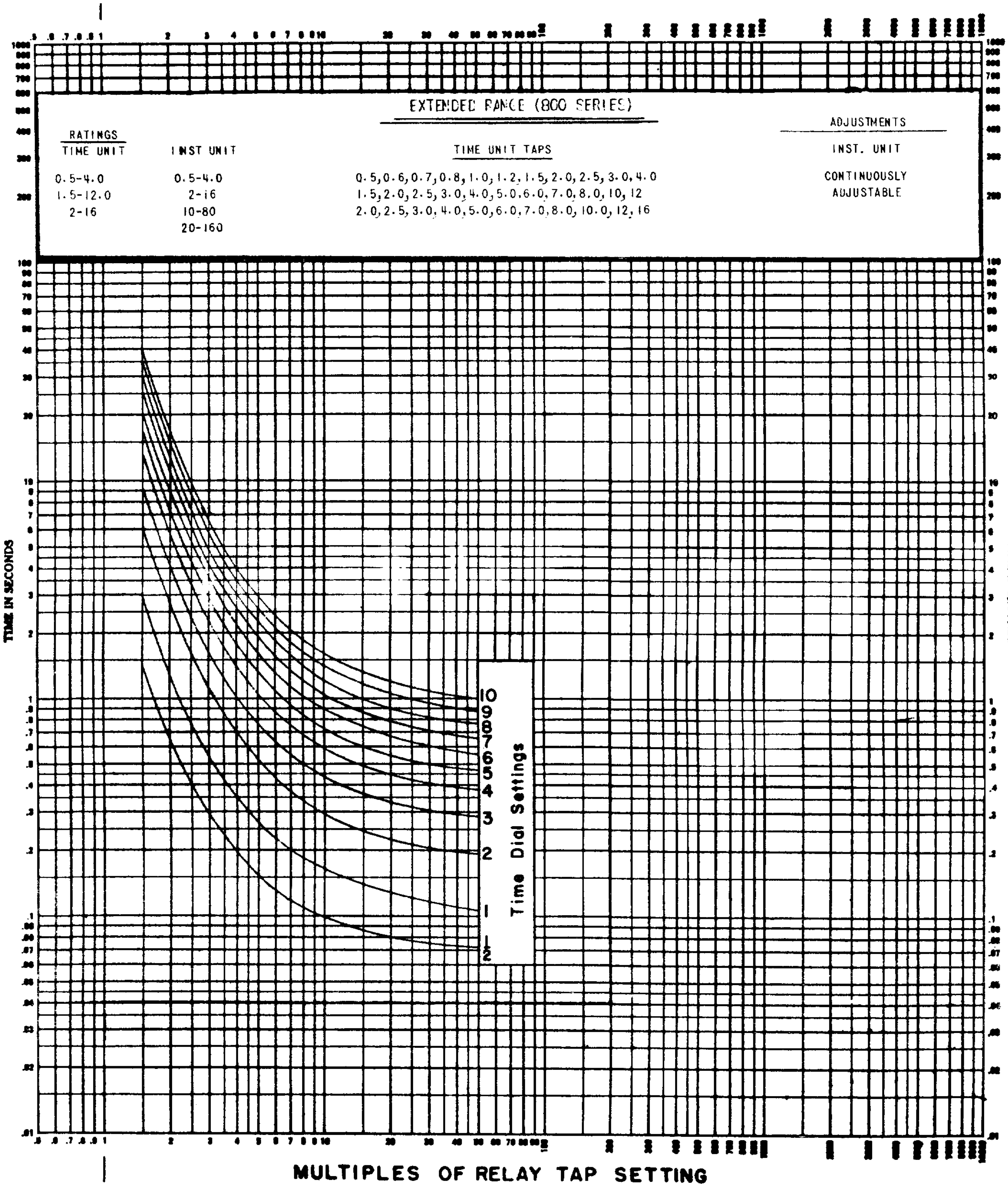


Figure 12 (0888B0270-3) Time Current Characteristic of Very Inverse Time Overcurrent Unit

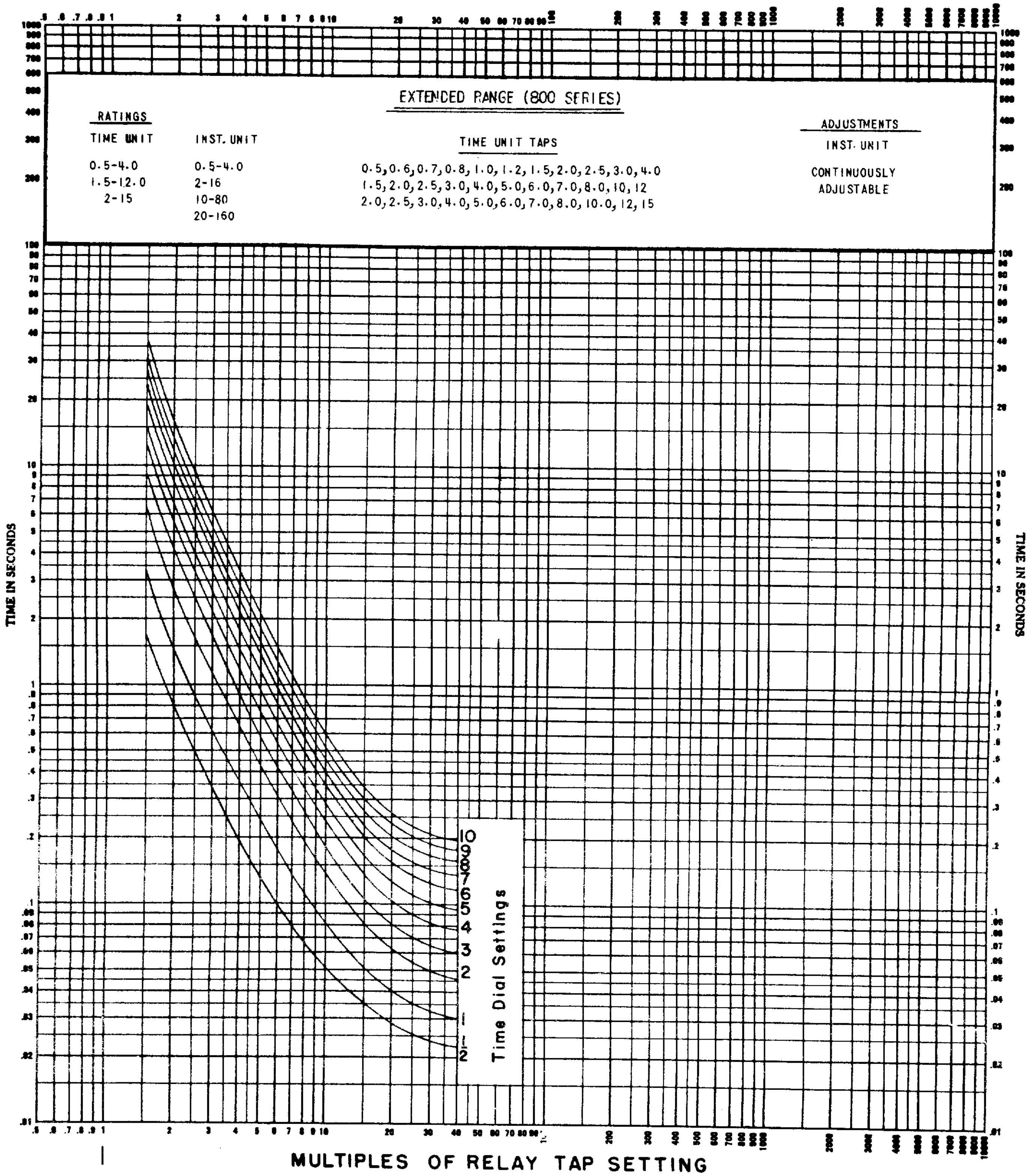


Figure 13 (0888B0274-5) Time Current Characteristic of Extremely Inverse Time Overcurrent Unit

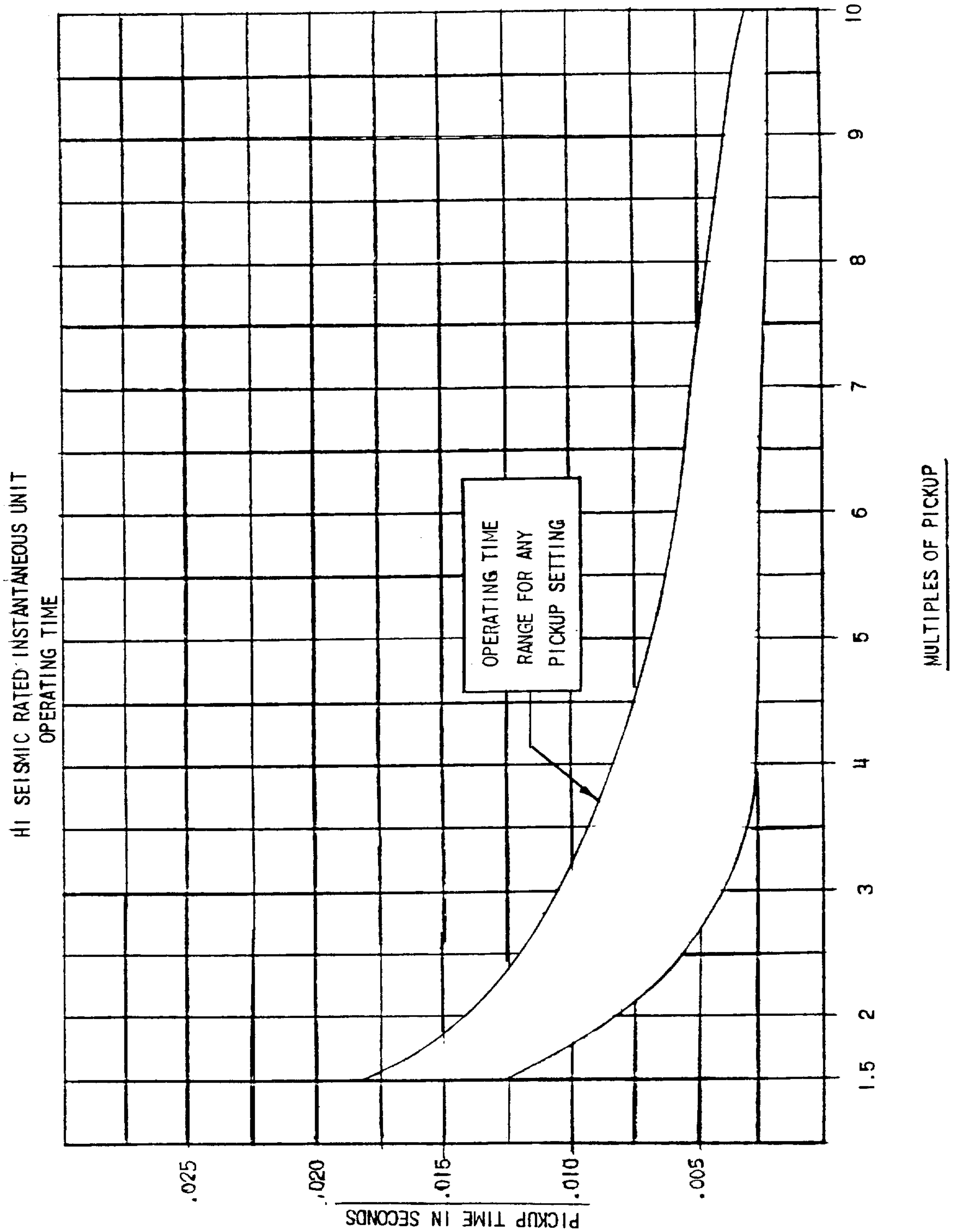


Figure 14 (0208A8695-1) Time Current Characteristic of the Hi-Seismic Instantaneous Unit

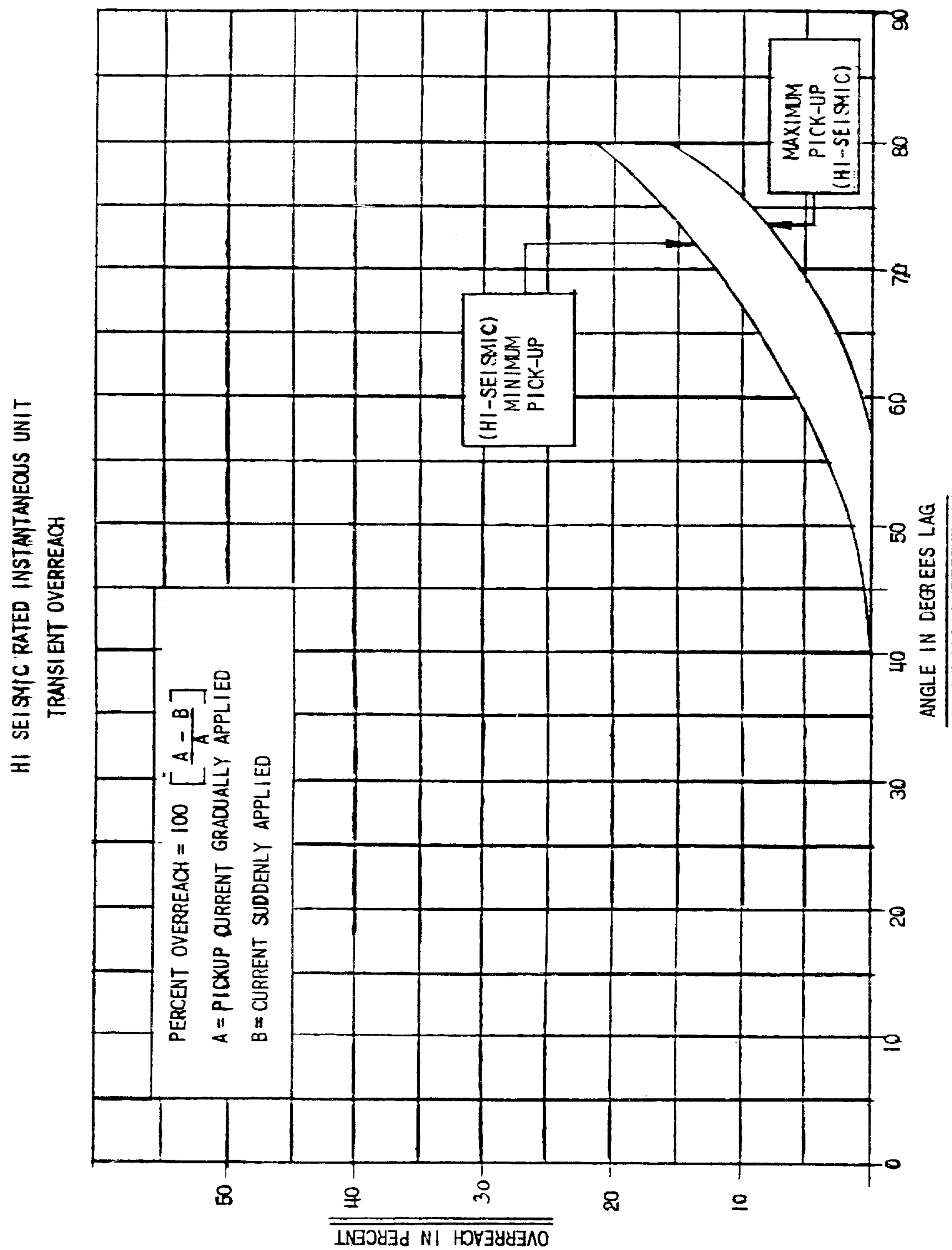


Figure 15 (0208A8694-2) Transient Overreach Characteristics of the Hi-Seismic Instantaneous Unit

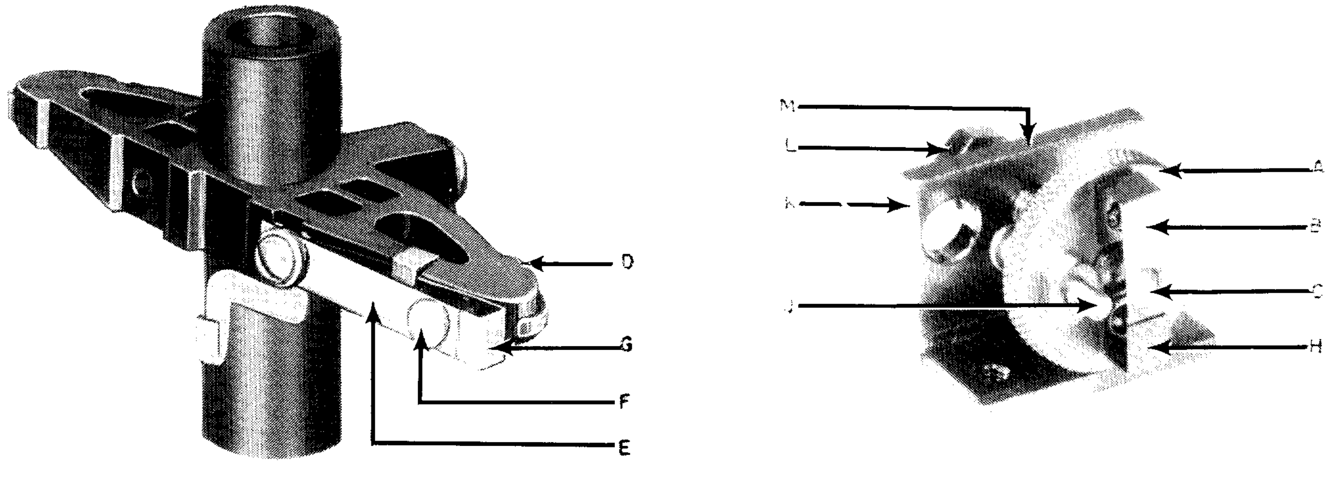
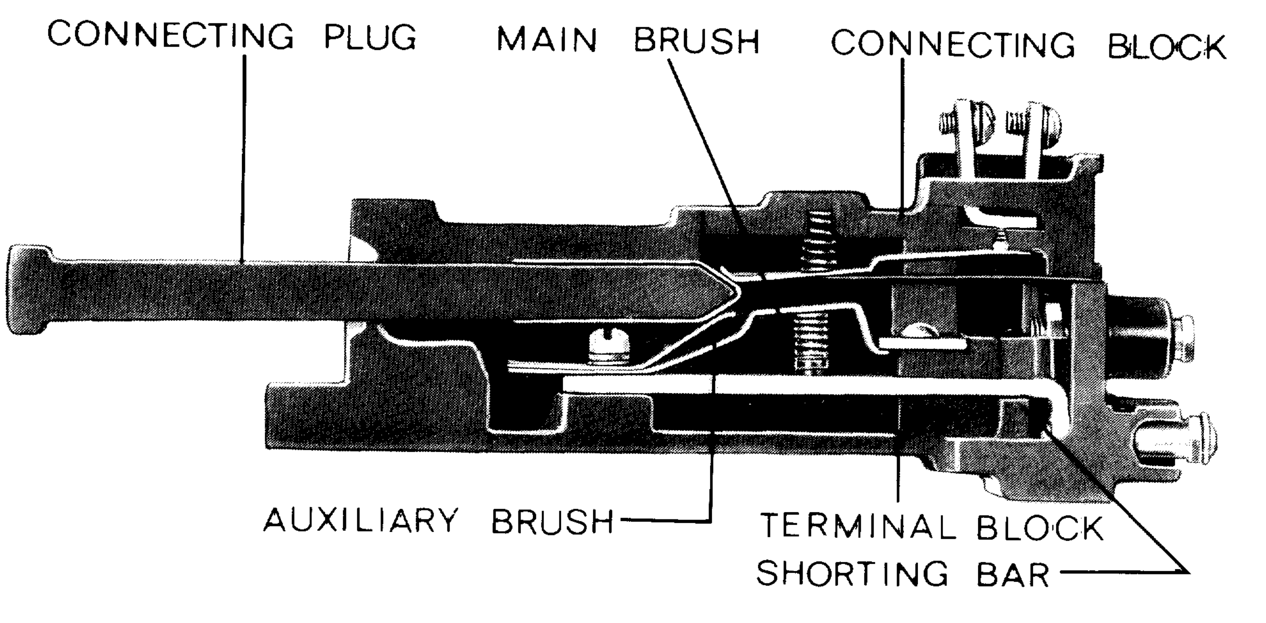


Figure 16 (8027688 and 8023399) Low Gradient Contact Assembly
for the Directional Unit



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

Figure 17 (8025039) Cross-Section of Drawout Case
Showing Position of Auxiliary Brush

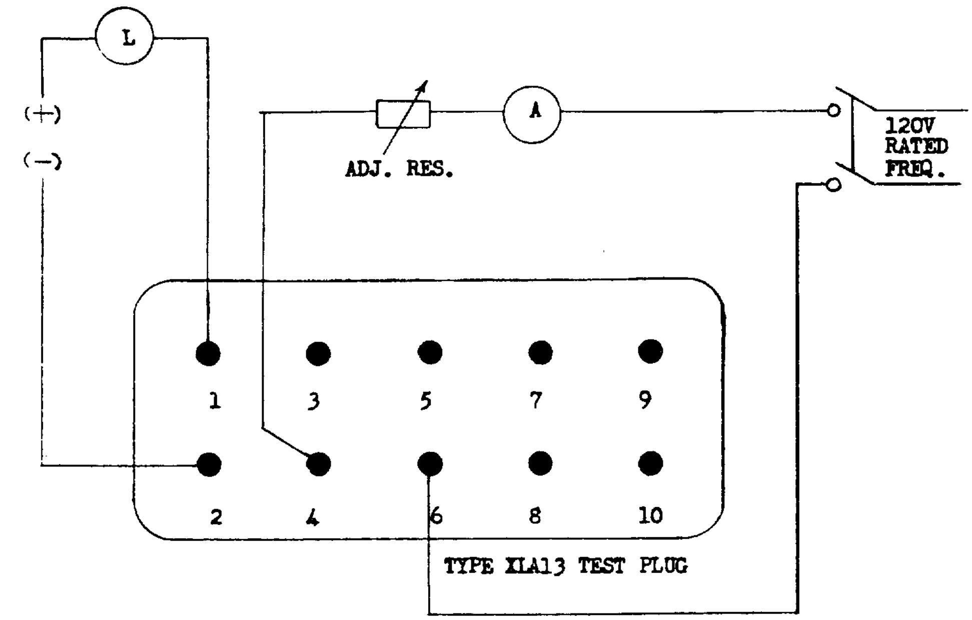


Figure 18 (0195A9179-0) Test Connections for Checking Pickup of TOC Unit

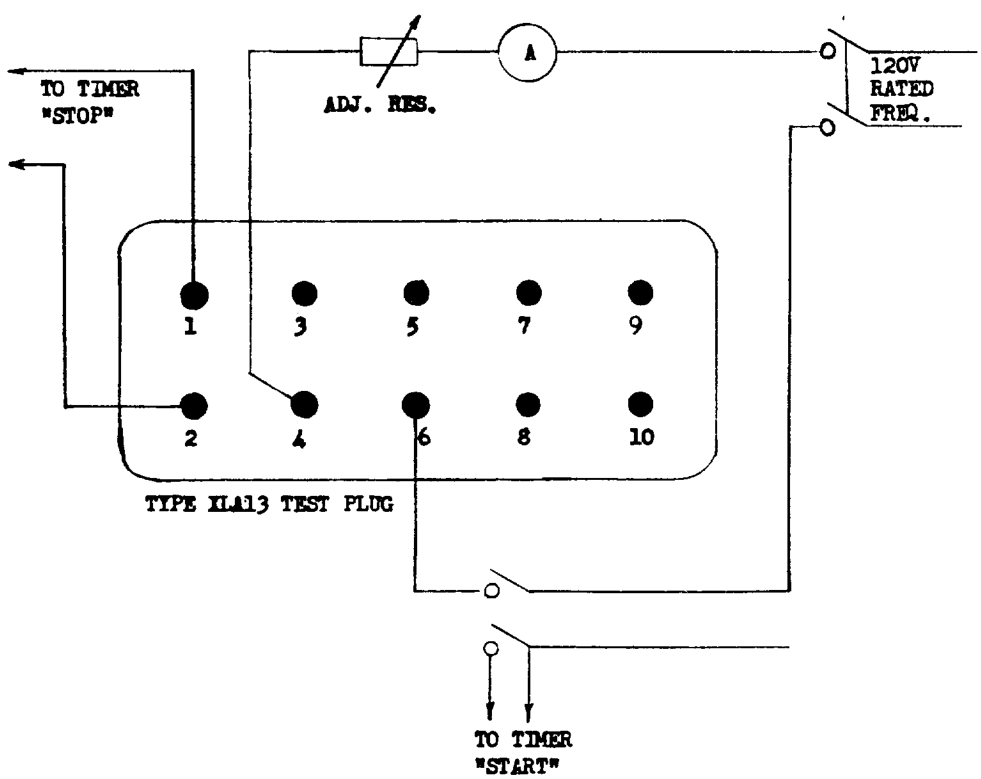
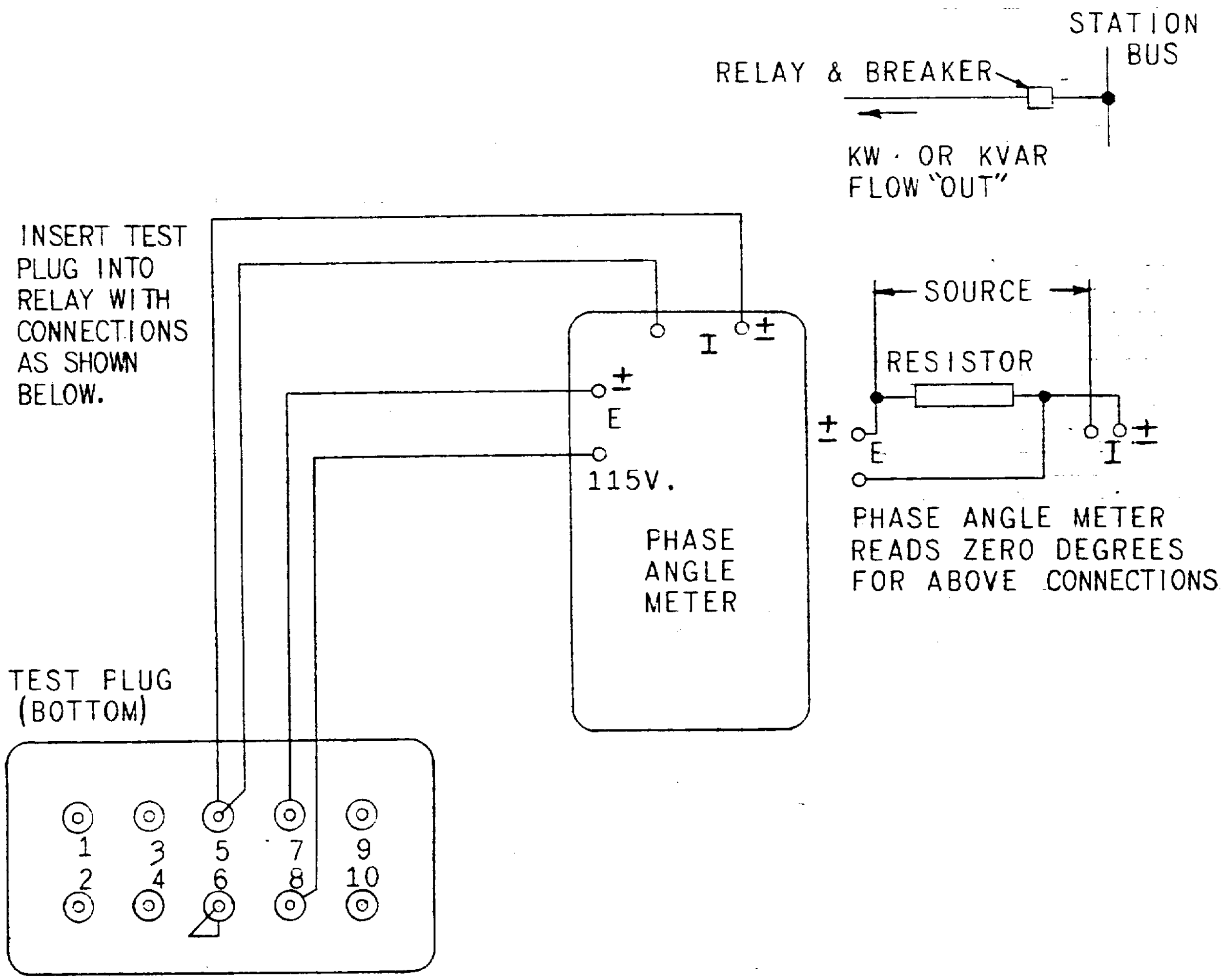


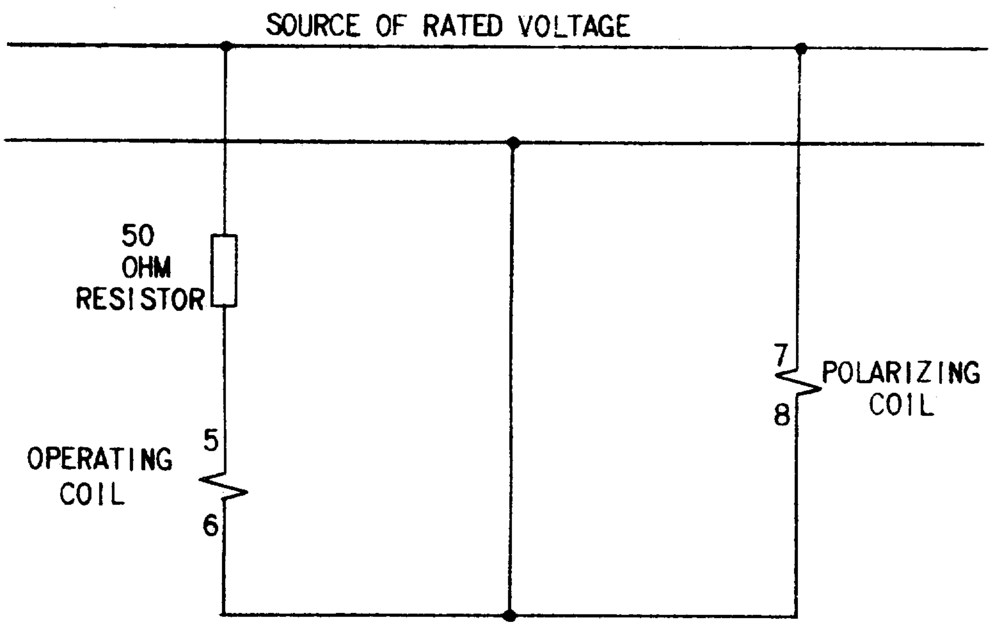
Figure 19 (0195A9180-0) Test Connections for Checking Operating Time of TOC Unit



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 20 (0377A0195-3) Test Connections for External Wiring of Type IBC Relay Using the 90 Degree Connection



NOTE: THE DIRECTIONAL UNIT CONTACTS SHOULD CLOSE WHEN THE RELAY IS ENERGIZED WITH THE ABOVE CONNECTIONS.

Figure 21 (0418A0970-0) Test Connections for Checking Polarity of the Directional Unit Internal Wiring

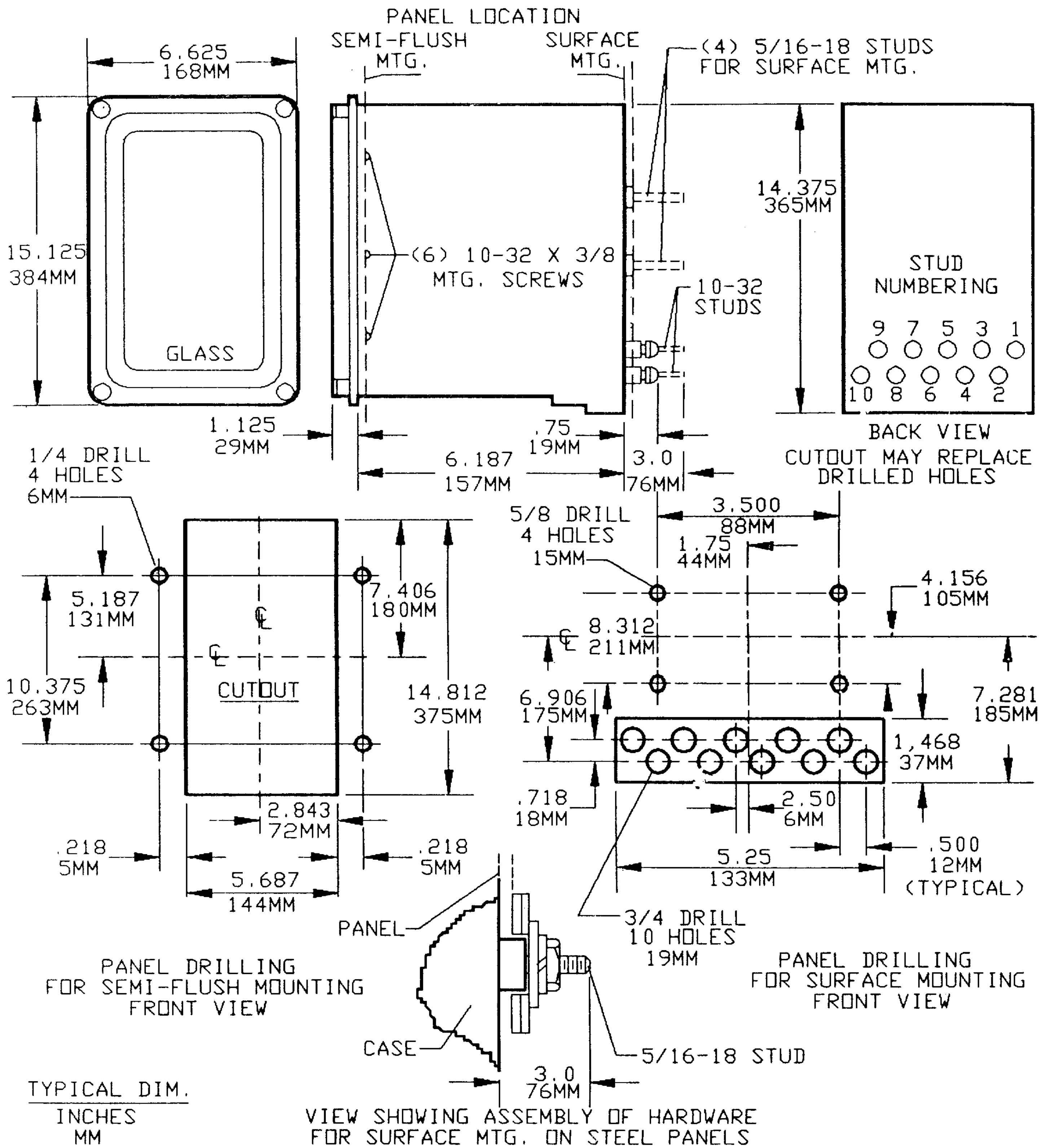


*Figure 22 (K-6209273 [5]) Outline and Panel Drilling Dimensions for IBC Relays

* Indicates revision

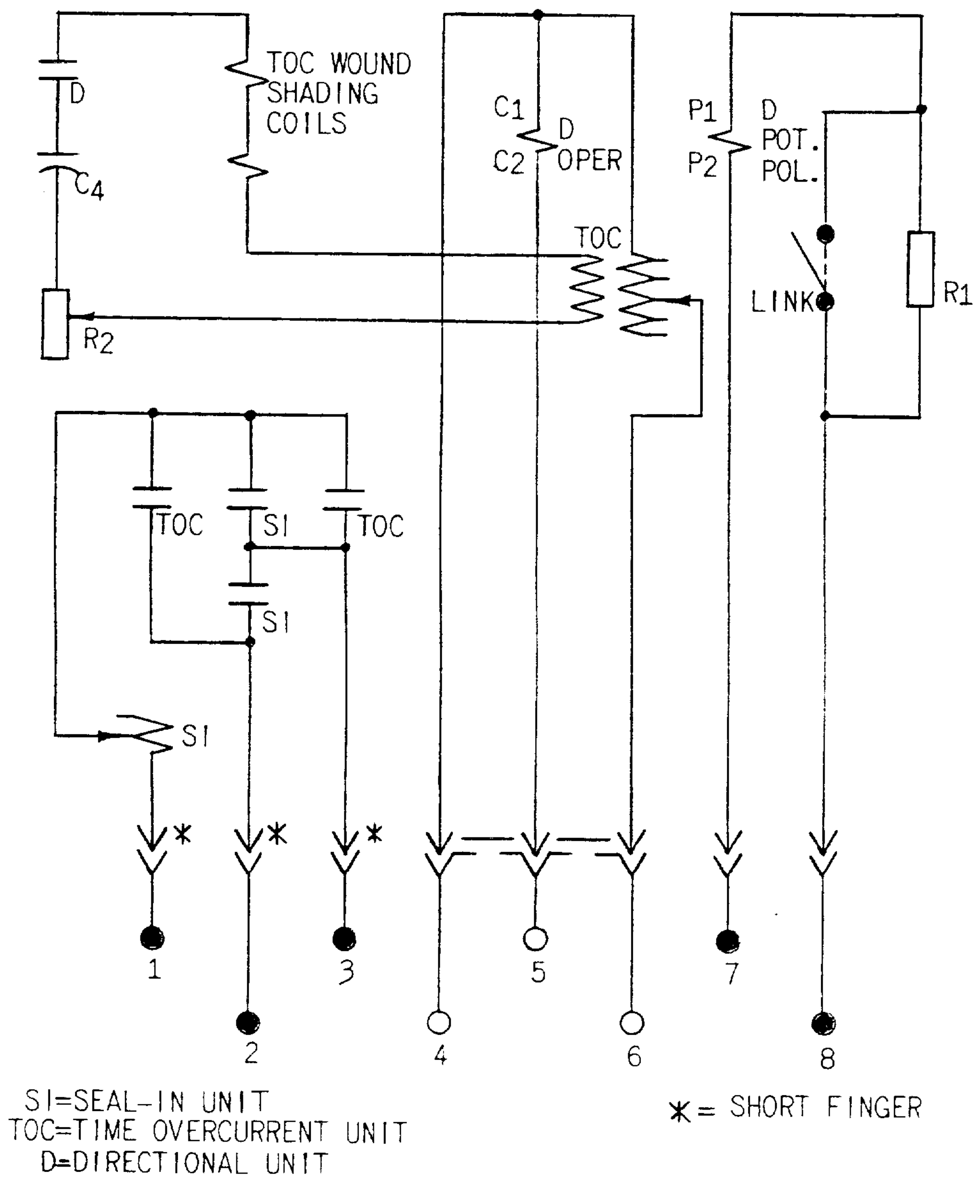
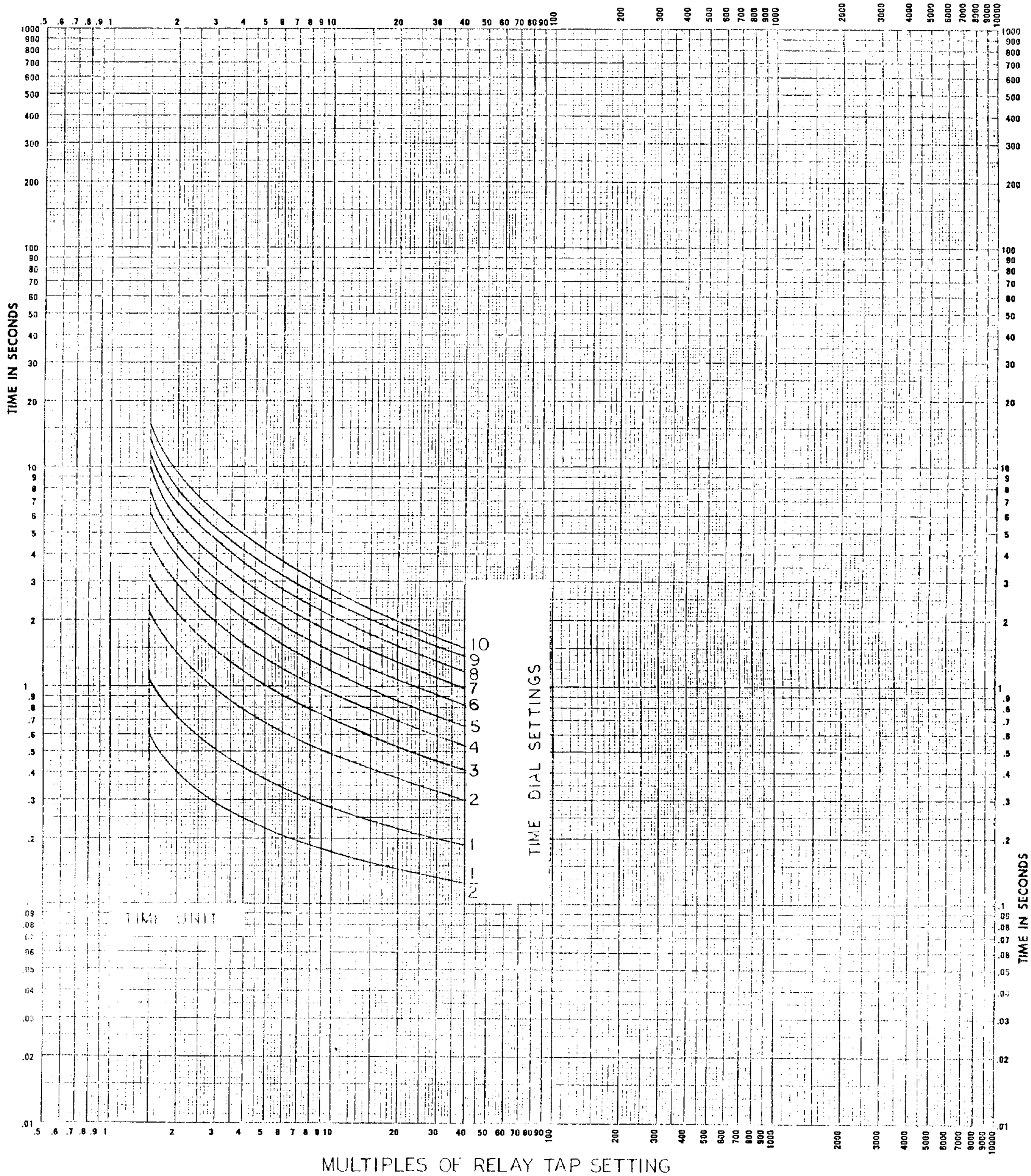
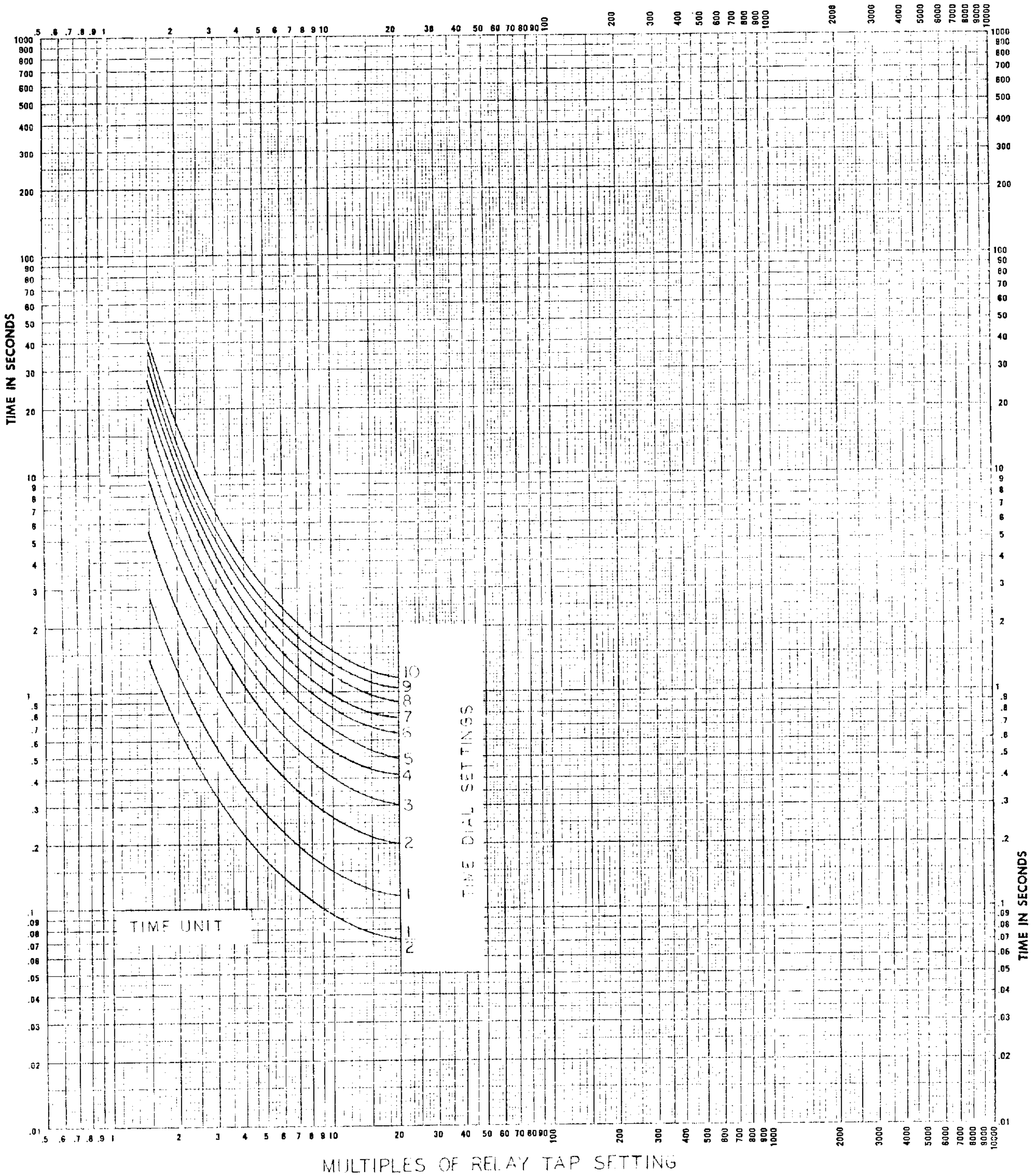


Figure 23 (0127A9422-1) Internal Connections Diagram for IBC78M Relay (Front View)

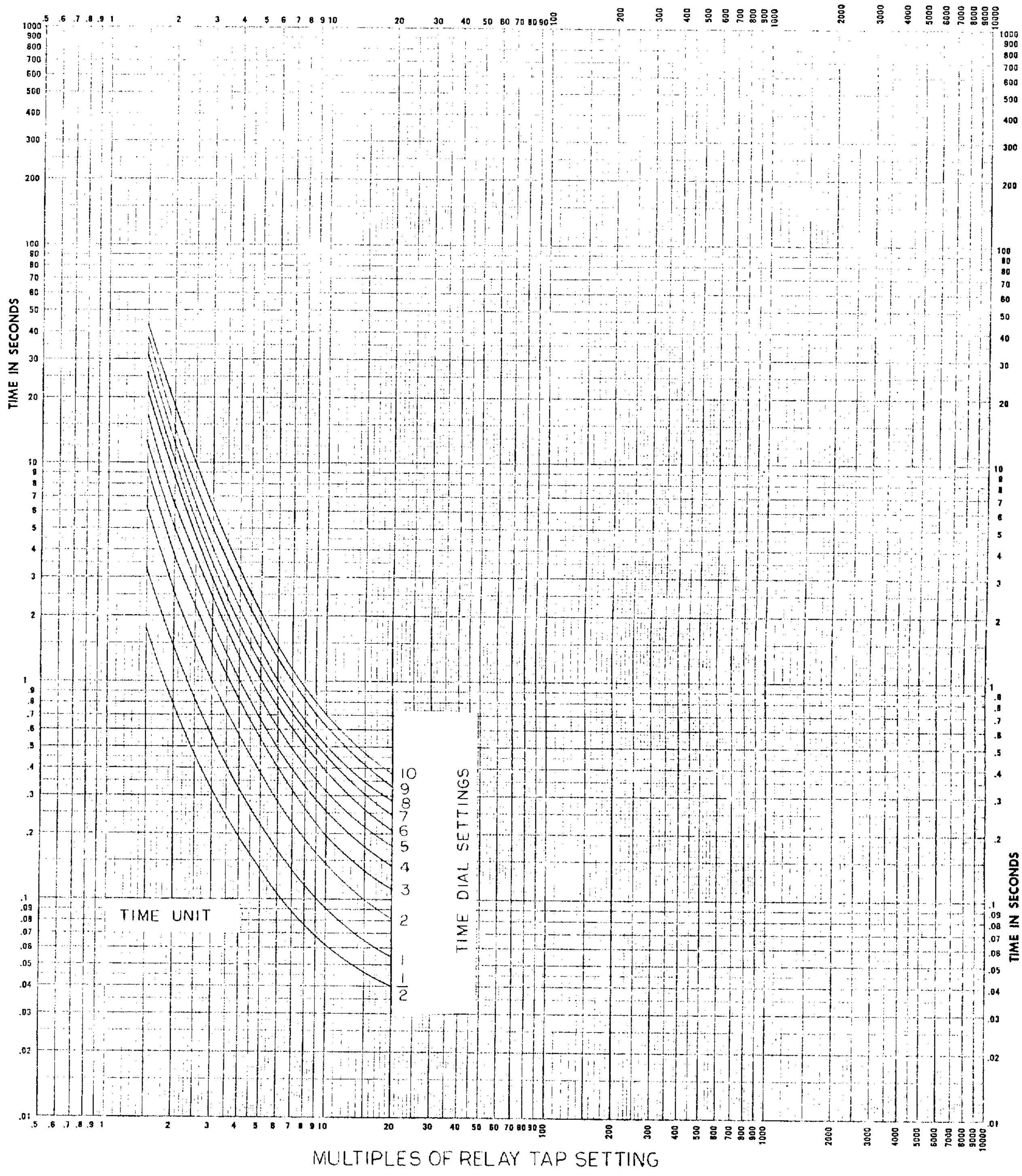


* Figure 24 (0108B8938-2) 50 Hertz Time Current Characteristic of the Inverse Time Overcurrent Relay

* Revised since last issue



* Figure 25 (0108B8939-2) 50 Hertz Time Current Characteristic of the Very Inverse Time Overcurrent Relay



* Figure 26 (0108B8940-3) 50 Hertz Time Current Characteristic of the Extremely Inverse Time Overcurrent Relay

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