



Bulletin 18.2-1A

CIRCUIT SHIELD™ SOLID-STATE OVERCURRENT RELAYS

PROTECTION, APPLICATION, and ORDERING GUIDE



- Inverse
- Very Inverse
- Extremely Inverse
- Short-Time
- Long-Time
- Definite-Time
- Instantaneous

INTRODUCING...

I-T-E's new Space Saving CIRCUIT-SHIELD™ SOLID-STATE OVERCURRENT RELAY

...Offering new standards
of operational performance

- CLOSER COORDINATION
- BETTER PROTECTION
- UNIVERSAL INSTANTANEOUS
- LOW MAINTENANCE
- SEISMIC AND SHOCK PROOF

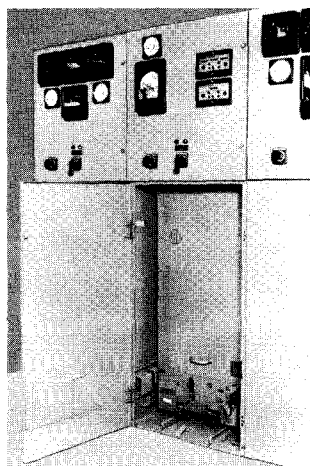
CIRCUIT-SHIELD™ is a totally new line of solid-state overcurrent relays designed to match the time-current characteristic curves of conventional induction disk overcurrent relays. They are comparable in operational characteristics to electro-mechanical overcurrent relays presently in use, and are operated from standard current transformers with 5 ampere secondary ratings. The output (tripping) circuit will operate a conventional circuit breaker trip coil or auxiliary relay.

CIRCUIT-SHIELD is provided in a semi-flush case suitable for panel mounting. Controls are accessible from the front and are protected by a transparent front cover. Input and output connections are made on numbered terminals at the rear of the case.

The input (upper) section is stationary and is constructed as either a single-phase or three-phase unit with individually tapped input transformers in a choice of three standard tap ranges.

Time and instantaneous circuits are contained in the drawout (lower) section which is compatible with any upper section. The drawout section also contains trip indication, trip circuit components, surge protection, and built-in test circuits.

CIRCUIT-SHIELD solid-state overcurrent relays are self-powered, requiring no continuous drain from the trip source.



Metal-clad switchgear installation of single- and three-phase CIRCUIT-SHIELD.



Control board application dramatically shows the space saving feature of CIRCUIT-SHIELD.

COMPARATIVE FEATURES

PHYSICAL CHARACTERISTICS		
CHARACTERISTIC	ELECTRO-MECHANICAL INDUCTION DISK OVERCURRENT RELAY	CIRCUIT-SHIELD SOLID-STATE OVERCURRENT RELAY
Case And Mounting	Available in single-phase construction only. Panel area requires up to 57 sq. in. Provided in a semi-flush case for panel mounting.	Either single-phase or three-phase construction is available. Panel area requires 32 sq. in. Provided in a semi-flush case for panel mounting.
Time-Current Curves	Five to eight curves. Time dial shapes vary due to induction disk drag constant.	Five curves. Time dial shapes identical for easy computer representation.
Instantaneous	Select from 5 ranges. Each range has a 4 to 1 ratio.	Universal instantaneous range. Range is identical for each relay.
Target Indicators	Mechanical target can accidentally be shocked to either an on or off position.	Magnetic memory type target is shock-proof and retains correct position after loss of control power.
Output Circuit	Seal-in unit must be adjusted for specific high or low trip coil currents.	Output circuit will handle trip coil currents of 0.1 to 30 amperes without any adjustment.
Testing	No built-in operational test. Alt testing must be done with external test set.	Push-to-test buttons allow easy operational check of time and inst. External test set may be used.
PERFORMANCE CHARACTERISTICS		
Over Travel	Induction disk inertia creates over-travel which can cause unnecessary tripping or added coordination time.	CIRCUIT-SHIELD has negligible over-travel. More coordination margin can be obtained in all applications, thus allowing faster clearing.
Reset Time	Induction disk requires long reset time. Each time-current characteristic curve has a different reset time. The need for contact wipe prevents fast back-off of reduced accuracy.	Completely resets within a few cycles. All curves have similar reset characteristics.
Reduced Damage Improved Service Continuity	Due to long reset time, reclosing sequences require long open intervals and main breaker induction disk relay can ratchet to operation, thereby losing coordination.	Full coordination can be obtained with faster settings and closer intervals. This provides greater continuity of service and reduced damage.
Burden	High burden characteristic causes saturation of current transformer at high fault currents, resulting in reduced accuracy.	Saturation characteristics are such as to maintain current transformer accuracy at high fault currents, regardless of relay and connection impedance.
Shock and Vibration Resistance	Contacts, disk pivots and targets have low shock, vibration and seismic resistance. This can result in incorrect operation or damage.	Shock and vibration resistance is substantially improved through solid-state construction. Seismic qualification requirements are more readily met.
Contamination Immunity	Contacts, bearing and disk contamination and spring corrosion impair relay performance in contaminated atmospheres.	No bearings, springs or other moving parts. Contact erosion is eliminated. Protective coatings on circuit board and components resist contaminated atmospheres. Drawout contacts are gold plated.
Maintenance	Cleaning and dressing of contacts and inspection of moving parts is required at regular intervals.	Maintenance reduced to a minimum. Some cleaning may be desirable when relay is operated in a heavily contaminated area.

OPERATION

The inverse time-current characteristic of the solid-state relay is obtained by placing a dc voltage proportional to the input current across a resistor-capacitor timing network.

When the voltage across the capacitor reaches a predetermined value, the relay output contact (SCR) closes to connect the circuit breaker trip coil or auxiliary relay to control power.

The relay circuit must keep the capacitor voltage at zero when the input is below pickup in order to prevent load current from precharging the capacitor.

- **Input** The input circuit receives current (I_s) from a conventional current transformer and derives a proportional dc voltage (V_i) required to drive the reference, pickup, and timing circuits.

- **Reference** The reference circuit provides a fixed reference voltage (V_F) for the pickup and trip circuits.

- **Pickup** The pickup circuit prevents timing until the input exceeds the reference.

- **Timing** The timing circuit contains the resistor-capacitor timing network.

- **Trip** The trip circuit (SCR) connects the trip coil to control power to trip the breaker.

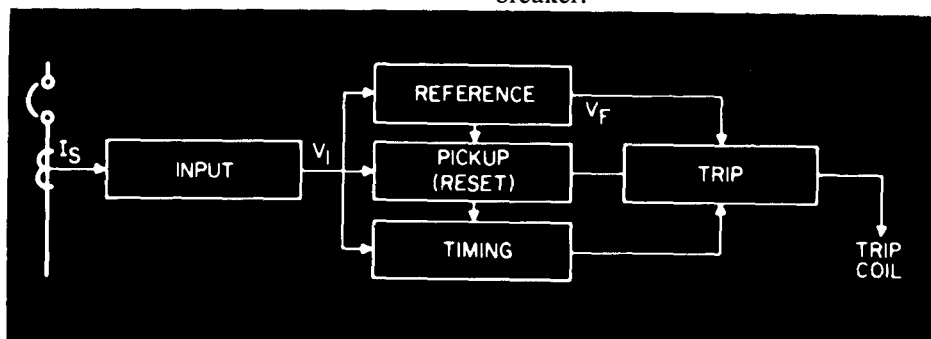
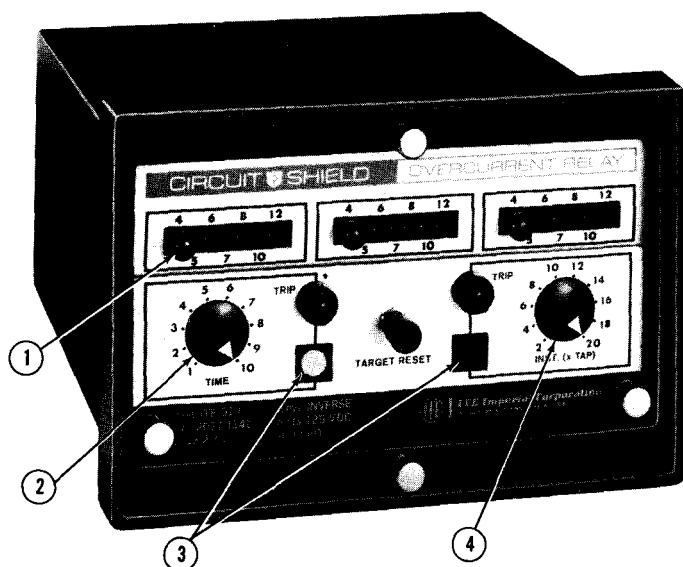


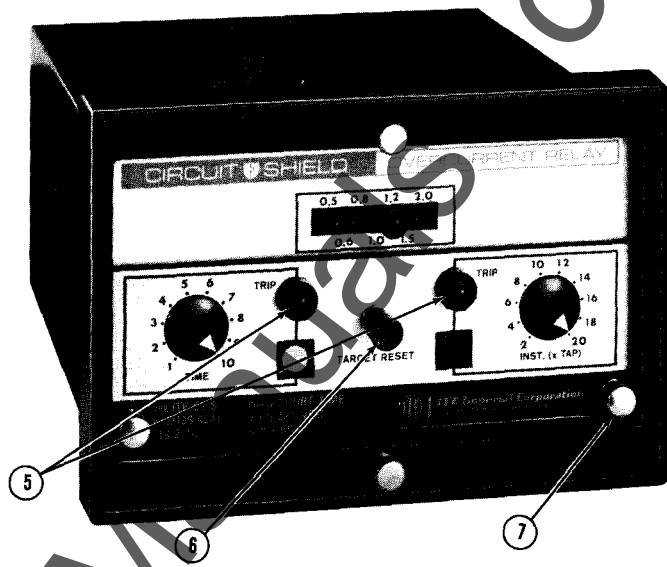
Fig. 1. Block Diagram of Solid-state Overcurrent Relay.

These functions are provided by the basic circuits shown in the block diagram of Fig. 1. The circuits are related as follows:

CONSTRUCTION



Front view of **three-phase**
CIRCUIT-SHIELD
solid-state overcurrent relay.



Front view of **single-phase**
CIRCUIT-SHIELD
solid-state overcurrent relay.

1 Current Tap Pickup Control

A tap block for each phase is on the stationary portion of the relay front panel. Three standard tap ranges are available: 0.5-2A; 1.5-6A; and 4-12A. Current pickup tap settings for each range are shown on page 8.

2 Time Dial Control

One of ten (10) available time curves is selected by a potentiometer dial on the left side of the removable portion of the relay front panel. This TIME dial permits intermediate settings verified by standard test.

3 Positive Target Indicators

Panel closing or vibration will not cause target to move to a false position. If moved to an incorrect position by an external force, the target indicator will automatically revert to a proper position upon removal of the force.

4 Inst. Dial Control

Instantaneous function pickup is selected by a potentiometer dial on the right side of the removable portion of the relay front panel. This INST. dial has markings 2 through 20, indicating instantaneous pick-up current in multiples of current tap settings.

5 Built-in Test Buttons

Push-to-test buttons independently check operation of time and instantaneous functions. Both buttons are recessed behind glass to prevent accidental operation.

6 Target Reset

Target indicators for inst. and time are reset by depressing a common target reset pushbutton.

7 Drawout Circuit Board

The drawout solid-state circuit boards for single- and three-phase relays are identical. Thus, one spare drawout board can be utilized for servicing both single- or three-phase relays with the same curve shapes. The exchange can be made without disturbing an energized circuit.

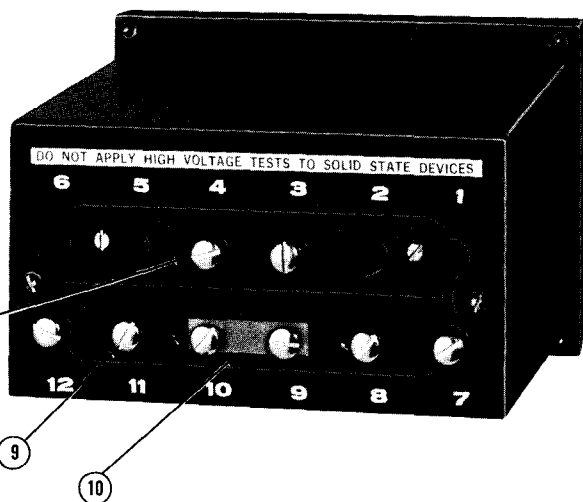
8 Input Current Terminals

Phase (A) current - terminals 1 & 2
Phase (B) current - terminals 3 & 4
Phase (C) current - terminals 5 & 6

The current input for the single-phase residual ground relay is made at terminals 3 & 4.

9 Output Tripping Terminals

Control power (positive) - terminal 7
Control power (negative) - terminal 8
Trip bus - terminal 12



Rear view of **single-phase**
CIRCUI-T-SHIELD
solid-state overcurrent relay.



Front view of **three-phase**
CIRCUI-T-SHIELD
solid-state overcurrent relay with
circuit board partially withdrawn.

10 Instantaneous Cut-out Link

Connected across terminals 9 and 10. If removed, instantaneous function becomes inoperative. Cutout link can be replaced by a supervisory contact in reclosing applications.

11 Physical Data

Attractive Appearance

CIRCUI-T-SHIELD provides an attractive, colorful appearance to a switchgear panel. It complements the increasing attractiveness of modern switchboard instruments.

Space Saving

Single-phase or three-phase relay is packaged in one small 6 $\frac{1}{8}$ " x 4 $\frac{5}{8}$ " x 7 $\frac{7}{8}$ " semi-flush drawout case.

Weight

Single-phase CIRCUI-T-SHIELD weighs 4 lbs.
Three-phase CIRCUI-T-SHIELD weighs 4 $\frac{3}{4}$ lbs.

12 Pull Knobs

For ease of drawing out removable element.

13 Solid-State Design

Component Selection

Only the highest quality solid-state components are selected for use in CIRCUI-T-SHIELD. Quality control is assured by proper aging of components and by use of silicon semi-conductors subjected to high-temperature thermal screening and careful testing and monitoring of characteristics. Components are automatically wave-soldered on high quality polyester circuit boards.

Circuit Design

Components are selected to operate at 50% or less of rating to insure stability and unlimited operating life. Temperature compensation techniques are used in the design to maintain accuracy over a wide range of operating temperature.

Design Testing

All relays are subjected to extensive production tests in addition to comprehensive design qualification tests which included:

- Dielectric tests
- Low and high temperature tests
- Continuous and momentary current tests
- Surge withstand tests
- Shock, vibration and Seismic tests

SELECTION AND APPLICATION

CIRCUIT-SHIELD solid-state overcurrent relays can be used for phase and ground overcurrent protection in utility, industrial and commercial electrical power systems. Common applications consist of a three-phase relay for protection against phase faults and a single-phase relay (with low tap range) for ground fault protection.

Six time-current characteristic curve families are available: inverse (51 I), very inverse (51Y), extremely inverse (51E), short-time (51S), long-time (51L) and definite time (51D). A universal instantaneous function can be furnished with any of the above relays, or as a separate instantaneous (50) relay only. This family of inverse time-current characteristic curves allows selective coordination between relays. An inverse characteristic provides faster relay operation for high-fault currents and slower operation for low-fault currents or overloads.

In general, the application will indicate the use of a particular relay. Short-time relays respond more quickly to trip the associated breaker to avoid equipment damage. Long-time relays allow additional delay on incidence of transient current inrush such as during motor starting.

Table 1, substitution guide and Table 2, selector guide provide basic application information and a comparison of CIRCUIT-SHIELD with similar electro-mechanical induction-disk overcurrent relays. These tables assist in selecting the proper I-T-E solid-state overcurrent relay for the particular application.

TABLE 1—CIRCUIT-SHIELD SUBSTITUTION GUIDE

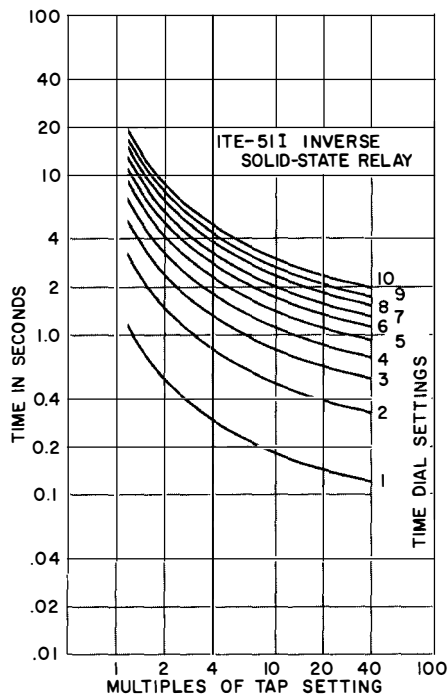
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TABLE 2—SELECTION GUIDE

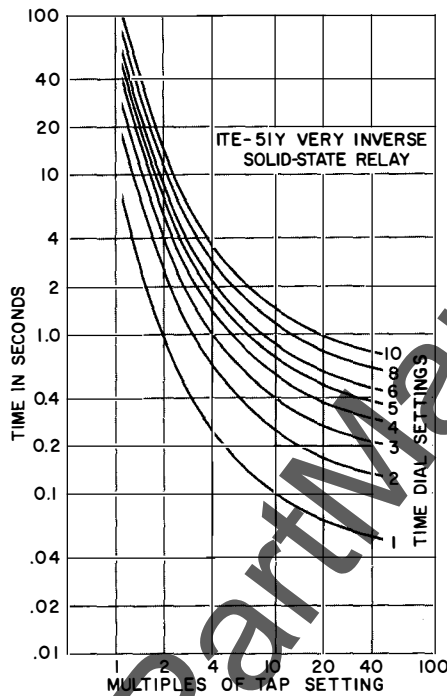
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TIME-CURRENT CHARACTERISTIC CURVES

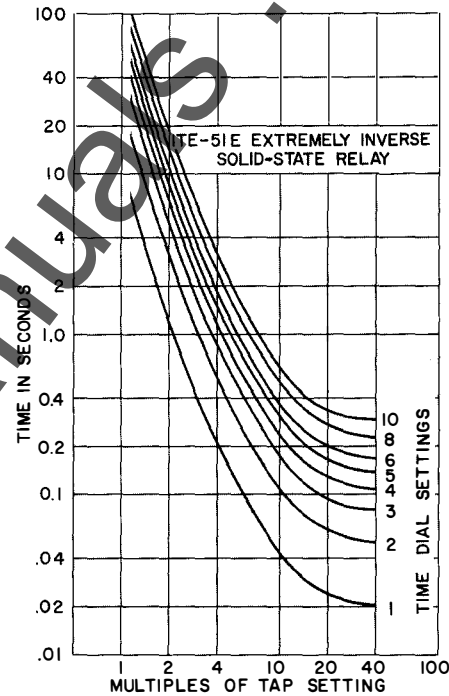
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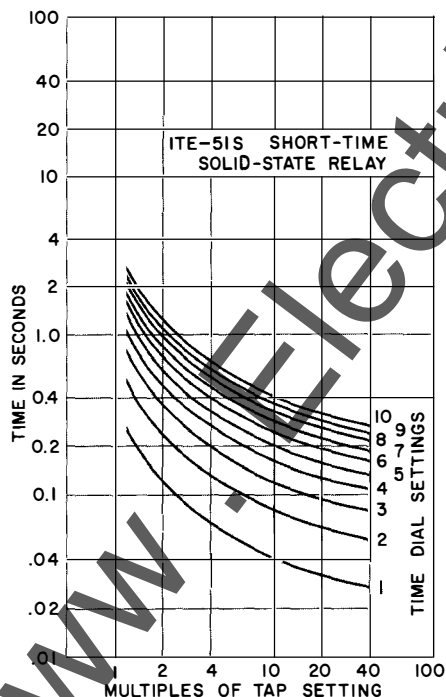
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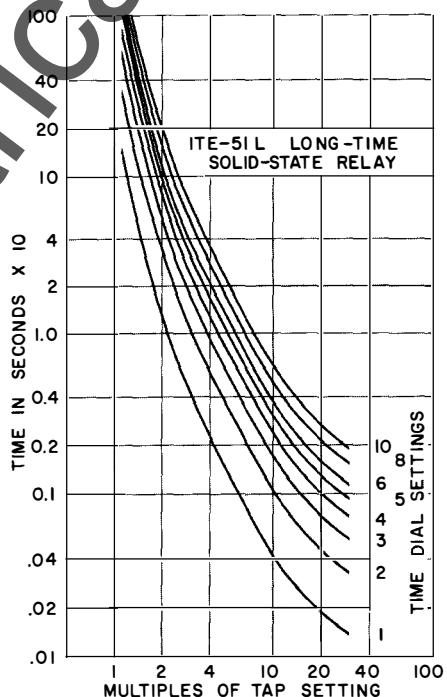
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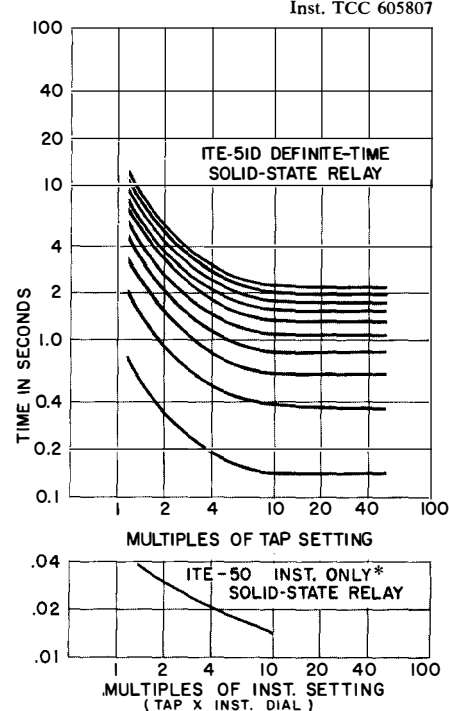
TCC 605804



TCC 605805



Def. TCC 605806
Inst. TCC 605807



*Also inst. attachment to time relays.

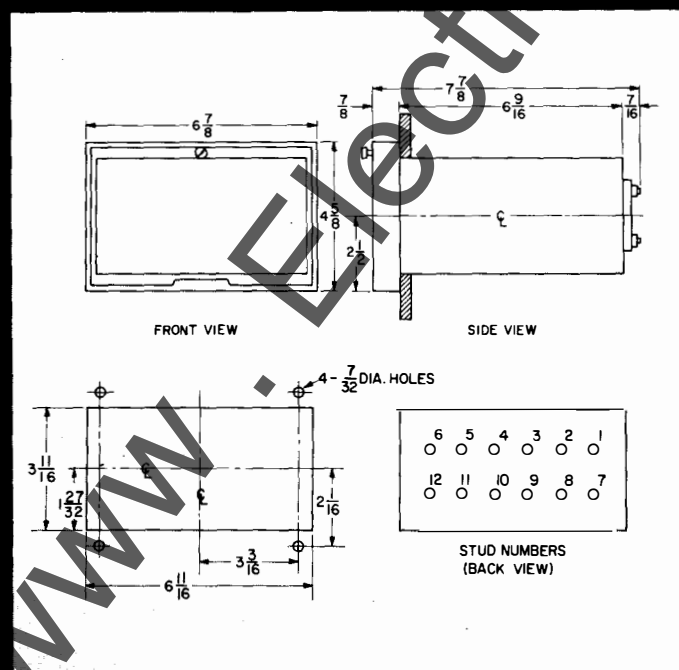
SELECTION AND APPLICATION

Tap Range	Taps ⁽¹⁾	Burden ⁽²⁾ , VA
0.5 - 2A	0.5, 0.6, 0.8, 1.0, 1.2, 1.5, 2.0	1.05 - 1.20
1.5 - 6A ⁽³⁾	1.5, 2.0, 2.5, 3, 4, 5, 6	1.1 - 1.4
4 - 12A	4, 5, 6, 7, 8, 10, 12	1.4 - 2.6

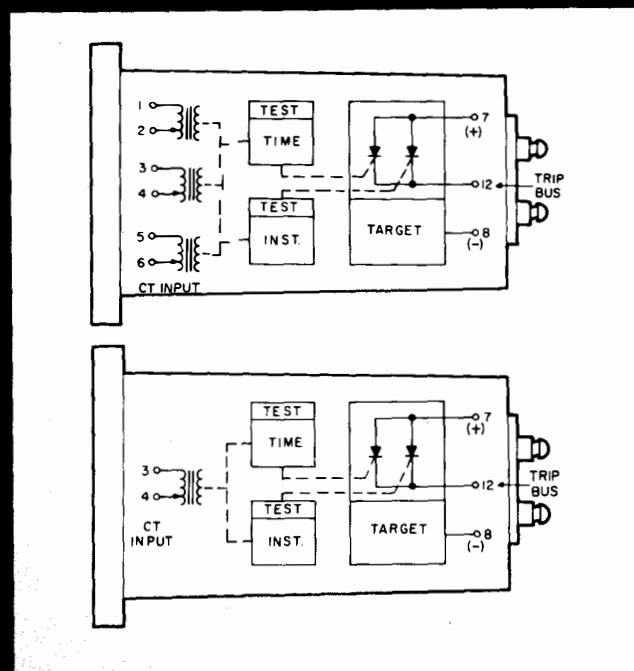
Time	Tap Range, A	Input Current, 1Φ or 3Φ (CT Secondary Amperes)
1 Second	0.5 - 2	300 multiples of pick-up tap setting or 235 A rms, whichever is less.
	1.5 - 6	300 multiples of pick-up tap setting or 235 A rms, whichever is less.
	4 - 12	300 multiples of pick-up tap setting or 390 A rms, whichever is less.
Continuous	All Ranges	1.5 multiples of pick-up tap setting.

Nominal Voltage	Range of Operation	Trip Coil Currents (Amps DC)		
		6 Cycles	1 Second	Continuous
48 Vdc 125 Vdc 250 Vdc 120 Vac 240 Vac	28-60 70-140 140-280 175 Vdc Capacitor Trip 350 Vdc Capacitor Trip	30	15	1

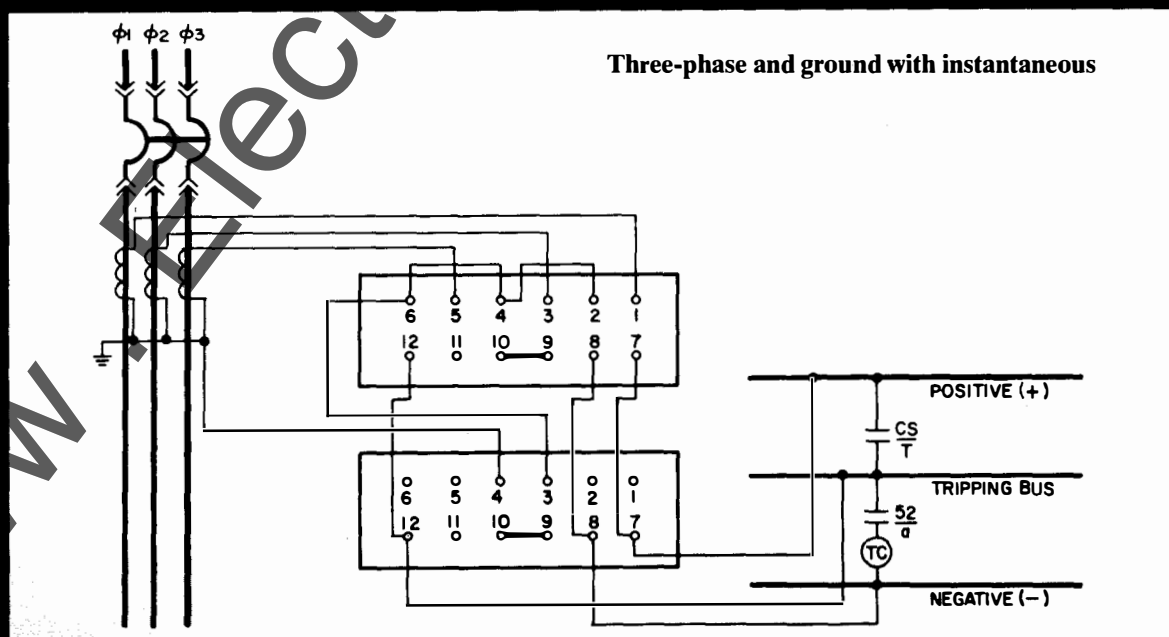
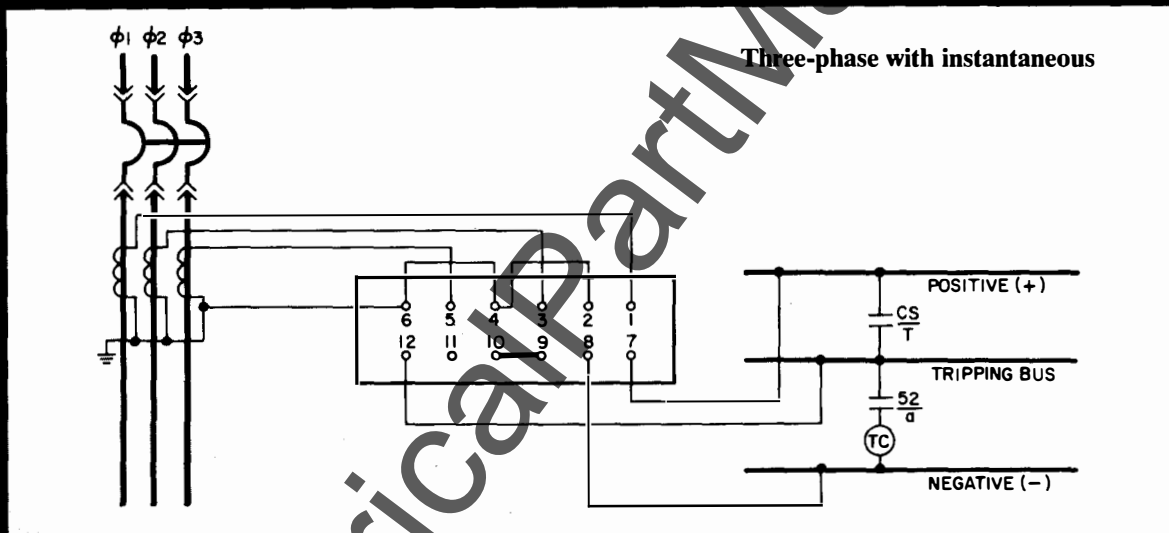
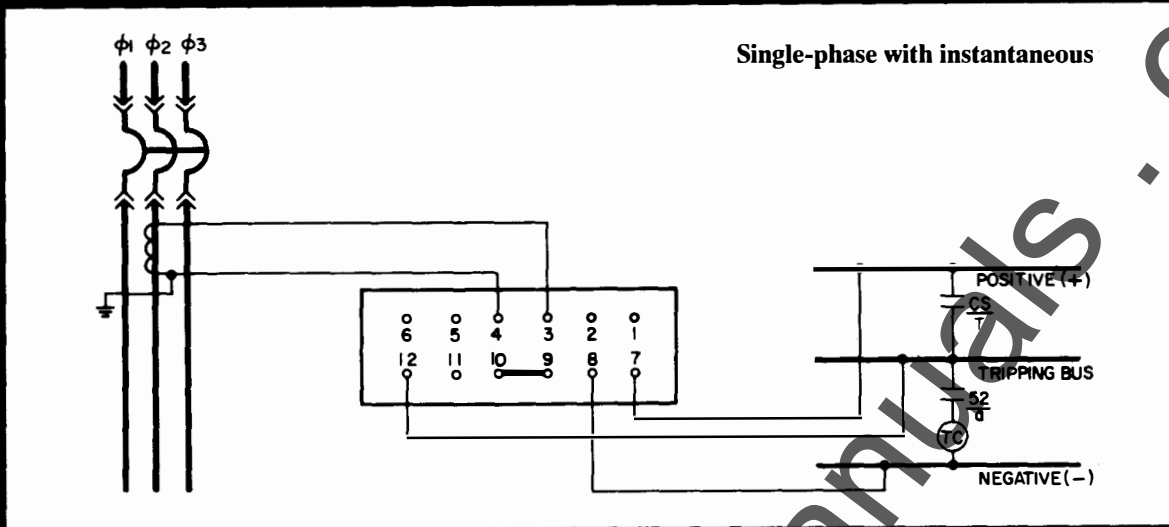
DIMENSIONS



INTERNAL CONNECTIONS



EXTERNAL WIRING CONNECTIONS



TESTING

GENERAL

In general, it is not necessary to schedule periodic maintenance and testing of CIRCUIT-SHIELD™ because of the absence of moving parts, contacts, bearings and springs. However, should testing be desired to confirm proper functioning of the relay, the procedures outlined below may be used.

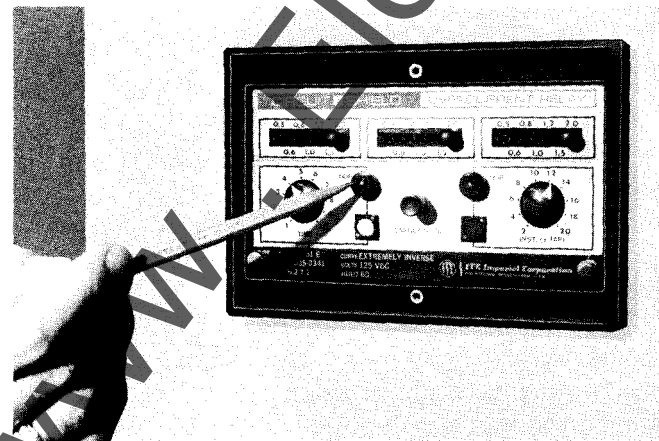
CIRCUIT-SHIELD has two built-in operational test pushbuttons; one is for the time function and the second is for the instantaneous function. When the TIME button is depressed control voltage corresponding to 2 multiples of pick-up is applied to the timing current. This produces an SCR output signal and operates the time target. The INST pushbutton similarly tests the instantaneous circuit.

For further details, refer to CIRCUIT-SHIELD Instruction Bulletin IB-18.2.7-1.

OPERATIONAL TESTS

When bench testing, connect the d-c control power positive and negative leads and an output load coil to the relay terminals. The operational test button will check the relay solid-state circuitry.

When mounted on switchgear, remove the relay cover and press the operational test button. This will cause the relay to operate and trip the breaker, when breaker is in either the operating or test position. The drawout board can be removed and a spare inserted instantly while energized, or if desired, the input transformers can be monitored by inserting the universal drawout test accessory.

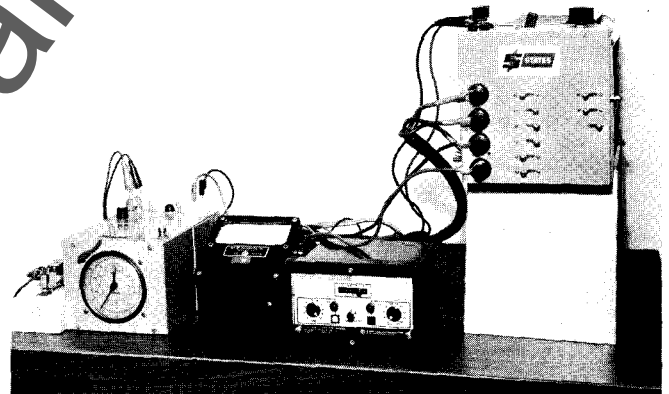


Built-in Operational Test

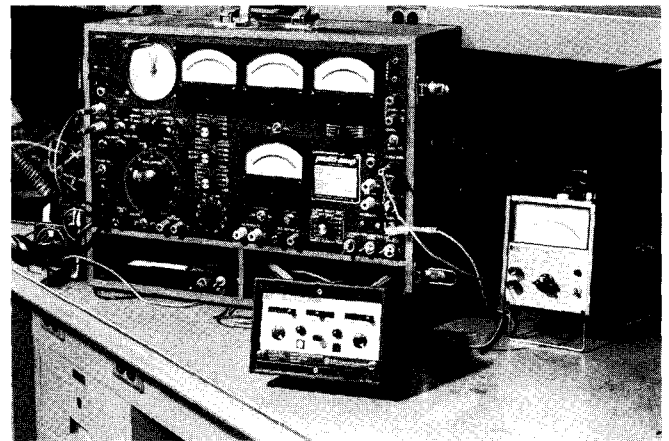
CALIBRATION TESTS

When bench testing, use conventional overcurrent relay test procedures with an auxiliary relay contact to stop the timer. For further details, refer to Instruction Bulletin IB-18.2.7-1.

When mounted on switchgear, in-service calibration tests of CIRCUIT-SHIELD are not necessary due to solid-state design. If user's practice is to periodically make calibration tests on energized circuits, separate conventional test switches should be specified and installed on the switchgear panel.



Calibration Test—Resistance Tester



Calibration Test—Multi-Amp Tester

ORDERING GUIDE

Typical catalog number for CIRCUIT-SHIELD overcurrent relay, three-phase, very inverse, 4-12 ampere tap, 48 volts d c, with instantaneous element.

TYPICAL CATALOG NUMBER *	203	T	2	3	3	1
	203					
	T	x				
	2		x			
	3			x		
	3				x	
	1					x

*To order instantaneous only relay, refer to your local I-T-E sales office.

SELECTION GUIDE

To select CIRCUIT-SHIELD solid-state overcurrent protection, five items must be considered and specified:

- Select relay circuitry. Choose either single- or three-phase construction.
- Select time - current characteristic. Choose between inverse, very inverse, extremely inverse, short-time, long-time, or definite time-current characteristics.
- Select tap range. Choose between 0.5-2A, 1.5-6A or 4-12A available tap ranges.
- Select output control voltage. Choose between 48, 125 and 250 volts dc or 120 volts ac capacitor trip (175V dc) and 240V ac capacitor trip (350V dc).
- Select whether or not instantaneous element is desired.

SPECIFICATION GUIDE

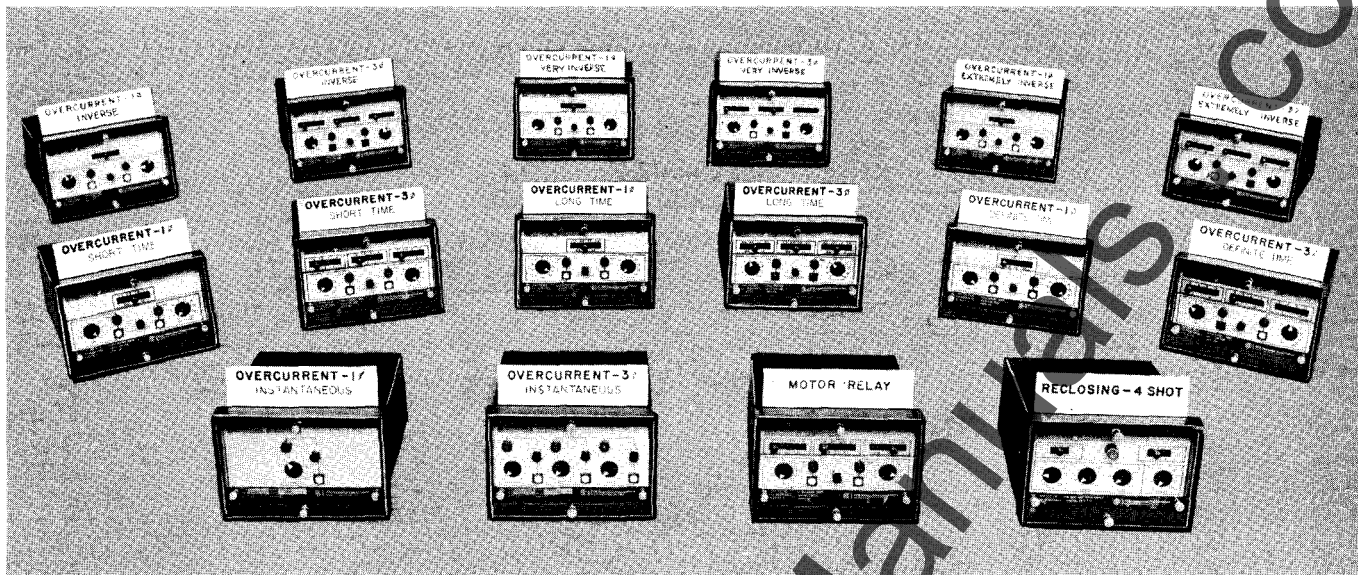
Overcurrent relays described herein shall be of solid-state, low-burden construction for (3-phase), ((3) 1-phase) phase protection and/or (1-phase) ground protection. They are intended for use on a — volt, 3-phase, 60 Hertz, (3) (4)-wire (delta) (wye) (un-grounded), (solid) (resistance) (reactance) grounded, or (grounded through grounding transformer) system. Estimated maximum ground fault current is — amperes. Nominal operating temperature is to be 25°C ambient but relay must be capable of operation from -30°C to +70°C ambient

Relay shall be equipped with shock-proof positive target indicators which

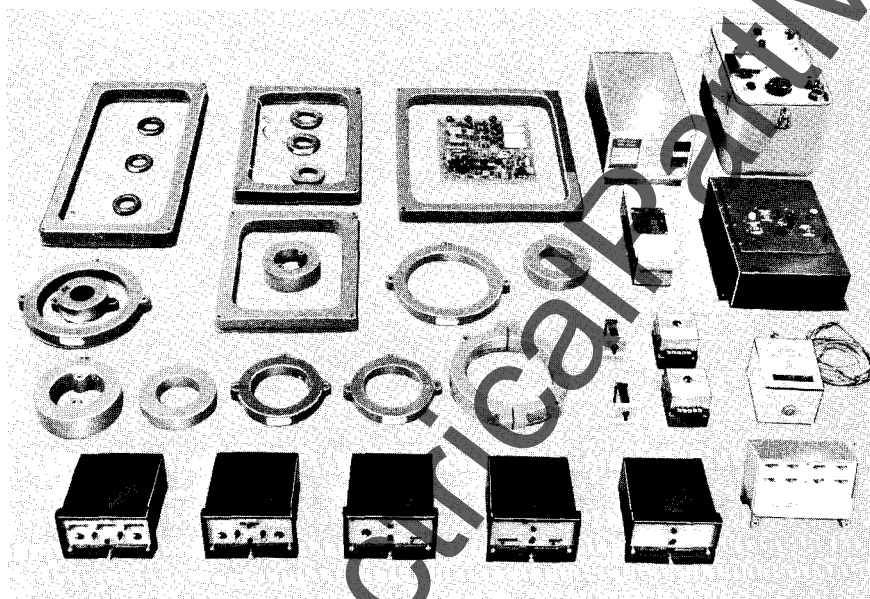
shall retain proper position with loss of control power. Push-to-test buttons shall be provided to check operation of both time and inst. functions.

Relay shall be supplied with (inverse) (very inverse) (extremely inverse) (short-time) (long-time) (definite-time) time-current characteristics. Tap range is to be (0.5-2) (1.5-6) (4-12) amperes. In addition to time-current function, the overcurrent relays shall be complete (without) (with) universal instantaneous function. Control voltage output rating shall be (48) (125) (250) volts dc or (120) (240) volts ac capacitor trip. Relays shall operate from standard 5 ampere CT secondaries.

PRODUCTS AND FACILITIES



Line up of solid-state relays including single- and three-phase overcurrent inverse, very inverse, extremely inverse, short-time, long-time, definite-time and instantaneous only. Also motor and 4-shot reclosing relays.



Family of other I-T-E solid-state relays and current sensors.



Relay final assembly area.



Relay final testing area.

The I-T-E IMPERIAL CORPORATION has a fully trained staff of Technical Sales Engineers located in principal cities throughout the United States. Your local engineer stands ready to assist you by answering any questions you may have regarding products, application or prices. Why not call on him today?

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