



# ***Power Break®***

*Insulated Case  
Circuit Breakers*

*Featuring  
MicroVersaTrip®  
RMS-9 Programmer*





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# POWER BREAK® Circuit Breakers

**Rugged, Durable Construction  
Combined with Accuracy,  
Versatility, and Coordination**

The General Electric line of POWER BREAK® insulated case circuit breakers offers the rugged, reliable type of system protection critical for heavy-duty applications. POWER BREAK circuit breakers are rated up to 200,000 amperes rms symmetrical interrupting capacity without fuses or current limiters. The POWER BREAK design consists of five physical envelope sizes from 200 to 4000 amperes.

POWER BREAK is a versatile breaker, designed for a wide variety of applications with features such as—temperature insensitive trip units—push-to-open and close buttons—maximum five-cycle closing time—field installable rating plugs to change ampere ratings—U/L listed, field installable accessories—easy to operate, rotary, stored energy operating mechanism.

A full line of selective tripping characteristics can be used to provide overcurrent protection from overloads, short-circuits and ground faults. Additionally, trip indicators are available to aid in fault diagnosis.

POWER BREAK circuit breakers offer application flexibility for ac as well as dc power systems with ratings up to 700 volts dc and 750 volts ac.

The custom tailored support required for today's exacting applications is available with a full line of POWER BREAK draw-out structures, interlocks, internal accessories, electrical operators, connectors, and a solid-state test kit.

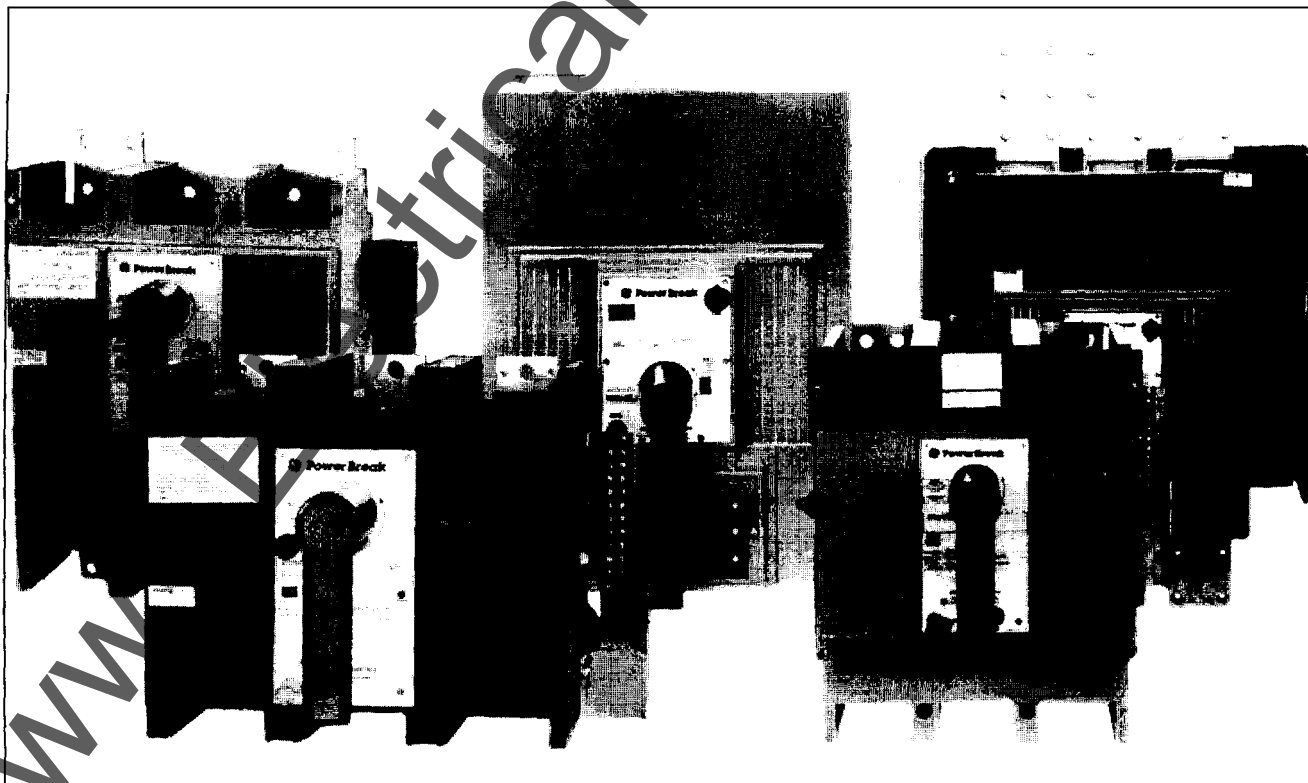


Fig 3.1 POWER BREAK Circuit Breakers



# Features and Characteristics

## Key Features

### 1. Increased Durability— Safety of Operation

High-dielectric strength, glass reinforced insulating case.

### 2. High Arc Quenching Capability

Supported steel grids suppress arcs and cool gases rapidly, providing quick arc interruption and extended circuit breaker life.

### 3. High Transient Voltage Withstandability

Interphase partitions mesh with breaker cover to completely isolate each pole.

### 4. Preloaded Constant Pressure Pivot

Eliminates braid whip and fraying on high short-circuit current and repeated operations.

### 5. Positive "On-Off" Position Indication

Green (OFF), Red (ON), eliminates any question about the position of the breaker contacts.

### 6. Simple, Stored Energy Charging

Extra heavy duty, low torque handle mechanism.

### 7. Easy Close Operation— Quick-Make

Push "ON" button to close breaker contacts. Allows 5 cycle maximum closing time from initiation of a close signal.

### 8. Easy Open Operation— Quick-Break

Finger-tip "OFF" button instantly opens the breaker contacts.

### 9. Interchangeable Rating Plug

MicroVersaTrip® RMS-9 programmers use a variety of field installable rating plugs to fix the frame continuous ampere rating.

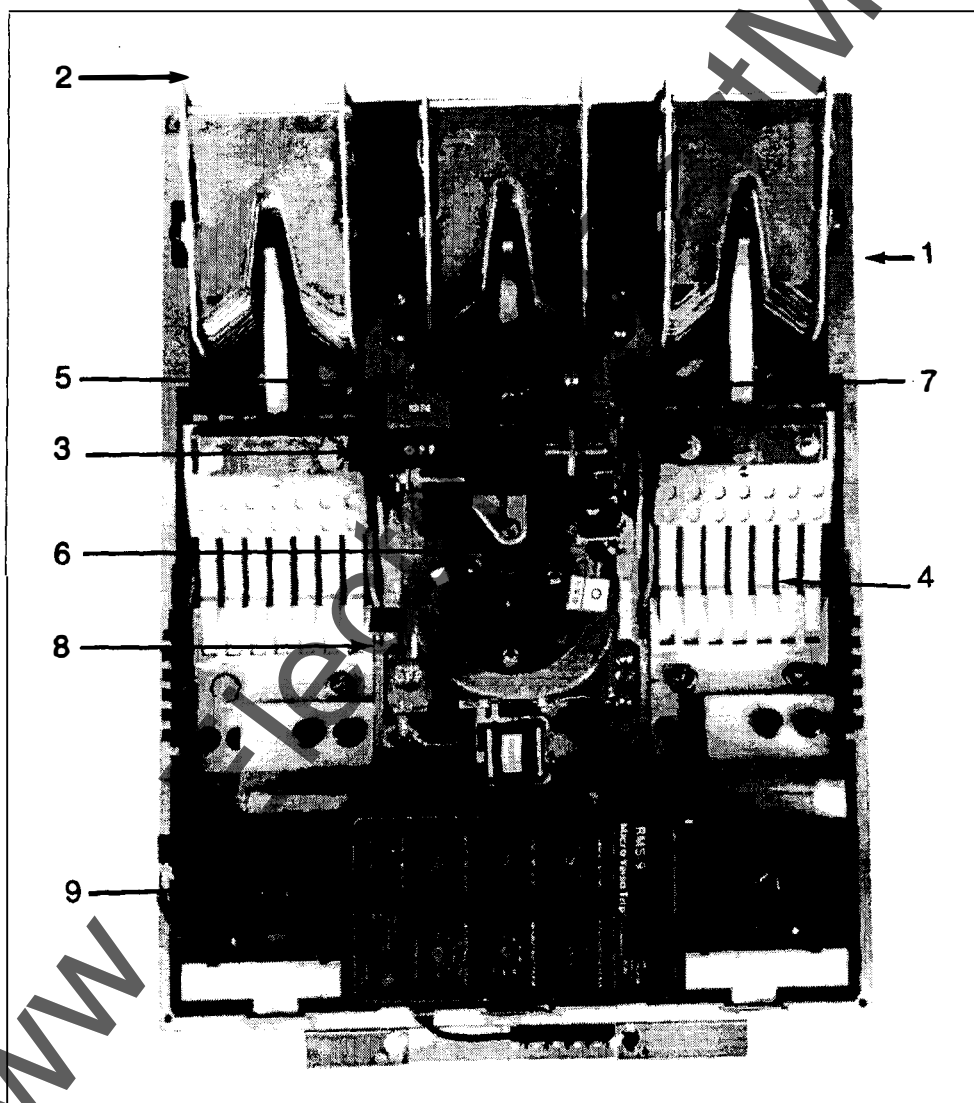


Fig. 4.1 POWER BREAK® Circuit Breaker Key Features



## Basic Configurations

POWER BREAK® is available in three basic configurations: MicroVersaTrip® RMS-9 solid-state trip; MagneTrip™ dual magnetic trip; and molded case switch. Each configuration is available in stationary or drawout construction with a full complement of control and signaling accessories. Standard rated breakers are designed to meet the majority of application requirements, calling for moderate short circuit conditions. They are furnished with grey case and cover.

Hi-Break® breakers, on the other hand, are specially designed to withstand the high stresses of, and safely interrupt, very high short-circuit current occasionally encountered. They are furnished with black case and cover.

Special Hi-Break breakers and molded-case switches are available for system voltages up to 750 Vac and 700 Vdc.

Table 5.1  
Available Configurations

| Frame Size (Amps) | MicroVersaTrip RMS-9 100% (ac only) |                  | MagneTrip™ 100% (ac or dc) |                  |                  | Molded Case Switch (ac or dc) |          |                  |
|-------------------|-------------------------------------|------------------|----------------------------|------------------|------------------|-------------------------------|----------|------------------|
|                   | Std. Break                          | Hi-Break         | Std. Break                 | Hi-Break         | Special Hi-Break | Std. Break                    | Hi-Break | Special Hi-Break |
| 800               | Yes                                 | Yes              | No                         | No               | No               | Yes                           | No       | No               |
| 1600              | Yes                                 | Yes              | Yes                        | Yes              | No               | Yes                           | No       | No               |
| 2000              | Yes                                 | Yes              | Yes                        | Yes              | No               | Yes                           | No       | No               |
| 2500              | Yes                                 | Yes              | Yes                        | Yes              | Yes              | Yes                           | Yes      | Yes              |
| 3000              | Yes                                 | Yes              | Yes                        | Yes              | Yes              | Yes                           | Yes      | Yes              |
| 4000              | Yes <sup>①</sup>                    | Yes <sup>①</sup> | Yes <sup>②</sup>           | Yes <sup>②</sup> | Yes <sup>②</sup> | Yes                           | Yes      | Yes              |

① Draw-out construction only; stationary 4000A uses VersaTrip™ construction.

② 80% rated.

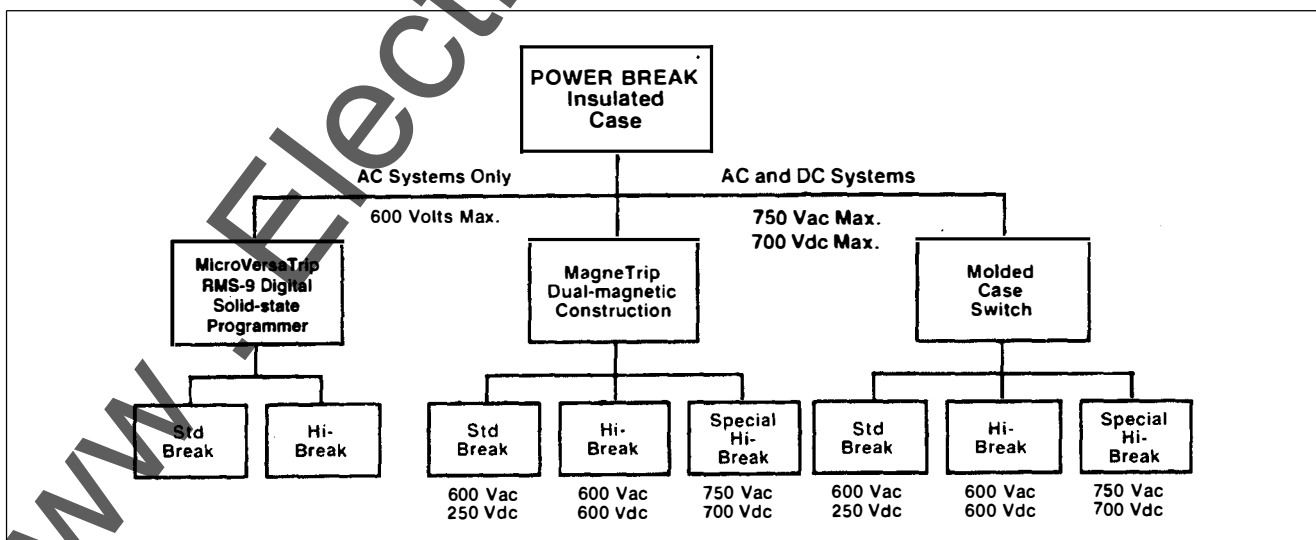


Fig. 5.1 The POWER BREAK Circuit Breaker Family



# Features and Characteristics (Continued)

## Manual Operation

The circuit breaker is charged by a single 120° rotation of the handle for 800, 1600, and 2000 ampere envelope sizes, and by three 120° rotations for 3000 and 4000 ampere envelopes. Each handle movement is a stage in precharging a spring-loaded, quick-make, quick-break mechanism. To close the breaker contacts, and energize the load, simply push the "ON" button. To open the breaker, and de-energize the circuit, manually push the "OFF" button. Both are provided on the front of the breaker. Each stage of operation (ON-OFF, "charged") is clearly shown by an indicator on the face of the circuit breaker.

Table 6.1  
Sequence of Operation

| Indicator     | Main Breaker Contacts | Condition of Charging Springs | Next Permissible Operating Function |
|---------------|-----------------------|-------------------------------|-------------------------------------|
| OFF           | Open                  | Discharged                    | Mechanism may be charged            |
| CHG (Charged) | Open                  | Fully charged                 | Contacts may be closed              |
| ON            | Closed                | Partially discharged          | Contacts may be opened              |

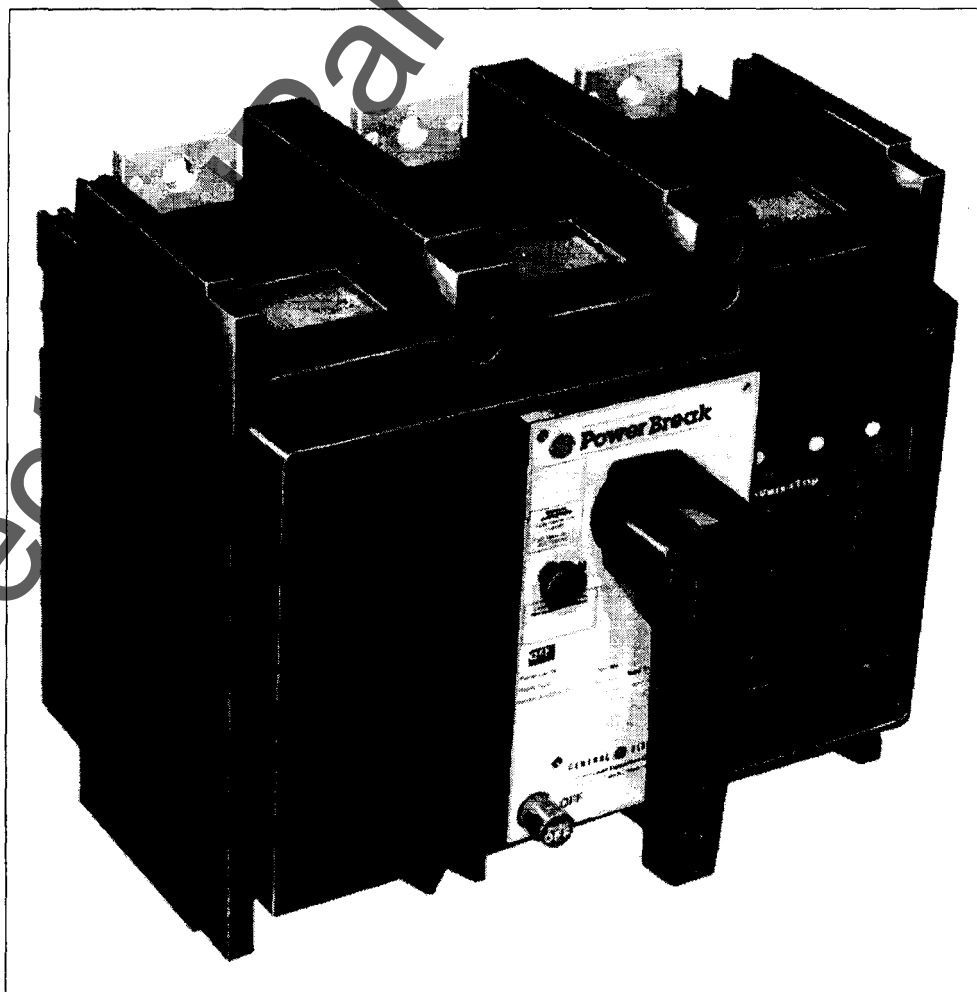


Fig. 6.1 800 Ampere Manually Operated Circuit Breaker



## Electrical Operation

The appearance of an electrically operated breaker is compatible with the manually operated POWER BREAK®. The motor operator is integrally mounted inside a heavy duty insulated case.

A motor charge, spring-close, stored-energy mechanism assures positive and complete closing of main contacts.

Five-cycle maximum closing time is standard. It fulfills requirements for generator synchronizing.

The independent charging action allows the mechanism to be charged without closing the breaker.

Remote electrical or local manual control (local controls placed on front of breaker) provide a completely separate system of mechanical operating functions, duplicating the

control functions to "Open," "Charge," or "Close" breaker. A shunt trip is supplied as standard on electrically operated breakers for the remote electrical opening. (An under-voltage trip device will be substituted upon request.)

A terminal block is provided for wiring control circuits to remote operating stations.

A charging handle is provided as an integral part of an electrically operated circuit

breaker for optional manual charging with no special tools or separate auxiliary handles required.

The manual charging handle is independent of the electrical drive mechanism. To engage the handle for manual charging simply depress the handle release button. Padlocking provisions for "ON" button and charging handle for prevention of manual operation of breaker by unauthorized personnel is standard.

Manual operation with the switchboard front panel in place or the hinged door closed, eliminates removing the front panel or opening the switchboard door for manual operation.

**Note:** For electrical control power requirements and wiring diagrams see pages 35-37.

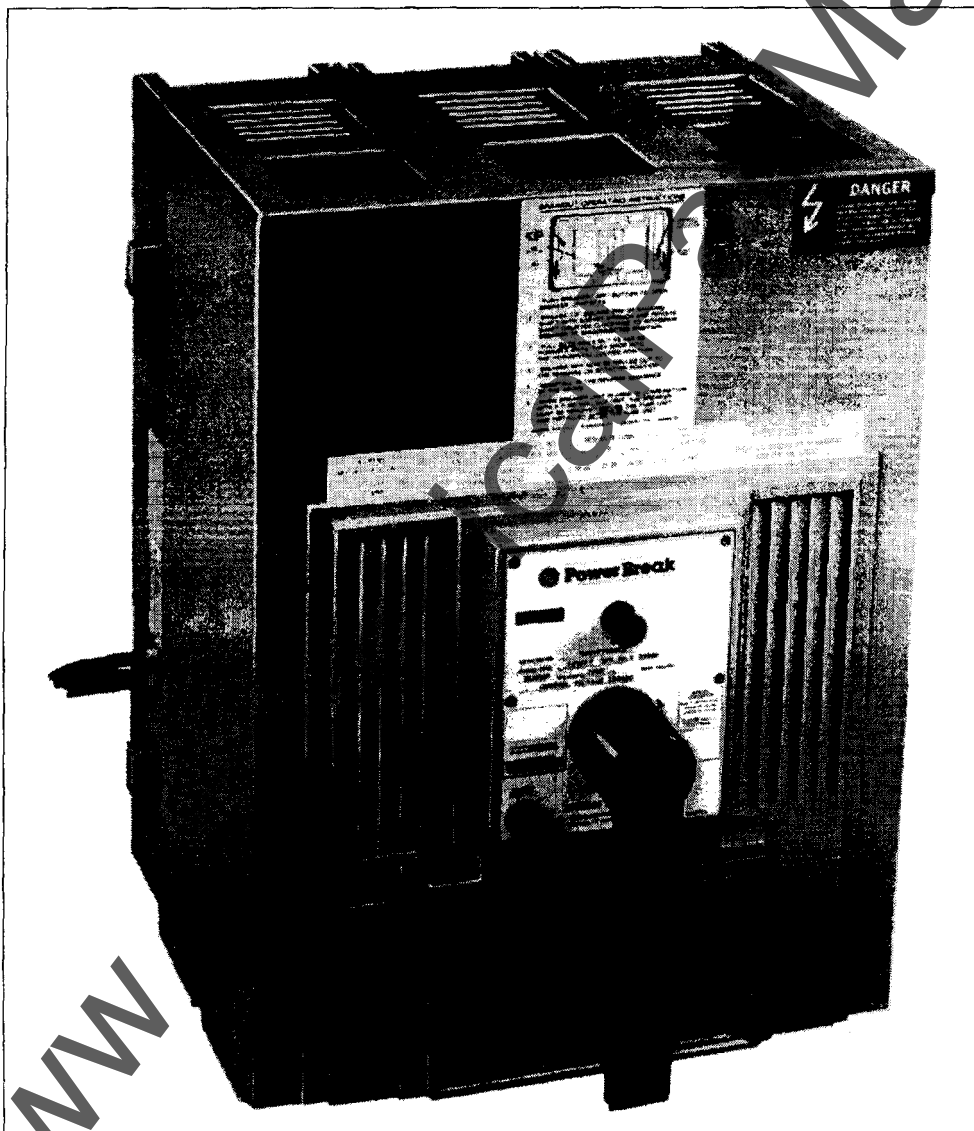


Fig. 7.1 3000 Ampere Electrically-Operated Circuit Breaker



# Features and Characteristics (Continued)

## Draw-out Construction

TC and THC POWER BREAK® draw-out circuit breakers are for use in type TDOS and THDOS substructures, providing the convenience and safety inherent in draw-out breaker construction. They permit activation of a new feeder, rapid replacement of a circuit breaker, and facilitate inspection and maintenance of the draw-out breaker without making it necessary to de-energize the entire switchboard.

Features (see photos on p 9)

- 1. Primary Disconnects:** Primary power is fed through multiple finger primary disconnects when connected to the primary stabs in the substructure.
- 2. Secondary Disconnects:** Control power is provided through the secondary disconnects, 48 circuits max., in the test and connected positions only.
- 3. Wheels:** The breaker has rollers which allow the unit to ride on the substructure retractable rails for easy removal and installation.
- 4. Draw-out Mechanism:** A racking shaft powers a centrally mounted power screw, through a chain drive, into a fixed nut in the substructure. A special speed wrench is supplied with an integral 1/2" square drive socket for racking breaker in and out of the substructure.
- 5. Wrench Interlock:** This interlock prevents engagement of the racking wrench when the breaker contacts are closed. This prevents disconnecting a closed breaker.
- 6. Draw-out Position Indicator:** A draw-out position indicator indicates whether the breaker is in the connected, test or disconnected position.
- 7. Draw-out Interlock:** This interlock will trip a closed circuit breaker. Tripping action will occur in either the connecting or disconnecting mode.
- 8. Rejection Feature:** A built in rejection feature prevents insertion of a breaker into an incorrect substructure. This prevents (1) insertion of a standard-break breaker in a Hi-Break® substructure, (2) insertion of a higher ampere rated breaker in a lower ampere substructure (not shown).
- 9. Programmer Disconnect Plug:** This accessory is provided only on MicroVersaTrip® RMS-9 draw-out breakers to provide zone selective interlocking for ground fault and short time or ground fault only.  
  
The programmer disconnect is available with all substructures required to accept MicroVersaTrip RMS-9 draw-out breaker units. The programmer disconnect allows separate circuit points for zone selective interlocking without having to sacrifice circuit points available through the secondary disconnect accessory. This accessory can be added on any substructure to permit upgrading to MicroVersaTrip RMS-9 breaker from a MagneTrip™ breaker.
- 10. Padlock Device:** Padlocking is optionally provided to prevent movement of the breaker in the test and disconnected positions (not shown).
- 11. Shutters:** Shutters are provided as an accessory to protect personnel from inadvertently contacting the primary stabs of an energized switchboard when the draw-out breaker unit is removed.
- 12. By-Pass Switch:** A by-pass switch accessory has normally open (N.O.) and normally closed (N.C.) contacts, which change state when the draw-out circuit breaker is racked from the connected to the test position. The switch is available in 4-circuit, 8-circuit, or 12-circuit of which half are N.O. and the other half N.C. (not shown).
- 13. Lifting Bar:** A lifting bar is available as an accessory and should be used to provide safe handling of the draw-out breaker.
- 14. Substructure:** The substructure is a self-contained framework serving as a stationary receptacle for POWER BREAK draw-out breakers type TC or THC and provides convenience and safety inherent in draw-out construction. It permits easy activation of a new circuit in a spare compartment (hole-filler), rapid replacement of a circuit breaker, and facilitates inspection and maintenance of POWER BREAK insulated case draw-out circuit breakers without making it necessary to de-energize the entire switchboard.  
  
The substructure is designed for convenient mounting, with holes provided for bolting on a shelf or supports. Holes are also provided in the primary stab for bolting to busbars or terminal lugs.  
  
The substructure has retractable rails which aid in the installation of the draw-out breaker.



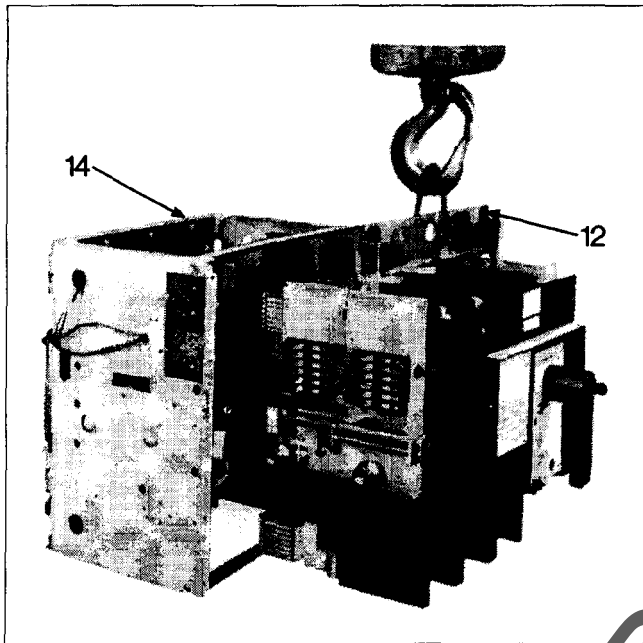


Fig. 9.1 1600 A. Draw-out Circuit Breaker and Sub-structure

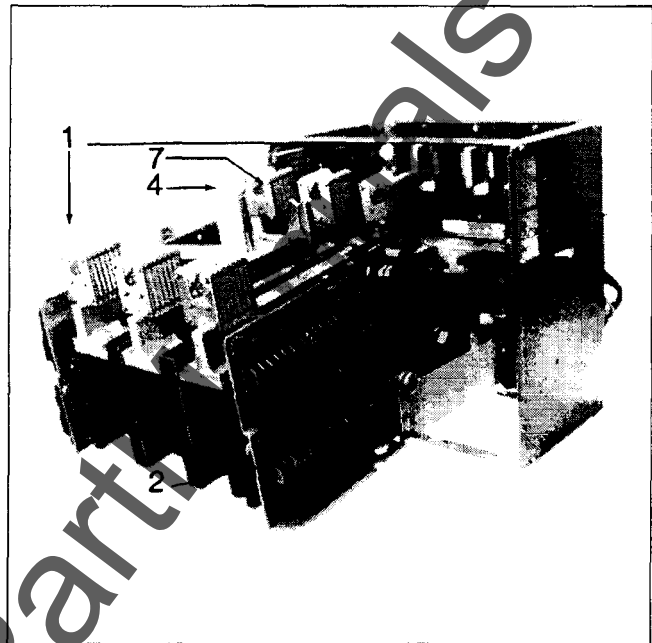


Fig. 9.2 Draw-out Breaker Rotated for Inspection

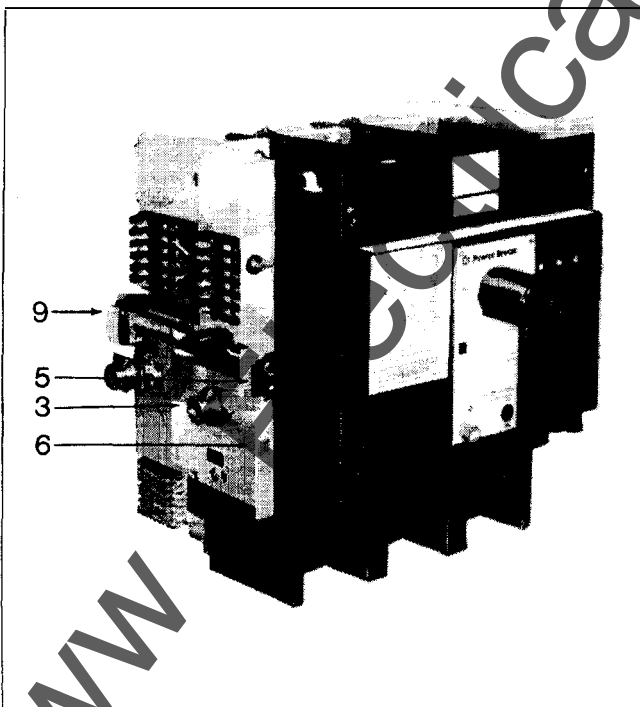


Fig. 9.3 1600 A. Draw-out Circuit Breaker

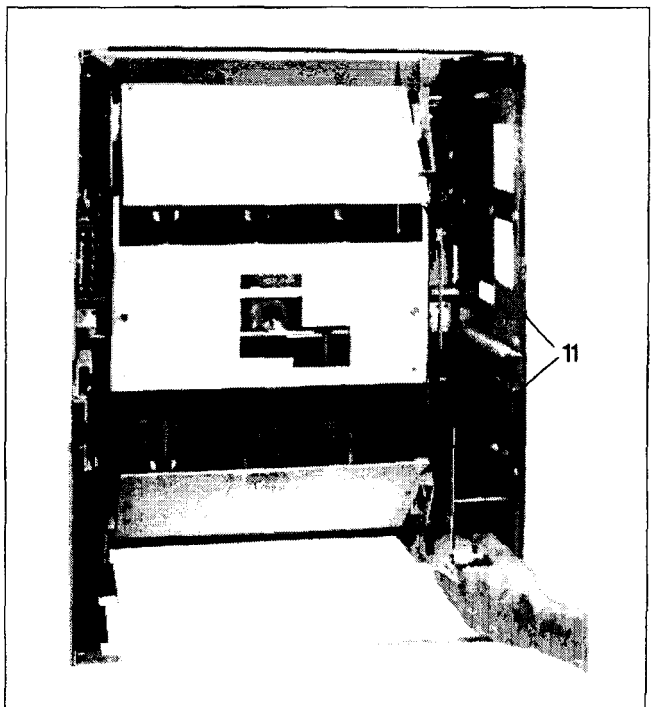


Fig. 9.4 Substructure with Optional Shutters (Shutters Partially Open)



# Trip Devices

## MicroVersaTrip® RMS-9 Programmer

The MicroVersaTrip® RMS-9 system for POWER BREAK® insulated case circuit breakers consists of four parts: the protection programmer, flux-shift trip device, current sensors and rating plugs.

The programmer contains a current sensor-powered, solid-state logic unit and incorporates rotary adjustment switches for up to nine functions, as well as targets for mechanical fault trip indication.

MicroVersaTrip® RMS-9 represents the latest technology in digital solid-state programmers.

### RMS Digital Sensing of Sinusoidal and Non-sinusoidal

MicroVersaTrip® RMS-9 provides accurate overload protection for both sinusoidal and non-sinusoidal currents by direct measurement of the true rms content of the current wave. This is accomplished by microprocessor digital sampling techniques. Therefore, the solid state microprocessor is not affected by component tolerance and does not require compensation for signal distortion. Since the design is based on complementary metal oxide (CMOS) technology, it

is less sensitive to extraneous noise produced by lightning, instrumentation, radio, etc.

The solid state microprocessor technology and fast analog to digital converters make it possible to measure the magnitude of the phase current over a number of time periods within the cycle. The MicroVersaTrip® RMS-9 sampling rate of 27 per cycle for each phase allows for errors of less than 1% on systems with distortions through the 13th harmonic. This digital sampling technique provides the most accurate system protection for distribution systems that include ac and dc variable speed drives,

rectifiers, induction heating, and other loads that cause non-sinusoidal currents.

### Full Function Trip Unit Available with Various Protection Feature Combinations

The MicroVersaTrip® RMS-9 trip line of programmers provides maximum breaker to breaker selectivity and custom load protection. Short-time and Ground Fault functions include the flexibility of coordination with and without an I<sup>2</sup>T ramp. POWER BREAK® circuit breakers are available with Standard Instantaneous

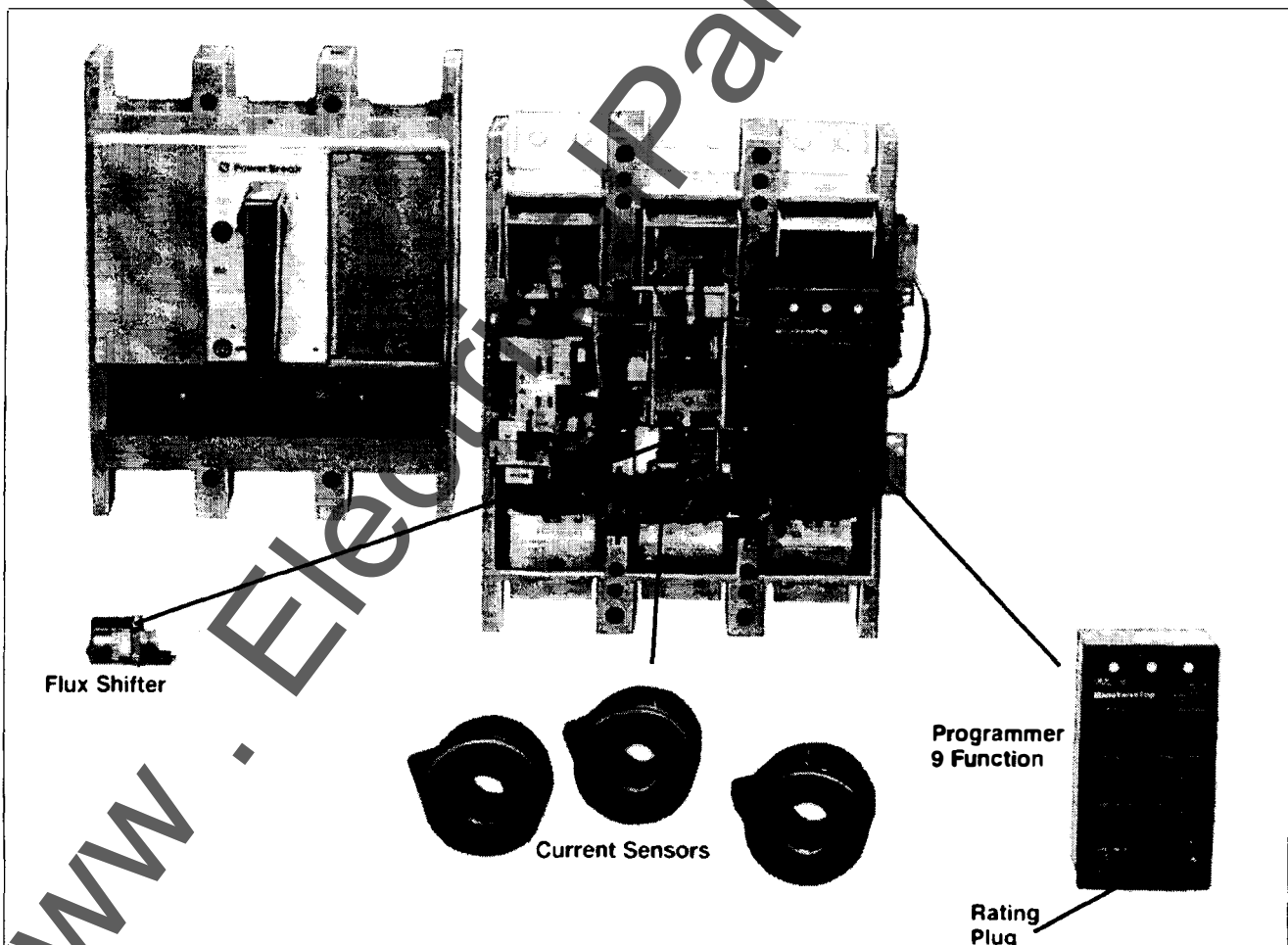


Fig. 10.1 MicroVersaTrip RMS-9 System Components



or High Range Instantaneous, and Ground Fault. All programmers include a clear plastic cover with provisions for sealing for tamper-proof installation.

### Current Sensors

Three toroidal current sensors provide maximum flexibility and reliability with minimum signal error. For sensors rated 2000A and less, the secondary output at rated input current is 200ma; for 2500, 3000, and 4000A sensors, secondary current is 400ma.

### Flux-shift Trip Device

The flux-shifter is a low energy, positive action tripping device that is automatically powered and controlled by the protection programmer. The low energy signal from the programmer counteracts the strength of a permanent magnet in the flux-shifter, allowing a spring to unseal the magnet and trip the breaker.

### Rating Plugs for Convenient Flexibility

All RMS-9 programmers utilize a broad range of field-installable rating plugs for future up-rating capability, minimum size cable selection, and an extra degree of coordination flexibility.

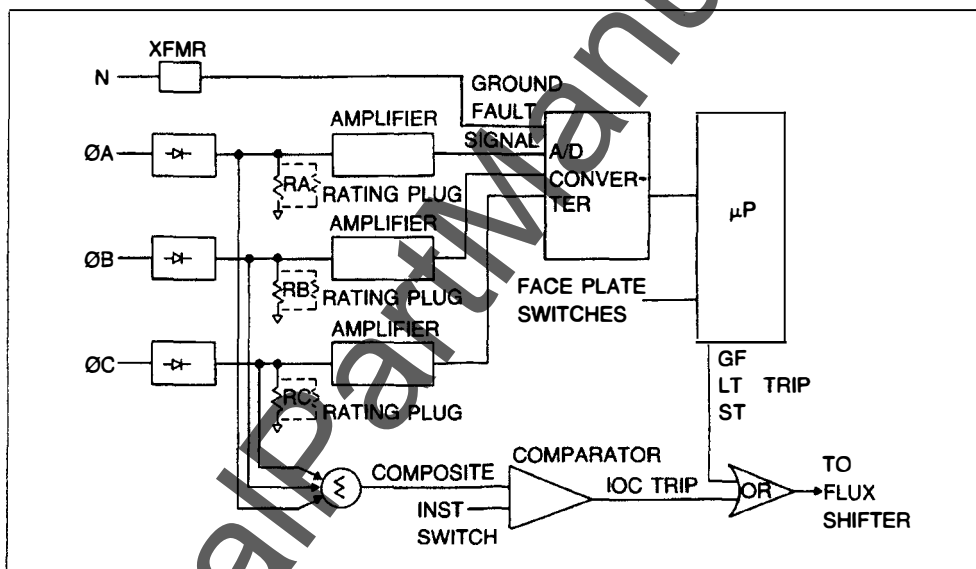


Fig. 11.1 MicroVersaTrip RMS-9 Block Diagram

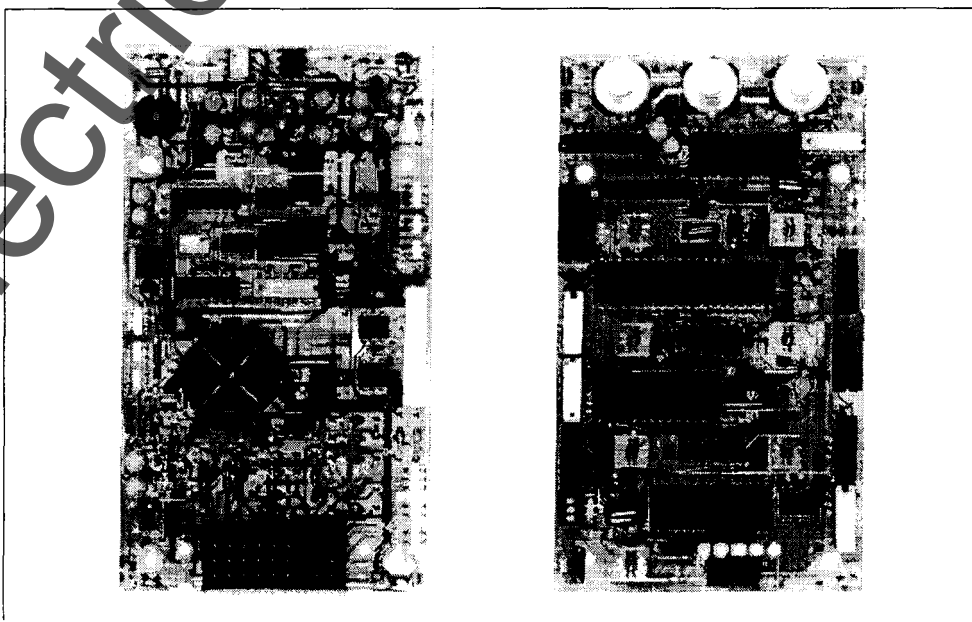


Fig. 11.1 Programmer Components: Power Supply Board, Logic Board



## MicroVersaTrip® RMS-9 Programmer Tripping Functions

1. Current Setting—Standard
  2. Long-time Delay—Standard
  3. Long-Time Pickup Light—Standard
  4. Short-time Pickup—Optional
  5. Adjustable Short-Time Delay with I<sup>2</sup>t IN or OUT—Optional
  6. Instantaneous Pickup—Standard
  7. Ground Fault Pickup—Optional
  8. Ground Fault Delay with I<sup>2</sup>t IN or OUT—Optional
  9. Rating Plug—Several plugs are available to easily change the breaker continuous amperage rating (see Table 13.2 and 18.2)
  10. Test Jack (for use with test kit cat. no. TVRMS)
  11. Fault Trip Annunciators—Optional
- Not Shown:
- Adjustable High Range Instantaneous—Optional
  - Zone Selective Interlock—Optional
- Available programmer function combinations are shown in Table 18.1

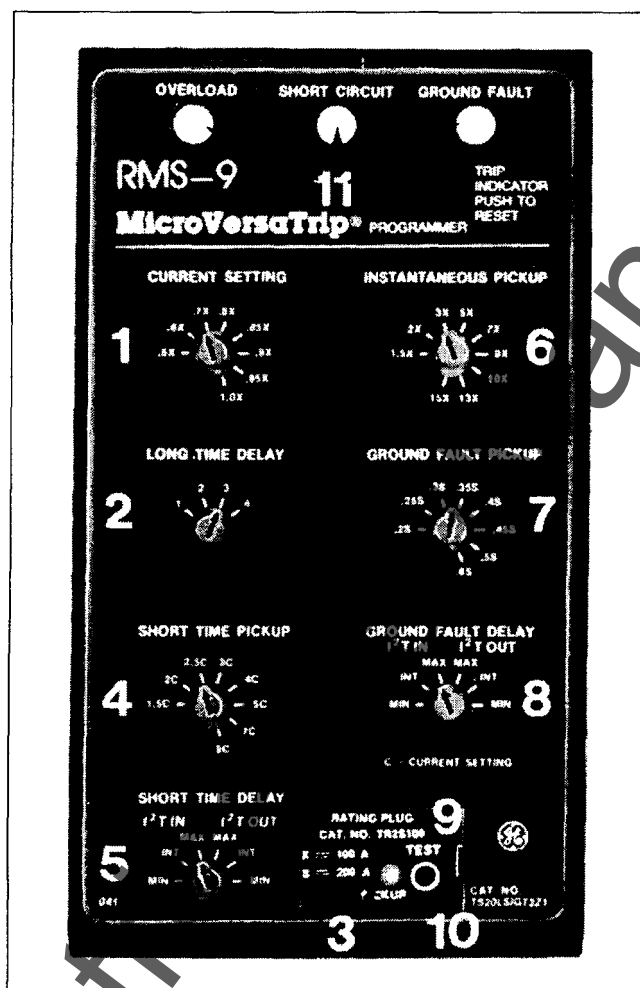


Fig. 12.1 MicroVersaTrip® RMS-9 Programmer

Table 12.1

Basic Frame Selection, Stationary or Draw-out, UL Listed, 100% Equipment Rated with MicroVersaTrip® RMS-9 Programmer

| Frame Size | Frame Size (Amps) | Sensor Rating (Amps) | Stationary     |           | Draw-out       |           |
|------------|-------------------|----------------------|----------------|-----------|----------------|-----------|
|            |                   |                      | Standard Break | HI-Break® | Standard Break | HI-Break® |
| 800        | 800               | 200                  | TP82SS         | THP82SS   | TC82SS②        | THC82SS②  |
|            |                   | 400                  | TP84SS         | THP84SS   | TC84SS②        | THC84SS②  |
|            |                   | 800                  | TP88SS         | THP88SS   | TC88SS②        | THC88SS②  |
| 1600       | 1600              | 1000                 | TP1610SS       | THP1610SS | TC1610SS       | THC1610SS |
|            |                   | 1600                 | TP1616SS       | THP1616SS | TC1616SS       | THC1616SS |
| 2000①      | 2000              | 2000                 | TP2020SS       | THP2020SS | TC2020SS       | THC2020SS |
| 3000       | 2500              | 1000                 | TP2510SS       | THP2510SS | TC2510SS       | THC2510SS |
|            |                   | 2000                 | TP2520SS       | THP2520SS | TC2520SS       | THC2520SS |
|            |                   | 2500                 | TP2525SS       | THP2525SS | TC2525SS       | THC2525SS |
| 3000       | 3000              | 3000                 | TP3030SS       | THP3030SS | TC3030SS       | THC3030SS |
|            |                   | 4000                 | TPSS9640③      | THSS9640③ | TC4040SS       | THC4040SS |

① Small frame size.

② Up to 24 secondary disconnects. For up to 48 secondary disconnects, use Cat. No. TCL\_\_\_SS or THCL\_\_\_SS.

③ 4000-amp stationary breaker uses VersaTrip programmer.



Table 13.1

POWER BREAK<sup>®</sup> MicroVersaTrip<sup>®</sup> RMS-9 Programmer Characteristics

| Current Setting                 | .5, .6, .7, .8, .85, .9, .95, 1.0 of Rating Plug Amp (X) |   |                                      |                            |
|---------------------------------|--|---|--------------------------------------|----------------------------|
| Long-time                       | Pick up  | Fixed at 1.1 of Current Setting (C)                         |                                      |                            |
|                                 | Delay <sup>①</sup>                                       | 2.4, 4.9, 9.8, 20 Seconds                                   |                                      |                            |
| Short-time                      | Pickup   | 1.5, 2, 2.5, 3, 4, 5, 7, 9, Multiple of Current Setting (C) |                                      |                            |
|                                 | Delay (I <sup>2</sup> t in) <sup>①</sup>                 | .40 Seconds   |                                      |                            |
|                                 | Delay (I <sup>2</sup> t out) <sup>②</sup>                | .10, .21, .35 Seconds                                       |                                      |                            |
| Adjustable Instantaneous Pickup | Frame Amp Rating   | 800, 1600, 2000   | 2500, 3000                           | 4000 <sup>③</sup>          |
|                                 | Without Short-time<br>(Multiple of rating plug amps (X)) | 1.5, 2, 3, 5, 7, 9, 10                                      | 1.5, 2, 3, 5, 7, 9, 10               | 1.5, 2, 3, 5, 7, 9         |
|                                 | With Short-time<br>(Multiple of rating plug amps (X))    | 1.5, 2, 3, 5, 7, 9, 10, 13, 15                              | 1.5, 2, 3, 5, 7, 9, 10, 13           | 1.5, 2, 3, 5, 7, 9         |
| High Instantaneous Pickup       | Frame Amp Rating   | 800, 1600, 2000   | 2500, 3000                           | 4000 <sup>③</sup>          |
|                                 | With Short-time<br>(Multiple of frame ST rating (H))     | .4, .6, .8, 1.0   |                                      |                            |
| Ground Fault                    | Frame Amp Rating   | 800, 1600, 2000   | 2500, 3000                           | 4000 <sup>③</sup>          |
|                                 | Pickup (Multiple of sensor amp rating (S))               | .2, .25, .3, .35, .4, .45, .5, .6                           | .2, .22, .24, .26, .28, .3, .34, .37 | .2, .22, .24, .26, .28, .3 |
|                                 | Delay (I <sup>2</sup> t in) <sup>①</sup>                 | .40 Seconds   |                                      |                            |
|                                 | Delay (I <sup>2</sup> t out) <sup>②</sup>                | .10, .21, .35 Seconds                                       |                                      |                            |

① Time delay shown at 600% of current setting at lower limit of band.

② Time delay shown at lower limit of each band. All tolerances are  $\pm 10\%$ . Ground fault pickup does not exceed 1200 amps.

③ 4000-amp stationary breaker uses VersaTrip programmer. See footnote ① to Table 18.1, page 18 for available characteristics.

④ Delay shown at 200% of pick-up setting at lower limit of band.

X = Rating plug amps

C = Current setting

S = Sensor amp rating

H = Frame short-time rating

Table 13.2

POWER BREAK<sup>®</sup> Rating Plug Selection

| Frame Size (Amps) | Sensor Rating (Amps) (S) | Current Rating (Amps) (X)              | Rating Plug Cat. No.   | Frame Size (Amps) | Sensor Rating (Amps) (S) | Current Rating (Amps) (X)            | Rating Plug Cat. No.  |
|-------------------|--------------------------|--|--|-------------------|--------------------------|--------------------------------------|---|
| 800               | 200                      | 100<br>150<br>200                      | TR2S100<br>TR2S150<br>TR2S200                                  | 2000              | 2000                     | 800<br>1000<br>1200<br>1600<br>2000  | TR20S800<br>TR20S1000<br>TR20S1200<br>TR20S1600<br>TR20S2000  |
| 800               | 400                      | 150<br>200<br>225<br>250<br>300<br>400 | TR4S150<br>TR4S200<br>TR4S225<br>TR4S250<br>TR4S300<br>TR4S400 | 2500              | 1000                     | 400<br>600<br>800<br>1000            | TR10S400<br>TR10S600<br>TR10S800<br>TR10S1000                 |
| 800               | 800                      | 300<br>400<br>500<br>600<br>700<br>800 | TR8S300<br>TR8S400<br>TR8S500<br>TR8S600<br>TR8S700<br>TR8S800 | 2500              | 2000                     | 800<br>400<br>1200<br>1600<br>2000   | TR20S800<br>TR20S1000<br>TR20S1200<br>TR20S1600<br>TR20S2000  |
| 1600              | 1000                     | 400<br>600<br>800<br>1000              | TR10S400<br>TR10S600<br>TR10S800<br>TR10S1000                  | 2500              | 2500                     | 1600<br>2000<br>800                  | TR25S1600<br>TR25S2000<br>TR25S2500                           |
| 1600              | 1600                     | 600<br>800<br>1000<br>1200<br>1600     | TR16S600<br>TR16S800<br>TR16S1000<br>TR16S1200<br>TR16S1600    | 3000              | 3000                     | 2000<br>2500<br>3000                 | TR30S2000<br>TR30S2500<br>TR30S3000                           |
|                   |                          |  |  | 4000 <sup>①</sup> | 4000                     | 1600<br>2000<br>2500<br>3000<br>4000 | TR40S1600<br>TR40S2000<br>TR40S2500<br>TR40S3000<br>TR40S4000 |

① Draw-out breaker only.



## MicroVersaTrip® RMS-9 Programmer Tripping Functions (Continued)

### Current Setting (Long-Time Function)

Moving from left to right on the current axis, Figure 14.1, the upper part of the time current curve is the long-time region. The current setting is used to protect a circuit against low magnitude overcurrents. The breaker trips because the current has exceeded the current setting. If a breaker is protecting a motor, the accelerating time can be accommodated by setting the breaker to allow for a momentary delay while the motor has a chance to reach its normal operating speed or full load current.

### Short-Time Function

The middle portion of the curve is the short-time function. It is used to protect against higher magnitude overcurrents and low-level short circuit faults. Overcurrent due to short circuits is generally in the order of ten or more times full-load current, and is measured as symmetrical rms (root mean square) short-circuit current.

### Instantaneous Function

At the bottom of the time current curve is the protective device's instantaneous function. The instantaneous trip point determines the level at which the breaker will trip without an intentional time delay. This immediate interruption occurs only as a result of a severe overcurrent condition, such as a high-level short circuit, that would damage the electrical system if not interrupted.

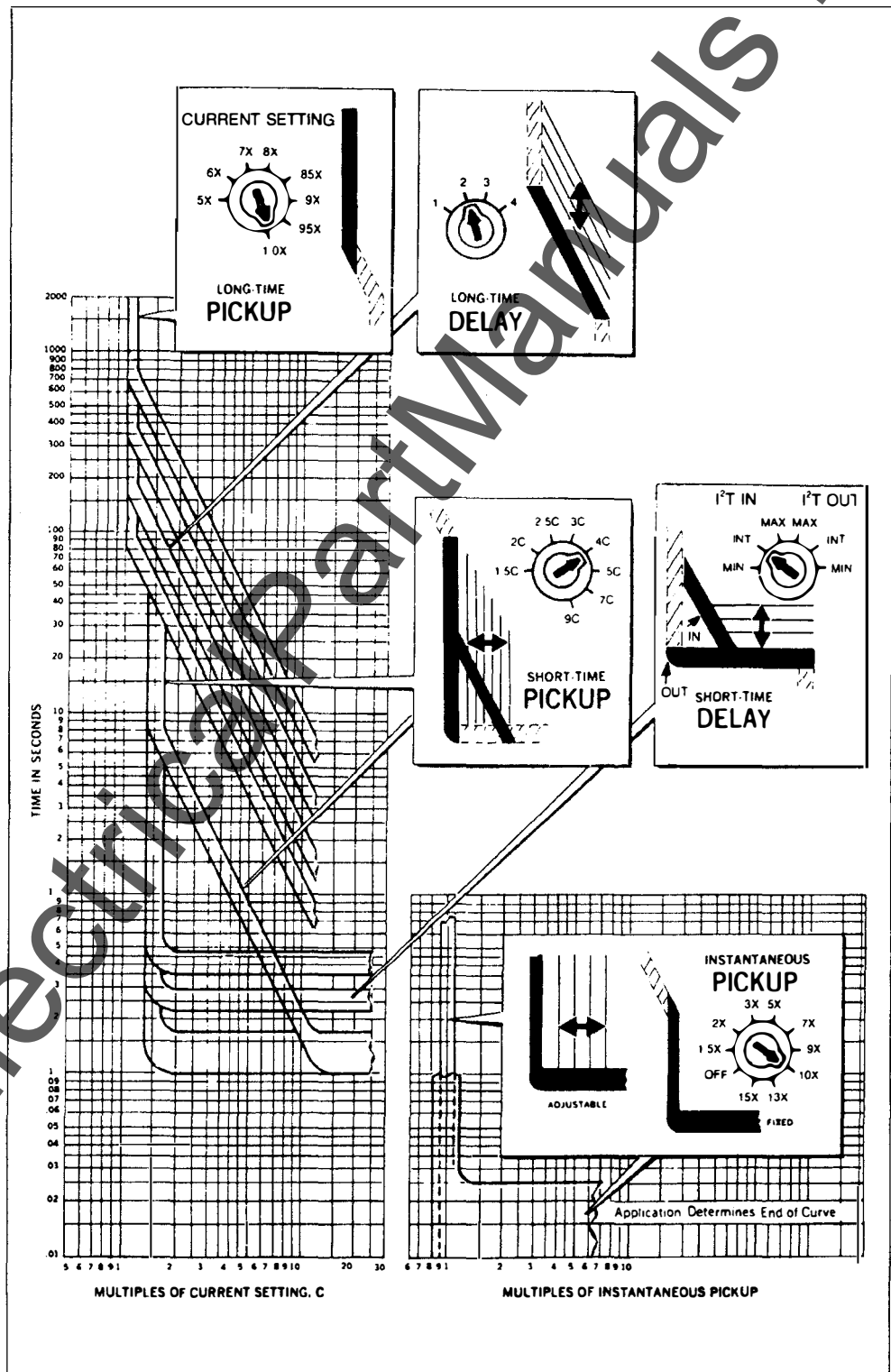


Fig. 14.1 Time Current Curve Definition — Overload and Short Circuit



## I<sup>2</sup>t Function

An I<sup>2</sup>t function is available with MicroVersaTrip® RMS-9. This provides a ramp function ( $I^2t = \text{constant}$ ) in the short-time and ground fault characteristic (see Fig. 15.1) that allows maximum coordination with downstream thermal-magnetic protective devices that follow a curve instead of a square path. The I<sup>2</sup>t function also allows tighter motor protection by accommodating the transient inrush while the short-time pickup remains just slightly higher than the steady state starting current. In other words, the path follows the hypotenuse instead of the right angle. When the square short-time path might intersect with a downstream fuse or breaker, the I<sup>2</sup>t function permits the short-time delay path to veer in front of the time current curve for the downstream device. Without this function, coordination and selectivity would be difficult to attain.

## Ground Fault Protection

A ground fault is unintentional current flowing from a circuit through a conducting path to ground. It is usually of a low magnitude (less than the long-time pickup value) and not sensed by the protective device. Using modern electronic trip devices, protection against ground faults can be built into a distribution protection system with ground fault pickup and delay functions added to the circuit breaker's fault interrupting capability. Before electronic trips came on the scene, a complex collection of external relays and current sensors were needed to sense a ground fault and signal a breaker to trip. Eight ground fault pickup levels and three delay bands with I<sup>2</sup>t in and out allow full selectivity, ensuring that only the breaker closest to the ground fault will

trip. Addition of zone selective interlocking for the ground fault function further enhances this protection by permitting "timed" tripping and closer back-up protection.

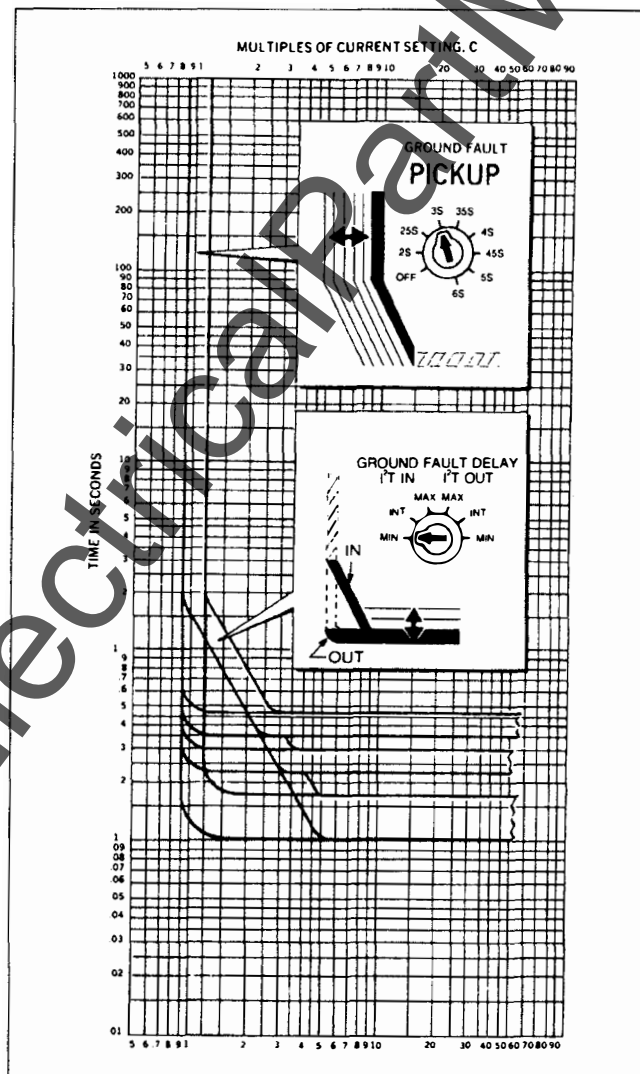


Fig. 15.1 Time Current Curve Detection — Ground Fault



## MicroVersaTrip® RMS-9 Programmer Tripping Functions (Continued)

### Current Setting (Standard)

The adjustable current setting varies the level of current the breaker will carry indefinitely without tripping. It is adjustable in eight steps from 50–100% of rating plug rating.

### Long-Time Delay (Standard)

This long-time delay adjustment varies the time it will take the breaker to trip under sustained overload conditions. It provides the function of withstanding momentary overloads such as motor starting, welding, or other overcurrent conditions without interrupting the service.

### Long-Time Pickup Light (Standard)

The long-time pickup light provides visual indication that the breaker is experiencing an overload condition. Indication is provided by a light-emitting diode (LED). Light flashes when current value is 95% of pickup and is on continuously at 100% of pickup. Saves test and system start up time.

### Short-Time Pickup (Optional)

This short-time pickup adjustment controls the level of high current the breaker can carry for short periods of time without tripping. Permits downstream breakers to clear short circuit faults without tripping out the upstream protective device.

### Short-Time Delay (Optional)

The short-time delay adjustment is used in conjunction with the short-time pickup setting to provide a further refinement of coordination between circuit breakers. It establishes the time interval the breaker will wait before responding to the short-circuit current level selected on the short-time trip point adjustment.

### Instantaneous Pickup (Standard)

The instantaneous trip point determines the level at which the breaker will trip without intentional time delay (0.025 seconds or less). This immediate interruption occurs only as a result of a severe over-

current condition, thereby minimizing damage to the electrical system and equipment.

### High Range Instantaneous (Optional)

Includes adjustable short-time pickup, adjustable short-time delay and a high-level instantaneous setting is adjustable in four steps from 40 to 100 percent of the circuit breaker frame short-time rating permitting maximum use of the breaker's short-time capability. This high level instantaneous function increases system protection without losing selectivity.

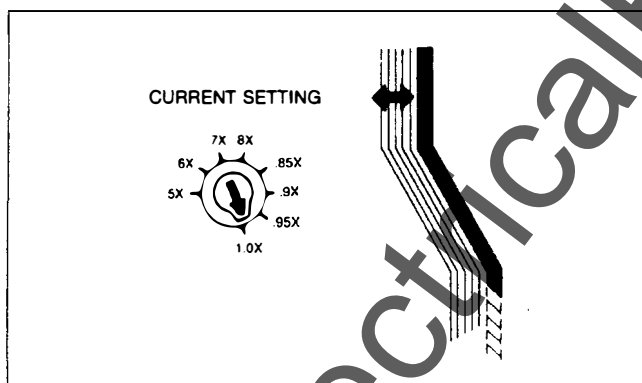


Fig. 16.1 Current Setting

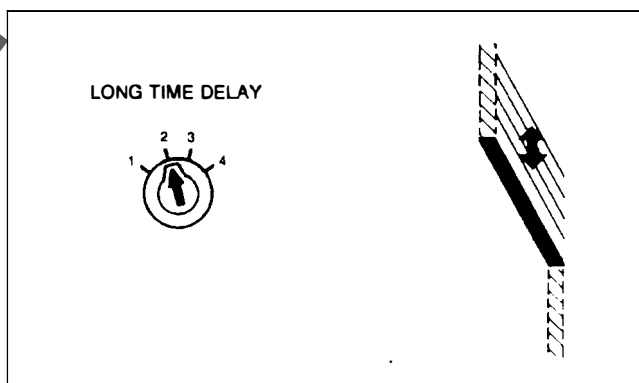


Fig. 16.2 Long-Time Delay

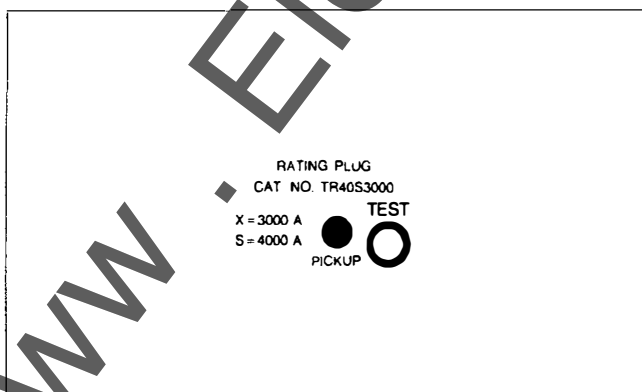


Fig. 16.3 Long-Time Pickup Light

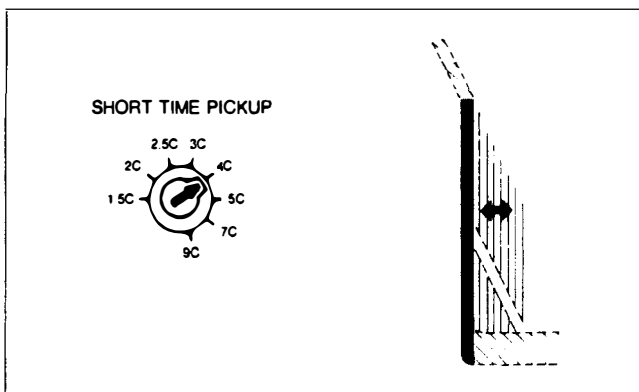


Fig. 16.4 Short-Time Pickup



## Ground Fault Pickup and Ground Fault Delay (Optional)

The ground fault pickup adjustment controls the level of ground fault current at which circuit interruption will occur. To comply with the 1987 National Electrical Code (NEC 230-95), no trip point exceeds 1200 amperes. The common square knee of the curve can be replaced with an  $I^2t$  function to facilitate coordination with downstream devices such as thermal-magnetic breakers and fuses whose time-current curves do not easily relate to the square-shape sensing characteristics common to solid state trip devices.

The ground fault delay adjustment is used to add a pre-determined delay in time to the trip point once the ground fault pickup level has been

reached. This provides tripping selectivity between main and feeder or other downstream breakers. The ground fault unit also includes as standard selectable inverse  $I^2t$  ramp to substantially improve coordination with downstream protective devices such as fuses and thermal magnetic circuit breakers.

## Memory Circuit

Because of the highly intermittent and erratic nature of arcing ground faults, a memory circuit has been incorporated in all MicroVersaTrip® RMS-9 ground fault sensing circuits as standard. The memory circuit integrates arcing fault current with time, essentially summing the intermittent ground current spikes. In the diagrams, it can be seen how the memory function works.

Diagram A shows a typical ground fault with half-cycles, whole cycles and multiple cycles missing, as normally occurs.

Diagram B shows trip response of a typical ground fault function which does not include memory. The breaker never trips because the time

delay circuits are reset with every missing cycle.

Diagram C shows response of MicroVersaTrip RMS-9 ground fault circuits to the same ground fault; the circuit's memory carries through the missing cycles and generates a trip signal after the preset time delay.

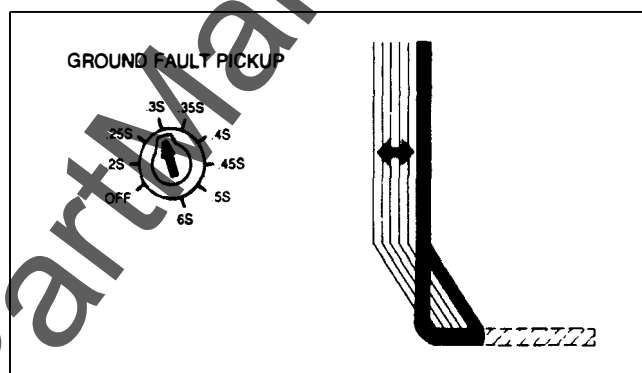


Fig. 17.3 Ground Fault Pickup

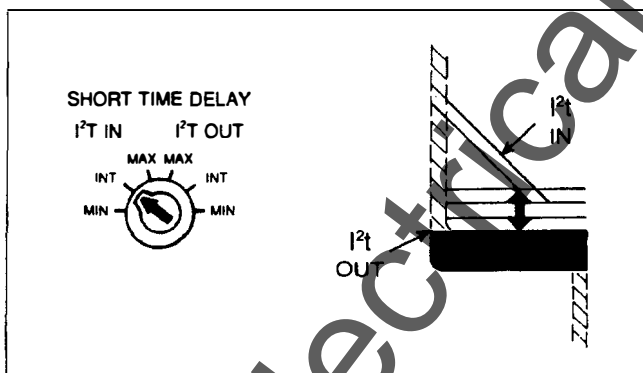


Fig. 17.1 Short-Time Delay

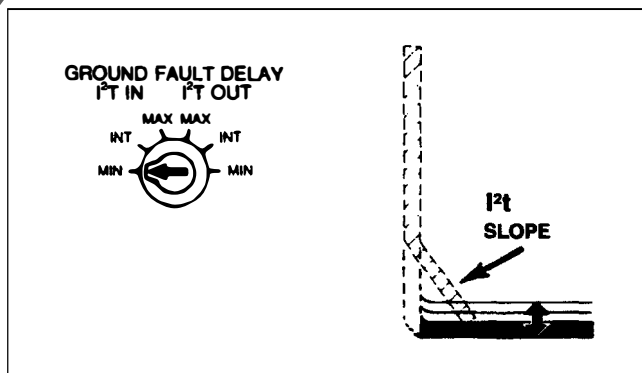


Fig. 17.4 Ground Fault Delay

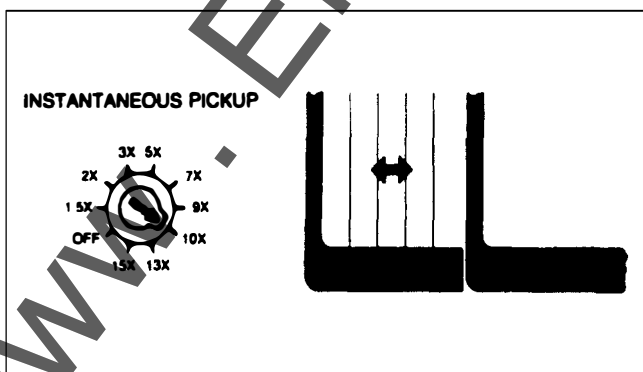


Fig. 17.2 Instantaneous Pickup

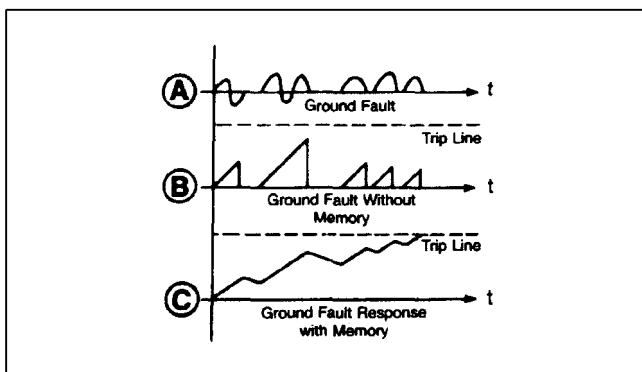


Fig. 17.5 Memory Circuit



## MicroVersaTrip® RMS-9 Programmer Tripping Functions (Continued)

### Fault Trip Indicators

Indicators are designed to reduce system downtime by analyzing any overcurrent fault and identifying its cause. Mechanical pop-out type indicators are available on the programmer for identifying overload or short circuit overcurrent faults when breakers are ordered without integral ground fault protection. Indicators are available to identify overload, short circuit and ground fault trips — for breakers supplied with integral ground fault protection. See Figure 18.1

### Zone Selective Interlocking

The standard means of obtaining selectivity between main and feeder breakers is by incorporating programmers with time-coordinated trip characteristics. This consists of setting the farthest downstream breaker with a small time delay, and progressively increasing the time delay as you get closer to the main protective device. The disadvantage in this method is

that the system must now endure the stress of the high current fault until time-out occurs.

The Zone Selective Interlock module, Figure 18.2, receives a signal from a downstream MicroVersaTrip® RMS-9 programmer (Logic 0) which causes the module to transmit a low-level interlock signal to a MicroVersaTrip RMS-9 programmer upstream. The interlock signal activates the LED portion of an LED-Transistor Opto-isolator in the upstream programmer causing the fixed delay band to shift from "MIN" to the programmer delay band setting (Figure 39.1 and 40.1). Both the Short-Time and Ground Fault functions are capable of being interlocked.

Zone selective interlocking is available for the ground fault function only, or for the ground fault and short time together.

### Rating Plug (Standard)

Various ratings plugs are available to fix the ampere rating equal to or lower than the sensor ampere rating as in Table 13.2.

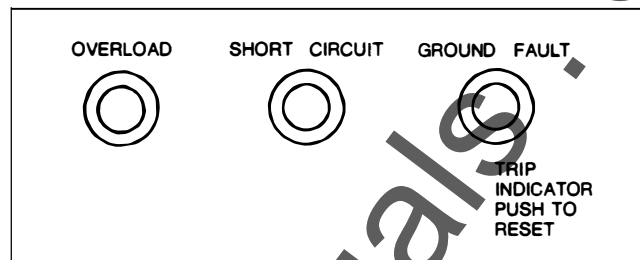


Fig. 18.1 Fault Trip Indicators

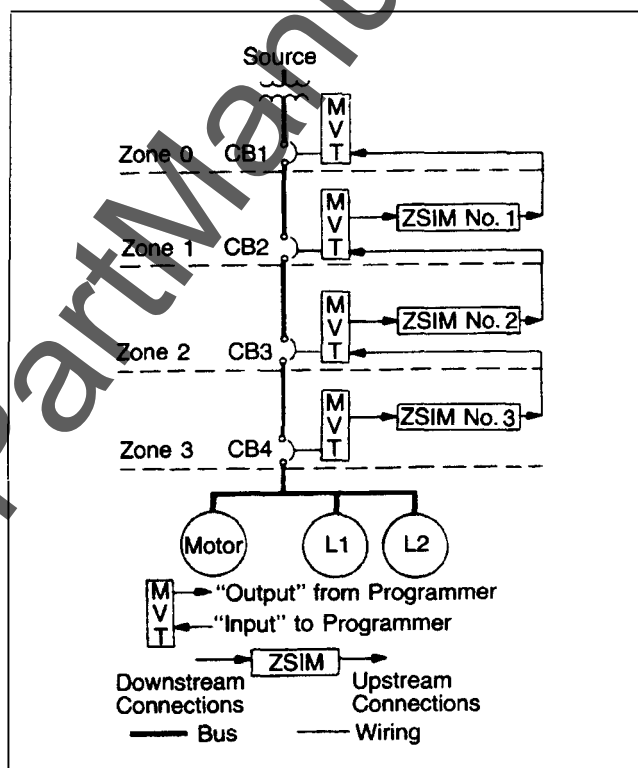


Fig. 18.2 Multi-Zone Interlocking

Table 18.1  
POWER BREAK® Programmer Suffix Selection

| Programmer Suffix                          | Logic 0 (L) | Short-Time (S) | Instantaneous (I) | High Range (H) | Ground Fault (G) | OL/ST Trip (T1) | OL/ST/ST Trip (T2) | GF Zone Interlock (Z1) | GF/ST Zone Interlock (Z2) |
|--|-------------|----------------|-------------------|----------------|------------------|-----------------|--------------------|------------------------|---------------------------|
| <b>Adjustable Instantaneous</b>            |             |                |                   |                |                  |                 |                    |                        |                           |
| LI   | X           |                | X                 |                |                  |                 |                    |                        |                           |
| LIT1                                       | X           |                | X                 |                |                  | X               |                    |                        |                           |
| LIG  | X           |                | X                 |                | X                |                 |                    |                        |                           |
| LIGT2                                      | X           |                | X                 |                | X                |                 | X                  |                        |                           |
| LIGT2Z1                                    | X           |                | X                 |                | X                |                 | X                  | X                      |                           |
| LSI  | X           | X              | X                 |                |                  |                 |                    |                        |                           |
| LSIT1                                      | X           | X              | X                 |                |                  | X               |                    |                        |                           |
| LSIG                                       | X           | X              | X                 |                | X                |                 |                    |                        |                           |
| LSIGT2                                     | X           | X              | X                 |                | X                |                 | X                  |                        |                           |
| LSIGT2Z1                                   | X           | X              | X                 |                | X                |                 | X                  | X                      |                           |
| LSIGT2Z2                                   | X           | X              | X                 |                | X                |                 | X                  |                        | X                         |
| <b>Adjustable High Range Instantaneous</b> |             |                |                   |                |                  |                 |                    |                        |                           |
| LSHT1                                      | X           | X              |                   | X              |                  | X               |                    |                        |                           |
| LSHGT2                                     | X           | X              |                   | X              | X                |                 | X                  |                        |                           |
| LSHGT2Z1                                   | X           | X              |                   | X              | X                |                 | X                  | X                      |                           |
| LSHGT2Z2                                   | X           | X              |                   | X              | X                |                 | X                  |                        | X                         |

| Suffix   | Description                           |
|----------|---------------------------------------|
| None     | Adj. LT delay, adj. instantaneous     |
| S        | Adj. ST, adj. instantaneous           |
| D        | Adj. ST, fixed instantaneous          |
| G① or G3 | Adj. GF, 3-phase, 4-wire              |
|          | Adj. GF, 3-phase, 3-wire              |
| A2 or A3 | Targets — overload, short circuit     |
|          | Targets — overload, short circuit, GF |

① Available VersaTrip 4000-amp stationary breaker characteristic suffix.



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## MagneTrip™ Trip Unit

POWER BREAK® with MagneTrip™ features dual magnetic trip construction suitable for ac or dc voltage applications. All breakers are UL listed as 100 percent rated (TPMM, THMM) breakers-Ref. NEC-220-10. Two tripping functions are supplied per pole, each independently adjustable; adjustable ampere setting (70-100%) plus either adjustable instantaneous or fixed instantaneous with adjustable short time.

The dual-magnetic trip construction consists of twin armatures hinged to a laminated magnetic structure. One armature is fastened to a dashpot. The fluid inside the dashpot is a silicone based oil that has a negligible viscosity change over a broad range of temperatures ensuring ambient insensitivity. During overload conditions, the oil-dashpot acts as a long time delay, allowing transient overcurrents to occur without tripping the breaker.

The second armature, restrained by a mechanism, will not trip the breaker during overload currents. However, when a short circuit occurs, magnetic forces overcome the restraint put on the armature by the mechanism and cause the armature to close instantaneously, overriding any time delay in tripping the breaker.

Each function is continuously adjustable with positive stops at the low and high ends.

All adjustable trip functions are front-accessible and shielded by a protective cover to avoid unauthorized entry.

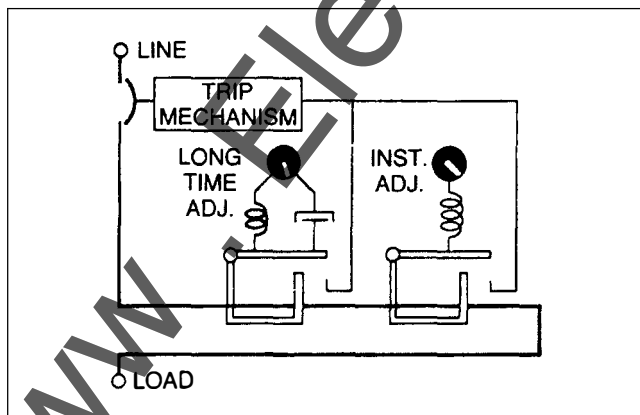


Fig. 19.1 Dual-Magnetic Trip Schematic

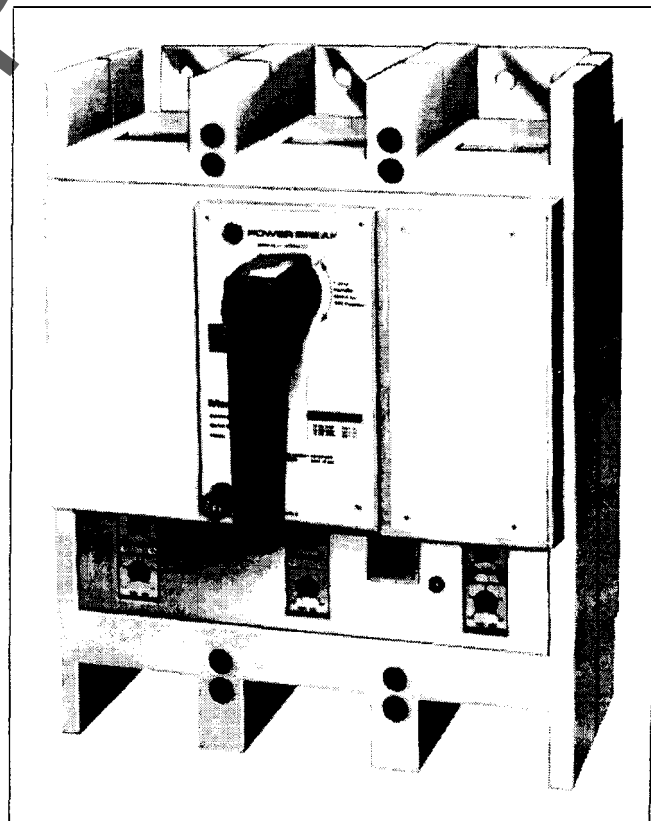


Fig. 19.2 POWER BREAK with MagneTrip, 1600A (with trip adjustment cover removed)



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# Trip Devices (Continued)

## MagneTrip™ Trip Unit (Continued)

### Adjustable Trip Characteristics

#### ■ Ampere Setting

The ampere setting adjusts the value of current the circuit breaker will carry indefinitely without tripping. The long-time delay rating is a direct function of this setting.

#### ■ Instantaneous Trip

The instantaneous trip setting provides immediate interruption of high overcurrents (short circuits) in 26 milliseconds maximum (1.56 cycles). Its adjustment range is a function of the breaker nameplate ampere rating and independent of ampere setting. A fixed instantaneous override is applied to breakers ordered with adjustable short time.

#### ■ Short-time Delay

The short-time delay adjustment automatically combines pick-up point and delay time. It is used to introduce a slight delay at higher current levels for greater system coordination purposes. This permits the downstream feeder to clear the fault rather than the main. A fixed instantaneous override function is standard.

### Special Purpose MagneTrip™ Breakers

POWER BREAK® is available for 700 volt dc and 750 volt ac application. These are all of 3-pole construction with MagneTrip dual-magnetic trip units. These units are not UL listed since they are beyond the normal scope of UL 489 voltage ratings.

Used for disconnect purposes, POWER BREAK molded case switches are constructed without automatic overcurrent sensing mechanisms. All other POWER BREAK features have been incorporated.

### High DC Interrupting Ratings

The 2500–4000 A MagneTrip dual-magnetic frame size circuit breakers have UL listed dc ratings up to 200kA @300 vdc and 65ka @ 600Vdc. See Table 30.3.

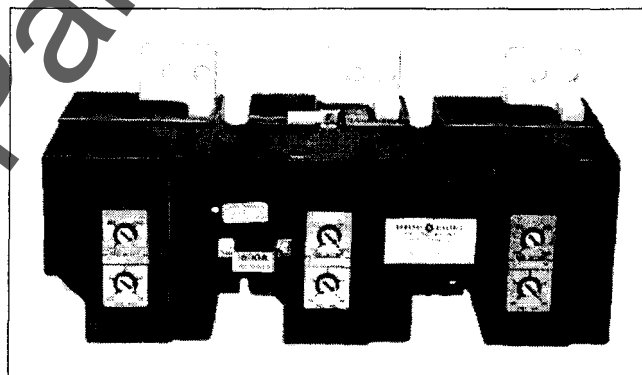


Fig. 20.1 MagneTrip Interchangeable Trip Unit for 2500 and 3000 A frames

Table 20.1

Trip Characteristics for MagneTrip™ Trip Unit

| Frame Size (Amps) | Current Ratings (Amps)                       | Ampere Setting (Multiple of Current Rating) | Long time Delay (Seconds) ① | Short time                                 |                   | Adjustable Instantaneous Pickup (Multiple of Current Rating) | Optional Fixed Instantaneous Override (Amps) |
|-------------------|--|---|-----------------------------|--|-------------------|--|--|
|                   |  |   |                             | Pickup (Multiple of Current Rating)        | Delay (Seconds) ② |  |  |
| 1600              | 200,400,600<br>800,1000<br>1200<br>1600      | 0.7-1.0                                     | 4                           | 3-10<br>3-8.2<br>3-7.5                     | 0.04              | 3-10<br>3-8.2<br>3-7.5                                       | None   |
| 2500              | 600,800,1000<br>1200<br>1600<br>2000<br>2500 |   |                             | 3-10<br>3-8.2<br>3-7.5<br>3-6.8<br>2.3-5.5 | 0.07              | 3-10<br>3-8.2<br>3-7.5<br>3-6.8<br>2.3-5.5                   | 42,000                                       |
| 3000              | 3000   |   |                             | 3-5.3                                      |                   | 3-5.3  |  |
| 4000              | 3500<br>4000                                 |   |                             | 2.5-4.5<br>2.2-4                           |                   | 2.5-4.5<br>2.2-4   |  |

① Time delay shown at 600% of breaker current rating at lower limit of band.

② Time delay shown at 10X of breaker current rating at lower limit of band.



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# Accessories

## Stationary or Draw-out Breakers

**Warning:** When installing accessories, the breaker must be completely deenergized and disconnected from the electrical circuit. This is mandatory because breaker must be "ON" during certain stages of installation and testing.

### Limited Access "ON" Button (Factory Installed)

The limited access (concealed) "ON" button (Fig. 21.1) provides limited manual accessibility to the "ON" button. It allows the breaker to be turned ON by qualified personnel by use of 1/8" diameter pin or rod. Manually operated devices may be ordered with an electrical accessory closing solenoid for remote closing operation.

### Remote Close Solenoid (Factory-Installed)

This accessory provides an electrically operated solenoid which, when energized, closes the breaker. It is suitable for control interlock schemes in which manual closing capability would be hazardous or

not desirable. Manual close button is provided.

### Padlock Function (Factory-Installed)

The OFF button padlock provision (Figure 21.2) prevents charging of the mechanism.

The OFF Button Padlock with Door Interlock is designed to prevent the panel door opening with the breaker "ON" or "CHARGED."

### MicroVersaTrip® RMS-9 Programmer Sealing Provisions

All Power Break breakers with MicroVersaTrip® RMS-9 programmers have a sealable, clear plastic cover over the programmer. Sealing may be accomplished by attaching a sealing wire through the programmer window and the rim of the programmer, then through the screw head as shown in Figure 21.3.

### Terminal Boards (Factory-Installed)

Up to 36 accessory circuits can be terminated on optional terminal boards.

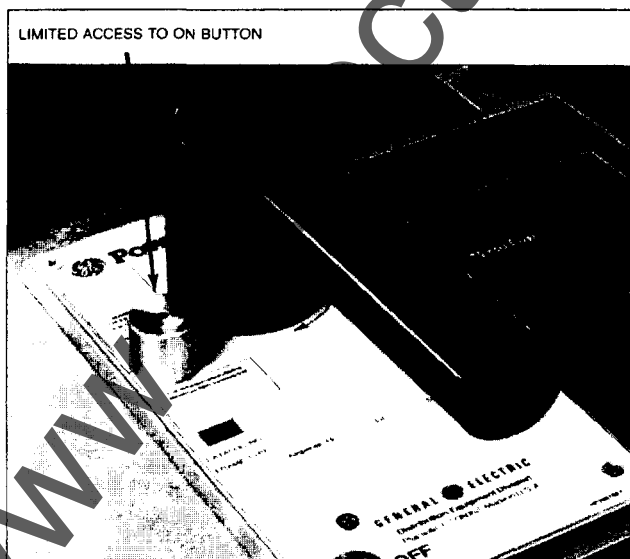


Fig. 21.1 Limited Access "ON" Button

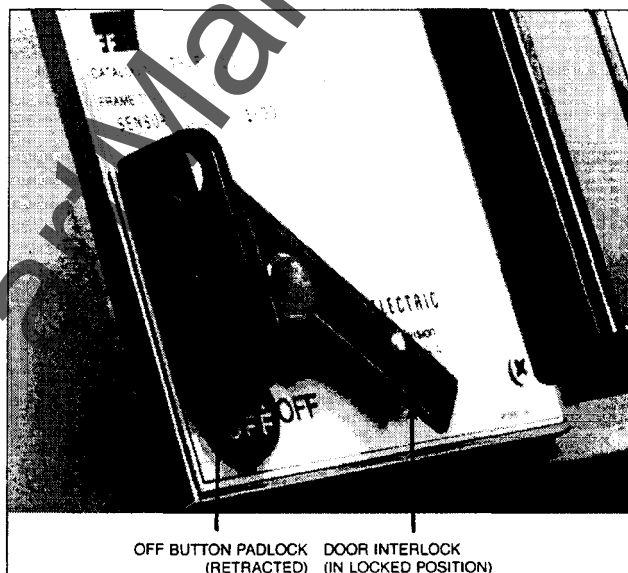


Fig. 21.2 Padlock Function

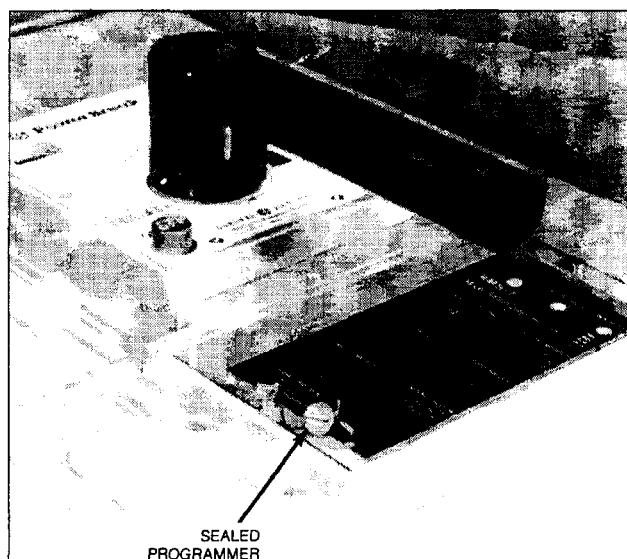


Fig. 21.3 Programmer Sealing Provision



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# Accessories (Continued)

## Stationary or Draw-out Breakers (Continued)

### Kirk Key Provision (Factory-Installed)

The Kirk Key provision provides mounting means for customer supplied locks. On 800-2000A frames a slide covers the OFF Button when the bolt is extended and the key removed. On 2500-4000A frames, key action works directly on trip mechanism.

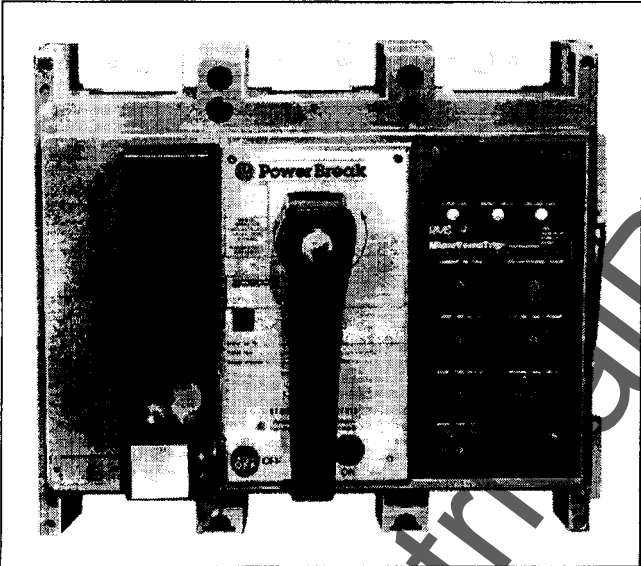


Fig. 22.1 TPK01 on 800A Frame Circuit Breaker

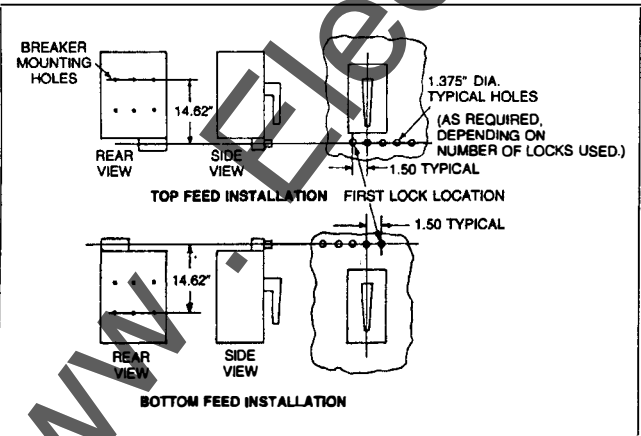


Fig. 22.2 Recommended Panel Cut-out — 2500-4000A Breakers

Table 22.1 Kirk Key Provision

| Frame Size (Amps) | Key Provision Cat. No. | Max. No of Locks | ITE Lock Type  | Remarks                           |
|-------------------|------------------------|------------------|--|-----------------------------------|
| 800-2000          | TPK01                  | 1                | Type F, zero-bolt projection, retracted and key retained           | Mounted on front of breaker cover |
|                   | TPK02                  | 2                |  |                                   |
|                   | TPK03                  | 3                |  |                                   |
|                   | TPK04                  | 4                |  |                                   |
| 2500-4000         | TPK01B                 | 1                | Type F or FS, one-inch bolt projection, retracted and key retained | Bottom-fed only                   |
|                   | TSK16                  | 6                |  | MagneTrip and Molded Case Switch  |
|                   | TSK26                  | 6                |  | MicroVersaTrip RMS-9 only         |

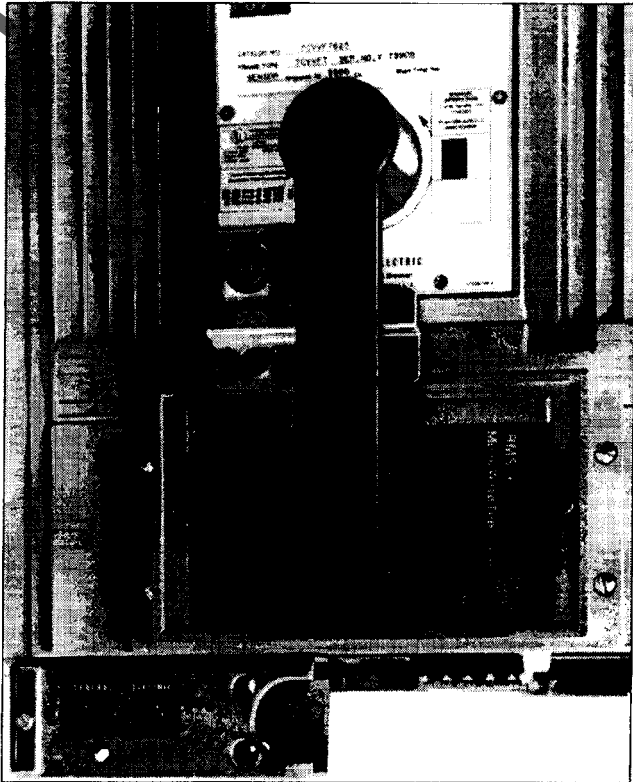


Fig. 22.3 TSK26 on 2500A Frame Circuit Breaker



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## Control Leads

On stationary breakers, the control leads of internally mounted accessories exit the breaker in "pigtail" non-terminated form with 30-inch leads. Optional terminal blocks can be specified for stationary mounted breakers. For draw-out breakers, these leads are terminated at the secondary disconnect blocks. All leads are color coded as shown in Table 23.1

## Undervoltage Release Device (UVR) (Field-Installable)

The undervoltage release device is used to open the circuit breaker when the supply voltage drops to 35-70 percent of the rated voltage. Resealing of the undervoltage release coil requires 80 percent of rated coil voltage.

## Time Delay Unit For UVR

The time delay unit prevents nuisance tripping due to momentary loss of voltage. Two units with adjustable time delay are available—Cat. No. TD110A530 has 0.1 to 0.5 seconds delay and Cat. No. TD1000 has 0.1 to 1.0 seconds delay. Both units have 120 VAC input and 125 Vdc output and must be used with the 125 Vdc UVR catalog number.

Table 23.3  
UVR Time Delay Units

| Time Delay Unit Catalog Number | Adjustable Delay, Sec. |
|--------------------------------|------------------------|
| TD110A530                      | 0.1 - 0.5              |
| TD1000                         | 0.1 - 1.0              |

Table 23.1  
Circuit Breaker Accessory Lead Color Code

| Accessory                              | Lead Color   | Leads Per Accessory (30 inches) |
|--|--|---------------------------------|
| Shunt Trip                             | Black  | 2                               |
| Undervoltage Release                   | Blue   | 2                               |
| Auxiliary Switch                       | White-Common<br>Red-OPEN (NO)①<br>Brown/White-CLOSED (NC)①     | 3 per switch                    |
| Bell Alarm (Overcurrent Lock-Out)      | Yellow-Common<br>Purple-OPEN (NO)②<br>Brown-CLOSED (NC)②       | 3                               |
|  | Phase      Line End      Load End                              |                                 |
| Blown Fuse Trip                        | A  | Red                             |
|  | B  | Blue                            |
|  | C  | Yellow                          |
| Closing Solenoid (Manual Devices Only) | White-Common<br>Black-Remote Indication<br>Orange-Remote Close | 3                               |

- ① NO - Normally open when circuit breaker is in "OFF" position.  
NC - Normally closed when circuit breaker is in "OFF" position.  
② NO - Normally open when circuit breaker is in an overcurrent tripped condition.  
NC - Normally closed when circuit breaker is in an overcurrent tripped condition.

Table 23.2  
Electrical Data — Undervoltage Release

| Rated Voltage<br>(60 Hz ac) | MA Current |    | Dropping Resistor<br>(Ohm's Type 270) |
|-----------------------------|------------|----|---------------------------------------|
|                             | dc         | ac |                                       |
| 120 Vac                     | —          | 25 | none                                  |
| 240 Vac①                    | —          | 25 | 5,000 Ohms, 25 watt                   |
| 480 Vac②                    | —          | 25 | 15,000 Ohms, 50 watt                  |
| 600 Vac③                    | —          | 25 | 20,000 Ohms, 50 watt                  |
| 12 Vdc                      | 211        | —  | none                                  |
| 24 Vdc                      | 104        | —  | none                                  |
| 48 Vdc                      | 54         | —  | none                                  |
| 125 Vdc                     | 24         | —  | none                                  |
| 250 Vdc④                    | 24         | —  | 5,000 Ohms, 25 watt                   |

- ① Externally mounted dropping resistor supplied with device

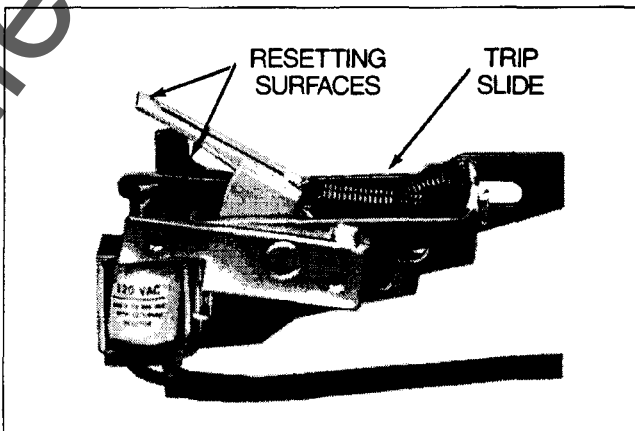


Fig. 23.1 Undervoltage Release Device (2500-4000A shown)

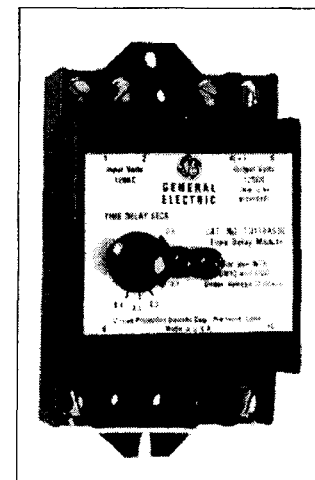


Fig. 23.2 Delay Unit, TDA110A530



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# Accessories (Continued)

## Stationary or Draw-out Breakers (Continued)

### Shunt Trip Device (Field-Installable)

The shunt trip device provides remote control capability to trip the circuit breaker. A cutoff switch is supplied as part of the shunt trip to automatically remove power from its coil when the circuit breaker is tripped.

### Bell Alarm with Lockout (Factory- Installed Only)

Single-pole, double-throw (AB-type) switch element. Used for remote indication of breaker trip when caused by overload,

short circuit or ground fault conditions only. Switch element ratings are identical to those listed for Auxiliary Switch Accessories. Bell alarm distinguishes between over-current trip and manual/shunt/UVR trip.

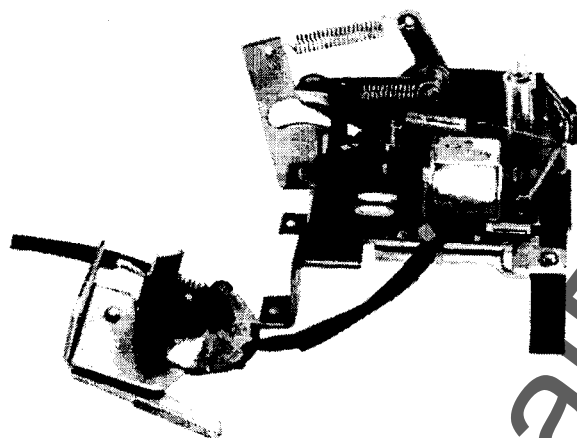


Fig. 24.1 Shunt Trip Device (800-2000A Shown)

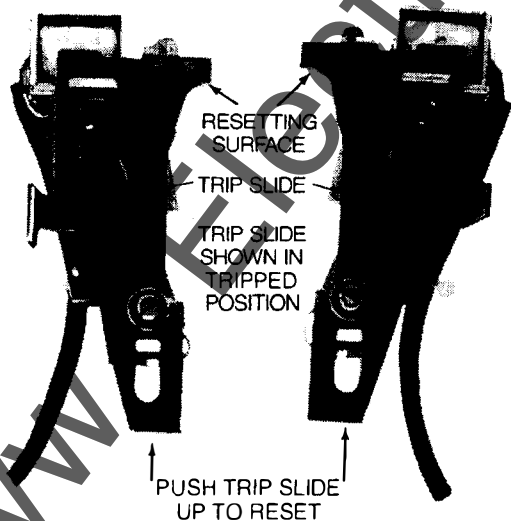


Fig. 24.2 Shunt Trip Device (2500-4000A Shown)

Table 24.1  
Electrical Data for Shunt Trip Devices

| Coil Identification Number | Voltage Rating | Coil Resistance Ohms $\pm$ 15% | Max Inrush Current Ampe |
|----------------------------|----------------|--------------------------------|-------------------------|
| G44                        | 120 Vac        | 20                             | 2.25                    |
| G44                        | 240 Vac        | 20                             | 4.50                    |
| G8                         | 480 Vac        | 313                            | 1.64                    |
| G8                         | 600 Vac        | 313                            | 2.05                    |
| G39                        | 12 Vdc         | 1.6                            | 6.90                    |
| G40                        | 24 Vdc         | 5.2                            | 2.18                    |
| G43                        | 48 Vdc         | 20                             | 1.09                    |
| G45                        | 125 Vdc        | 130                            | 1.00                    |
| G42                        | 250 Vdc        | 658                            | 0.40                    |

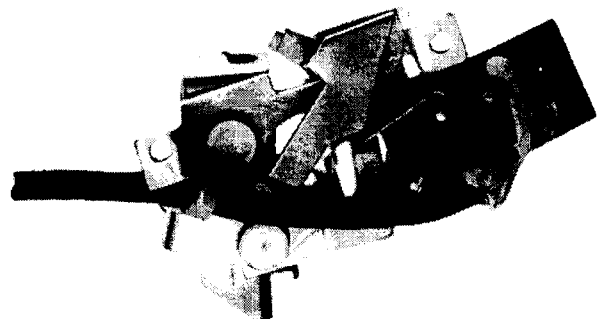


Fig. 24.3 Bell alarm with lockout (2500-4000A Frames)



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### Blown Fuse Trip Device (Field-Installable)

The blown fuse trip device (three-coil shunt trip) is intended for use in applications where breakers and fuses are used in series. This accessory prevents single-phasing conditions by monitoring the fuses and automatically tripping the circuit breaker when a fuse blows. It does not protect from single-phasing of the power source.

Each coil of the blown fuse trip device is wired across a fuse so that the voltage across an open fuse energizes the solenoid core, releases the spring biased latch and trips the breaker. The fuse must be replaced and the breaker reset before it can be reclosed.

If the breaker is closed on an open fuse, the blown fuse trip device will automatically open the circuit breaker.

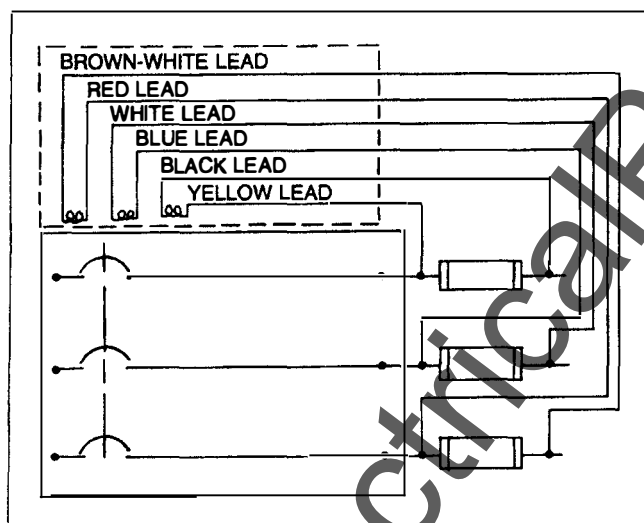


Fig. 25.1 Blown Fuse Trip Device Wiring Diagram

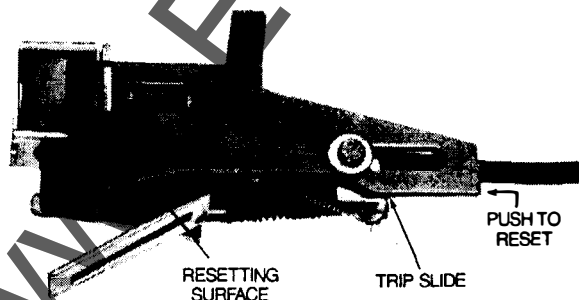


Fig. 25.2 Blown Fuse Trip Device (2500-4000A Shown)

### Auxiliary Switch (Field-Installable)

The auxiliary switch is used for remote indication of breaker main contact position—OPEN or CLOSED. No distinction is made between an open or tripped mode. A maximum of 12 switches can be installed per breaker. Each is single-pole, double-throw (AB-type) and rated as shown in Table 25.1. Two switch positions must be devoted to each shunt trip accessory (if used).

Table 25.1  
Auxiliary Switch Electrical Data

| Voltage                      | Number of Switch Elements | Maximum Amperes Rating Switch Elements   |
|------------------------------|---------------------------|--|
| 240 Vac Max.<br>250 Vdc Max. | 1-12                      | 6A at 240 Vac<br>1/4A at 250 volts dc<br>1/2A at 125 volts dc                  |
| 600 Vac Max.<br>250 Vdc Max. | 1-12                      | 6A at 600 Vac<br>1/4A at 250 volts dc<br>1/2A at 125 volts dc<br>Not UL listed |

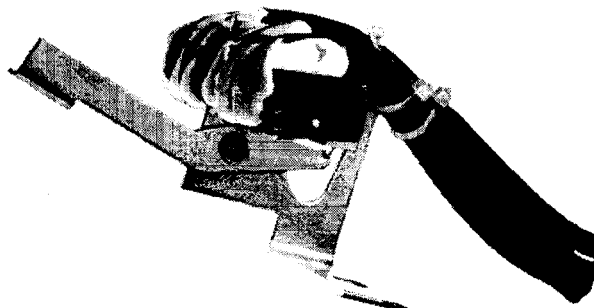


Fig. 25.3 Auxiliary Switch



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## Draw-out Breakers Only

### Disconnects

Primary power is fed through multiple finger primary disconnects when the breaker is in the connected position.

Control power is provided through the secondary disconnects in the test and connected positions only. Table 26.1 shows the number of secondary disconnects required for each auxiliary device installed in the circuit breaker.

Breaker secondary disconnects are supplied when the auxiliary devices shown in Table 26.1 are ordered with the breaker. Secondary disconnects are factory assembled to the breaker element, but are shipped separately for field mounting to the substructure element.

Programmer disconnects are available for all substructures required to accept MicroVersaTrip® RMS-9 draw-out breaker elements, and allow separate circuit points for

zone selective interlocking functions. Table 26.2 shows the availability of substructure disconnects for MicroVersaTrip RMS-9 remote function zone interlocking and for auxiliary devices.

### Control Circuit Numbering and Locations

Secondary disconnect control circuit numbers and locations are determined by using circuit index card, GEJ-3038 (for MicroVersaTrip RMS-9) or GEJ-4672 (for MagneTrip™ or molded case switches). Index Card GEJ-3038 is shown in Figure 27.2.

When a limited number of accessories are installed, the circuit index position is advanced to the lowest possible position number in the order shown on the circuit index card.

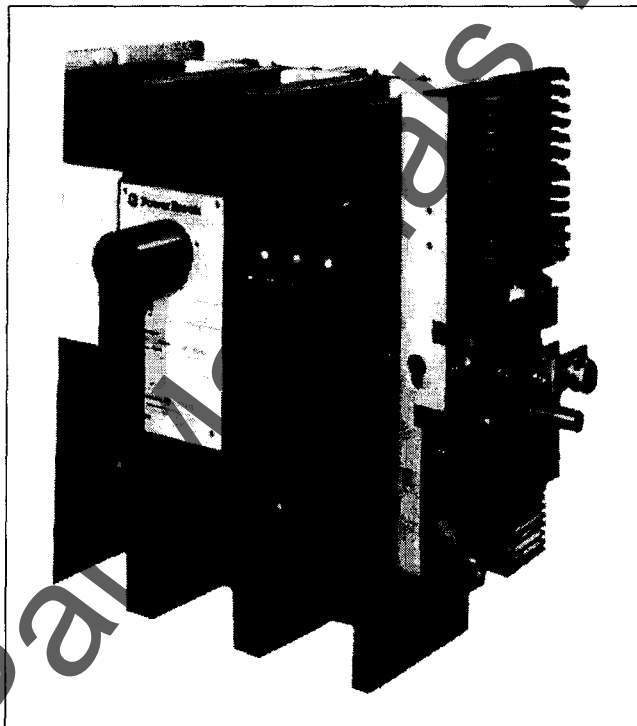


Fig. 26.1 Front View of 1600A Showing Secondary Disconnects

Table 26.1

Number of Secondary Disconnect Circuits Required per Auxiliary Device

| Auxiliary Device                            | Number of Circuits |
|---|--------------------|
| Neutral Sensor Leads (MicroVersaTrip® only) | 2                  |
| Electrical Operation                        | 6                  |
| Auxiliary Switch per Element                | 3                  |
| Undervoltage Release                        | 2                  |
| Bell Alarm                                  | 3                  |
| Shunt Trip                                  | 2                  |
| Blown Fuse Trip                             | 6                  |
| Remote Close Solenoid and Charge Indication | 3                  |
| Remote Charge Indication                    | 2                  |

**NOTE:** MicroVersaTrip RMS-9 draw-out breakers are provided as standard with secondary disconnect positions for possible neutral current sensor leads. (Position A, B on Block A).

Table 26.2

Secondary Disconnects

Field installation kits; 48 circuits maximum per draw out (24 maximum for small 800-ampere draw out).

| Kit Description  | Kit No.  |
|--|----------|
| Substructure Disconnect kit - 6 Circuits   | TDOSD6S① |
| Breaker Disconnect kit - 6 Circuits  | TDOSD6B  |
| Substructure Disconnect for MicroVersaTrip RMS-9 with Zone Interlocking, Z1 or Z2 Suffix | TDOSVDO4 |

① Secondary disconnects for substructure portion must be ordered and priced separately.

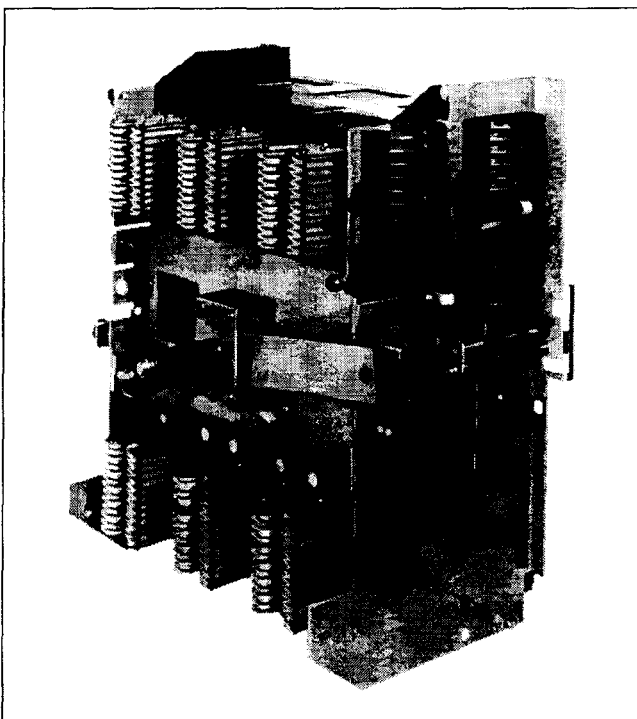


Fig. 26.2 Rear View of Above



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Referring to the example in Figure 27.1, a MicroVersaTrip® RMS-9 breaker is electrically operated and has a shunt trip, a two-stage auxiliary switch and a bell alarm. Positions A and B on secondary disconnect block A are reserved for the neutral sensor leads, whether used or not. The remaining four positions on Block A are used for terminal numbers 1-4 and terminals 5 and 6 are positioned at the first two positions on Block B. Next the six leads for the two-stage auxiliary switch are brought to the remaining four positions on Block B plus the first two positions on Block C. Next the three bell alarm leads (terminal numbers 33-35), are placed in the next three locations on Block C. Finally, the shunt trip (terminal numbers 36 and 37) are placed in the last location on Block C and the first position on Block D.

## By-Pass Switch

A by-pass switch is available with normally open (N.O.) and normally closed (N.C.) contacts which change state between the connected and test position. The switch is available in 4, 8 or 12 circuits, each consisting of half N.O. and half N.C. contacts.

## Shutters

Shutters are available for installation and service personnel protection from inadvertently contacting the primary stabs of an energized switchboard when the draw-out breaker is withdrawn and removed.

## Other Accessories

The draw-out breaker and substructure is available with many optional accessories sometimes required for specific applications:

- **Lifting Bar**  
Provides safe, easy removal of breaker from substructures.
- **Racking Tool**  
Engages the end of the draw-out racking shelf to crank the breaker into or out of engagement with the substructure primary studs.
- **Padlock Device**  
Prevents engagement of the racking shaft wrench.
- **Mechanical Interlock**  
Provides interlocking of two breakers in (1) the same vertical section or (2) in adjacent sections.

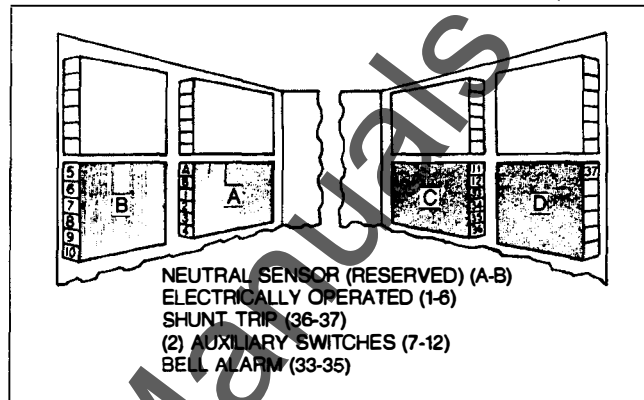


Fig. 27.1 Secondary Disconnect Block Locations (Shown in Substructure)

| POWER BREAK-ACCESSORY DEVICES<br>WIRING TERMINAL NUMBERS |                            |              |
|--|----------------------------|--------------|
| TERMO.   | DEVICE                     | WIRE COLOR   |
| 1  | GROUND FAULT NEUTRAL C.T.  | BLACK        |
| 2  | GROUND FAULT NEUTRAL C.T.  | WHITE        |
| 3  | ELECT. OPER. POWER CIRCUIT | RED          |
| 4  | CHARGING                   | BLACK        |
| 5  | CLOSING                    | WHITE        |
| 6  | CLOSING                    | BLUE         |
| 7  | ALARM SWITCH               | YELLOW       |
| 8  | COMMON                     | BROWN        |
| 9  | STAGE A                    | WHITE        |
| 10   | STAGE B                    | BROWN/WHITE* |
| 11   | COMMON                     | WHITE        |
| 12   | STAGE A                    | RED          |
| 13   | STAGE B                    | BROWN/WHITE* |
| 14   | COMMON                     | WHITE        |
| 15   | STAGE A                    | RED          |
| 16   | STAGE B                    | BROWN/WHITE* |
| 17   | COMMON                     | WHITE        |
| 18   | STAGE A                    | RED          |
| 19   | STAGE B                    | BROWN/WHITE* |
| 20   | COMMON                     | WHITE        |
| 21   | STAGE A                    | RED          |
| 22   | STAGE B                    | BROWN/WHITE* |
| 23   | COMMON                     | WHITE        |
| 24   | STAGE A                    | RED          |
| 25   | STAGE B                    | BROWN/WHITE* |
| 26   | COMMON                     | WHITE        |
| 27   | STAGE A                    | RED          |
| 28   | STAGE B                    | BROWN/WHITE* |
| 29   | COMMON                     | WHITE        |
| 30   | STAGE A                    | RED          |
| 31   | STAGE B                    | BROWN/WHITE* |
| 32   | COMMON                     | WHITE        |
| 33   | BELL ALARM SWITCH          | YELLOW       |
| 34   | STAGE A                    | PURPLE       |
| 35   | STAGE B                    | BROWN        |
| 36   | SHUNT TRIP                 | BLACK        |
| 37   | SHUNT TRIP                 | BLACK        |
| 38   | 3-COR. SHUNT TRIP          | RED          |
| 39   | COMMON                     | BROWN/WHITE* |
| 40   | STAGE A                    | BLUE         |
| 41   | STAGE B                    | WHITE        |
| 42   | COMMON                     | WHITE        |
| 43   | STAGE A                    | RED          |
| 44   | STAGE B                    | BROWN/WHITE* |
| 45   | COMMON                     | WHITE        |
| 46   | STAGE A                    | RED          |
| 47   | STAGE B                    | BROWN/WHITE* |
| 48   | COMMON                     | WHITE        |
| 49   | STAGE A                    | RED          |
| 50   | STAGE B                    | BROWN/WHITE* |
| 51   | COMMON                     | WHITE        |
| 52   | STAGE A                    | RED          |
| 53   | STAGE B                    | BROWN/WHITE* |
| 54   | COMMON                     | WHITE        |
| 55   | STAGE A                    | RED          |
| 56   | STAGE B                    | BROWN/WHITE* |
| 57   | COMMON                     | WHITE        |
| 58   | STAGE A                    | RED          |
| 59   | STAGE B                    | BROWN/WHITE* |

\*Formerly Green Wire \*\*Formerly Located 38 & 39 Respectively

| TERMO. | DEVICE     | WIRE COLOR |
|--------|------------|------------|
| 60     | SHUNT TRIP | BLACK      |
| 61     | SHUNT TRIP | BLACK      |

| MANUAL QUICK CLOSE ACCESSORIES |                          |        |
|--------------------------------|--------------------------|--------|
| 62                             | REMOTE CLOSE INDICATION  | ORANGE |
| 63                             | REMOTE CHARGE INDICATION | BLACK  |
| 64                             | COMMON                   | WHITE  |
| 65                             | REMOTE CHARGE INDICATION | BLACK  |
| 66                             | COMMON                   | WHITE  |

| FAULT (TARGET) ANNUNCIATORS—MICRO VERSATRIP |                 |        |
|---|-----------------|--------|
| 67  | GROUND FAULT    | GREEN  |
| 68  | SHORT CIRCUIT   | RED    |
| 69  | OVERLOAD        | YELLOW |
| 70  | LONG TIME DELAY | YELLOW |
| 71  | GROUND FAULT    | BLUE   |
| 72  | GROUND FAULT    | BLUE   |

| ZONE SELECTIVE INTERLOCK FUNCTIONS—MICRO VERSATRIP |                     |        |
|--|---------------------|--------|
| 73   | INPUT—GROUND FAULT  | WHITE  |
| 74   | INPUT—GROUND FAULT  | GREEN  |
| 75   | OUTPUT—GROUND FAULT | WHITE  |
| 76   | INPUT—SHORT TIME    | WHITE  |
| 77   | INPUT—SHORT TIME    | YELLOW |
| 78   | OUTPUT—SHORT TIME   | WHITE  |
| 79   | OUTPUT—SHORT TIME   | BLUE   |

| ALARM SWITCH |         |       |
|--------------|---------|-------|
| 80           | COMMON  | WHITE |
| 81           | STAGE A | RED   |
| 82           | COMMON  | WHITE |
| 83           | STAGE A | RED   |
| 84           | COMMON  | WHITE |
| 85           | STAGE A | RED   |
| 86           | COMMON  | WHITE |
| 87           | STAGE A | RED   |
| 88           | COMMON  | WHITE |
| 89           | STAGE A | RED   |
| 90           | COMMON  | WHITE |
| 91           | STAGE A | RED   |
| 92           | COMMON  | WHITE |
| 93           | STAGE A | RED   |
| 94           | COMMON  | WHITE |
| 95           | STAGE A | RED   |
| 96           | COMMON  | WHITE |
| 97           | STAGE A | RED   |
| 98           | COMMON  | WHITE |
| 99           | STAGE A | RED   |
| 100          | COMMON  | WHITE |
| 101          | STAGE A | RED   |
| 102          | COMMON  | WHITE |
| 103          | STAGE A | RED   |
| 104          | COMMON  | WHITE |
| 105          | STAGE A | RED   |

| EPC MICROVERSATRIP FUNCTIONS |                 |        |
|------------------------------|-----------------|--------|
| 106                          | HOMENET-E       | GREEN  |
| 107                          | HOMENET-C       | YELLOW |
| 108                          | VOLTAGE-C PHASE | RED    |
| 109                          | VOLTAGE-B PHASE | WHITE  |
| 110                          | VOLTAGE-A PHASE | BLUE   |
| 111                          | +24Vdc          | BLACK  |
| 112                          | +24Vdc          | RED    |

| ZONE SELECTIVE INTERLOCK FUNCTIONS—MICRO VERSATRIP RMS-9 |                                       |       |
|--|---------------------------------------|-------|
| 73   | INPUT—GROUND FAULT AND/OR SHORT TIME  | WHITE |
| 74   | INPUT—GROUND FAULT AND/OR SHORT TIME  | GREEN |
| 75   | OUTPUT—GROUND FAULT AND/OR SHORT TIME | WHITE |
| 76   | OUTPUT—GROUND FAULT AND/OR SHORT TIME | RED   |

CONNECTED THRU PROGRAMMER DISCONNECT ON D.O. DEVICES  
NOTE: All accessory contacts are shown with the circuit breaker in an overcurrent tripped condition.

Fig. 27.2 Index Card for Control Circuit Numbering and Locations



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# Application Data

## Current Rating Factors

Minimum circuit breaker current rating

$$I_{CB} = I_L \times A \times B \times C \times D \times E$$

where:

- $I_L$  = Actual full-load current or RMS current
- A = Wire size factor
- B = Ambient temperature rating factor
- C = Frequency rating factor
- D = Altitude rating factor
- E = Load class rating factor

POWER BREAK® insulated case circuit breakers are designed to protect insulated cables; therefore, the characteristics of breakers are closely tied to the Underwriters' Laboratories specified size and type of wire for each rating as well as the load characteristics. The following factors should be considered when applying and using these circuit breakers:

### Factors

- A. Cable or bus size must be equal to, or greater than, that specified by Underwriters' Laboratories Inc. Standard for Safety 489. The cable or bus acts as a heat sink to help control the temperature of the breakers; reducing the size of the conductor raises the temperature. Breaker current rating and conductor size are a matched pair; any 75°C or higher type insulation may be used but the cross section must remain constant. See Table 29.1.
- B. Ambient temperatures have an even wider effect on the rating of the breaker-cable system. High ambient temperatures may cause internal temperatures to exceed the temperature limits of the insulating materials. Low temperatures, on the other hand, substantially increase the current carrying ability of the system until

other limiting factors occur, such as lubricant failure, binding due to differential contraction of parts, or excessive degradation of the case and cover strength. The effect of ambient temperature on the continuous current carrying ability of the breaker and cable system is shown on page 29 "FACTOR B-AMBIENT TEMPERATURE."

- C. System operating frequency also has a major effect on the rating and performance of insulated case circuit breakers. Most circuit breakers may be directly applied at their published ratings on 50 or 60 Hertz systems, but should not be applied at other frequencies except as described on page 29 "FACTOR C-FREQUENCY RATING."

At nominal system frequencies less than 50 hertz but above direct current, solid-state trip devices become inoperative due to sensor saturation. On direct current systems, solid-state trip units are completely inoperative.

- D. Another factor to be considered is the altitude at which the breaker will be applied. The design altitude for POWER BREAK circuit breakers is 0 to 6000 feet. At altitudes above 6000 feet the thin atmosphere affects the heat transfer of the breaker as well as its maximum voltage rating (see Table 29.6). So an additional derating is applied at altitude from 6000 to 15,000 feet. See Table 29.4.

- E. Load type and duty cycle must also be considered in the application of POWER BREAK circuit breakers. Loads such as capacitors and electromagnets require a substantial, continuous current derating factor if the breaker is normally used to switch the load.

With loads such as resistance welders, the breaker continuous current rating must be no less than 125 percent of the welder 100 percent duty-cycle rating.

In general where load protection in addition to cable protection is desired, the load characteristics and protection requirements must be fully evaluated. See Table 29.5.



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Table 29.1  
Factor A: Wire Size

| % ① | Factor A |
|-----|----------|
| 50  | 1.40     |
| 60  | 1.25     |
| 70  | 1.15     |
| 80  | 1.07     |
| 90  | 1.02     |
| 100 | 1.00     |
| 125 | 0.99     |
| 150 | 0.97     |
| 200 | 0.97     |

① Applied wire cross-sectional area as a percentage of rated cross-sectional area.

Table 29.2  
Factor B: Ambient Temperature①

| Ambient Temperature① | Minimum Wire Insulation Rating② | Factor B |
|----------------------|---------------------------------|----------|
| 25°C                 | 75°C                            | 1.00     |
| 40°C                 | 90°C                            | 1.00     |
| 50°C                 | 105°C                           | 1.00     |
| 60°C                 | 125°C                           | 1.10     |
| 70°C③                | 125°C                           | 1.15     |
| 80°C③                | 125°C                           | 1.25     |

① Average air temperature over a 24-hour period outside the circuit breaker insulated case, but inside the enclosure.

② Cable (wire) size must be based on 75°C ampacities per Table 310-16 of 1987 National Electrical Code.

③ MagneTrip™ only. MicroVersaTrip® RMS-9 limited to 60°C.

Table 29.3  
Factor C: Frequency Rating

| Frequency  | Factor C MicroVersaTrip RMS-9 | Factor C MagneTrip |
|------------|-------------------------------|--------------------|
| dc         | —                             | 1.00               |
| 50–60 HZ   | 1.00                          | 1.00               |
| 150–180 HZ | 1.07                          | —                  |
| 200–240 HZ | 1.25                          | —                  |
| 300–350 HZ | 1.40                          | —                  |
| 400–450 HZ | 1.51                          | —                  |

Table 29.4  
Factor D: Altitude Rating

| Altitude above sea level | Factor D |
|--------------------------|----------|
| –100 to 6000 ft.         | 1.00     |
| 6001 to 10,000 ft.       | 1.04     |
| 10,001 to 15,000 ft.     | 1.08     |

Table 29.5  
Factor E: Load Class Rating Total①

| Load Type  | Factor E |
|--|----------|
| Switching Capacitors                                 | 1.50     |
| Switching Electro-Magnetics                          | 1.50     |
| Single Motor Branch Circuit Protection (Normal Duty) | 1.50     |
| Single Motor Branch Circuit Protection (Heavy Duty)② | 1.75     |
| All Other Load Types③ (Normal Duty)                  | 1.00     |

① E = product of load class rating factors which apply to the circuit in question.

② Use this factor for plugging duty or cycling loads with over 25 starts per hour where the rms current cannot be reliably calculated.

③ Voltage variations, such as voltage reduction on a constant kVA load or voltage increase on a fixed impedance load, may require Factor E > 1.

Table 29.6  
Altitude Factor for Voltage

| Altitude above sea level | Rated Voltage Correction Factor |
|--------------------------|---------------------------------|
| –100 to 6000 ft.         | 1.00                            |
| 6001 to 10,000 ft.       | 0.95                            |
| 10,001 to 15,000 ft.     | 0.80                            |



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## Basic Ratings

POWER BREAK® with MicroVersaTrip® RMS-9 is rated both for short-time withstand current and interrupting capacity (RMS symmetrical). The maximum short-time rating shown is for 600 Vac, 50/60 Hz, 500 milliseconds duration. MicroVersaTrip® breakers have no dc rating due to current sensor saturation.

POWER BREAK with MagneTrip™ can be applied to either an ac source or dc source. With a special Hi-Break® construction, MagneTrip breakers have ratings up to 750 Vac and 700 Vdc.

Table 30.1

MicroVersaTrip® RMS-9 Interrupting Capacity in RMS Symmetrical kA

| RMS<br>Breaker Rating<br>(kAIC) | Frame Size (Amps) |      |      |      |      |
|---------------------------------|-------------------|------|------|------|------|
|                                 | 800               | 1600 | 2000 | 3000 | 4000 |
|                                 | 25                | 50   | 50   | 42   | 42   |
| Standard Break                  |                   |      |      |      |      |
| 240 Vac                         | 65                | 85   | 85   | 100  | 100  |
| 480 Vac                         | 65                | 65   | 65   | 100  | 100  |
| 600 Vac                         | 42                | 50   | 50   | 85   | 85   |
| Hi-Break®                       |                   |      |      |      |      |
| 240 Vac                         | 100               | 125  | 125  | 200  | 200  |
| 480 Vac                         | 100               | 100  | 100  | 150  | 150  |
| 600 Vac                         | 65                | 65   | 65   | 100  | 100  |

① Applies to frames with "H" suffix

Table 30.2

POWER BREAK Molded Case Switch Withstand Ratings

| Breaker<br>Frame Size<br>(Amps) | Continuous<br>Current<br>Rating<br>(Amps) | Short-Time<br>Rating, 5000<br>Cycle, Amps<br>at<br>600 Vac, 500<br>ms, 50 Hz | Built-in on 200,000 RMS<br>Sym. Amp. Peak-Close<br>When Provided by Class<br>1 Power Transformer |                                      | Short Circuit Withstand<br>Rating when Provided by<br>POWER BREAK<br>MicroVersaTrip Breaker |         |         |
|---------------------------------|---|--|--|--------------------------------------|---|---------|---------|
|                                 |   |  | Line Side<br>Max. Peak<br>Amp Rating   | Load Side<br>Max. Peak<br>Amp Rating | Breaker<br>Frame Size<br>(Amps)   | 600 Vac | 600 Vdc |
| 800                             | 800                                       | 25,000   | 2000   | 800                                  | 800   | 100,000 | 65,000  |
| 1600                            | 1600                                      | 30,000   | 2500   | 1600                                 | 2000  | 100,000 | 65,000  |
| 2000                            | 2000                                      | 30,000   | 2500   | 2000                                 | 2000  | 100,000 | 65,000  |
| 2500                            | 2000                                      | 42,000   | 2500   | 2500                                 | 4000  | 100,000 | 65,000  |
| —                               | 2500                                      | 42,000   | 2500   | 2500                                 | 4000  | 100,000 | 65,000  |
| 3000                            | 3000                                      | 42,000   | 4000①  | 3000                                 | 4000  | 100,000 | 65,000  |
| 4000                            | 4000                                      | 42,000   | 4000①  | 4000①                                | 4000  | 100,000 | 65,000  |

① Hi-Break construction only

Table 30.3

MagneTrip Interrupting Capacities

| Interrupting Capacity (kAIC) | Frame Size (Amps) |      |      |
|------------------------------|-------------------|------|------|
|                              | 1600              | 3000 | 4000 |
| Standard Break               |                   |      |      |
| 240 Vac                      | 65                | 100  | 100  |
| 480 Vac                      | 65                | 100  | 100  |
| 600 Vac                      | 50                | 85   | 85   |
| 250 Vdc                      | 22                | 42   | 42   |
| Hi-Break                     |                   |      |      |
| 240 Vac                      | 125               | 200  | 200  |
| 480 Vac                      | 100               | 150  | 150  |
| 600 Vac                      | 65                | 100  | 100  |
| 250 Vdc                      | 35                | 85①  | 85①  |
| 500 Vdc                      | —                 | 65   | 65   |
| 600 Vdc                      | —                 | 65   | 65   |
| Special Hi-Break             |                   |      |      |
| 750 Vac                      | —                 | 35   | 35   |
| 700 Vdc                      | —                 | 65   | 65   |

① Also UL listed for 200kA at 300Vdc max. with circuit time constant of 6.6 milliseconds maximum

Table 30.4

(Ref. UL 489 - See UL Test Procedures, page 31)

| Frame Size<br>(Amps) | Bus Bars per Terminal |                |
|----------------------|-----------------------|----------------|
|                      | Number                | Size by Inches |
| 1600                 | 2                     | 1/4 × 3        |
| 2000                 | 2                     | 1/4 × 4        |
| 2500                 | 2                     | 1/4 × 5        |
|                      | 4                     | 1/4 × 2-1/2    |
| 3000                 | 4                     | 1/4 × 4        |
| 4000                 | 4                     | 1/4 × 5        |

Table 30.5

(Ref. UL 489 - See UL Test Procedures, page 31)

| Frame Size<br>(Amps) | Number of Cycles at Breakpoint |                 |       |
|----------------------|--------------------------------|-----------------|-------|
|                      | With Current                   | Without Current | Total |
| 800                  | 500                            | 3000            | 3500  |
| 1600                 | 500                            | 2000            | 2500  |
| 2000                 | 500                            | 2000            | 2500  |
| 2500                 | 500                            | 2000            | 2500  |
| 3000                 | 400                            | 1100            | 1500  |
| 4000                 | 400                            | 1100            | 1500  |



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## Standards and Testing

POWER BREAK® circuit breakers are UL listed in accordance with UL Standard 489. This standard requires the breaker to meet or exceed endurance and interrupting criteria. POWER BREAK has been designed and tested to exceed these requirements.

UL 489 requirements for endurance capability without current (mechanical endurance) vary with frame rating. For an 800 ampere frame, the UL requirement is 3000 operations, while a 4000 frame requires 1100 operations. All POWER BREAK breakers exceed this requirement by meeting GE testing with a minimum of 10,000 mechanical operations.

### UL Test Procedures

(Extracted from ANSI/UL Standard 489, Seventh Edition, September 15, 1986.)

The following information briefly describes the types of tests POWER BREAK insulated case circuit breakers, rated 800 through 4000 amperes, must successfully pass.

1. Calibration—tested at 200%, and 125% at 25°C. At 200%, an 800A breaker must trip in 14 minutes with the maximum trip time increasing to 24 minutes for frame sizes larger than 2000A. At 125%, all sizes (larger than 50 amperes) must trip within 2 hours.
2. Overload—50 operations making and breaking six times rated current at rated maximum voltage, 0.45-0.50 power factor for 800 and 1600A frame sizes, 2000 and 2500A frames, 25 operations at 6 times rated current; and, 3000 and 4000A frames, 3 operations at 6 times rated current plus 25 operations at 2 times rated current. Tests are conducted at one operation per minute, (make and break), but may be done in groups of five operations with 15

minute delay between groups.

Overload test is conducted in a metal enclosure representing the minimum size enclosure for which the breaker is suitable. The ground fault fuse described in item 5 below must not rupture.

3. Calibration—200% of rated current.
4. Temperature Test—the circuit breaker after overload is outfitted with 4 feet minimum of rated copper cable per pole, line and load end, and rated current is passed through the breaker which is *not* in an enclosure. After temperatures have stabilized, the temperature rise on the cables at the connection to the breaker wiring terminals must not exceed 50°C rise, (75°C total in a 25°C room ambient), and the breaker must not trip. Cables are sized as shown in Table 33.1, page 33. When copper bus bars are used instead of cable for 1600-4000A breakers, they are sized per Table 30.4.
5. Endurance—the breaker must complete an endurance test (1) making and breaking rated current at rated voltage, .75-.80 lagging power factor and (2) additional no load (mechanical) on-off operations per Table 30.5 (page 30). No electrical or mechanical breakdown is permitted and a 30 ampere fuse, connected from the metal enclosure to the line lead least likely to arc to the enclosure, must not rupture. The rate of operation is one per minute except the 3000 and 4000A electrical test may be in groups of 5 with a delay in between after conducting the first 10 operations at one per minute.

6. 200% calibration repeated—breaker must trip within times outlined in item 1.

7. Interrupting Ability (short circuit)—for devices rated 600Vac (all POWER BREAK), each pole of the 3-pole unit must complete an "opening" operation (O) and a "close-open" operation (CO) of short circuit current (single-phase) in Table 31.1 at rated voltage. An "O" and "CO" operation using all three poles ("common" 3-phase tests) is also required on the same device used for the previous tests in items 1-6.

Short circuit tests are acceptable if:

- (a) there is no electrical or mechanical breakdown;
- (b) the ground fuse has not opened;
- (c) the conductor insulation is not damaged;
- (d) there is continuity in the closed position at rated voltage; and,
- (e) a cotton pad covering any vent openings in the enclosure has not ignited.

Short circuit tests are conducted with rated cable sizes (or bus for 1600A and larger breakers) using a maximum of four feet on the line side and a maximum of 10 inches on load side for 3-pole tests and four feet on load side for single-pole tests.

8. Trip-Out at 200% current—breaker must trip within same time limits as for the 200% calibration.

9. Dielectric Voltage Withstand—the tested breaker must withstand applied voltage of twice rated plus 1000 volts (2200 volts for 600V rated breaker) for one minute between:
  - (a) line and load terminals,
  - (b) poles of opposite polarity, and
  - (c) live parts and the metal enclosure.

### Performance — High Available Fault — Current (Hi-Break® POWER BREAK Breakers)

The UL Standard 489 specifies additional, optional requirements for evaluation of breakers on faults higher than the "standard" values shown in item 5.

Test sequence is as follows:

1. Calibration—200% of rated current.
2. Interrupting Capacity—short circuit tests are conducted to evaluate (1) maximum IC rating, (2) IC at maximum voltage, and (3) IC at maximum kVA. If one or more tests are covered by another (that is, for example, if maximum kVA occurs at maximum voltage test (3) can be omitted) they may be omitted. An "O" operation

Table 31.1  
Short Circuit Levels

| Frame Size (Amps) | Power Factor Lagging | Short Circuit Available |                 |
|-------------------|----------------------|-------------------------|-----------------|
|                   |                      | 1-Pole, 1-Phase         | 3-Pole, 3-Phase |
| 800               | .45-.50              | 8,660                   | 10,000          |
| 1600              | .25-.30              | 14,000                  | 20,000          |
| 2000              | .15-.20              | 14,000 <sup>①</sup>     | 25,000          |
| 2500              | .15-.20              | 20,000 <sup>①</sup>     | 30,000          |
| 3000              | .15-.20              | 25,000                  | 35,000          |
| 4000              | .15-.20              | 30,000                  | 45,000          |

① Circuit power factor may be .25-.30



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ation and a "CO" operation is required for each evaluation. Acceptable high available fault current ratings are, in RMS symmetrical kilo amperes: 7.5, 10, 14, 18, 22, 25, 30, 35, 42, 50, 65, 85, 100, 125, 150, 200.

3. Trip-Out—conducted at 250% of rated current. Breakers must trip within same time limits as for 200% calibration.
4. Dielectric Voltage Withstand—conducted at twice rated (test) voltage.

The preceding abbreviated outline of UL molded case circuit breaker performance evaluation does not address all of the details and numerous specific requirements of the standard. For a complete description of the requirements, obtain a copy of the UL Standard. See page 52 for address of UL and other standards organizations.

A standard rated device is rated to carry 100% of its nameplate current for *short periods* (up to three hours maximum) when enclosed in equipment, such as a switchboard, and 80% of its rating *continuously* per paragraph 220-10, 1987 National Electrical Code. This is where the term 80% device is derived.

On the other hand, 100% rated devices are designed specifically to carry 100% of their nameplate current rating when enclosed and tested in distribution equipment. Breakers with 100% *continuous rating* are so marked on the front of the breaker. This marking includes minimum enclosure size, minimum ventilation (if any) and minimum cable sizes and temperature ratings to be used. The 1987 National Electrical Code, paragraph 210-22 (c), exception no. 2, and 220-10 (b) exception permits such use.

All POWER BREAK® circuit breakers equipped with Micro-VersaTrip® RMS-9 programmers or with dual magnetic trip units (except the 4000A MagneTrip™) are UL listed to carry 100% nameplate current continuously when installed in accordance with guidelines printed on the breaker. Tables 33.1 and 47.1 also detail the installation requirements for 100% rating.



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## Cable Sizing and Power Factor Derating

Short circuit tests are conducted on available fault current circuits where the circuit power factor is 20% (lagging). Lower system short circuit power factors increase the instantaneous asymmetrical peak current to a value higher than the value as tested at 20%. The breaker may not be able to clear the fault at this lower power factor. Therefore the rated short circuit interrupting capacity must be derated for lower power factors as shown in Table 33.2.

Table 33.2  
Interrupting Capacity  
Multiplying Factors for  
Low Power Factors

| System Power Factor | Derating Factor (multiplier) |
|---------------------|------------------------------|
| .20                 | 1.00                         |
| .19                 | 0.99                         |
| .18                 | 0.98                         |
| .17                 | 0.97                         |
| .16                 | 0.96                         |
| .15                 | 0.95                         |
| .14                 | 0.93                         |
| .13                 | 0.92                         |
| .12                 | 0.91                         |
| .11                 | 0.90                         |
| .10                 | 0.89                         |
| .09                 | 0.88                         |
| .08                 | 0.87                         |
| .07                 | 0.85                         |

Table 33.1  
Required Cable Size

| Frame Size (Amps) | Sensor Ampere Rating or Rating Plug Ampere Rating | Cable Size and Quantity |            |                 |            | Cable Minimum Temperature Rating °C Carrying 100% Continuously |
|-------------------|---|-------------------------|------------|-----------------|------------|--|
|                   |   | Copper Cables           |            | Aluminum Cables |            |  |
|                   |   | Qty.                    | Size (mcm) | Qty.            | Size (mcm) |  |
| 800               | 200   | 1                       | 3/0        | 1               | 250        | 75   |
|                   | 400   | 1                       | 600        | 2               | 250        | 75   |
|                   | 600   | 2                       | 350        | 2               | 500        | 75   |
|                   | 800   | 2                       | 600 or 300 | 3               | 400        | 75   |
| 1600              | 800   | 3                       | 300        | 3               | 400        | 75   |
|                   | 1000  | 3                       | 400        | 4               | 350        | 75   |
|                   | 1200  | 4                       | 350        | 4               | 500        | 75   |
|                   | 1600  | 5                       | 400        | 5               | 600        | 90①  |
| 2000              | 2000  | 6                       | 400        | 6               | 600        | 90①  |
| 2500              | 2000  | 6                       | 400        | 6               | 600        | 75   |
|                   | 2500  | 7                       | 500        | 8               | 600        | 90①  |
| 3000              | 3000  | 9                       | 400 or 500 | 10              | 500 or 600 | 90①  |
|                   |   | 8                       | 500        | 9               | 600        | 90①  |
| 4000              | 4000  | 11                      | 500 or 600 | 13              | 500 or 600 | 90①  |
|                   |   | 10                      | 600        | 12              | 600        | 90①  |

① 100% continuous load requires use of 90°C cable sized to 75°C ampacity; lugs must be marked CU9AL or AL9CU or AL9 denoting suitability with 90°C cable.

Table 33.3 — Properties of Conductors

| Size AWG, MCM | Area Cir. Mils | Concentric Lay Stranded Conductors |                       | Bare Conductors |                     | DC Resistance Ohms/M Ft. At 25°C, 77°F. |                  |          |
|---------------|----------------|------------------------------------|-----------------------|-----------------|---------------------|---|------------------|----------|
|               |                | No. Wires                          | Dia. Each Wire Inches | Dia. Inches     | Area Square Inches① | Copper                                  |                  | Aluminum |
|               |                |                                    |                       |                 |                     | Bare Conductor                          | Tinned Conductor |          |
| 250           | 250,000        | 37                                 | .0822                 | .575            | .260                | .0431                                   | .0449            | .0708    |
| 300           | 300,000        | 37                                 | .0900                 | .630            | .312                | .0308                                   | .0374            | .0590    |
| 350           | 350,000        | 37                                 | .0973                 | .681            | .364                | .0320                                   | .0320            | .0505    |
| 400           | 400,000        | 37                                 | .1040                 | .728            | .416                | .0270                                   | .0278            | .0442    |
| 500           | 500,000        | 37                                 | .1162                 | .813            | .519                | .0216                                   | .0222            | .0354    |
| 600           | 600,000        | 61                                 | .0992                 | .893            | .626                | .0180                                   | .0187            | .0295    |
| 700           | 700,000        | 61                                 | .1071                 | .964            | .730                | .0154                                   | .0159            | .0253    |
| 750           | 750,000        | 61                                 | .1109                 | .998            | .782                | .0144                                   | .0148            | .0236    |
| 800           | 800,000        | 61                                 | .1145                 | 1.030           | .833                | .0135                                   | .0139            | .0221    |
| 900           | 900,000        | 61                                 | .1215                 | 1.090           | .933                | .0120                                   | .0123            | .0197    |
| 1000          | 1,000,000      | 61                                 | .1280                 | 1.150           | 1.039               | .0108                                   | .0111            | .0177    |
| 1250          | 1,250,000      | 91                                 | .1172                 | 1.289           | 1.305               | .00863                                  | .00888           | .0142    |
| 1500          | 1,500,000      | 91                                 | .1284                 | 1.410           | 1.561               | .00719                                  | .00740           | .0118    |
| 1750          | 1,750,000      | 127                                | .1174                 | 1.526           | 1.829               | .00616                                  | .00634           | .0101    |
| 2000          | 2,000,000      | 127                                | .1255                 | 1.630           | 2.087               | .00539                                  | .00555           | .00885   |

① Area given is that of a circle having a diameter equal to the over-all diameter of a stranded conductor. The values given in the table are those given in Handbook 100 of the National Bureau of Standards except that those shown in the 8th column are those given in Specification B33 of the American Society for Testing and Materials, and those shown in the 9th column are those given in Standard No. S-19-81 of the Insulated Power Cable Engineers Association and Standard No. WC3-1969 of the National Electrical Manufacturers Association.



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## 400 Hz Ratings and Internal Impedances

Table 34.1

Estimated 400 Hz Interrupting Ratings in RMS Symmetrical Amperes — Not UL Listed —  
POWER BREAK with MicroVersaTrip® RMS-9 Programmer Only

| Frame Size (Amps) | Maximum Rating Plug Ampacity <sup>①</sup> | Standard Break |         |         | HI-Breaks |         |         |
|-------------------|---|----------------|---------|---------|-----------|---------|---------|
|                   |   | 120/240        | 277/480 | 346/600 | 120/140   | 277/480 | 346/600 |
| 800               | 600                                       | 6,500          | 5,000   | 4,200   | 10,000    | 10,000  | 6,500   |
| 1600              | 1,000                                     | 8,500          | 6,500   | 5,000   | 12,500    | 10,000  | 6,500   |
| 2000              | 1,200                                     | 8,500          | 6,500   | 5,000   | 12,500    | 10,000  | 6,500   |
| 2500              | 1,600                                     | 10,000         | 10,000  | 8,500   | 20,000    | 15,000  | 10,000  |

① No additional thermal derating is required for above maximum rating plug ratings for frame sizes noted.

NOTE: 400-Hertz interrupting ratings are based on engineering judgement, taking into consideration the operating characteristics of insulated case circuit breakers and the worldwide lack of test facilities to verify performance.

Table 34.2

Internal Impedances and Power Losses —  
MicroVersaTrip® RMS-9

| Frame Size (Amps) | Rated Rating | R (Cold)<br>$\Omega \times 10^{-3}$<br>Per Pole | Watts Hot<br>Total (3 Poles) |
|-------------------|--------------|---|------------------------------|
| 800               | 200          | 31  | 4.1                          |
|                   | 400          | 31  | 16                           |
|                   | 600          | 31  | 65                           |
|                   | 800          | 31  | 65                           |
| 1600              | 1000         | 24  | 79                           |
|                   | 1600         | 24  | 203                          |
| 2000              | 2000         | 23  | 304                          |
| 2500              | 1000         | 18  | 59                           |
|                   | 2000         | 18  | 238                          |
|                   | 2500         | 18  | 371                          |
| 3000              | 3000         | 15  | 446                          |
| 4000              | 4000         | 15  | 792                          |

Table 34.3

Internal Impedances and Power Losses —  
MagneTrip™

| Frame Size (Amps) | Trip Unit Rating | R (Cold)<br>$\Omega \times 10^{-3}$<br>Per Pole | Watts Hot<br>Total (3 Poles) |
|-------------------|------------------|---|------------------------------|
| 1600              | 200              | 445   | 64                           |
|                   | 400              | 232   | 134                          |
|                   | 600              | 84  | 109                          |
|                   | 800              | 70  | 161                          |
|                   | 1000             | 53  | 191                          |
|                   | 1200             | 51  | 264                          |
|                   | 1600             | 26  | 240                          |
| 3000              | 600              | 90  | 117                          |
|                   | 800              | 96  | 221                          |
|                   | 1200             | 48  | 249                          |
|                   | 1600             | 36  | 332                          |
|                   | 2000             | 24  | 346                          |
|                   | 2500             | 23  | 745                          |
| 4000              | 4000             | 17  | 979                          |



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# Application Data (Continued)

## Miscellaneous Information and Control Power Requirements

### Shock and Vibration

MicroVersaTrip® RMS-9 POWER BREAK® circuit breakers have the following shock and vibration capabilities:

- Shock  
Half sine shock pulses of 3 G's with duration of 10 ms and 2 G's with duration of 250 ms.
- Vibration  
Random vibration from 2 to 600 Hz to the acceleration density curve shown.  
MagneTrip™ POWER BREAK circuit breakers have reduced vibration capabilities in the front to back axis.

### Humidity and Fungus

Ferrous parts are cadmium or zinc plated for corrosion protection with the exception of some parts made from alloy steels that are inherently corrosion resistant.

Current carrying parts are silver or tin plated for corrosion protection and to assure reliable electrical joints.

The molded cases and covers and all internal insulators are made from non-organic materials that are inherently fungus proof.

### Control Power Requirements — Electrical Operation

The control power required for each motor operator may be determined from Table 35.1 and 35.2. If several motor operators are to be fed from the same source, it should be sized to accommodate all operators simultaneously, especially if they are wired for automatic charge.

The drop in source supply voltage from no load to the motor full load current level

(ref. Tables) should not exceed 7%. Acceptable dc power sources are: three phase full wave rectified ac, dc generator; battery; or any other dc source with a peak-to-peak ripple voltage of not more than 15% of rated voltage at the motor full load current.

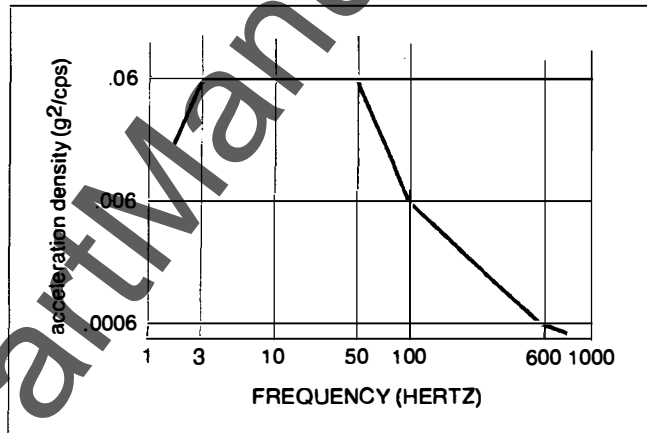


Fig. 35.1 Vibration Test Specification

Table 35.1  
Control Power Required for Motor Operators 800-2000A Frame Sizes

| Rated Voltage | Operating Voltage Range | Motor Current (Amps) |           |         | Close Solenoid (Peak) (Amps) | Fuses (Slo Blo) 125V | Nominal Charge Time (Sec.) | Maximum Close Time (Sec.) <sup>①</sup> | Maximum Opening Time (Sec.) <sup>①</sup> |
|---------------|-------------------------|----------------------|-----------|---------|------------------------------|----------------------|----------------------------|--|--|
|               |                         | Locked Rotor         | Full Load | Average |                              |                      |                            |  |  |
| 120 Vac       | 102-132 Vac             | 8                    | 2.5       | 1.5     | 3.0                          | 2A                   | 5.0                        | .083                                   | .050                                     |
| 125 Vdc       | 100-140 Vdc             | 10                   | 2.5       | 1.5     | 3.5                          | 2A                   | 6.0                        | .083                                   | .050                                     |
| 72 Vdc        | 57-81 Vdc               | 13                   | 3.0       | 2.0     | 5.0                          | 3A                   | 6.0                        | .083                                   | .050                                     |
| 48 Vdc        | 38-58 Vdc               | 20                   | 5.0       | 2.5     | 6.6                          | 4A                   | 6.0                        | .083                                   | .050                                     |
| 24 Vdc        | 19-29 Vdc               | 24                   | 7.0       | 3.0     | 13.2                         | 6.5A                 | 7.5                        | .083                                   | .050                                     |

① At rated nominal or higher voltage; times may be longer at lower end of voltage range.

Table 35.2  
Control Power Required for Motor Operators 2500-4000A Frame Sizes

| Rated Voltage | Operating Voltage Range | Motor Current (Amps)      |           |              | Close Solenoid (Peak) (Amps) | Fuses Type 2AB (Amps) <sup>②</sup> | Charge Time (Sec.) <sup>③</sup> | Close Time (Sec.) <sup>④</sup> | Maximum Opening Time (Sec.) <sup>⑤</sup> |
|---------------|-------------------------|---------------------------|-----------|--------------|------------------------------|------------------------------------|---------------------------------|--------------------------------|--|
|               |                         | Locked Rotor <sup>①</sup> | Full Load | Average Load |                              |                                    |                                 |                                |  |
| 120 Vac       | 102-132 Vac             | 20                        | 7.0       | 4.0          | 8.8                          | MDX 4                              | 3.5                             | .083                           | .083                                     |
| 240 Vac       | 204-264 Vac             | 10                        | 3.5       | 2.0          | 4.0                          | MDA 4                              | 3.5                             | .083                           | .083                                     |
| 125 Vdc       | 100-140 Vdc             | 20                        | 4.0       | 3.0          | 3.4                          | ABC 5                              | 4.0                             | .083                           | .083                                     |
| 72 Vdc        | 57-81 Vdc               | 28                        | 10        | 7.0          | 8.1                          | ABC 10                             | 4.5                             | .083                           | .083                                     |
| 48 Vdc        | 38-58 Vdc               | 30                        | 10        | 7.0          | 6.7                          | ABC 10                             | 4.5                             | .083                           | .083                                     |
| 24 Vdc        | 19-29 Vdc               | 60                        | 20        | 14           | 14.1                         | ABC 20                             | 5.0                             | .083                           | .083                                     |

① Momentary motor reversing current is 150% locked rotor current.

② Recommended type is Bussman or equivalent. Do not use slo-blo fuses for type ABC.

③ Measured from sequence initiation to motor cutoff at 100% rated voltage.

④ Measured from sequence initiation to contact closure at 100% rated voltage.

⑤ Measured from sequence initiation to contact opening at 100% rated voltage.



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## Wiring Diagrams — Power Sources

### Wiring for Remote Operation

For proper operation the electrical circuit should be wired as shown. All customer supplied switches (or contacts) can be either momentary action or maintained contact. If momentary action switches are used, they should be 0.083 seconds minimum duration, with the exception of the charge contact for 120 and 240 Vac operators, which requires 0.25 sec. minimum duration. Momentary action switches are recommended to preclude inadvertent recharging and/or reclosing. These switches or contacts must be rated at least 1/4-amp at 125 Vdc for dc motor operators and suitable to handle motor current and voltage for ac motor operators.

### Caution:

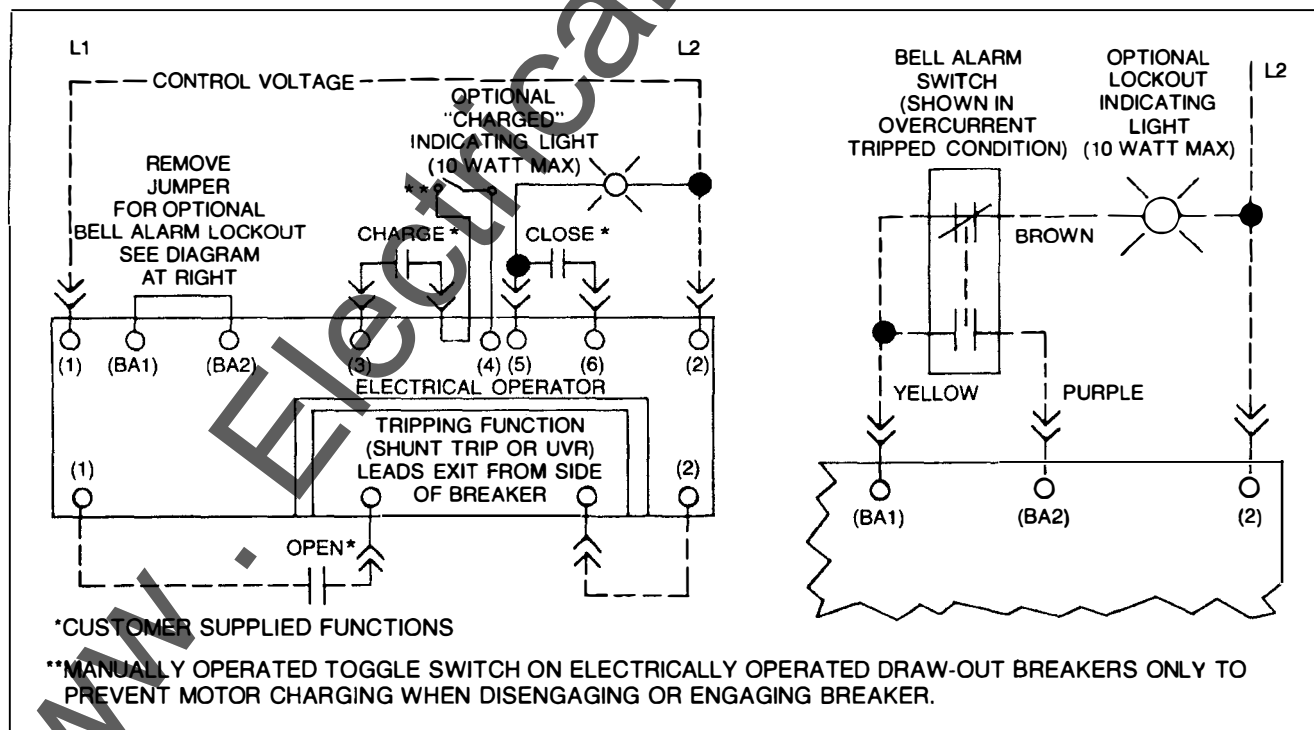
1. Do not apply power to any terminals other than (1) and (2).
2. Observe proper polarity (+ at L1) on dc motor operators.
3. Do not wire breakers for both automatic charge and automatic close unless a bell alarm overcurrent lockout function is incorporated. Failure to do so may result in repeated closures into an overcurrent fault.
4. The bell alarm lockout and undervoltage release device both hold the breaker latch open when activated. To prevent continuous cycling when wired for automatic charging, the following is required:

a) For bell alarm lockout—Interconnect bell alarm switch to motor operator terminal board as shown in Figures 36.1 or 37.1.

b) For undervoltage release — do not wire breaker for automatic charge, or, if automatic charge is required, use an undervoltage relay in the charging unit.

### NOTE:

The motor operator contains a feature which shuts off control power if the OFF button is held depressed. Thus, electrical operation is prevented if a "Kirk" lock or padlock accessory is used in the breaker locked OPEN condition. If the breaker is equipped with a draw-out interlock (TPDO-2), electrical operation is permitted only if the draw-out carriage is in the ENGAGED or TEST position.





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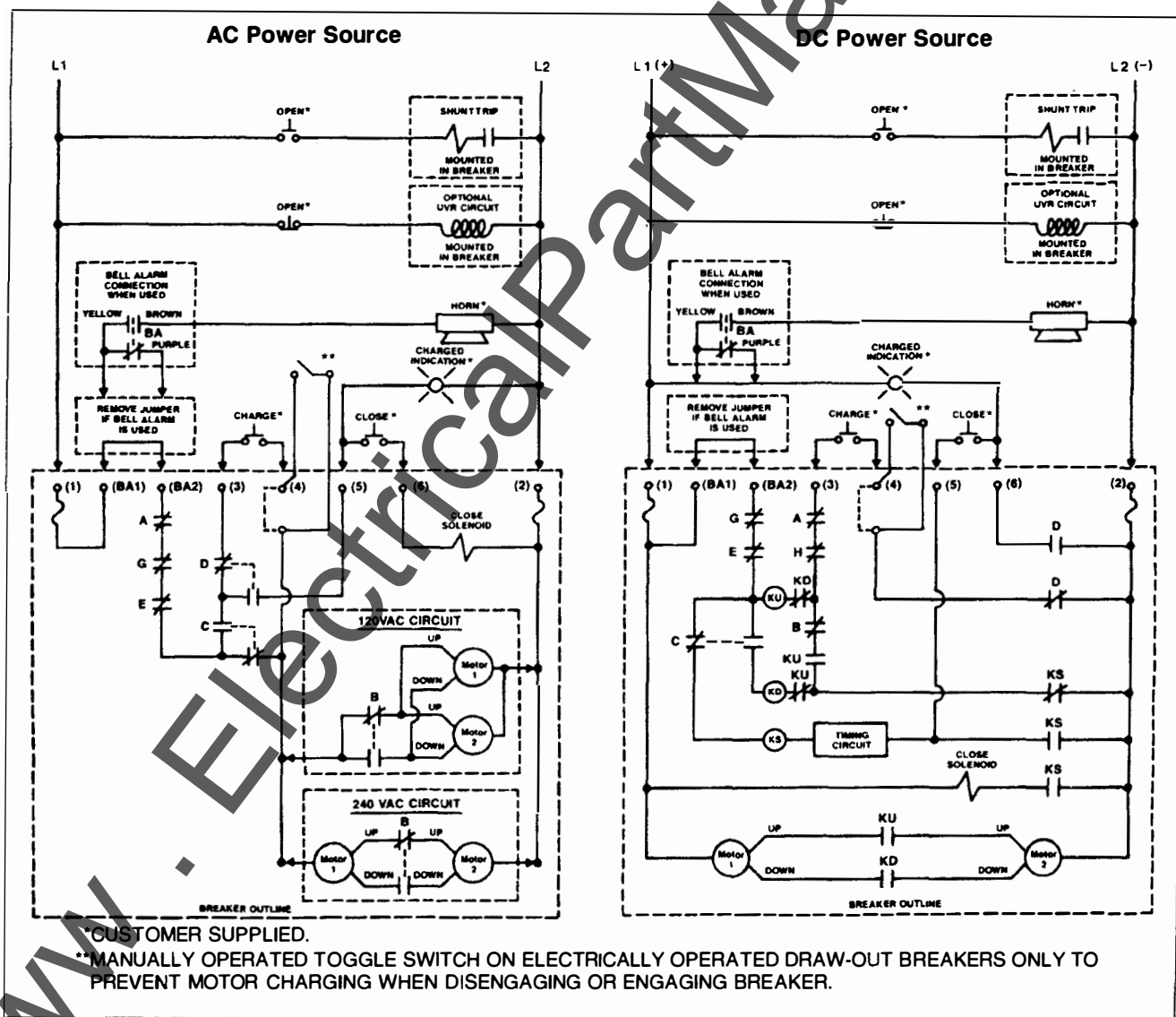


Fig. 37.1 2500-4000A Frame. AC and DC Power Source Wiring Diagrams



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## Time Current Tripping Characteristics

Insulated case circuit breaker time current curves are the engineering documents which define technical performance characteristics of the devices.

Information provided on the time current curve includes the following:

1. Product family type(s)
2. Specific device type(s)
3. Ampere ratings covered on curve
4. Overcurrent characteristics — long time, short time, instantaneous, etc.
5. Maximum total clearing time
6. Maximum and minimum temperature limits
7. Frequency ratings
8. Voltage ratings
9. Specific trip unit ratings
10. Trip unit adjustment ranges
11. Tolerances (band width)

Multiples of circuit breaker trip rating are shown on the top and bottom horizontal axis, with time in seconds on the vertical axis. Approximate minimum and maximum clearing time is readily determined from the characteristics curves. Tripping characteristics meet National Electrical Manufacturers Association and Underwriters' Laboratories, Inc. standards for rating and calibration.

Table 38.1  
Time Current Curves

| Trip Unit   | 600A-900A              | 1200A                  | 1600A                  | 2000A                  | 2500A                  | 3000A                  | 4000A                  |
|---|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| MicroVersaTrip<br>RMS-9<br>• LI, LSI<br>• Ground Fault (G)  | GES-6235<br>GES-6228   | GES-6235<br>GES-6228   | GES-6235<br>GES-6228   | GES-6235<br>GES-6228   | GES-6235<br>GES-6228   | GES-6235<br>GES-6228   | GES-6235<br>GES-6228   |
| MagneTrip<br>• Standard<br>• With Adjustable Short Time   |                        | GES-6164<br>GES-6168   | GES-6164<br>GES-6168   | GES-6166<br>GES-6169   | GES-6167<br>GES-6170   | GES-6167<br>GES-6171   | GES-6167<br>GES-6171   |
| <b>Old Style (For Reference Only)</b>   |                        |                        |                        |                        |                        |                        |                        |
| MicroVersaTrip<br>• LI, LSI <sup>①</sup><br>• G   | GES-6199<br>GES-6195   | GES-6199<br>GES-6195   | GES-6199<br>GES-6195   | GES-6199<br>GES-6195   | GES-6199<br>GES-6195   | GES-6199<br>GES-6195   | GES-6199<br>GES-6195   |
| VersaTrip (MOD2)<br>• All Breakers<br>• Ground Fault Option   | GES-6168A<br>GES-6189  | GES-6168A<br>GES-6189  | GES-6187<br>GES-6189   | GES-6187<br>GES-6189   | GES-6186<br>GES-6190   | GES-6187<br>GES-6191   | GES-6187<br>GES-6191   |
| VersaTrip-<br>• All Breakers<br>• Ground Fault Option   | GES-6163A<br>GES-6161  | GES-6163A<br>GES-6161  | GES-6162A<br>GES-6161  | GES-6143A<br>GES-6161  | GES-6143A<br>GES-6161  | GES-6143A<br>GES-6145A | GES-6144A<br>GES-6145A |
| SelecTrip<br>• Standard<br>• With Adjustable Magnetic Delay   | GES-6140B<br>GES-6149A | GES-6140B<br>GES-6149A | GES-6140B<br>GES-6149A | GES-6140B<br>GES-6149A | GES-6140B<br>GES-6149A | GES-6140B<br>GES-6149A |                        |
| <b>Obsolete Devices:</b><br>S-2500 (600-2500 amps LI) ..... GES-6117<br>S-2500 (600-2500 amps LSI) ..... GES-6118<br>TPS (600-2500 amps LI) ..... GES-6125<br>TPS (3000-4000 amps LI) ..... GES-6126<br>THS (600-2500 amps LI) ..... GES-6127<br>THS (600-2500 Amps LSI) ..... GES-6131<br>THS (3000-4000 amps LI) ..... GES-6128<br>THS (600-2500 amps LSI) ..... GES-6129<br>THS (3000-4000 amps LSI) ..... GES-6132<br>TPS (600-2500 amps LSI) ..... GES-6130<br>Complete Set of Curves ..... GEZ-7001 |                        |                        |                        |                        |                        |                        |                        |

① For MicroVersaTrip with 4-function programmer, refer to GES-6198.

L = Long Time  
S = Short Time

I = Instantaneous  
G = Ground Fault



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# Time Current Curves

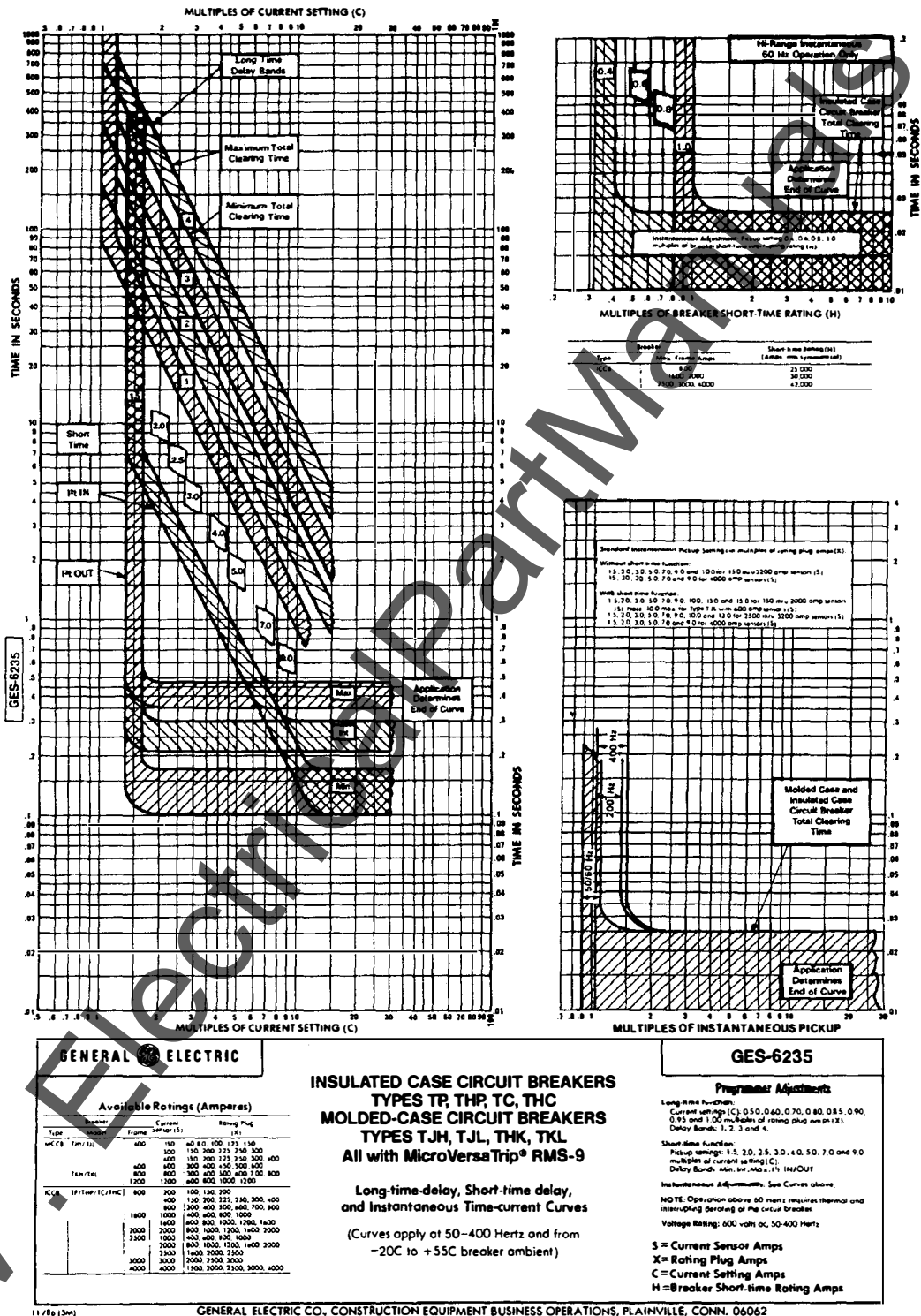


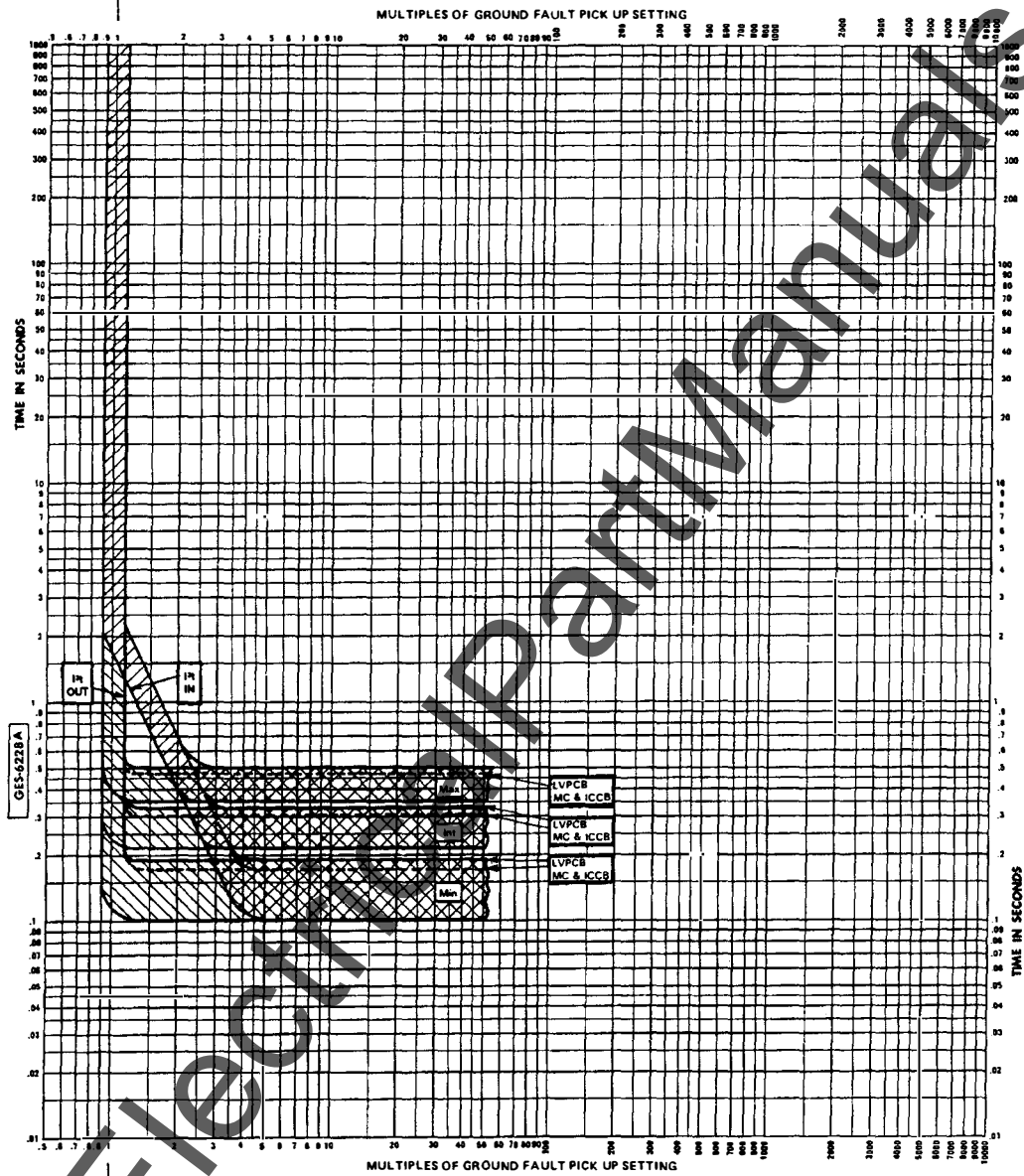
Fig. 39-1 MicroVersaTrip® RMS-9 Phase Overcurrent Time Current Curve



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# Time Current Curves (Continued)



**GENERAL ELECTRIC**

**Available Ratings (Amperes)**

| Breaker | Type          | Model         | Frame | Current Sensor (S)                    |
|---------|---------------|---------------|-------|---------------------------------------|
| MCB     | TH/TK         | TH/TK         | 400   | 150, 300, 400, 600, 800               |
|         |               |               | 800   | 1500                                  |
|         |               |               | 1200  | 1500                                  |
|         |               |               | 1600  | 1500                                  |
| ICB     | TH/TK/THC/TKL | TH/TK/THC/TKL | 800   | 200, 400, 600, 1000, 1400, 2000, 2500 |
|         |               |               | 1200  | 2000, 2500                            |
|         |               |               | 1600  | 2000, 2500                            |
|         |               |               | 2000  | 2000, 2500                            |
| LVPGB   | AER 30S/50H   | AER 30S/50H   | 800   | 150, 400, 800                         |
|         |               |               | 1200  | 600, 1400                             |
|         |               |               | 1600  | 2000, 3000                            |
|         |               |               | 2000  | 3000, 4000                            |

S = Current Sensor Amps

**LOW-VOLTAGE POWER CIRCUIT BREAKERS**

**TYPEAKR**

**INSULATED-CASE CIRCUIT BREAKERS**

**TYPES TP, THP, TC, THC**

**MOLDED-CASE CIRCUIT BREAKERS**

**TYPES TJH, TJL, TKH, TKL**

**All with MicroVersaTrip® RMS-9**

**or**

**Epic MicroVersaTrip™**

**Ground Fault**

**Time-current Curves**

(Curves apply at 50/400 Hertz and from -20C to +55C breaker ambient)

**GES-6228A**

**Programmer Adjustments**

**Ground Fault Function:**

Factory setting: in multiple of current sensor amp (S): 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5 and 0.4 for 150 thru 2000 amp sensor (S)

0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5 and 0.4 for 2500 thru 3200 amp sensor (S)

0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5 and 0.4 for 4000 amp sensor (S)

**Delay times:**

Min. 100 ms, IN/OUT

**NOTE:** Operation above 50Hz requires thermal and interrupting derating of the circuit breaker

**Voltage Rating:** 600 Volts ac, 50 through 400 Hertz

GENERAL ELECTRIC CO. CONSTRUCTION EQUIPMENT BUSINESS OPERATIONS, PLAINVILLE, CONN. 06062

Fig. 40.1 MicroVersaTrip® RMS-9 Ground Fault Time-Current Curve

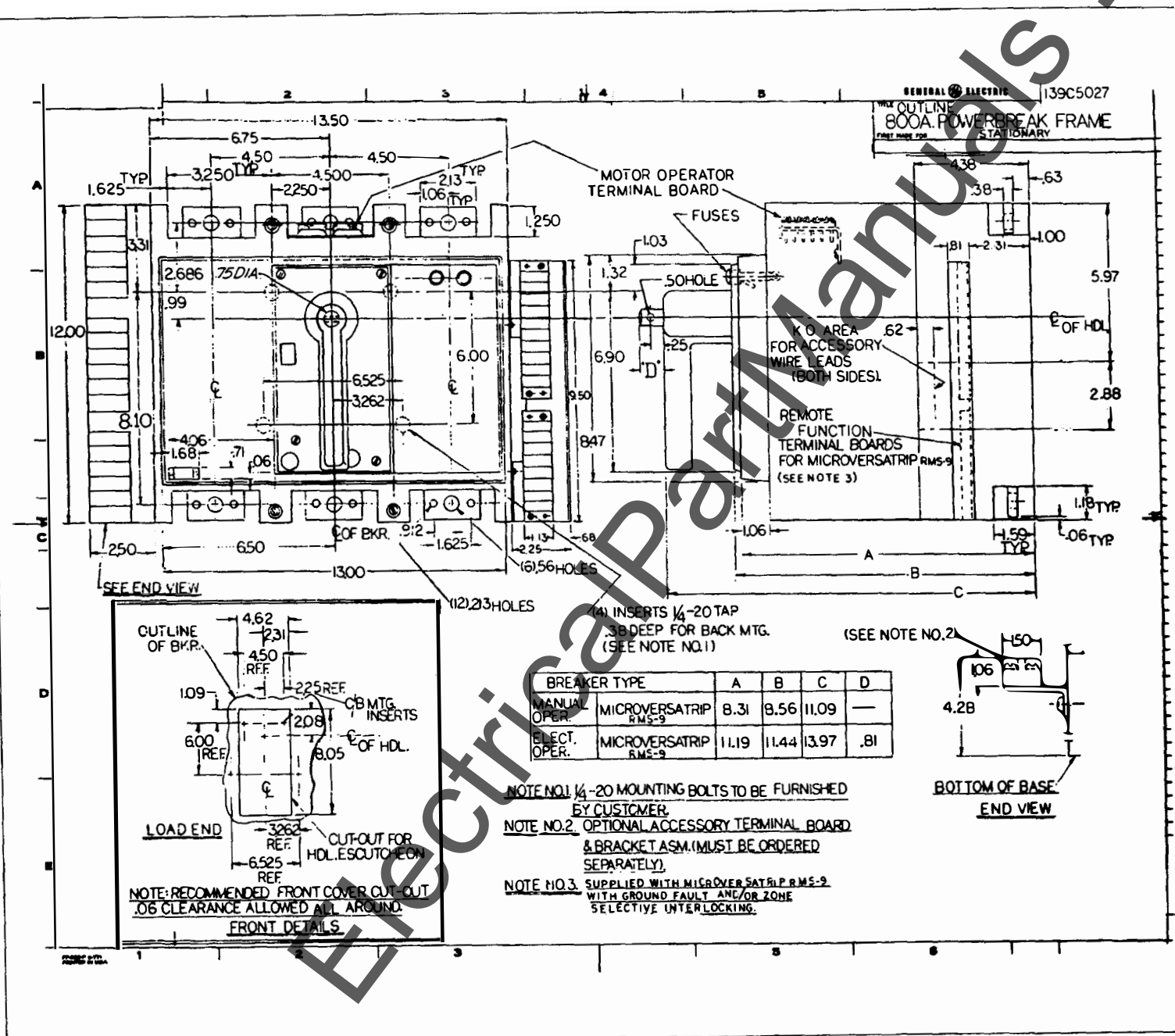


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# Outline Dimension Drawings

Fig. 41.1 800A Stationary Frame





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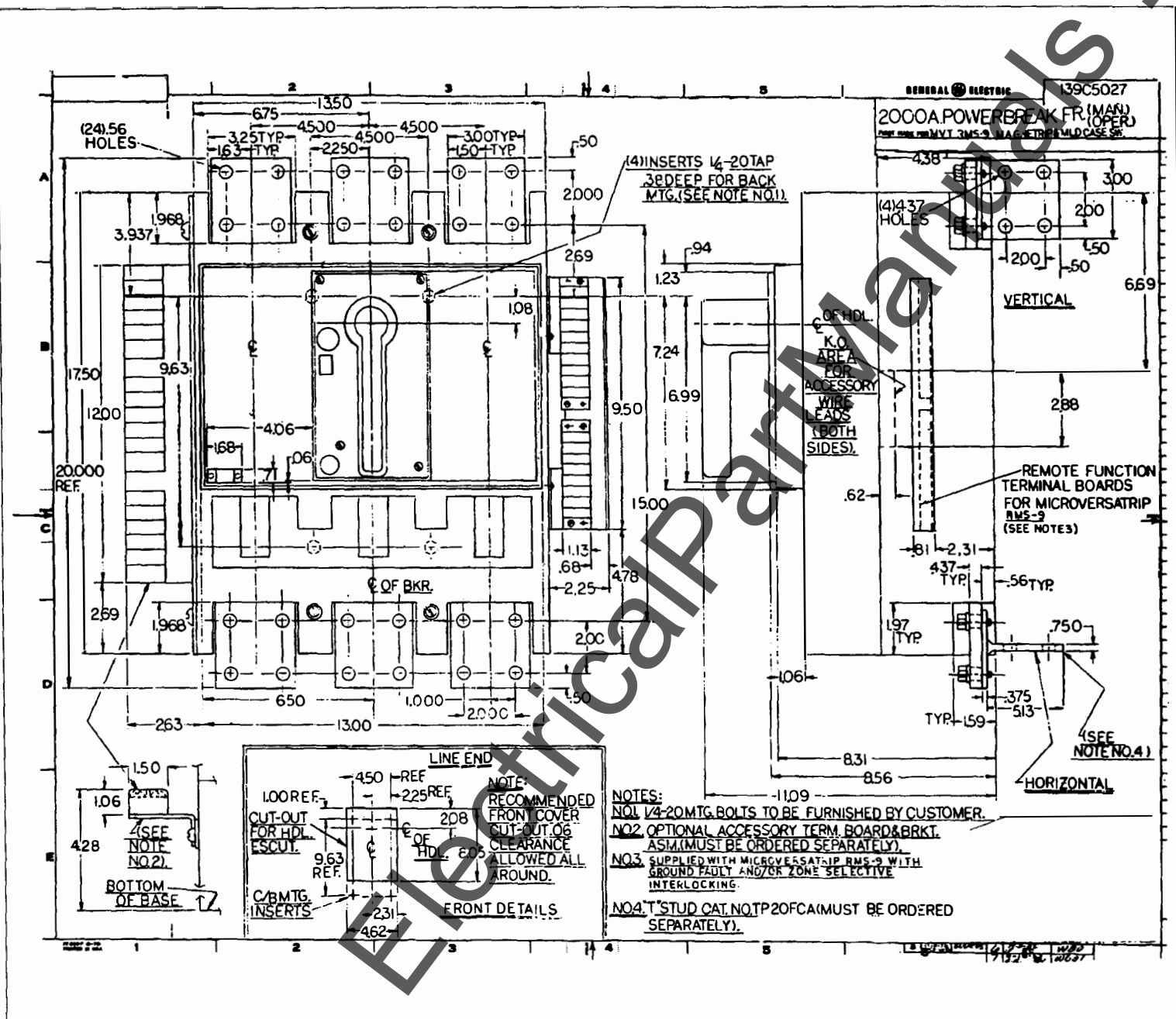
42



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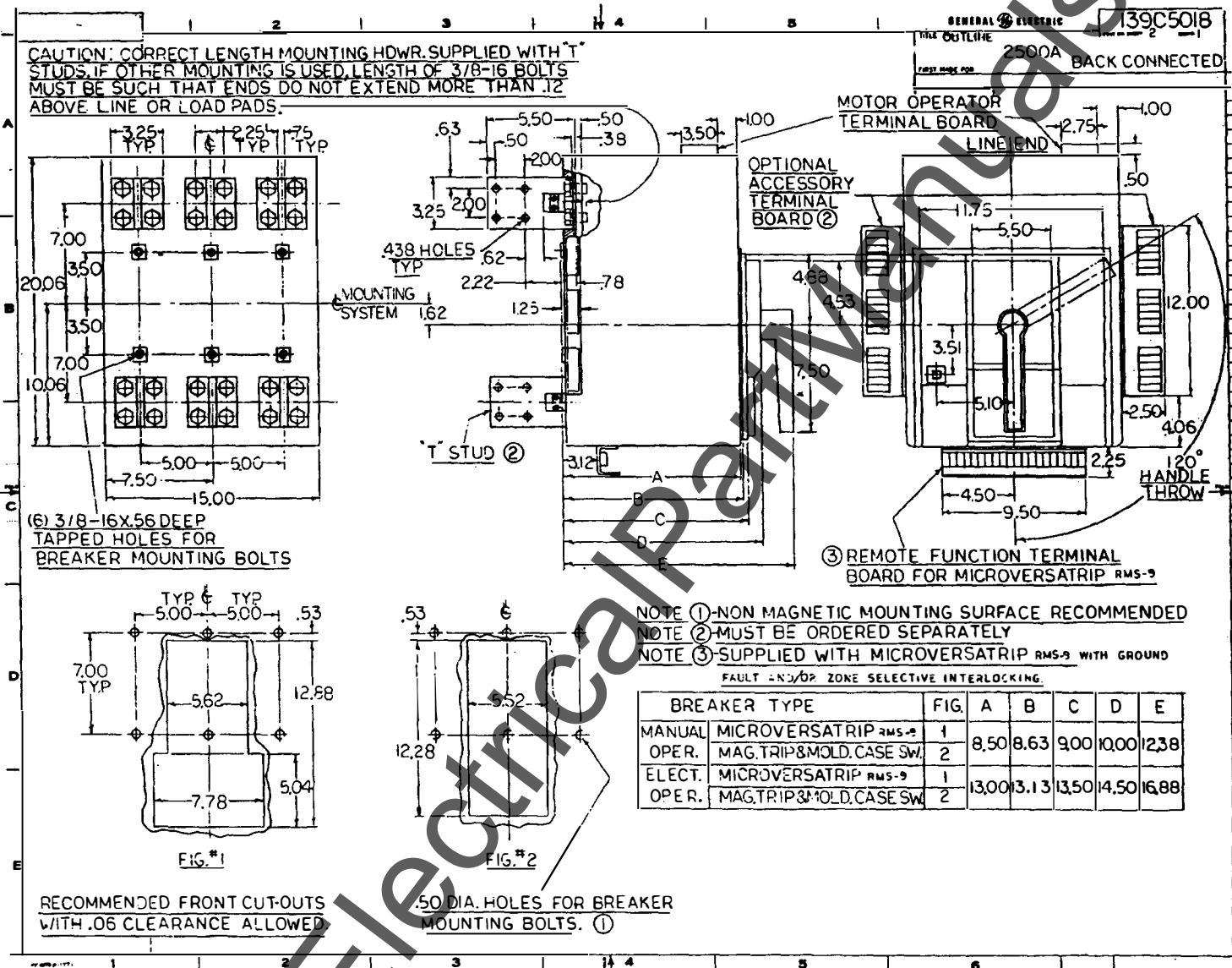


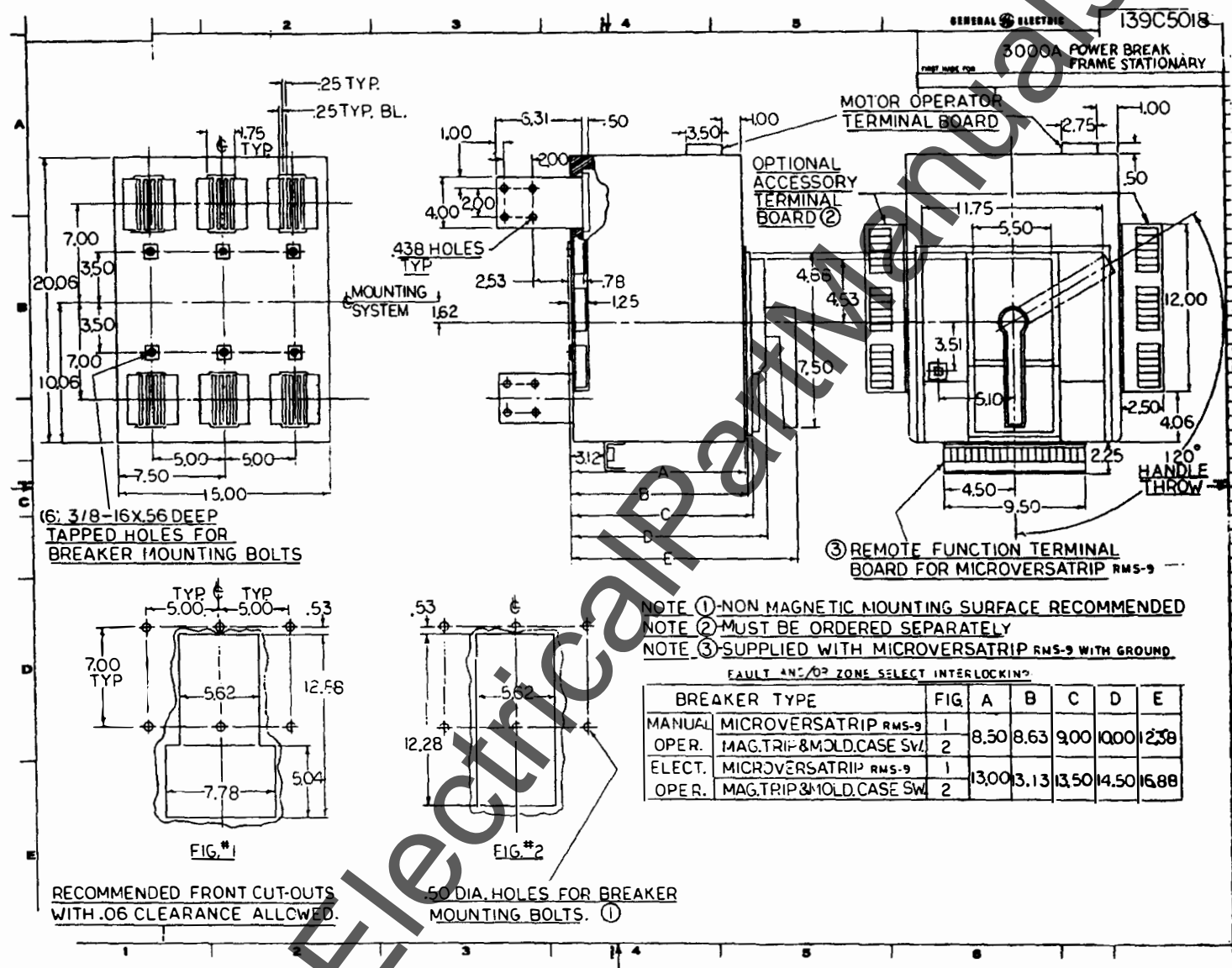
Fig. 44.1 2500A Stationary Frame



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Fig. 45.1 3000A Stationary Frame





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Com



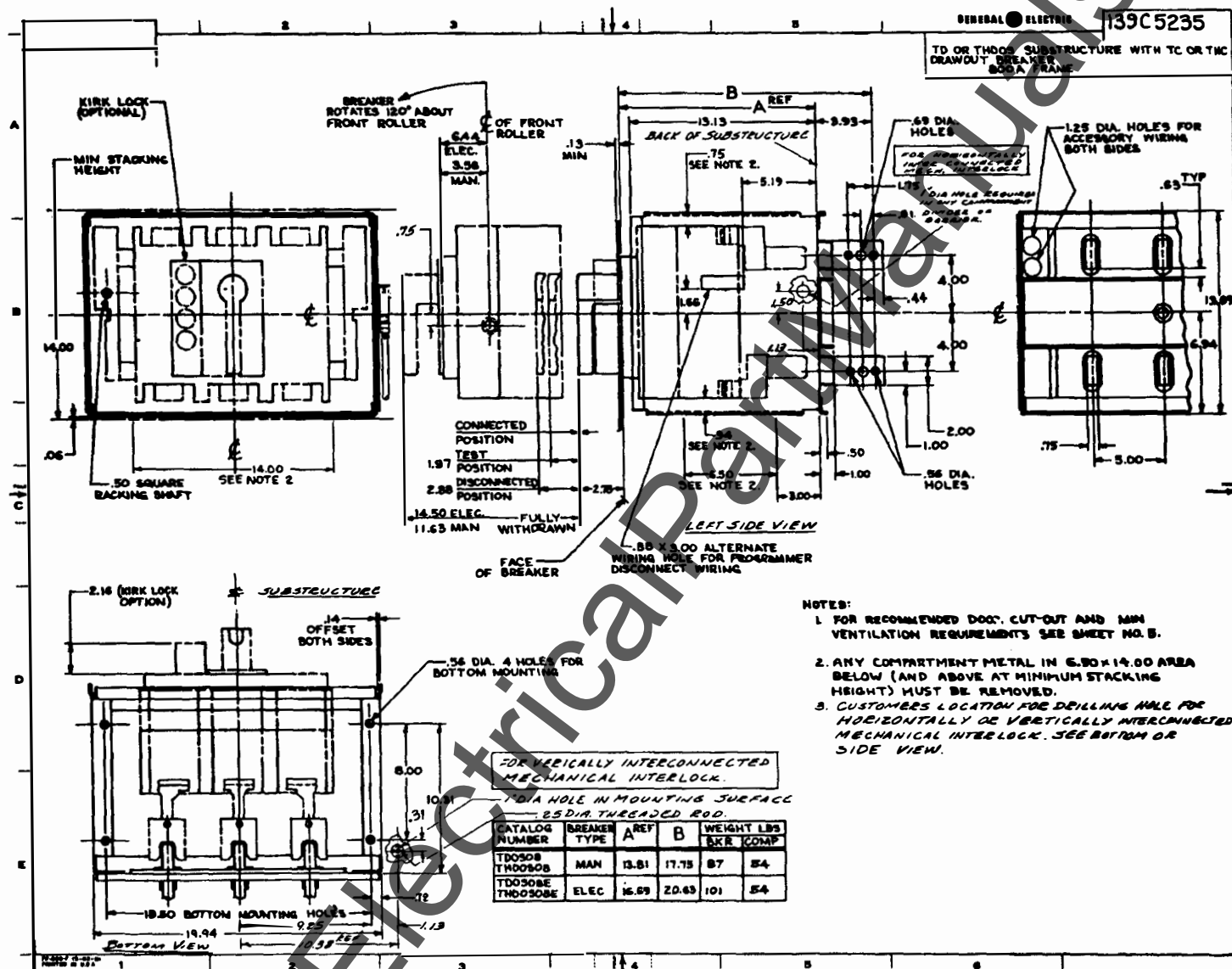
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Fig. 47.1 800A Draw-Out Frame





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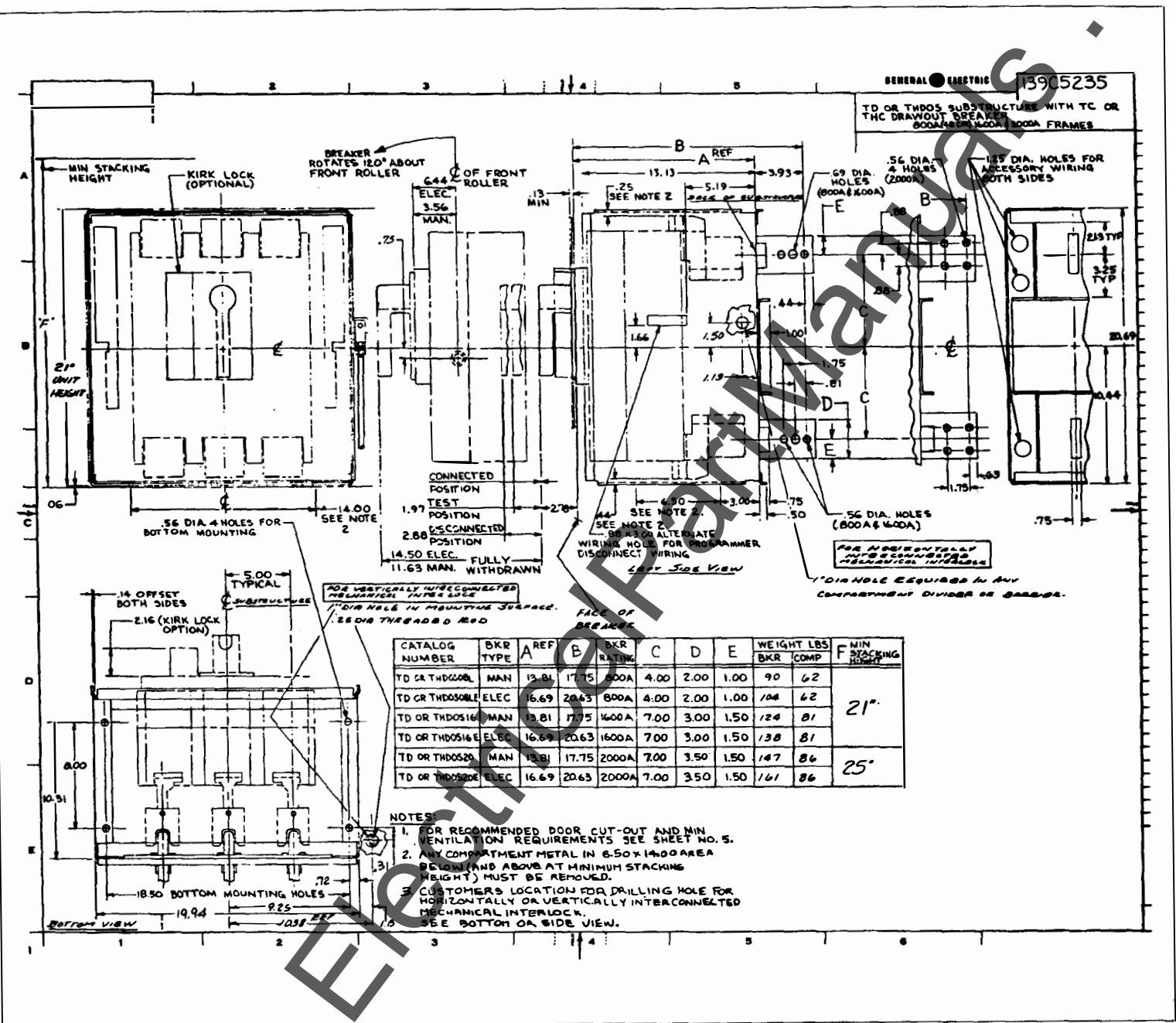


Fig. 48.1 800A (48-Disconnect), 12000A, 1600A Draw-Out Frame



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6



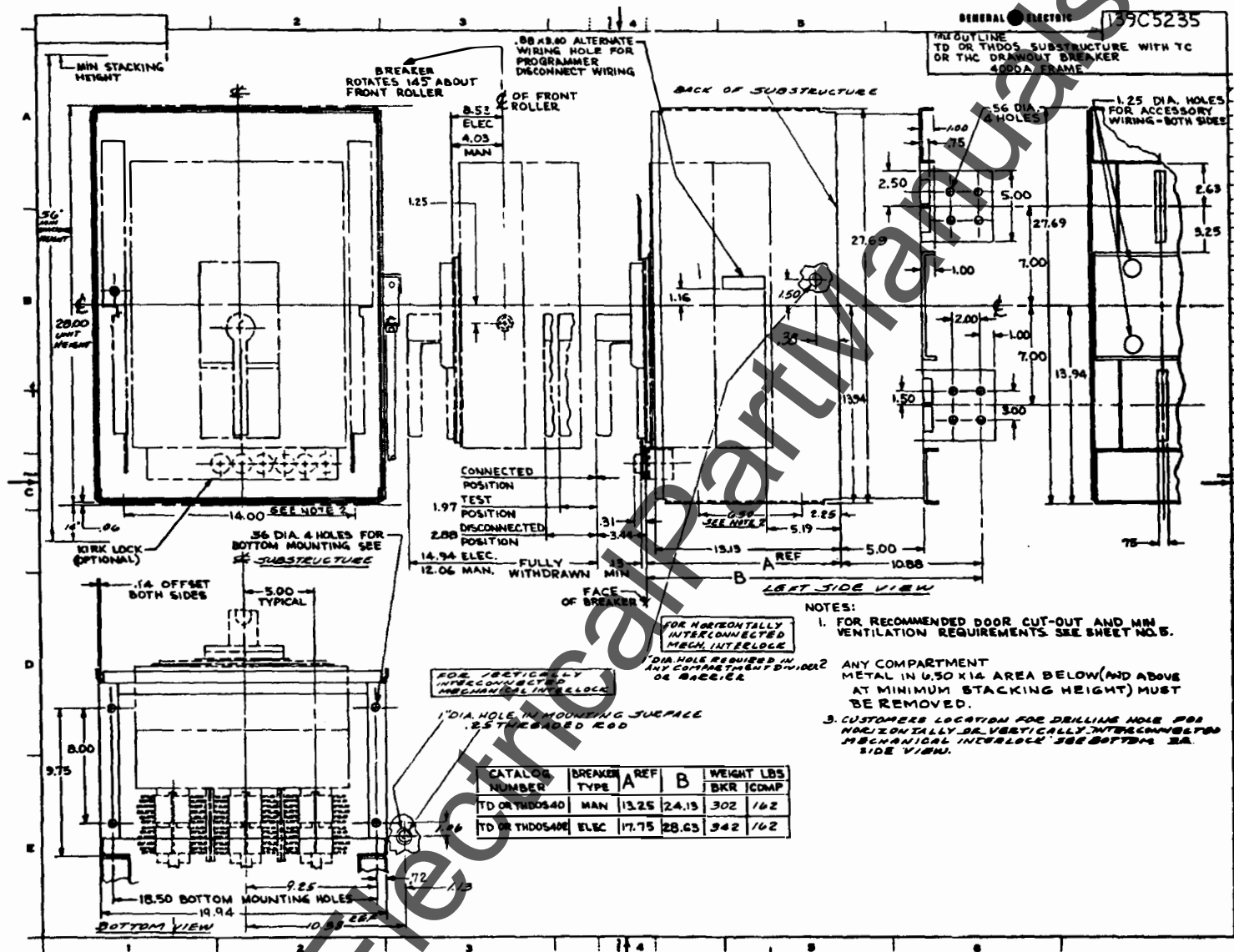


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# Outline Dimension Drawings (Continued)

Fig. 50.1 4000A Draw-Out Frame

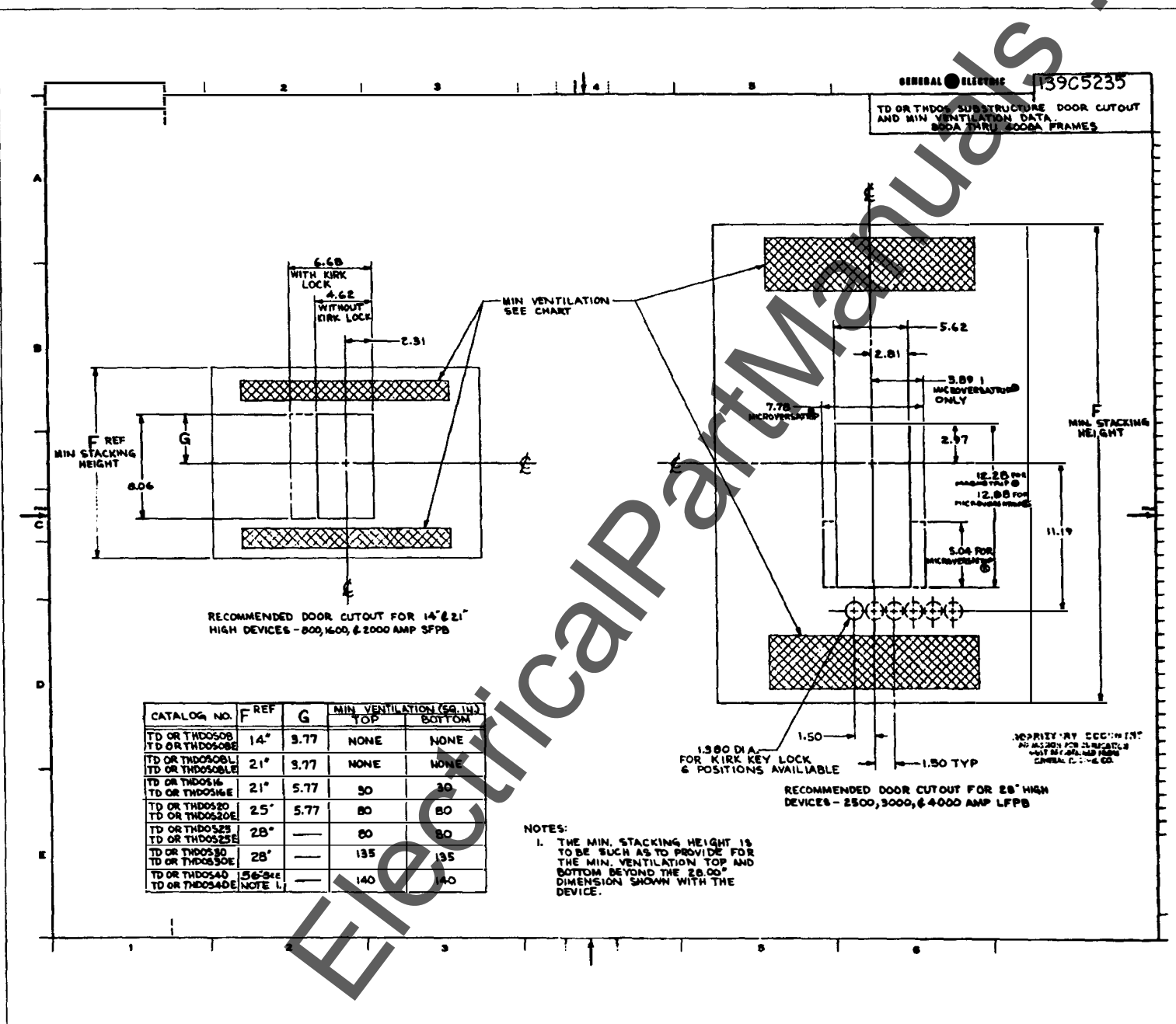




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Fig. 54.1 Door Cut-Out, Minimum Stacking Height and Ventilation Data





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## Breaker Outline Dimension Drawing Numbers

Table 52.1  
Outline Drawings

| Frame Size | Stationary Breaker   |                          |             |                          | Draw-out Breaker and Substructure Manual and Electrical |
|------------|----------------------|--------------------------|-------------|--------------------------|---|
|            | Manual               |                          | Electrical  |                          |   |
|            | Line Top             | Line Bottom <sup>①</sup> | Line Top    | Line Bottom <sup>①</sup> |   |
| 800A       | 139C5027SH1          | 139C5027SH2              | 139C5027SH1 | 139C5027SH2              | 139C5235SH1<br>139C5235SH2                              |
| 1600A      | 139C5027SH3          | 139C5027SH5              | 139C5027SH4 | 139C5027SH6              | 139C5235SH2   |
| 2000A      | 139C5027SH7          | 139C5027SH9              | 139C5027SH8 | 139C5027SH2              |   |
| 2500A      | 139C5018SH1          | 139C5018SH2              | 139C5018SH1 | 139C5018SH2              | 139C5235SH3   |
| 3000A      | 139C5018SH1          | 139C5018SH4              | 139C5018SH3 | 139C5018SH4              | 139C5235SH4   |
| 4000A      | See Table 52.3 below |                          |             |                          | 139C5235SH4   |

① Applicable to MagneTrip and Molded Case Switch only. All MicroVersaTrip® RMS-9 breakers are suitable for reverse feed.

Table 52.2  
T-Studs for Stationary Breakers

| Frame Size | Maximum Ampere Rating | T-Stud Catalog No.  |  | Outline Drawing No.              |
|------------|-----------------------|---------------------|--|----------------------------------|
|            |                       | Front Connected     | Back Connected                         |                                  |
| 800        | 800                   | TP08FCA             | —                                      | 139C4172 Sh. 12                  |
| 1600       | 1600                  | TP16FCA             | —                                      | 139C4172 Sh. 12                  |
| 2000       | 2000                  | TP20FCA             | —                                      | 139C5027 Sh. 7                   |
| 2500       | 2000<br>2500          | TS20FCA<br>TS25FCA  | TS20BCA<br>TS25BCA                     | 139C5018 Sh. 7<br>139C5018 Sh. 7 |
| 3000       | 3000                  | TS30FCA             | Supplied as standard—<br>not removable | 139C5018 Sh. 7                   |
| 4000       | 4000                  | TS40FCA<br>TS40LFCA | —<br>—                                 | 139C5018 Sh. 7<br>139C5018 Sh. 7 |

Table 52.3  
Stationary 4000A Outline Drawings

| 4000A Front Connected—MagneTrip |  |              |
|---------------------------------|--|--------------|
| Line Top—Manual                 |  | 139C4105SH1  |
| Line Top—Electrical             |  | 139C4105SH2  |
| Line Bottom—Manual              |  | 139C4105SH3  |
| Line Bottom—Electrical          |  | 139C4105SH4  |
| 4000A Front Connected—VersaTrip |  |              |
| Line Top—Manual                 |  | 139C4105SH10 |
| Line Top—Electrical             |  | 139C4105SH11 |
| Line Bottom—Manual              |  | 139C4105SH16 |
| Line Bottom—Electrical          |  | 139C4105SH17 |

Table 52.4  
Lug Adapter Kits for Stationary Breakers

| Breaker Frame Size | Adapter Catalog Number | Outline Drawing No. |
|--------------------|------------------------|---------------------|
| 800A               | TPLUGA08               | 139C4172 Sh. 11     |
| 1600A              | TPLUGA16               | 139C4172 Sh. 11     |

Table 52.5  
Neutral Sensors-MicroVersaTrip® RMS-9

| Breaker Frame (Amps) | Sensor Rating (Amps)   | Cat No.  | Outline Drawing No. |
|----------------------|--|--|---------------------|
| 800                  | 200<br>400/200<br>600/300 <sup>③</sup><br>800/400  | TSVG302<br>TSVG304A<br>TSVG306A<br>TSVG308A                                      | 139C5016 Sh. 1      |
| 1600                 | 800/400 <sup>③</sup><br>1000/500<br>1200/600 <sup>③</sup><br>1600/1000   | TSVG808A<br>TSVG810A<br>TSVG812A<br>TSVG816A                                     |                     |
| 2000                 | 2000/1000  | TSVG820A   |                     |
| 2500/3000            | 800/400 <sup>③</sup><br>1000/500<br>1200/600 <sup>③</sup><br>1600/1000 <sup>③</sup><br>2000/1200<br>2500/1800<br>3000/2400 | TSVG808A<br>TSVG810A<br>TSVG812A<br>TSVG816A<br>TSVG820A<br>TSVG825A<br>TSVG830A |                     |
| 4000                 | 4000/3000  | TSVG940A <sup>②</sup>  |                     |
|                      |  |  | 139C5016 Sh. 2      |

① Match neutral current sensor rating (or tap setting) to circuit breaker sensor rating.

② Do not use with 4000-amp stationary TSSS/THSS. Use Cat. No. TSSG40.

③ For use with multiple source ground fault protection schemes. Rating does not match MicroVersaTrip RMS-9 frame sensor.



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## Dimensions, Weights and Miscellaneous Data

Table 53.1  
Electrical Formula — For Obtaining kW, kVA, Horsepower and Amperes

| Wanted           | Alternating Current Single Phase                        | Two-phase, four-wire   | Direct Three-phase  | Current                                       |
|------------------|---|--|---|---|
| Kilowatts        | $I \times E \times PF$<br>1000                          | $I \times E \times 2 \times PF$<br>1000                          | $I \times E \times 1.73 \times PF$<br>1000                          | $I \times E$<br>1000                          |
| kVA              | $I \times E$<br>1000                                    | $I \times E \times 2$<br>1000                                    | $I \times E \times 1.73$<br>1000                                    | $I \times E$<br>1000                          |
| Horsepower       | $I \times E \times \% \text{ Eff.} \times PF$<br>746    | $I \times E \times 2 \times \% \text{ Eff.} \times PF$<br>746    | $I \times E \times 1.83 \times \% \text{ Eff.} \times PF$<br>746    | $I \times E \times \% \text{ Eff.}$<br>746    |
| Amperes from kVA | $kVA \times 1000$<br>E                                  | $kVA \times 1000$<br>$2 \times E$                                | $kVA \times 1000$<br>$1.73 \times E$                                | $kVA \times 1000$<br>E                        |
| Amperes from kW  | $kW \times 1000$<br>$E \times PF$                       | $kW \times 1000$<br>$2 \times E \times PF$                       | $kW \times 1000$<br>$1.73 \times E \times PF$                       | $kW \times 1000$<br>E                         |
| Amperes from Hp  | $Hp \times 746$<br>$E \times \% \text{ Eff.} \times PF$ | $Hp \times 746$<br>$2 \times E \times \% \text{ Eff.} \times PF$ | $Hp \times 746$<br>$1.73 \times E \times \% \text{ Eff.} \times PF$ | $Hp \times 746$<br>$E \times \% \text{ Eff.}$ |

KEY: E = Volts  
I = Amperes  
% Eff. = Percent Efficiency  
PF = Power Factor  
Hp = Horsepower

Table 53.2 shows minimum enclosure dimensions allowed under circuit breaker UL standard 489; the dimensions shown do not reflect enclosure dimensions offered by GE.

Table 53.2  
Minimum Enclosure Dimensions

| Max. Ampere Rating | Minimum Stationary Dimensions (Inches) |    |        | Minimum Ventilation Area (sq. in.) | Minimum Clearance to Ground (in.) |
|--------------------|--|----|--------|------------------------------------|-----------------------------------|
|                    | H                                      | W  | D      |                                    |                                   |
| 800                | 21                                     | 22 | 10-1/2 | 60                                 | 4-1/2                             |
| 1600               | 28                                     | 22 | 10-1/2 | 60                                 | 5                                 |
| 2000               | 35                                     | 22 | 8-3/4  | —                                  | 5                                 |
| 2500               | 36                                     | 25 | 15-1/2 | 160                                | 8                                 |
| 3000               | 40                                     | 32 | 15     | 240                                | 8                                 |
| 4000               | 51                                     | 29 | 17     | 270                                | 8                                 |

Note: Includes minimum clearance required to grounded metal from arc areas for standard Hi-Break or special Hi-Break.

Table 53.3  
Bolt Torques

| Breaker Frame | Terminal "T" Stud |                | Bus Connection  |                |
|---------------|-------------------|----------------|-----------------|----------------|
|               | Bolt Size (DIA)   | Torque (In-Lb) | Bolt Size (DIA) | Torque (In-Lb) |
| 800           | —                 | —              | (1) 1/2 in.     | 300            |
| 1200-1600     | (2) 3/8           | 200            | (2) 1/2 in.     | 300            |
| 2000          | (4) 3/8           | 200            | (4) 1/2 in.     | 300            |
| 2500-3000①    | (4) 3/8-16        | 200            | (4) 3/8 in.     | 200            |
| 4000          | (6) 1/2-13        | 300            | (4) 1/2 in.     | 300            |

① 3000A Back connected terminal studs are factory brazed to breaker.

Table 53.4  
Approximate Net Weights

| Frame Rating | Type       | Weight (Lbs) |         |
|--------------|------------|--------------|---------|
|              |            | Stationary   | Drawout |
| 800A         | Manual     | 50           | 87      |
| 800A         | Electrical | 64           | 101     |
| 1600A        | Manual     | 82           | 124     |
| 1600A        | Electrical | 96           | 138     |
| 2000A        | Manual     | 88           | 147     |
| 2000A        | Electrical | 102          | 161     |
| 2500A        | Manual     | 175          | 225     |
| 2500A        | Electrical | 215          | 265     |
| 3000A        | Manual     | 220          | 231     |
| 3000A        | Electrical | 260          | 271     |
| 4000A        | Manual     | 320          | 302     |
| 4000A        | Electrical | 360          | 342     |

Note: For transformer short circuit curves, refer to GE publication GET-3550.



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# Standards and References

---

Underwriters' Laboratories, Inc.

UL 489, Molded Case Circuit Breakers and Circuit Breaker Enclosures. Order from UL Publications Stock, 333 Pfingsten Road, Northbrook, Illinois 60062.

National Electrical Manufacturers Association (NEMA)

AB-1 Standards Publication—Molded Case Circuit Breakers. Order from NEMA Publications, 155 East 44th Street, New York, New York 10017.

Federal Specifications

W-C-375 B/GEN Circuit Breaker, Molded Case; Branch Circuit and Service. Order from General Services Administration, Specifications Distribution Unit, ROB, Rm 6662, 7th & D Sts., SW, Washington, DC 20407.

Institute of Electrical and Electronics Engineering (IEEE)

No. 45 Recommended Practice for Electrical Installation on Shipboard.

Order from IEEE Service Center, 445 Hoes Lane, Piscataway, New Jersey 08854.

National Electrical Code (NEC)

1987 Issue. Order from National Fire Protection Association, Batterymarch Park, Quincy, Ma. 02269.



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# Guide Form Specifications

Circuit breakers shall be General Electric Insulated Case POWER BREAK® and shall be UL listed in accordance with UL standard 489 and meet the requirements of NEMA Standard AB1-1975.

POWER BREAK insulated case circuit breakers equipped with MicroVersaTrip® RMS-9 programmers shall include a microelectronic digital processor which is automatic and self-contained, and requires no external relaying, power supply, or accessories. Its printed circuit cards shall be conformally coated to resist moisture absorption, fungus growth, and signal leakage and shall have highly reliable fixed-point programmable controls with repetitive accuracy and precise unit settings. All electronics shall be housed within a metallic enclosure to protect against high-fault interruption arcs, magnetic interference, dust and other contaminants.

The protective programmer shall digitally measure the "true" heating value of the current with an error of less than 1% on systems with distortions through the 13th harmonic. Peak sensing devices are not acceptable. In addition, the protective programmer shall utilize interchangeable rating plugs to change the continuous current rating. The rating plug shall be front accessible, permitting changing without removing the breaker from its cubicle.

The protective programmer shall have the following minimum features:

- A long-time timing light that provides visual indication that the breaker is approaching an overload (flashing light) or is timing out to trip (continuous light) under an overload.
- A clear plastic cover that is sealable to prevent unauthorized tampering of settings.
- The capability of being test-

ed with a portable test set while in service, with or without load current flowing.

- Eight adjustable current settings in discrete steps from 0.5 to 1.0 times the rating plug amperes.
- Four discrete long-time delay settings.

[Where specified, breaker shall have (1) adjustable short-time pickup and adjustable delay with I<sup>2</sup>t IN/OUT switch, (2) adjustable ground fault pickup and adjustable delay with I<sup>2</sup>t IN/OUT switch, (3) adjustable high instantaneous, (4) overload and short circuit and ground fault trip indicators, and/or zone selective interlocking for ground fault or for ground fault and short-time functions.]

Pick-up and delay settings shall be:

- Current setting — .5, .6, .7, .8, .85, .9, 1.0 times rating plug amperes
- Long-time delay — 1, 2, 3, 4
- Short-time pick up — 1.5, 2, 2.5, 3, 4, 5, 7, 9 times current setting
- Short-time delay — minimum, intermediate, maximum with or without I<sup>2</sup>t slope
- Instantaneous pick up — multiples of rating plug amperes:
  - With short-time — 1.5, 2, 3, 5, 7, 9, 10, 13, 15 for 800-2000A frame ratings; 1.5, 2, 3, 5, 7, 9, 10, 13 for 2500 and 3000A frames; 1.5, 2, 3, 5, 7, 9 for 4000A frame
  - Without short-time — 1.5, 2, 3, 5, 7, 9, 10 for 800-3000A frame ratings; 1.5, 2, 3, 5, 7, 9 for 4000A frame
- Ground fault pick up — multiples of sensor ampere rating:
  - .2, .25, .3, .35, .4, .45, .5, .6 for 200-2000A sensors

– .2, .22, .24, .26, .28, .3, .34, .37 for 2500 and 3000A sensors

– .2, .22, .24, .26, .28, .3 for 4000A sensor

- Ground fault delay — minimum, intermediate, maximum with or without I<sup>2</sup>t slope

Current sensors shall be of toroidal construction, encased in a plastic housing filled with epoxy to protect against damage and moisture and shall be integrally mounted on the breaker. [For four-wire ground fault, a fourth current sensor shall be included with construction similar to the phase overcurrent sensors.]

The ground fault function shall contain a memory circuit which integrates arcing fault current with time essentially summing intermittent ground-current spikes.

A hand-held, portable, plug-in test kit shall [be provided] [be available] for testing and verifying the MicroVersaTrip RMS-9 programmer settings. The test kit shall plug into the front of the programmer to permit testing while the breaker is in service using a no-trip or trip mode.

POWER BREAK insulated case circuit breakers with MicroVersaTrip RMS-9 programmers shall be rated to carry 100% current continuously and shall be [stationary] [draw-out] construction. These breakers shall be [standard break] [Hi-Break®] and have current interrupting ratings equal to or greater than specified at the system voltage.

When specified, the breakers shall be provided with an adjustable high instantaneous option permitting a maximum pickup equal to the breaker short-time rating. Breaker short-time ratings shall be as shown in Table 51.1.

The breaker shall be equipped with a field installable, UL listed interchangeable rating plug which shall fix the continuous current-carrying value of the circuit breaker frame as specified on the drawings.

Breakers shall be [manually] [electrically] operated and shall have a stored energy charging mechanism and independent closing function. The closing function shall be [local only via a closing button on the face of the breaker] [both local and remote]. [The local closing function shall employ a "hidden" ON button to preclude unintentional closing of a charged breaker.]

[Breakers shall be equipped with one or more of the following internal control accessories as specified on the drawings:

- Auxiliary switches
- Shunt trip
- Undervoltage release
- Bell alarm with lockout]

[One or more of the following external accessories shall be provided as specified on the drawings:

- Terminal blocks for terminating internal accessory leads on stationary breakers
- Door interlock and padlock or padlock only
- Kirk key provision
- Mechanical ("walking beam") interlock
- T-studs]



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## Guide Form Specifications (Continued)

MagneTrip™ POWER BREAK insulated case circuit breakers shall employ temperature insensitive, dual-magnetic trip units with adjustable ampere setting plus either adjustable instantaneous or fixed instantaneous with adjustable short-time functions. The long-time delay shall be achieved by use of a temperature insensitive silicone-filled dashpot.

MagneTrip POWER BREAK circuit breakers shall be UL listed to carry 100% current continuously and shall be so labeled.

MagneTrip breakers shall have UL listed ac and dc ratings, including 600 Vdc for 2500-4000A frame sizes.

Table 56.1  
POWER BREAK Circuit Breakers with  
MicroVersaTrip RMS-9 Short Time Ratings

| Circuit Breaker<br>Envelope Size (Amps) | 500 Millisecond Short-time Rating<br>in KA rms Sym at 600 Vac Max. |
|---|--|
| 800                                     | 25   |
| 1600, 2000                              | 30   |
| 3000, 4000                              | 42   |



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# Other Appropriate Publications

## General Instructions, Breakers and Accessories

|  |          |
|--|----------|
| Circuit Breaker Construction Details (800-4000A) . . . . | GEF-4458 |
| MicroVersaTrip® RMS-9 Programmer (800-4000A) . . .       | GEH-4657 |
| MagneTrip™ Trip Unit (2500-3000A) . . . . .              | GEH-4658 |
| POWER BREAK® Circuit Breaker (800-2000A) . . . . .       | GEH-4693 |
| General Information                                      |          |
| Accessory Installation                                   |          |
| POWER BREAK Circuit Breaker (2500-4000A) . . . . .       | GEH-4694 |
| General Information                                      |          |
| Accessory Installation                                   |          |
| POWER BREAK Draw-out Breakers (800-4000A) . . . .        | GEH-4698 |

## Field Installed Accessories and Options

|   |           |
|---|-----------|
| Padlock Accessory (2500-4000A) . . . . .  | GEH-3394  |
| Bell Alarm For MagneTrip (2500-4000A) . . . . .                                 | GEH-3403  |
| Terminal Board For Accessories (800-4000A) . . . . .                            | GEH-3407  |
| Circuit Breaker Enclosure (800-4000A) . . . . .                                 | GEH-3498  |
| Lug Kits (2500-4000A) . . . . .   | GEH-4303  |
| Key Interlock Mounting (800-4000A) . . . . .                                    | GEH-4324  |
| Key Interlock Mounting (Old Style) (2500-4000A) . . .                           | GEH-4341  |
| Bell Alarm For MicroVersaTrip RMS-9<br>(2500-4000A) . . . . .                   | GEH-4358  |
| Mechanical Interlock-Stationary Breakers<br>(800-4000A) . . . . .               | GEH-4383  |
| Remote Close Option (2500-4000A) . . . . .                                      | GEH-4544  |
| Lug Kits (800-2000A) . . . . .  | GEH-4546  |
| POWER BREAK Draw-out Secondary Disconnect<br>(800-4000A) . . . . .              | GEH-4696  |
| POWER BREAK Draw-out Substructure, Accessories<br>(800-4000A) . . . . .         | GEH-4697  |
| POWER BREAK Draw-out Motor Cutoff Switch<br>(800-4000A) . . . . .               | GEH-4699  |
| POWER BREAK Draw-out Mechanical Interlock<br>(800-4000A) . . . . .              | GEH-5006  |
| MicroVersaTrip RMS-9 Portable Test Kit<br>(Cat. No. TVRMS) . . . . .            | GEK-97367 |
| MicroVersaTrip Test Set (800-4000A)<br>(not for MicroVersaTrip RMS-9) . . . . . | GEK-64464 |

## Field Replacement Parts

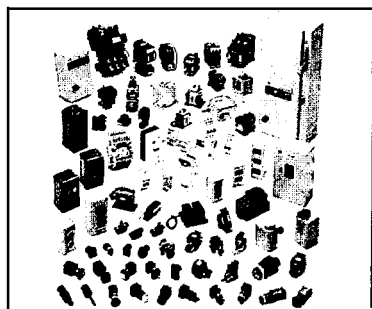
|  |          |
|--|----------|
| Handle and Arc Chute (2500-4000A) . . . . .      | GEF-4456 |
| Cam, Latch, Reset Fork (2500-4000A) . . . . .    | GEF-4459 |
| Motor Operator Components (2500-4000A) . . . . . | GEF-4553 |
| Handle (800-2000A) . . . . .                     | GEF-4557 |



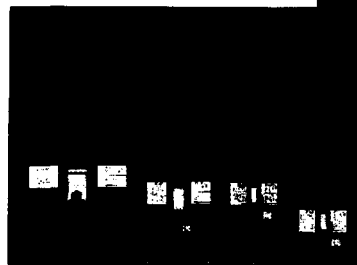
[www.ElectricalPartManuals.com](http://www.ElectricalPartManuals.com)



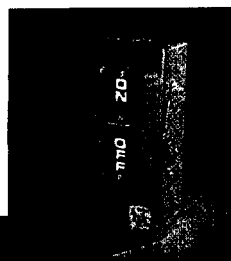
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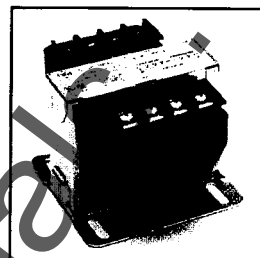
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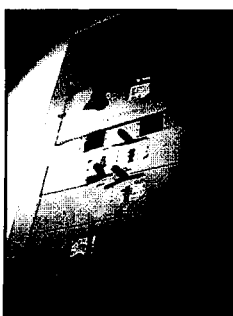
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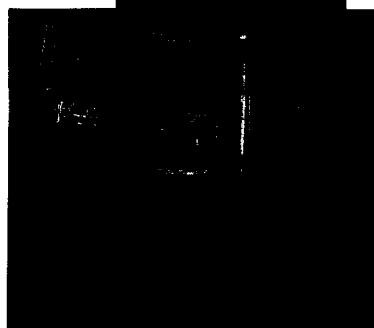
C



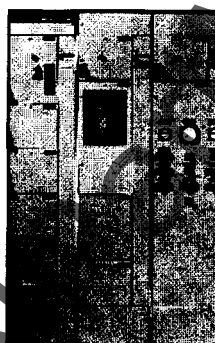
D



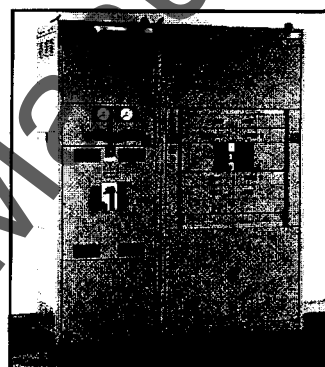
E



G



H



F



I

#### A General Purpose Controls

- Motor starters
- Push buttons •Relays

#### B Circuit Breakers

- Molded case •Insulated case
- Low voltage power
- Medium voltage distribution

#### C Disconnect Switches

- General & heavy duty •High pressure contact
- Safety switches

#### D Specialty Transformers

- Dry type •Volt-Pac® •Core & coil
- Integral distribution centers
- Power conditioning equipment

#### E Panelboards

- Lighting •Distribution •Service entrance
- Residential load centers

#### F Switchboards

- Group mounted •Individually mounted
- Service entrance

#### G Switchgear

- Low voltage •Medium voltage
- Power management systems

#### H Motor Control Equipment

- Low voltage motor control centers
- Limitamp® medium voltage motor control

#### I Busway

- Lighting •Feeder & plug-in

#### Other Products

- Arresters & capacitors •Metering products
- Modular metering

For a Publication Index that references available publications on all our products, write to GE Electrical Distribution and Control, Literature Distribution Center, P.O. Box 2913, Bloomington, IL 61702-2913 or fax (309) 662-9660.



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