GET-6937

Introducing
MicroVersaTrip® RMS-9
Programmer and
Epic MicroVersaTrip™
System

AKD-8 Switchgear

GENERAL ELECTRIC

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General Description

AKD-8 switchgear is a heavy-duty equipment built to ANSI Standards and uses only Low Voltage Power Circuit Breakers for the circuit protective devices. It is designed to have more margin within its ratings to provide maximum continuity of service for those applications subject to severe duty such as repetitive switching encountered with motor starting, power factor correction demand control and load shedding, etc. A major factor contributing to this extended continuity of service is the availability of renewal parts complete with detailed maintenance instructions and original equipment documentation. From a coordination standpoint, the type AKR circuit breakers can provide full selectivity with each other and with other protective devices. The bus is thermally rated; i.e. based upon temperature rise, as contrasted to switchboards where the bus is sized on a current density basis.

AKD-8 switchgear houses type AKR low voltage power circuit breakers, instrumentation and other auxiliary circuit protective devices. It is available in single ended or double ended configuration and applied as a power distribution unit or as part of a unit substation in indoor or outdoor construction.

AKD-8 switchgear complies with ANSI Standards C37.20, NEMA SG-5 and is Underwriter Laboratories Listed to Standard 1558. The switchgear has been conformance tested according to ANSI C37.51.

The ANSI Standards require that the switchgear perform at the ratings of the devices installed. Short circuit ratings are based on tests performed at 15% power factor and two 30 cycle withstand tests with a 15 second interval, at 635Vac maximum contrasted with a single 3 cycle withstand test at a 20% power factor for switchboards at 600Vac maximum.

AKD-8 switchgear is available to the following maximum nominal ratings: 600V AC, 250 DC, 4000A AC, 6000A DC, 50/60 Hertz, 2200V AC RMS dielectric, and 200,000A sym. short circuit. It is designed to be operated in an ambient temperature between -30°C and 40°C.

The low voltage power circuit breakers available for the AKD-8 switchgear are type AKR available in five frame sizes, 800A AKR-30S, 30H; 1600A AKR-50, 50H; 2000A AKRT-50H; 3200A AKR-75; 4000A AKR-100. These breakers can be equipped with current limiting fuses. The fuses are integrally mounted on the AKRU-30S, and AKRU-50 breakers while a separate fuse carriage is required for AKRT-50H, AKR-75 and 100 breakers.

Features and Characteristics

Safety Features

- System safety

  Both standard and optional features are available with AKD-8 switchgear to provide electrical distribution equipment that will meet the increasing industry emphasis on system reliability and operating personnel safety.

- Closed door operation

  Breaker compartment doors have no ventilation openings, thus protecting operators from hot ionized gases vented by the breaker during circuit interruption.

- Closed door draw-out

  True closed-door draw-out is standard construction with all AKD-8 switchgear equipment. The breaker compartment doors remain stationary and closed while the breaker is racked out from the connected, through test to the disconnected position.

- Closed door control circuit accessibility

  A standard slide-out instrumentation tray is located above each breaker compartment eliminating cross-hinge wiring. When required, horizontal-edgewise ammeter, ammeter switch and indicating lights can be mounted on the front of the tray. Additionally, fuses for close and trip circuits can be mounted inside the tray, being accessible with the tray pulled out. Routine wiring inspections and fuse checks or fuse replacements can be performed with the breaker compartment door remaining closed so that operators are protected from energized primary circuits.

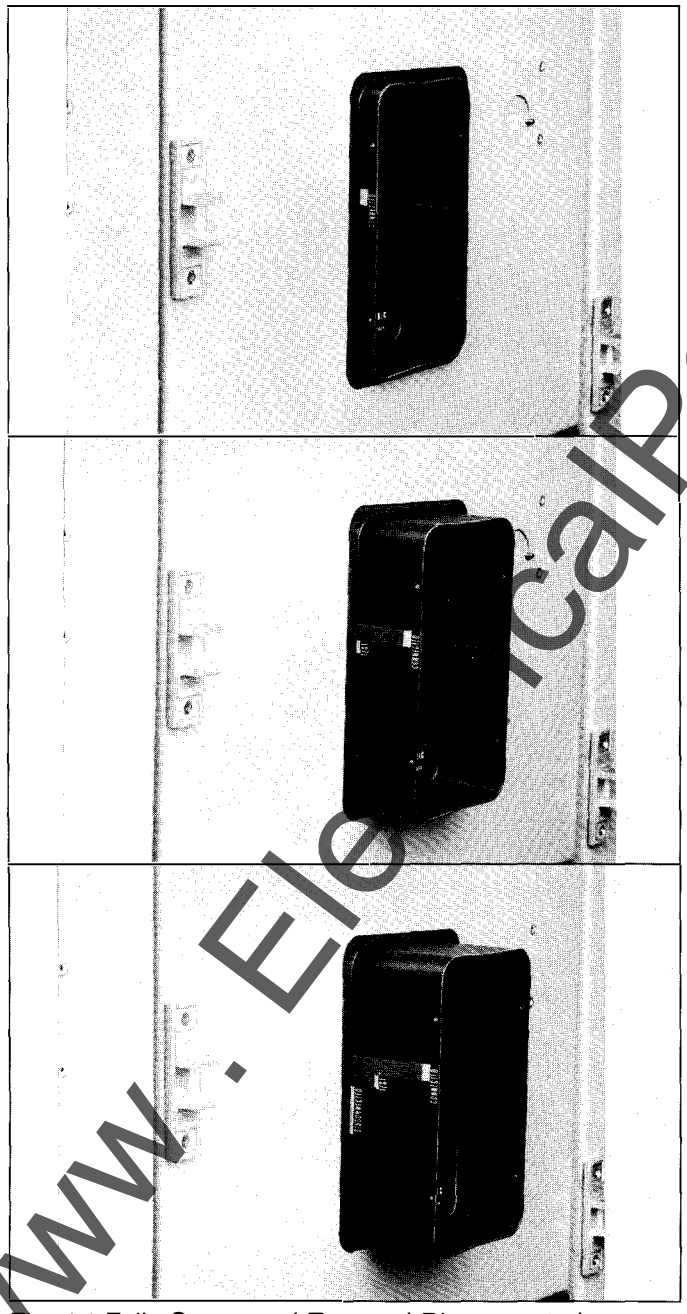


Fig. 4.1 Fully Connected Test and Disconnected Positions

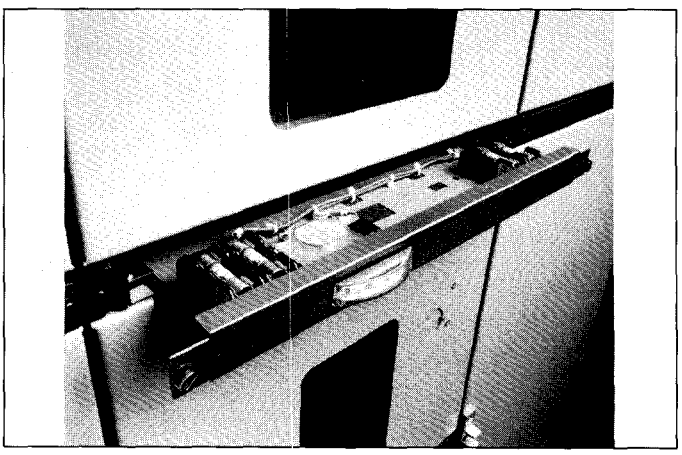


Fig. 4.2 Slide-out Tray

Safety Features (Continued)

- Safety shutters

  Safety shutters are optionally available in breaker compartments. They protect operators from accidental contact with live conductors when breaker is withdrawn.

- INSUL-BAR● insulated/isolated bus system

  An optional completely insulated/isolated bus bar system is available so that the only exposed energized parts in the rear power cable compartment are the outgoing feeder connections.

  The main bus has an epoxy coated insulation and molded Noryl● resin covers over busbars and joints.

  The vertical bus is nested between insulated phase barriers which are part of the glass reinforced back barriers. The runbacks for load connections can be insulated.

  The load cable area is completely isolated from the horizontal and vertical bus leaving only the load connections exposed.

- Interlocking and locking features

  LVPCB locking - As a standard feature, the LVPCB can be padlocked in the open position with up to three padlocks with 3/8″ shank to prevent unauthorized closing and racking of the breaker.

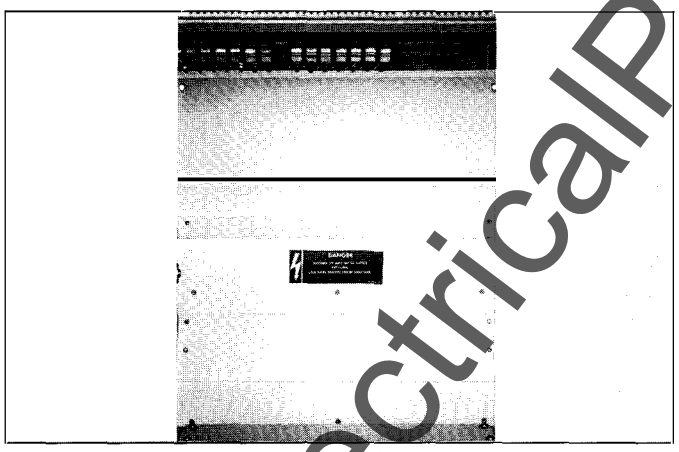


Fig. 5.1 Shutters Closed

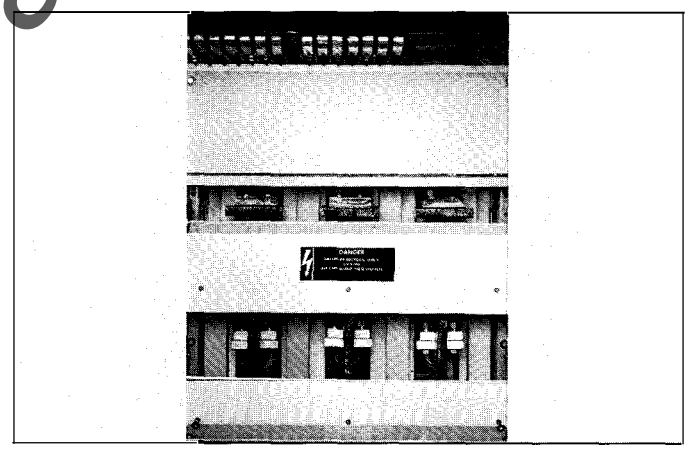


Fig. 5.2 Shutters Open

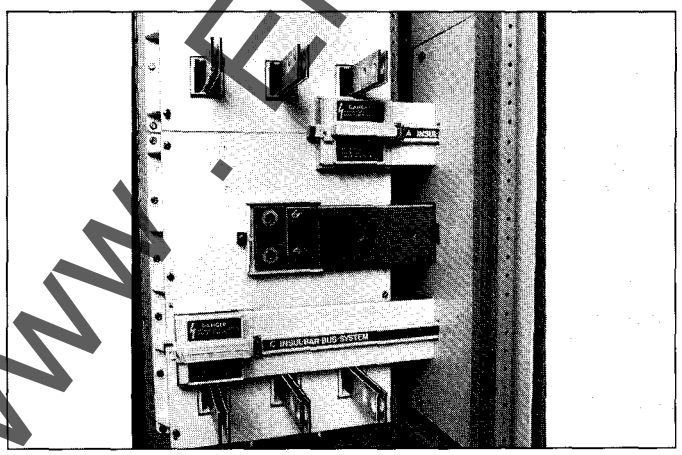


Fig. 5.3 Insul-Bar® Bus System

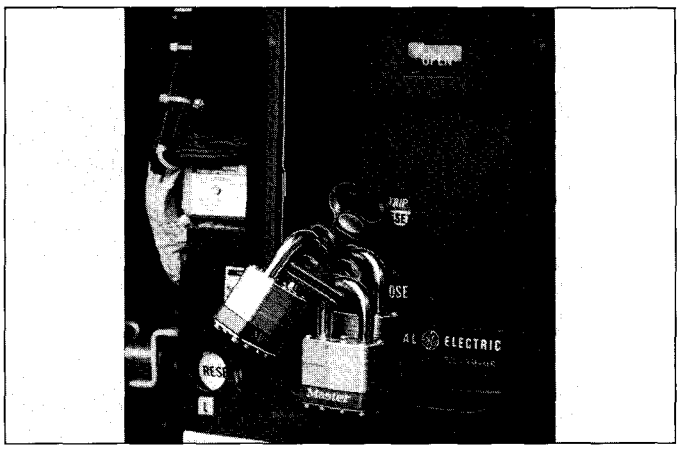


Fig. 5.4 Breaker Padlocking

Safety Features (Continued)

■ Interlocking and locking features (continued)

Breaker insertion and withdrawal interlocks - Interlocks prevent racking the breaker in or out when the breaker contacts are closed.

Breaker rejection feature - A rejection system is provided in each breaker compartment to prevent the insertion of a breaker with inadequate short circuit and/or incorrect continuous current ratings.

Key interlocks - This option provides for compulsory locking of breaker in the open, trip free position when fully connected. Applicable schemes would be mechanical interlocking of two breakers so only one can be closed at a time, or, in load center unit substations, interlocking of primary switch and secondary main breaker such that secondary main must be open before primary switch can be operated. Single and double key locks are available. Key locking does not prevent operation when breaker is in the test or disconnect position.

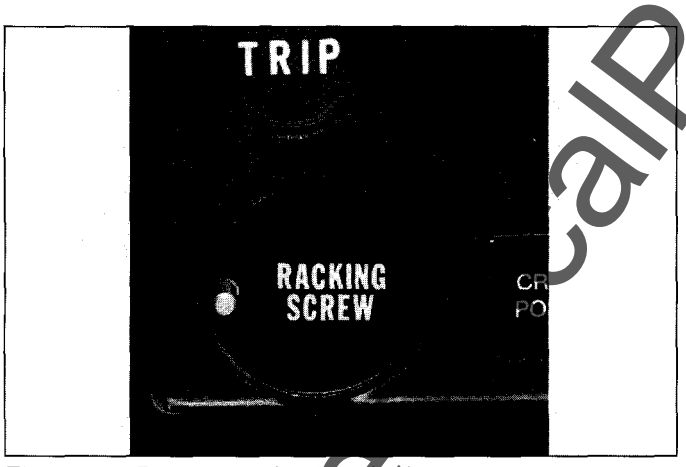


Fig. 6.1 AKR-50 Negative Interlock

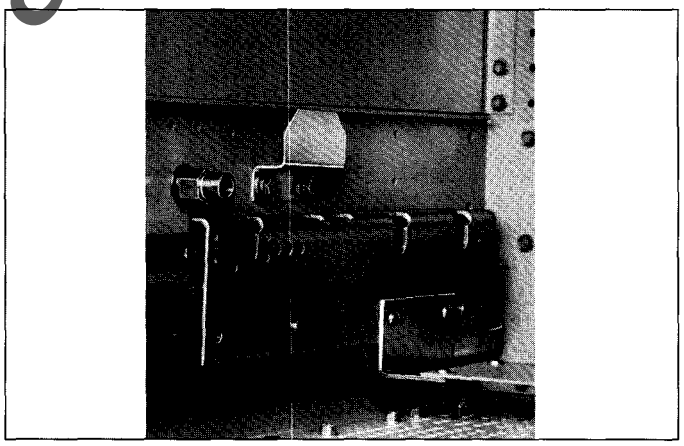


Fig. 6.2 AKR-50 Positive Interlock

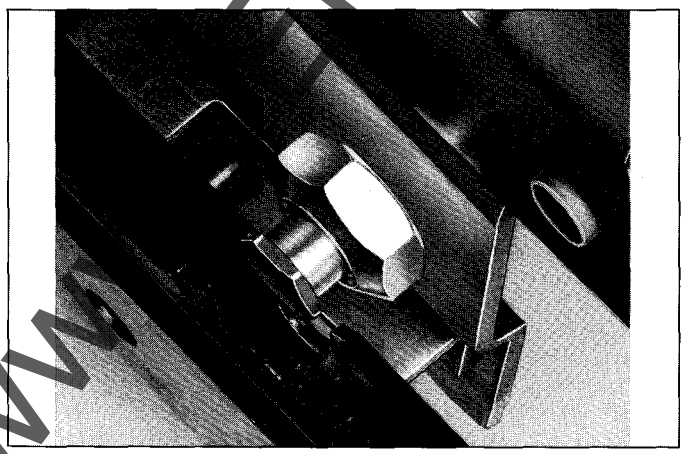


Fig. 6.3 Breaker Rejection Feature

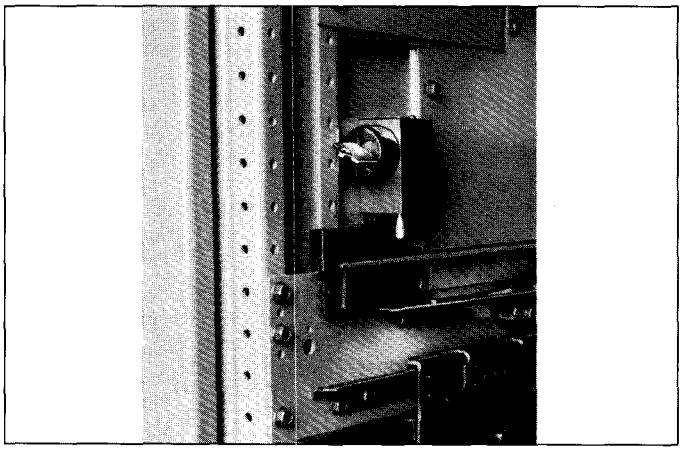


Fig. 6.4 Key Interlock

Safety Features (Continued)

- Interlocking and locking features (continued)

  Defeatable door interlock - This option prevents inadvertent opening of compartment door unless breaker is in the disconnect position. Provision is made for authorized defeat of interlock.

  Padlockable door latch - Provision is optionally available to padlock door latch to prevent unauthorized entry into breaker compartment.

  Draw-Out padlock provision - A mechanism padlock device is optionally available to lock out the draw-out mechanism in the test or disconnect position. This provision will accept up to three padlocks.

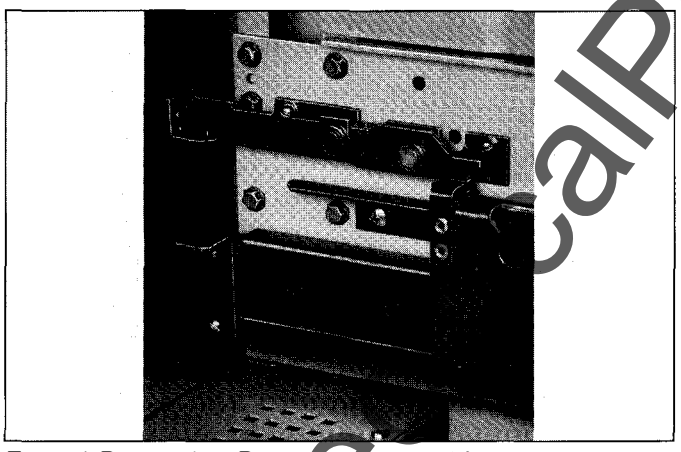


Fig. 7.1 Defeatable Door Interlock Inside

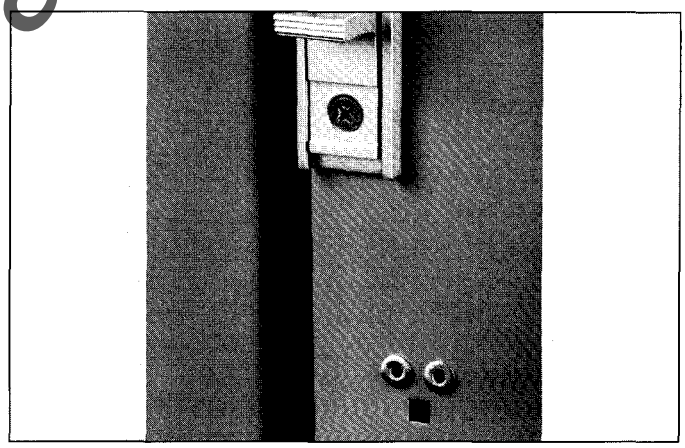


Fig. 7.2 Defeatable Door Interlock — Outside

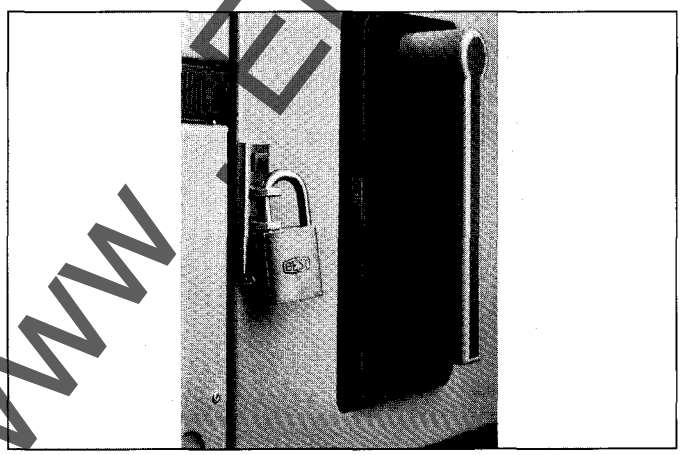


Fig. 7.3 Padlockable Door Latch

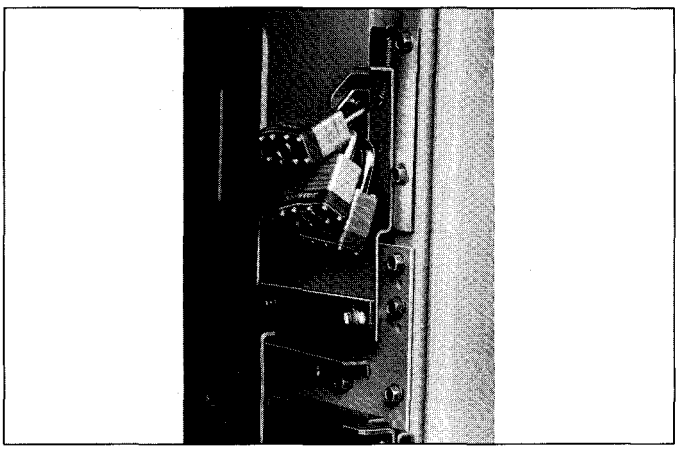


Fig. 7.4 Draw-Out Padlock Provision

Reliability Features

■ Circuit Isolation

Isolated breaker compartment - Each circuit breaker is located in a completely enclosed ventilated compartment with grounded metal steel barriers to minimize the possibility of fault communication between components.

Control circuit isolation - Control wires are run between compartments in steel riser channels. Wires to customer terminal clocks (in rear cable area) are run in front to back Noryl® resin sleeves. Intercubicle wiring is run in a metal enclosed wireway on top of the switchgear where interconnection terminal blocks are located.

Bus isolation - Each of the three vertical buses are nested in individual channels of the rear glass reinforced molded polyester base. Optionally available is complete insulation/isolation by fastening a sheet of glass polyester over the back of the vertical channels and epoxy coating the three horizontal busses which are arranged one above the other edge to edge to provide the minimum horizontal surface for accumulation of dust or contaminants. An extruded Noryl® resin cover is installed over the epoxy coating to provide a high degree of protection from possible physical damage. Finally, a

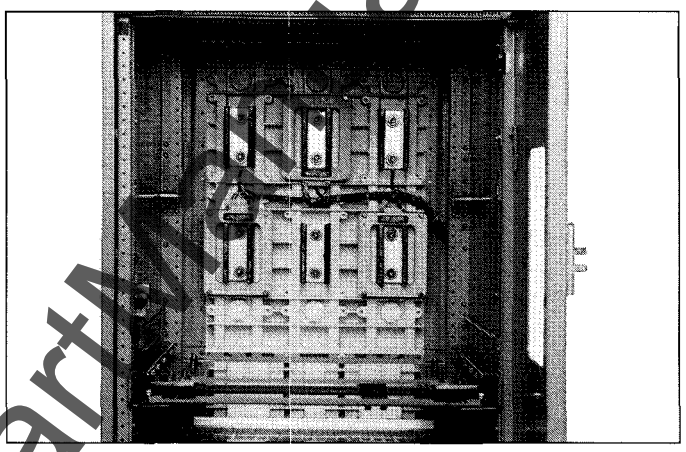


Fig. 8.1 AKR-75 Breaker Compartment

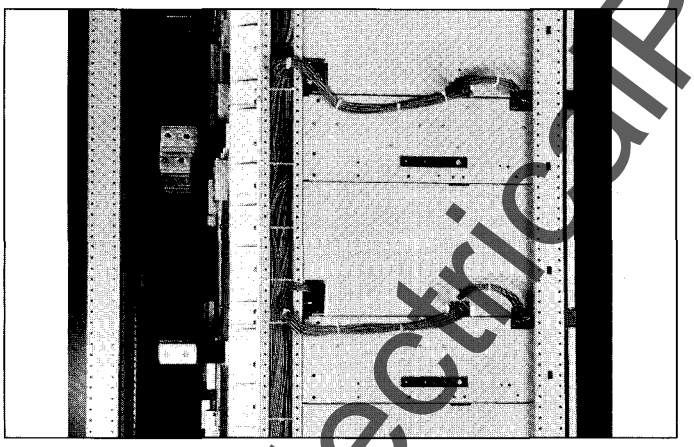


Fig. 8.2 Front to Rear Section Wiring

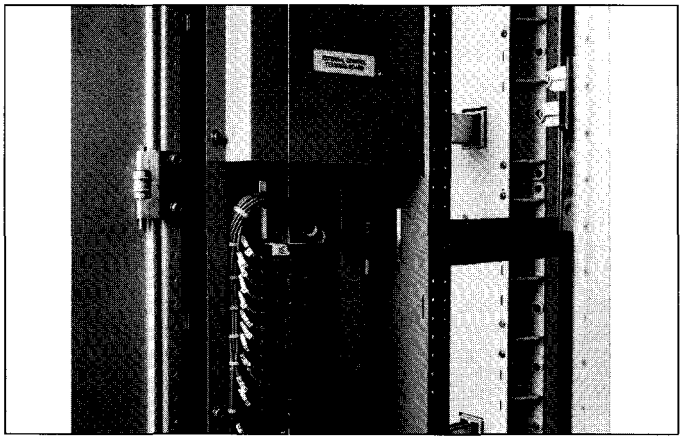


Fig. 8.3 Rear Terminal Block Compartment Wiring

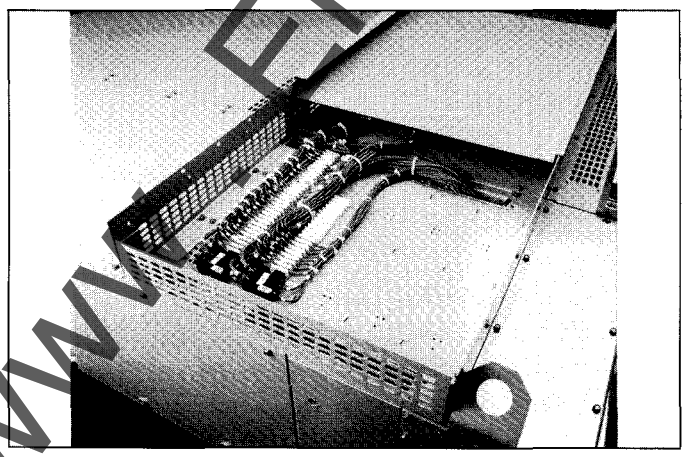


Fig. 8.4 Top Wiring Trough

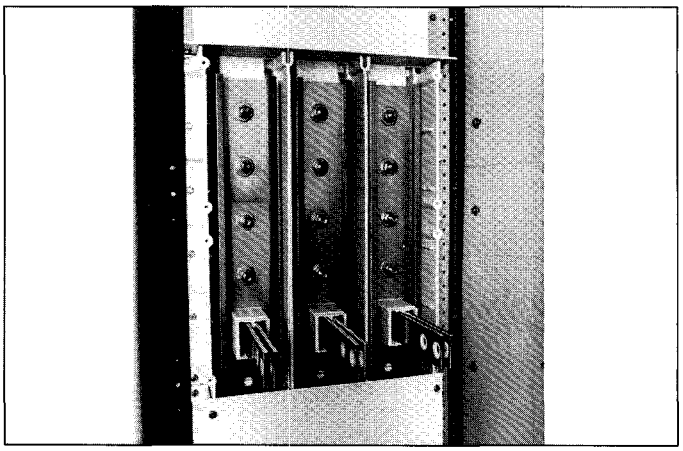


Fig. 8.5 Bus Isolation

Reliability Features (Continued)

cover, easily removed for maintenance provides insulation/isolation of area where the horizontal bus is connected to the vertical bus. Larger ampere ratings may use a boxed in cover to provide isolation. This cover is removable for maintenance.

Seismic tested - AKD-8 equipment has been seismically tested to certify its capability to withstand the most severe earthquake conditions and meets seismic requirements of the U.S.A. Uniform Building Code.

Computer generated drawings - AKD-8 drawings are computer generated. This assures consistently accurate drawings for the customer.

Welded aluminum bus - Welded aluminum bus is standard with welded main and vertical bus throughout. The main bus would only have bolted connections at the shipping splits. This welded aluminum bus means high reliability and integrity for the switchgear bus system.

Bolted copper bus - Bolted copper bus, ring silver plated at bolted connections is optionally available.

Fig. 9.1 Computer Generated Drawings

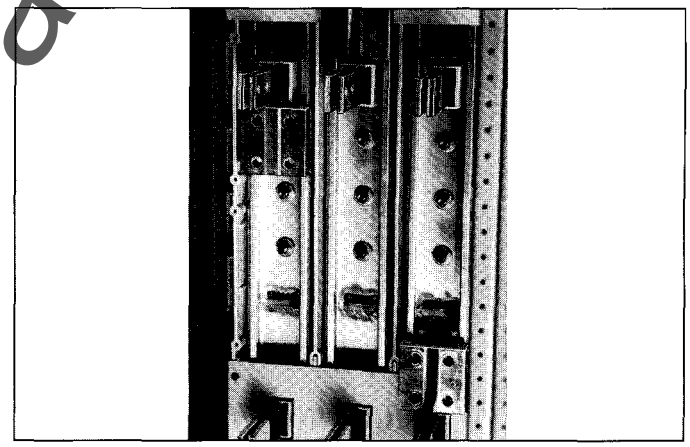


Fig. 9.2 Welded Aluminum Vertical Bus

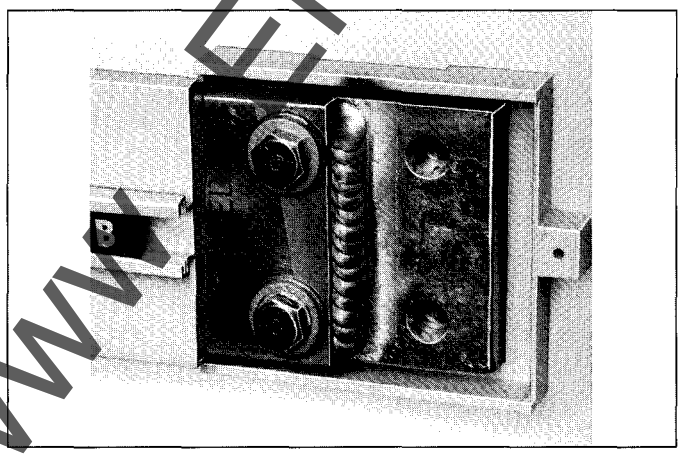


Fig. 9.3 Welded Aluminum Horizontal Bus

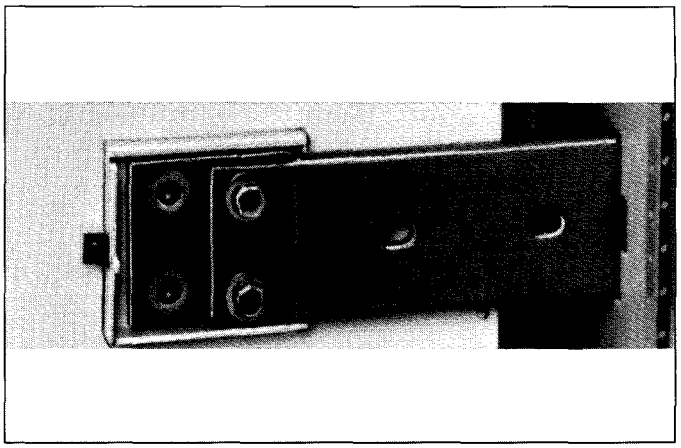


Fig. 9.4 Bolted Copper Bus

Reliability Features (Continued)

- Paint finish

  The "E-coat" paint system protects AKD-8 switchgear. It is a "cathodic electrodeposition" process employing the same principle used in electroplating: an electrically charged object immersed in a bath of oppositely charged particles will attract and become coated with those particles. In the process, parts are conveyed through a seven-stage washing process where they are thoroughly cleaned, surface-prepared, chrome-sealed and thoroughly rinsed. Next, they're immersed in the electrocoating tank, where they receive an epoxy coating .7 to .8 mills thick on every surface. After a rinse, the parts enter a curing oven where the coating is baked to fuse it to the metal and ensure a hard, uniform finish. The resulting ANSI-61 light gray paint finish far exceeds test requirements of UL1558 and ANSI C37.20.1 which requires at a minimum passing a 200 hour salt spray test. Periodic testing by an independent laboratory subjected the "E-coat" to 1,000 hours of salt spray, 2,000 hours in a humidity cabinet, plus acid and alkaline resistance tests, spot and stain tests, marring tests and impact and flexibility test. All to prove that AKD-8 switchgear can stand up to severe operating environments around the world.

- MicroVersaTrip RMS-9 solid state programmer unit

  MicroVersaTrip RMS-9 solid state trip device brings the newest technological advancements in overcurrent protection to low voltage power circuit breakers in AKD-8 equipment. The nine function programmer provides maximum application flexibility and improved system coordination with accurate eight-point trip adjustment switches and multiple time delay bands. Increased selectivity is obtained with both ramp functions and zone selective interlocking on short time and ground fault. The programmer is very compact. It's construction using highly reliable electronic components, gold plated contacts and protective conformal epoxy coated printed circuit boards provides the ultimate in accuracy, reliability and long life.

  Operation of the MicroVersaTrip RMS-9 solid state trip system of current sensors, programmer and flux shifter trip coil requires no external control power inputs. The self-powered, solid-state logic unit assures dependable operation. The pop out indicators on the MicroVersaTrip RMS-9 programmer provide clear indication of short circuit, overload and ground fault conditions. For reliability, the indicators require no external power to operate and remain in the indicated position until manually reset.

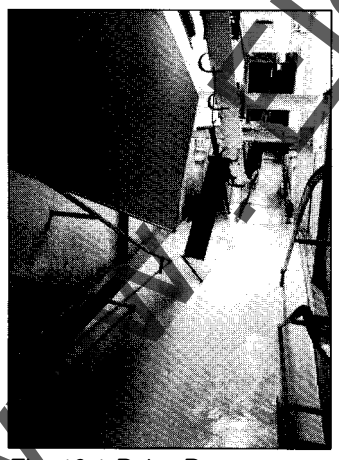


Fig. 10.1 Paint Process

Fig. 10.2 MicroVersaTrip® RMS-9 Programmer Unit

- Cable space

  Conduit entrance area - over 50% more space for outgoing cables than previous designs. This increased space permits easier, faster equipment installation and simplifies routine inspection and maintenance of cable connections.

- Breaker lifting device

  Mounted on top of the switchgear, this rail mounted hoist provides the means for installing and removing breakers from the equipment.

- Accessibility

  Accessibility to equipment compartments provides for ease of maintenance in the breaker compartment, cable area, control circuit elements in drawout tray and for checking bolted bus connections.

The design modularity of AKD-8 switchgear provides simplified installation. Switchgear sections are available in either 22 or 30 inch widths. Also, low voltage power circuit breakers of 800/1600/2000 amps can be stacked four-high, resulting in reduced floor space requirements. The 11-gauge modular designed steel frame results in flexibility in arrangements of breakers and associated components.

General Electric's AKD-8 low voltage switchgear can help you meet today's challenges for greater productivity, increased operator safety and improved equipment reliability and maintainability.

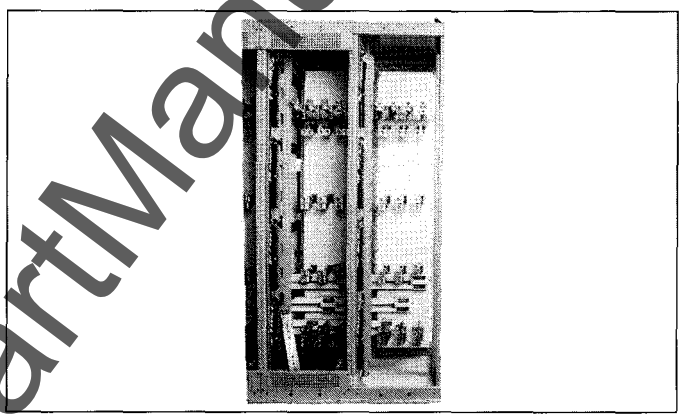


Fig. 11.1 Cable Space

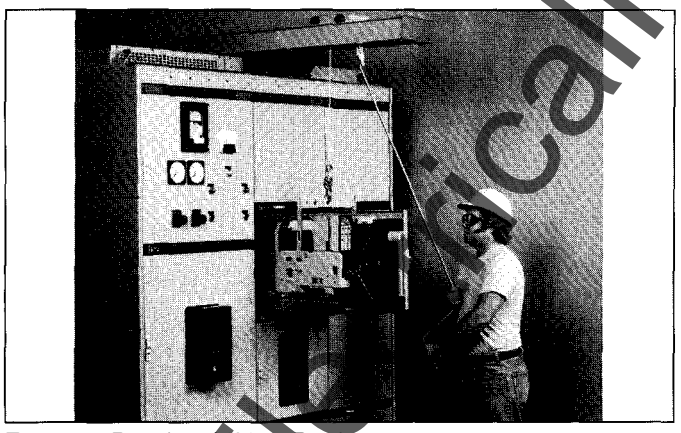


Fig. 11.2 Breaker Lifting Device

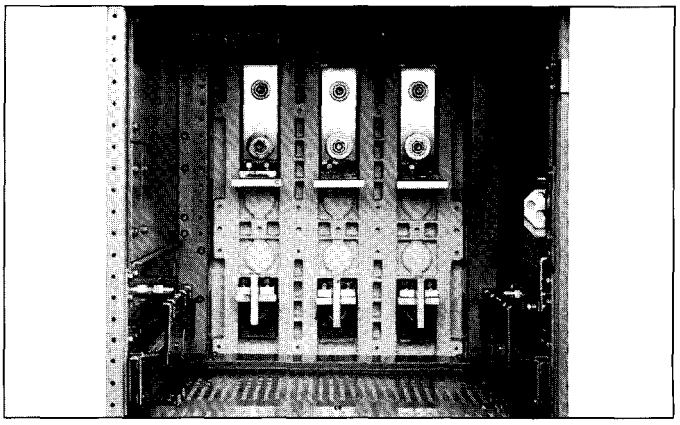


Fig. 11.3 AKR-50 Compartment

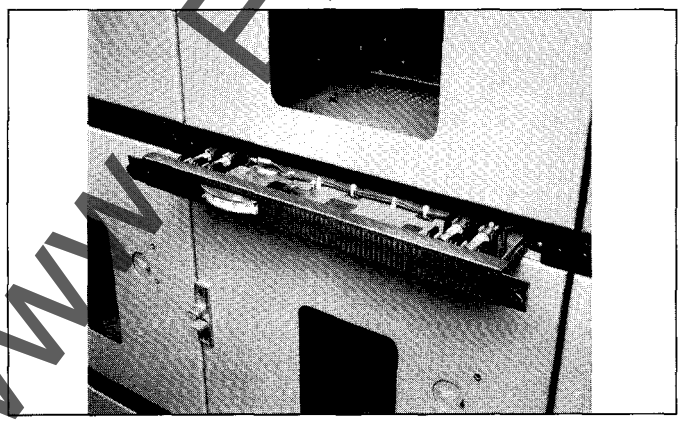


Fig. 11.4 Draw-Out Tray

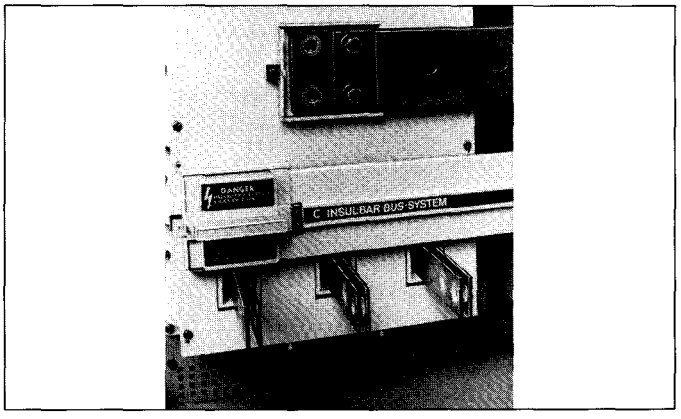


Fig. 11.5 Removeable Bolted Bus Cover

Trip Devices

MicroVersaTrip® RMS-9 Programmer

The MicroVersaTrip RMS-9 system for AKR low voltage power circuit breakers consists of four parts: plug-in 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

The 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 lighting, 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 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 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^2T ramp. Type AKR power circuit breakers are available with High Range Instantaneous, No Instantaneous, or Switchable (OFF) 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. Current sensor ratios are shown in Table 20.1, page 20.

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.

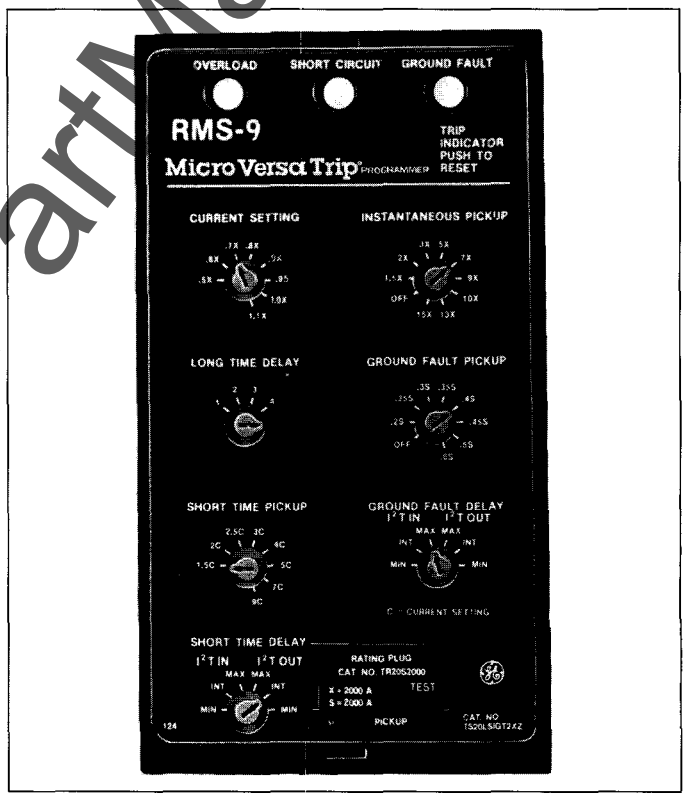


Fig. 12.1 Protection Programmer

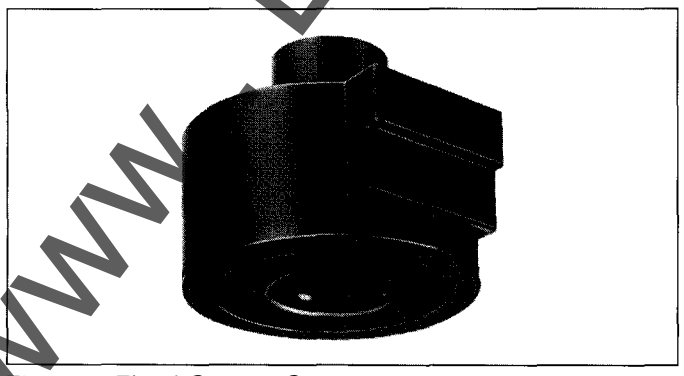


Fig. 12.2 Fixed Current Sensor

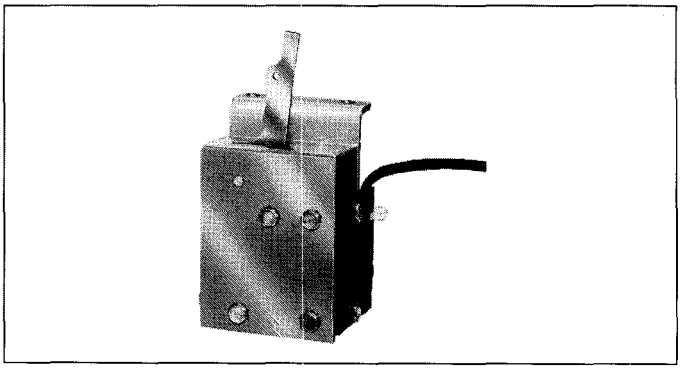


Fig. 12.3 Flux-Shift Trip Device

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 — Optional
6. Instantaneous Pickup — Standard
7. Ground Fault Pickup — Optional
8. Ground Fault Delay — Optional
9. Fault Trip Annunciator (Local)
10. Rating Plug

Not shown:
Adjustable High Range Instantaneous — Optional
Zone Selective Interlock — Optional
The quantity of these functions in any given breaker is determined by complete catalog number.

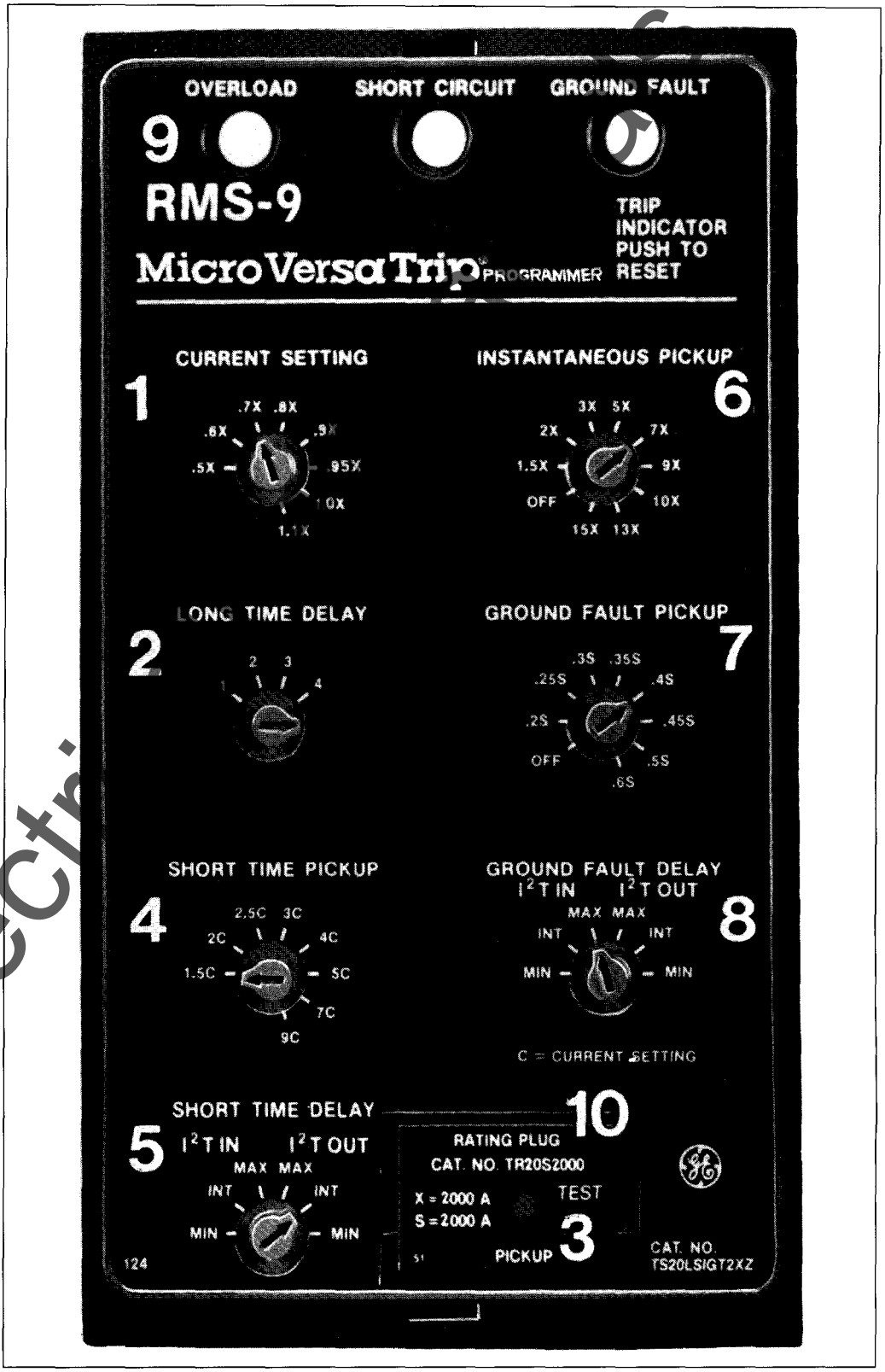


Fig. 13.1 MicroVersaTrip® RMS-9 Programmer

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 pickup. This is the function used to protect a circuit against low magnitude overcurrents. The breaker trips because the current has exceeded the long-time setting. If a breaker is protecting a motor, the start-up surge (in-rush current) 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. An instantaneous trip can be adjustable, depending upon the application.

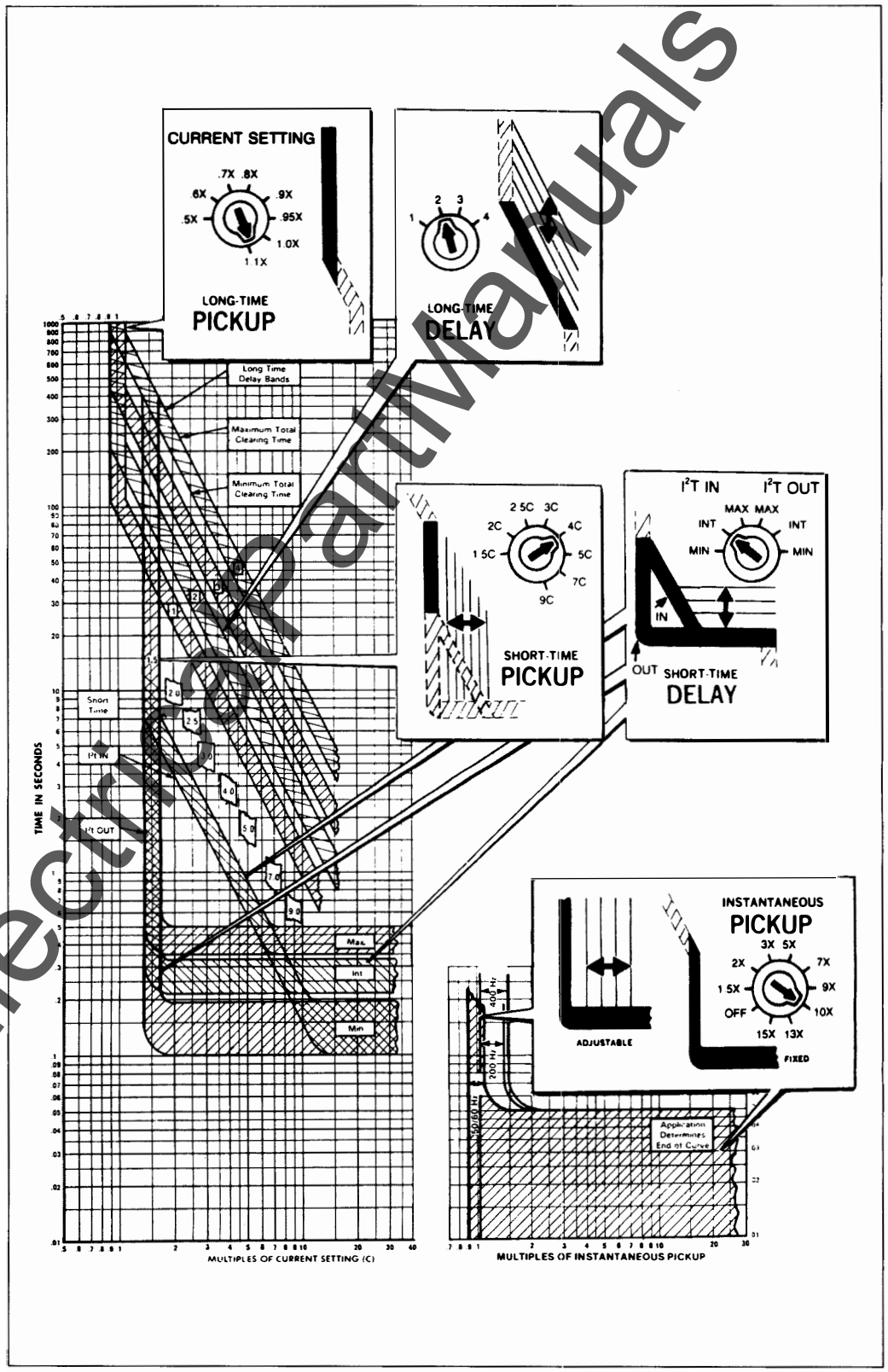


Fig. 14.1 Time Current Curve Definition — Overload and Short Circuit

I^2t Function

An I^2t function is available with MicroVersaTrip® RMS-9. This provides a ramp function (I^2t=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^2t 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^2t 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^2t in and out to 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.

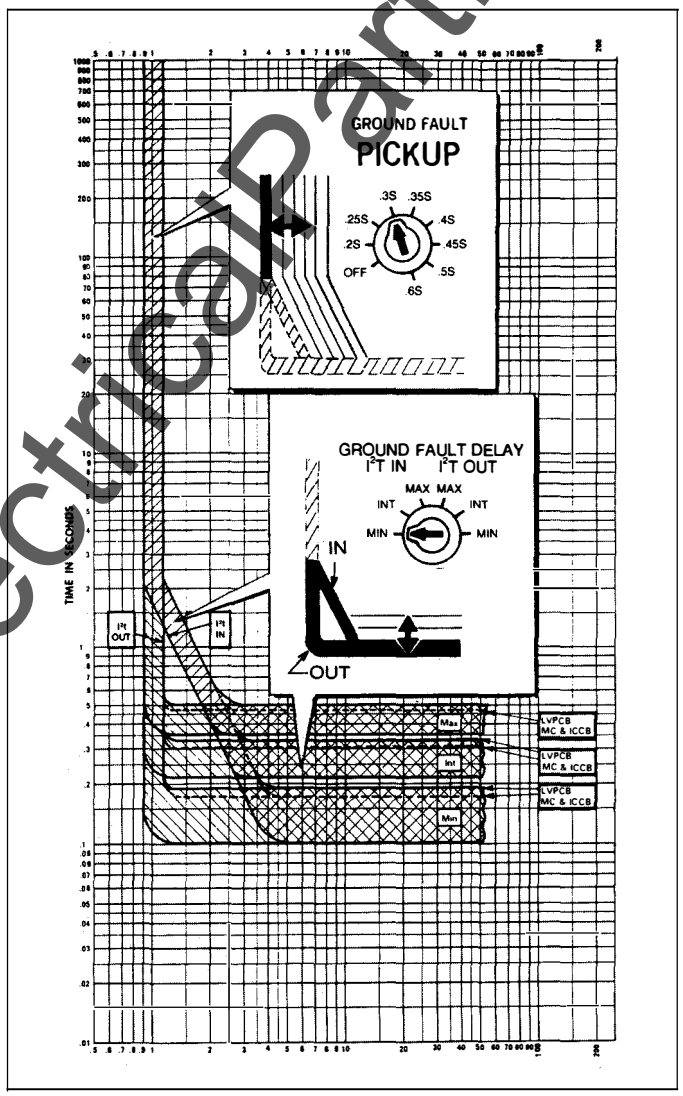


Fig. 15.1 Time Current Curve Detection — Ground Fault

Current Setting (Standard)

The adjustable current setting determines the nominal long time current setting with a ± 10% bandwidth. With a 1.1 setting, the breaker will carry indefinitely without tripping the rating plug rating. Changing these settings changes the nominal current rating for the breaker.

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) which is only activated prior to trip-out and during long-time time-out. 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.

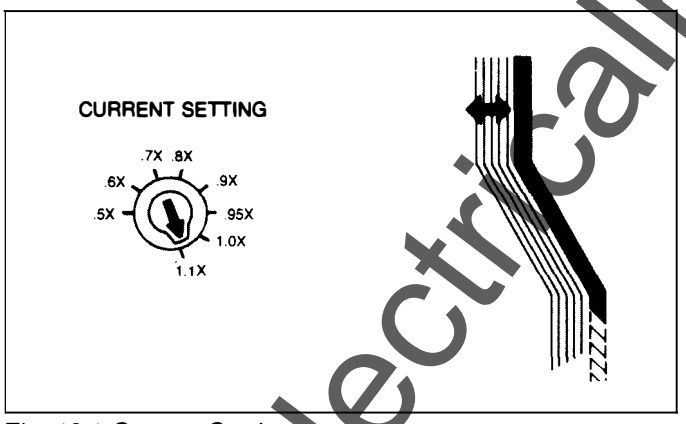


Fig. 16.1 Current Setting

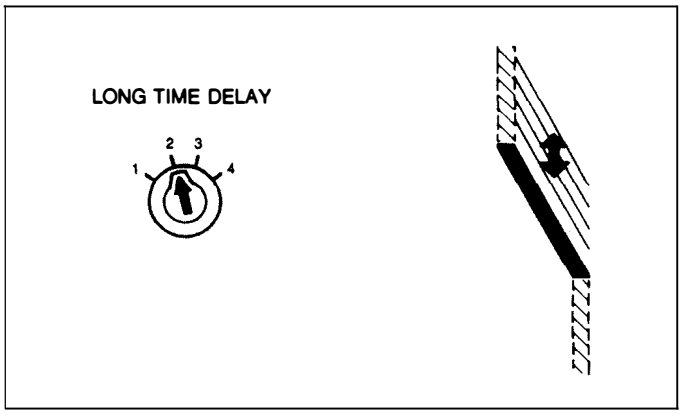


Fig. 16.2 Long-Time Delay

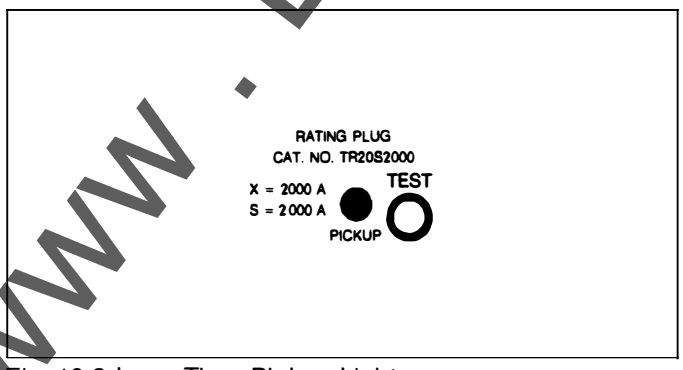


Fig. 16.3 Long-Time Pickup Light

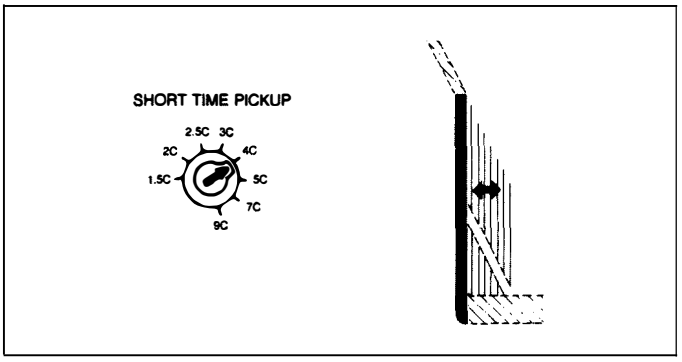


Fig. 16.4 Short-Time Pickup

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 overcurrent 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.

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 1981 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 predetermined 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.

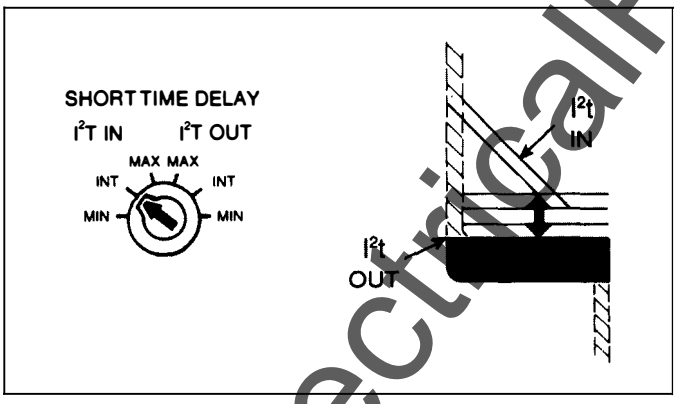


Fig. 17.1 Short-Time Delay

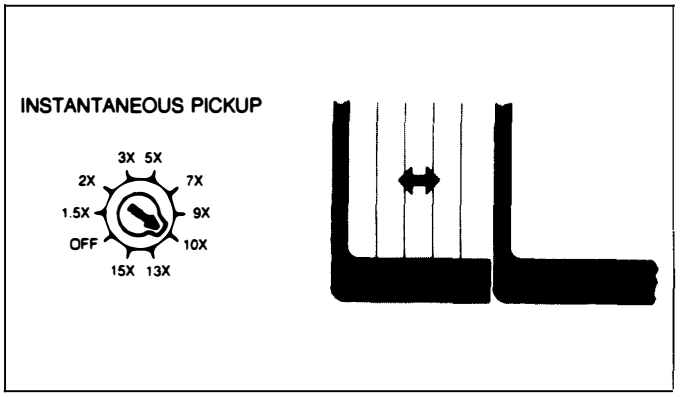


Fig. 17.2 Instantaneous Pickup

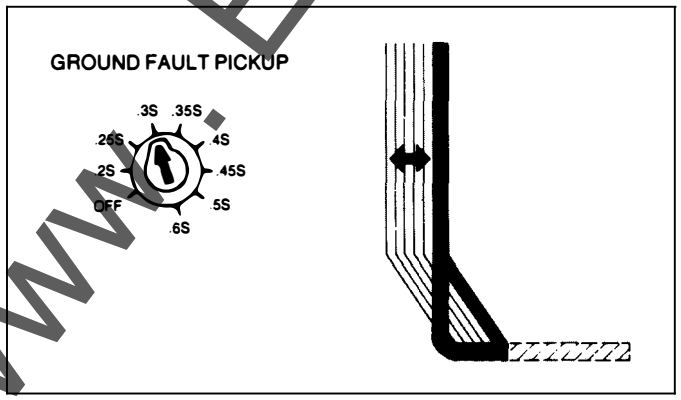


Fig. 17.3 Ground Fault Pickup

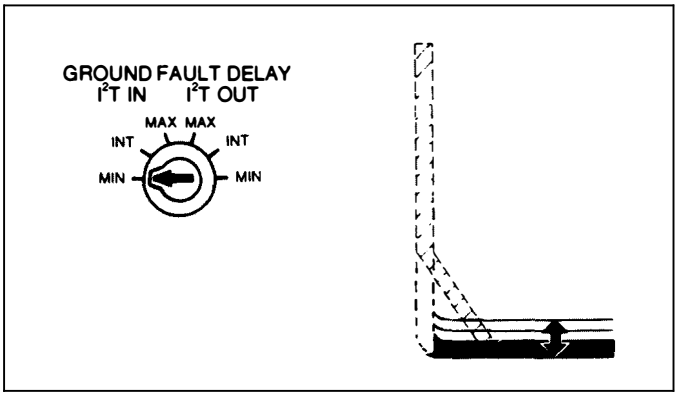


Fig. 17.4 Ground Fault Delay

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.

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.

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 18.3, 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 17.4. Both the Short-Time and Ground Fault functions are capable of being interlocked.

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

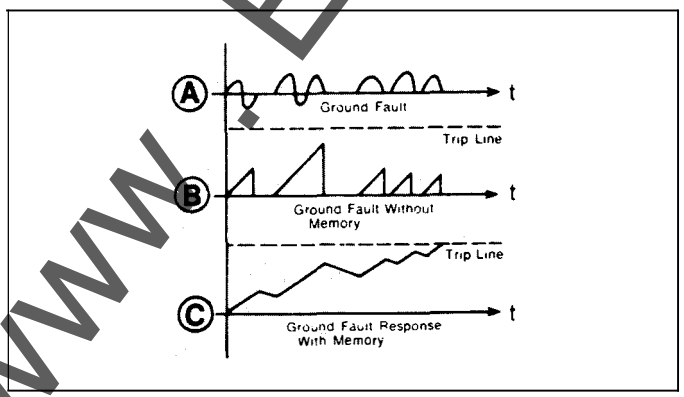


Fig. 18.1 Memory Circuit

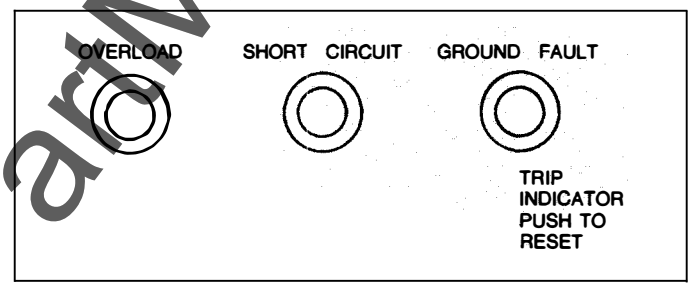


Fig. 18.2 Fault Trip Indicators

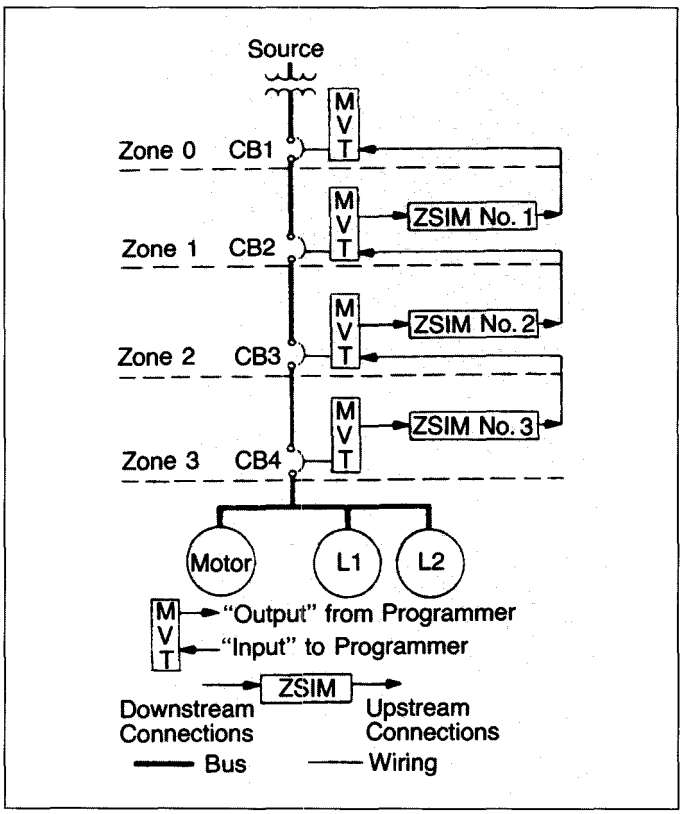


Fig. 18.3 Multi-Zone Interlocking

Table 19.1
MicroVersaTrip RMS-9 Programmer Function Settings

Frame Size	Max. Amp Rating	Sensor Rating (Amps) (S)	Current Setting (Multiple of Rating Plug Amps) (X)	Long-time		Short-time	
				Pick Up (Multiple of Current Setting) (C)	Delay① (Seconds)	Pick Up (Multiple of current Setting) (C)	Delay (Seconds)
AKR-30S AKR-30H	800	150, 400, 800	.5, .6, .7, .8, .9, .95, 1.0, 1.1	Fixed at 1.0 of Current Setting	2.4, 4.9, 9.8, 20	1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.0, 9.0	I^2T in:① .40 I^2T out:② .10, .21, .35
AKR-50	1600	800, 1600	.5, .6, .7, .8, .9, .95, 1.0, 1.1	Fixed at 1.0 of Current Setting	2.4, 4.9, 9.8, 20		
AKRT-50	2000	2000	.5, .6, .7, .8, .9, .95, 1.0, 1.1	Fixed at 1.0 of Current Setting	2.4, 4.9, 9.8, 20		
AKR-75	3200	3200	.5, .6, .7, .8, .9, .95, 1.0, 1.1	Fixed at 1.0 of Current Setting	2.4, 4.9, 9.8, 20		
AKR-100	4000	4000	.5, .6, .7, .8, .9, .95, 1.0, 1.1	Fixed at 1.0 of Current Setting	2.4, 4.9, 9.8, 20		

Frame Size	Adjustable Instantaneous Pick Up without ST (Multiple of Rating Plug Amps) (X)	Adjustable Instantaneous Pick Up with ST (Multiple of Rating Plug Amps) (X)	High Range Instantaneous (Multiple of Frame Short-time③ Rating) (H)	Triple Selective Trip, Fixed High Range Instantaneous ④⑤	Ground Fault		
					Pickup (Multiple of Sensor amp Rating) (S)	Delay with I^2T (Seconds)	Delay⑥ without I^2T (Seconds)
AKR-30S AKR-30H	1.5, 2, 3, 5, 7, 9, 10	1.5, 2, 3, 5, 7, 9, 10, 13, 15	.4, .6, .8, 1.0	+0 22kA −20%	.2, .25, .3, .35, .4, .45, .5, .6	.40 at 200% of pick up at lower limit of band	.10, .21, .35
AKR-50	1.5, 2, 3, 5, 7, 9, 10	1.5, 2, 3, 5, 7, 9, 10, 13, 15	.4, .6, .8, 1.0	NA	.2, .25, .3, .35, .4, .45, .5, .6		.10, .21, .35
AKRT-50	1.5, 2, 3, 5, 7, 9, 10	1.5, 2, 3, 5, 7, 9, 10, 13, 15	.4, .6, .8, 1.0	NA	.2, .25, .3, .35, .4, .45, .5, .6		.10, .21, .35
AKR-75	1.5, 2, 3, 5, 7, 9, 10	1.5, 2, 3, 5, 7, 9, 10, 13	.4, .6, .8, 1.0	NA	.2, .22, .24, .26, .28, .30, .34, .37		.10, .21, .35
AKR-100	1.5, 2, 3, 5, 7, 9	1.5, 2, 3, 5, 7, 9	.4, .6, .8, 1.0	NA	.2, .22, .24, .26, .28, .3		.10, .21, .35

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 pick up tolerances are ± 10%.
③ Refer to Table 25.1, page 25 for frame short-time ratings.
④ For AKR-30S only.
⑤ Triple selective trip is standard when long-time/short-time only is required.
⑥ Time delay shown at lower limit of each band. Ground fault pick up not to exceed 1200 amps.

X = Rating plug amps
S = Sensor amp rating
C = Current setting
H = Short-time rating

MicroVersaTrip® RMS-9 Programmer
Sensor Ratios and Available Combinations

Table 20.1
MicroVersaTrip RMS-9 Current Sensor Ratios

Breakers①	Sensor Ampere Rating	Sensor Turns Ratio	Secondary Output Current at Rated Input Current
AKR-30S AKR-30, 30H AKR-50, AKRT-50H	Fixed 150 800 1600 2000	 750:1 4000:1 8000:1 10000:1	200 mA
AKR-75 AKR-100	Fixed 3200 4000	 8000:1 10000:1	400 mA

① See Table 19.1 page 19 for applicable sensors.

Table 20.2
MicroVersaTrip RMS-9 Programmer — Available Combinations
(Suffix to Basic Catalog Number)

Programmer Suffix	Long-time (L)	Short-time (S)	Adj. Inst. (I)	Adj. High Inst. (H)	Fixed High Inst. (K)	Ground Fault (G)	OL/SC Targets (T1)	OL/SC/GF Targets (T2)	GF③ Zone Interlock (Z1)	GF/ST③ Zone Interlock (Z2)	Switch Inst/GF (X)
Adjustable Instantaneous											
L1	X		X				X				
LIT1	X		X			X		X			
LIGT2	X		X			X		X	X		
LIGT2Z1	X		X			X	X			X	
LSIT1	X	X	X				X				
LSIGT2	X	X	X			X		X	X		
LSIGT2Z1	X	X	X				X			X	
LSIGT2Z2	X	X	X			X		X		X	
Adjustable High Instantaneous											
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	
Fixed High Instantaneous②											
LSKT1	X	X			X		X				
LSKGT2	X	X			X	X		X			
LSKGT2Z1	X	X			X	X		X	X		
LSKGT2Z2	X	X			X	X		X		X	
No Instantaneous①											
LST1	X	X					X				
LSGT2	X	X				X		X			
LSGT2Z1	X	X				X		X	X		
LSGT2Z2	X	X				X		X		X	
Switchable Instantaneous/Ground Fault ①④											
LSIGT2X	X	X	X			X		X			X

① Not available for AKR-7D-30S or AKRU-7D-30S.
② Only available for AKR-7D-30S or AKRU-7D-30S.
③ Requires zone selective interlock module types TIM1 (120 V ac control voltage) or TIM2 (125V dc control voltage).
④ Not UL Listed.

EC Trip Devices for DC Applications

Type EC overcurrent trip devices are magnetically operated, using a series coil (or single conductor and an associated magnetic structure) to provide tripping force. Three basic characteristics: long-time delay, short-time delay and instantaneous, can be used in various combinations to suit the application.

Long-time delay is accomplished with a positive-displacement oil piston. Sealing of the assembly eliminates variations caused by atmospheric contamination, and silicone oil minimizes variations in time delay due to changes in ambient temperature.

Short-time delay is accomplished with a rugged mechanical escapement.

Instantaneous tripping is obtained when a tension spring yields to the force exerted on the magnetic armature at short circuit current levels, permitting the armature to move independently of the time delay piston.

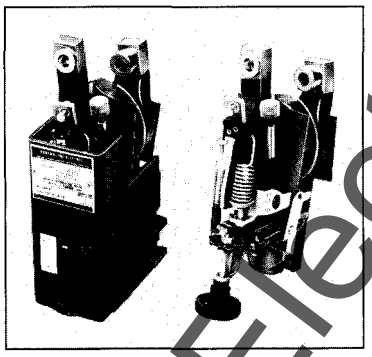
AKR breakers with EC trips are for use on DC system voltages, and are available in ratings of 40-6000 amperes. One EC trip device is mounted in each breaker pole and contains functional adjustments, overcurrent detection and tripping hardware.

EC trip devices are available as type EC-2A (Standard for frames through 2000A), EC-1 (optional for frames through 2000A) and EC-1B (standard for 4000 and 6000A frames). Trip characteristics are described in the table below.

Table 21.1
Adjustment Ranges for EC Trip Devices

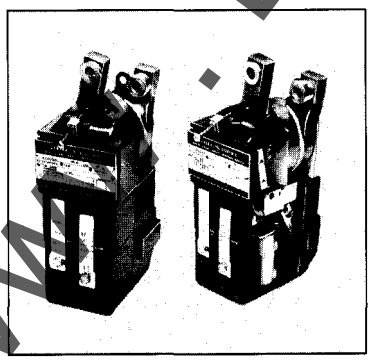
Trip Device	Long-Time		Short-Time		Instantaneous Pickup
	Pickup①	Delay②	Pickup	Delay③	
EC-2A	80-160%X (± 10%)	(1A) MAX — adj 15-38 sec or (1B) INTER — adj 7.5-18 sec or (1C) MIN — adj 33-82 sec	—	—	4-9X 6-12X 9-15X or 80-250% X ④
EC-1	80-160%X (± 10%)	(1A) MAX — 30 sec or (1B) INTER — 15 sec or (1C) MIN — 5 sec	2-5X 3-7X or 4-10X	(2A) MAX — 23 sec or (2B) INTER — 15 sec or (2C) MIN — 07 sec	High Set up to 15X Non-Adjustable
EC-1B	80-160%X (± 15%)	(1BB) MAX — 45 sec or (1CC) MIN — 2 sec	2-5X 3-7X or 4-10X	(2AA) MAX — 20 sec or (2BB) INTER — 13 sec or (2CC) MIN — 07 sec	4-9X 6-12X 9-15X or 80-250% X ④

① X = Trip device ampere rating. If trip devices are set above 100% for coordination purposes, such settings do not increase the breaker's continuous current rating.
② At lower limit of band at 6 times pickup setting.
③ At lower limit of band at 2½ times pickup setting.
④ Low-set instantaneous. Not available in combination with long time delay.



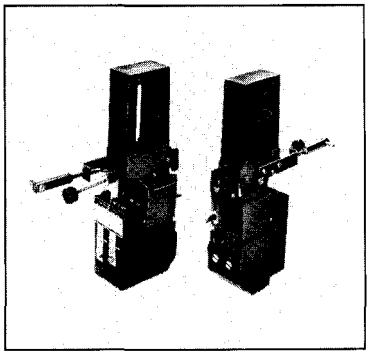
Trip Device for 600-2000 amp frame breakers. Available in combinations of long-time and instantaneous elements, or instantaneous alone.

Fig. 21.1 Type EC-2A



Trip Device for 600-2000 amp frame breakers. Combines long-time and short-time elements for intentional delay up to the short-time rating of the breaker. Instantaneous may be added.

Fig. 21.2 Type EC-1



Trip Device for 4000 and 6000 amp frame breakers. Combines long-time and short-time elements for intentional delay up to the short-time rating of the breaker. Instantaneous may be added.

Fig. 21.3 Type EC-1B

Epic MicroVersaTrip™ System

The Epic MicroVersaTrip system is an integrated electronic system which provides:

- Overcurrent protection
- Protective relaying
- Metering
- Breaker event reporting
- Breaker status reporting
- Remote monitoring

An Epic MicroVersaTrip system consists of:

- A protection unit on each breaker (an Epic MicroVersaTrip programmer)

  This overcurrent protection unit is driven by three integral breaker current sensors to provide overcurrent protection, current relaying and current metering data.

  A standard set of three bus PT's provides voltage input for other metering and relaying functions. The metering and relaying functions require control power. Please note that the three bus PT's for each incoming source and the control power should be specified in the equipment specification as they are not part of the Epic MicroVersaTrip system package.

  The Epic MicroVersaTrip programmer communicates with the Field Programming Unit.

- A Field Programming Unit (FPU)

  System parameter input is entered and changed at the FPU.

  Output readings are selected and displayed on the FPU.

  The entire system is interconnected by a communications bus which consists of a single twisted pair in a ring configuration for optimum reliability. In the unlikely event of a break in the control bus, the breaker units are still connected to the FPU through the alternate return loop.

  The ideal operation uses one system for each switchgear line-up. Under some circumstances several line-ups can be connected to a single FPU.

  One FPU can link up to 30 breakers on the system.

  A user-defined password must be entered to program, change or clear any parameters.

Overcurrent Function

The overcurrent settings are made using adjustment knobs on the breaker programming unit. The Epic MicroVersaTrip breaker programmer utilizes rms sensing for long time and short time overload sensing. Rms sensing provides more accurate overload protection than peak sensing since rms sensing reflects the true heating effect of the current wave regardless of the wave shape.

The interchangeable rating plug feature allows the operator to adjust the overload protection, without removing the breaker and replacing the current sensors, when changes in load conditions occur.

Each of the eight different current sensor ratings (ranging from 150 to 4000 amps) is available with a group of four to six interchangeable plug ratings.

The Epic MicroVersaTrip programmer is available with the functions listed in Table 20.2.

The LSI combination on breakers up to 2000A has an instantaneous trip pick-up range extending to 15 times the plug/sensor rating. This range allows the instantaneous trip to override the high starting inrush currents associated with some of the newer high-efficiency motors.

A switchable I^2t ramp is available on both the short time and ground fault characteristics.

An optional feature is an "off" switch for the instantaneous and ground fault functions (not UL listed).

A portable programmer test kit can perform the test functions without removing the unit from the breaker, and without taking load off the breaker.

A clear plastic cover over the breaker programming unit can be sealed to prevent unauthorized tampering with the settings.

Protective Relaying

The Epic MicroVersaTrip system provides these protective-relay functions:

- Undervoltage — The set points can be set from 50-99%. The delay can be set from 1 to 15 seconds.

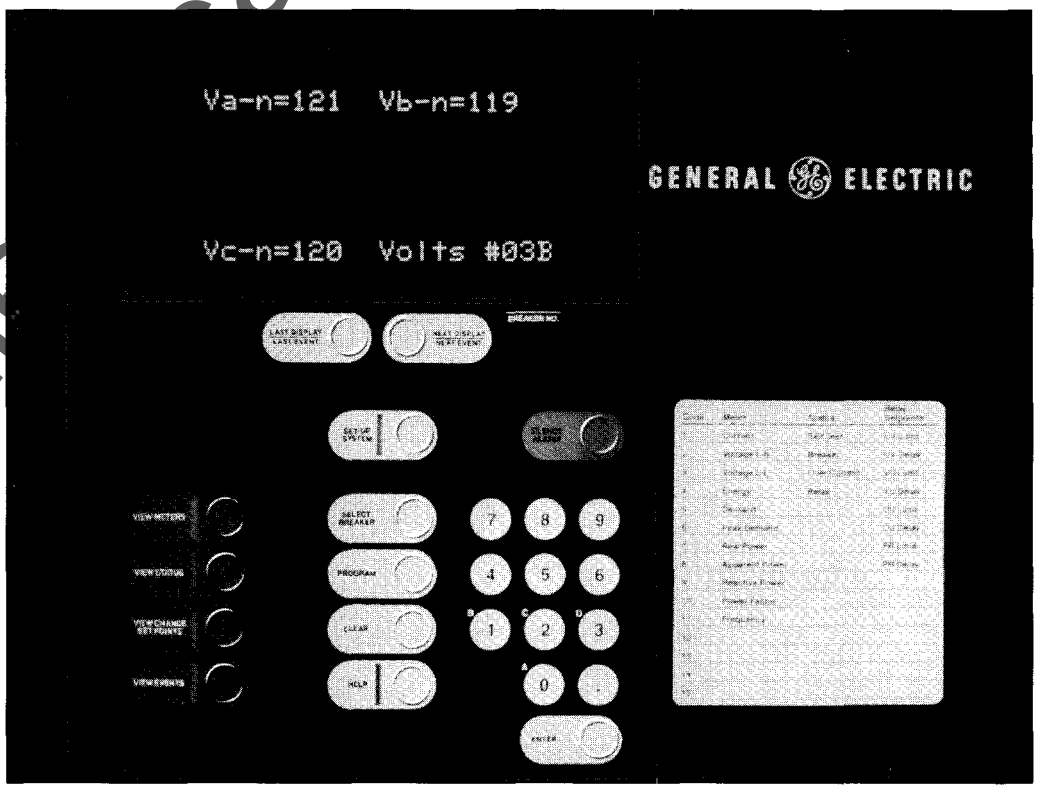


Fig. 22.1 Field Programming Unit

- Voltage unbalance — This pick-up set points can be set from 5-50%. The delay is in the range from 1 to 15 seconds.
- Current unbalance — The pick-up set points range from 5-50%. The delay can range from 1-15 seconds.
- Power reversal — The reverse power setting can range from 1KW to 7.2 MW with 1KW resolution. The delay can be set for 1 to 15 seconds.

All functions are available, however the customer may disable any or all of these functions; this is accomplished by programming the FPU.

The relay pick-up set points and delay interval settings are entered in the FPU panel and stored in a non-volatile memory. This means that should a power outage occur, all settings will be retained and the FPU will not need re-programming.

To change any of the settings, the user defined password must be entered.

Metering Functions

The Epic MicroVersaTrip system provides metering functions which can be displayed in breaker address sequence, or any specific address requested.

These are the functions available; each measurement represents real time data:

- Current — The display shows the breaker control unit address and rms current for *each* phase.
- Voltage — There are two different displays for voltage. One illustrates line-to-line and the other displays line-to-neutral rms voltage.
- Energy — The FPU displays kWH and the breaker address. The measurement reflects accumulated energy from system start-up. The operator has the option to reset (or clear) this value at any time.

Also displayed is the date of the last reset and corresponding breaker address.

- Present demand — This is the value of the present demand on a breaker. The breaker address is shown as well as the demand interval of the system. The demand interval is entered during system set-up.
- Peak demand — This value reflects the highest peak demand value since the system start-up. The operator has the options to reset (or clear) this value at any time. The date, time and breaker address of this peak demand value is also displayed.
- Real power — The FPU displays the breaker address and kW.
- Reactive power — The FPU displays kVAR and the breaker address.
- Total power — the FPU displays kVA for each of the three phases. The breaker address is also shown.
- Power factor — The power factor is displayed for each of the three phases. The breaker address is also displayed.
- Peak Capacity — This function tracks the peak current level which each breaker experiences as a percent of the rating plug value. The date and time of this peak is displayed as well as the breaker address. Like the peak demand and energy values, the peak capacity can also be reset locally at the FPU or remotely through the host computer.
- Frequency — The cycles per second is displayed for each phase as well as the breaker's address.

Event Reporting

The event display will first show how many events are currently logged. The event log will retain the last 64 events in chronological order (event 1 = oldest). After 64 events, the new event will be added in place of the oldest event. The event reporting data includes:

- # of event
- Date of event
- Time of the event to 1/100 sec.
- Reason of the event
- The breaker unit the event occurred on
- If event was a trip, the type of trip
- If a trip was caused by current, the value of the current causing the trip is displayed

This provides the operator with key diagnostic data. Since the time stamp is to 1/100 of a second, the sequence of breaker tripping can be determined.

The SILENCE ALARM key lights up to indicate unviewed events in the event log. This light will go out only after all events in the log have been viewed.

New events cause a set of contacts to close. These can be used to drive an alarm device such as a horn or siren. The SILENCE ALARM key, when depressed, releases the contacts to turn off the alarm.

This valuable information is stored in a non-volatile memory. The event data will remain in the memory during a power outage.

The operator can delete any or all event logs after entering the user-defined password.

Status Reporting

The status of each breaker may be checked through the FPU status displays:

- Functional self-test — The device self-test is a continuous self-diagnostic check of each electronic device. This will display the breaker address and if the electronics passed or failed. If it had a failure, an event would be added and silence alarm key lighted.
- Breaker status — The FPU will display the breaker address and indicate if that breaker is in the open, closed or trip position.
- Overcurrent status — The FPU will display the breaker address and indicate the status as normal or long time pick up or short-time trip, etc.
- Protective-relaying — The FPU will display the breaker address and indicate normal status or a trip. If tripped, the reason is indicated, such as undervoltage, etc.

System Set-Up Screens

The system set-up screens define the FPU system parameters:

- General parameters — The time of day is input to system and is battery backed so the time will keep running during a power outage.

  The date and demand interval are also input here. The demand interval is FPU system wide, and can be set at 5 min., 15 min., 30 min., or 60 min.

  If the host interface option exists, the host communication parameters can be set. These include baud rate, number of data bits, parity and number of stop bits.
- Breaker parameters — The Epic MicroVersaTrip system allows each customer to use their own breaker address scheme. Each breaker address can consist from

two to five characters or numbers in any given combination. This is entered into the FPU.

The type of potential transformer connection is entered on a breaker by breaker basis. The potential transformer rating is also entered.

Each breaker must be specified activated or deactivated. The FPU will not monitor deactivated breakers (ex: a breaker taken out for service should be programmed deactivated). The FPU will display the number of breakers defined. This number includes breakers that are defined, but deactivated.

A screen displays the breaker address and rating. The rating is determined from the breaker plug.

Help Screens

A key labeled HELP can be depressed when you are in any mode. Directions will appear on the FPU screen explaining what function you are currently in, and directions on how to modify or exit that function.

Communication With Host

As an option the FPU can be equipped with hardware to interface with a host computer. A RS232 link is added and the system will support modems.

The upgraded FPU can hook up to any vendor's computer system that supports a RS232 link and modems.

The host interface can display any data that can be displayed on the FPU. The host interface can perform only three changes to the system; reset (clear) the energy value; reset (clear) the peak demand value and reset (clear) the peak capacity value.

The General Electric Company will provide host interface protocol so the customer has the information necessary to communicate with the FPU, via his own custom software applications or utilizing a software package.

Discretes

Another feature of the remote communication function is the option to have the FPU monitor the status of up to 16 discrete inputs. The FPU can be supplied with 16 pairs of terminal points which are located on a terminal board in the rear section of an AKD-8 section, easily accessible for user connection. The user can connect to these contacts other functions that he wants to monitor (such as a transformer temperature alarm contact). The host computer may request the status of the discretes. The FPU would transmit the open/close status of these remote contacts back to the host computer. This information is only accessible through the host computer as it cannot be viewed at the FPU display screen.

Refer to GET-6963 for a more detailed description of the Epic MicroVersaTrip system.

Application Data

Basic Ratings

AKR LVPCB with MicroVersaTrip® RMS-9 programmer is rated for short-time withstand current and interrupting capacity (rms symmetrical). The maximum short-time rating is shown for 30 cycle duration at 50/60 Hz.

For dc applications, electromechanical EC type trip devices are available for dc ratings up to 250Vdc.

Table 25.1 Summary of Breaker Ratings

Rated Voltage (Nominal) 60 Hz	Breaker Type	Frame Size (Amperes)	Short Circuit Ratings RMS Symmetrical kA		
			Short-Time	With Instantaneous Trip	Without Instantaneous Trip
600	AKR-30S	800	22	22	22⑤
	AKR-30H	800	42	42	42
	AKR-50	1600	42	42	42
	AKR-50H		65	65	65
	AKRT-50H	2000	65	65	65
	AKR-75	3200	65	65	65
	AKR-100	4000	85	85	85
480	AKR-30S	800	22	30	30⑤
	AKR-30H	800	42	42	42
	AKR-50	1600	50	50	50
	AKR-50H		65	65	65
	AKRT-50H	2000	65	65	65
	AKR-75	3200	65	65	65
	AKR-100	4000	85	85	85
240	AKR-30S	800	22	42	42⑤
	AKR-30H	800	42	50	42
	AKR-50	1600	50	65	50
	AKR-50H		65	65	65
	AKRT-50H	2000	65	65	65
	AKR-75	3200	65	85	65
	AKR-100	4000	85	130	85

① The maximum fuse rating is the largest fuse which tests show will result in proper performance of the breaker and fuse in combination under short circuit conditions. Only Gould fuses should be used for proper coordination.
② Fuses are mounted on separate fuse roll-out element.
③ Refer to time-current curves GES-6000 (for EC-1) and GES-6005 (for EC-1B).
④ Observe Table 25.4 minimum overcurrent trip ratings.
⑤ Triple-Selective Trip at 1X short-time rating when standard Instantaneous Trip is omitted.

Table 25.2 — Overcurrent Trip Device Current Ratings in Amperes

Breaker Frame	RMS-9 MicroVersaTrip 50/60 Hz ac		EC Device Rating dc④
	Sensor Rating Amps (s)	Rating Plug Amps (x)	
AKR-30S, AKR-30H	150	60, 80, 100, 125, 150	NOT AVAILABLE ON AKR-30S 100, 125, 150, 175, 200, 225, 250, 300, 350, 400, 500, 600, 800
	400	150, 200, 225, 250, 300, 400	
	800	300, 400, 500, 600, 700, 800	
AKR-50 AKR-50H	800	300, 400, 500, 600, 700, 800	200, 225, 250, 300, 350, 400, 500, 600, 800, 1000, 1200, 1600, 2000
	1600	600, 800, 1000, 1200, 1600	
AKRT-50H	2000	800, 1000, 1200, 1500, 1600, 2000	—
AKR-75	3200	1200, 1000, 2400, 3200	2000, 2500, 3000, 4000
AKR-100	4000	1500, 2000, 2500, 3000, 4000	2000, 2500, 3000, 4000, 5000, 6000

x = Rating plug amps
s = Sensor amp rating

Table 25.3 Fused Breaker Ratings — Maximum 600V ac 50/60 Hz

Breaker Type	Frame Size Amperes	Fuse Rating Amperes①		Interrupting Rating RMS Symmetrical kA
		Min.	Max.	
AKRU-30S	800	300	1600	200
AKRU-50	1600	450	2500	200
AKRU-75②	3200	2000	3000	200
AKR-100②	4000	2000	4000	200

Table 25.4 Minimum EC Trip Ratings — Amperes at 250V dc

Breaker Type	With Instantaneous Trip	With Short-Time Trip Characteristic ③		
		2C	2B	2A
AKR-30	100	175	200	250
AKR-50	200	350	400	500
		2CC	2BB	2AA
AKR-75 AKR-100	2000	2000	2000	2000

Table 25.5 250V dc — EC Trip Device Only

Breaker Type	Frame Size Amperes	Short Circuit kA
AKR-30	800	25
AKR-50	2000	50
AKR-75	4000	75
AKR-100	6000	100

The Load Center Principle

Pioneered by General Electric, load center unit substations are the best equipment available to ensure dependable power distribution in industrial plants and commercial buildings, and to supply power station auxiliaries and other applications requiring continuity of service.

General Electric offers a complete line of load center unit substations for indoor or outdoor installations. They consist of an incoming line section, a transformer section and a low voltage switchgear section. They are handled as a single packaged unit simplifying engineering coordination and application.

Standard designs free you from unnecessary purchasing and engineering details. Factory assembly reduces installation time and cost.

Mechanical and electrical coordination results in greater reliability. Expert field engineering is available to further assure proper application, installation and operation.

Your investment in GE load center unit substations featuring AKD-8 switchgear is an investment in dependable electrical power distribution for growth and profit today and tomorrow.

How to Select Switchgear

The application tables on the following pages list the proper low-voltage power circuit breakers for load center applications. The power circuit breakers have been coordinated with transformer and system capacities — electrically, thermally, and mechanically. For additional details on motor starting and dc machine circuit applications, fused breakers, over-current trip details, etc., refer to ANSI C37. 13-1973, and ANSI C37. 16-1973, for short circuit ratings and analysis procedures.

These tables should be used only as guidelines, taking into consideration voltage, temperature, power factor, altitude, and other service conditions that may affect application to a particular power system. For instance, under certain circuit arrangements, the total running motor short-circuit current contribution may be greater than that shown in the motor contribution tables. This condition might exist for unit substations having a high ratio of running motor nameplate horsepower to actual demand, such as may occur in heavy machining or stamping press operations found in industrial plants. This condition also could exist when a secondary selective system operates with one main breaker open, and one main and one tie breaker closed so that the feeder breakers can see "twice" the normal motor contribution to a short circuit.

For these types of systems, the use of higher-rated or AKRU fused circuit breakers may be required to stay within the short-circuit rating of the feeder breaker.

Power circuit breakers are available with various combinations of long-time delay, short-time delay, and instantaneous trip elements. Care should be taken to specify the combination of trips which will provide the balance of selectivity and protection required by the power system.

A *selectively coordinated* substation uses main and tie breakers with long-time and short-time trip characteristics (LS) to delay the opening of the main circuit breaker until the faulted feeder has had an opportunity to clear. This provides service continuity for all but the faulted circuit and generally allows coordination of main and tie breakers with the various trip characteristics (LS) (LSI) (LI) available on feeder circuit breakers.

Selectivity may be carried a step further in the substation by specifying selective feeder circuit breakers that incorporate long-time, short-time, and high range instantaneous (LSI) to allow downstream devices to clear faults within their area.

A refinement of the selective feeder incorporates the long-time short-time, and instantaneous characteristics (LSI) to provide selectivity without sacrificing instantaneous fault protection at high short-circuit currents. This combination of trip characteristics permits application of short-time delay trips to override inrush currents to downstream loads and coordinate with downstream devices for lower fault current values, yet also permits the use of instantaneous trips to provide maximum system protection for high values of fault current. This is called the *Zone-Selective* arrangement and is often desirable when the load-center feeder serves a motor control center or other large load. This system can afford the best feeder protection in many instances.

Long-time and instantaneous trip characteristics (LI) are often used on feeder breakers when short-time delay is not required to coordinate with downstream devices. Depending on the magnitude of fault current and the circuit impedance between breakers, a feeder breaker with LI trips may also be able to coordinate (at least partially) with a similar downstream breaker also having LI trip characteristics. Breakers with LI trips are sometimes referred to as *fully rated* since these breakers may have higher interrupting capabilities when provided with instantaneous trips (LI or LSI characteristics). The majority of the breakers manufactured today, however, have the same interrupting rating regardless of the trip characteristic.

Long-time and instantaneous trips (LI) could also be used on main breakers when minimum breaker interrupting time is required for the rare occurrence of a fault on the switchgear main bus or when the system design does not require selective coordination.

Basis for Application Tables

Application tables are based on these factors:

- A three-phase bolted fault at the low-voltage terminals of the substation.
- Transformer impedances listed in table.
- Only source of power to the secondary is the substation transformer.
- Total connected motor kVA does not exceed 50 percent of transformer rating at 208Y/120-volts and 100 percent of transformer rating at 240-, 480-, and 600-volts.
- The motor contribution is taken as 2.0 times the rated current of the transformer at 208Y/120 volts and 4.0 times the rated current at 240, 480 and 600 volts.
- Tabulated values of short-circuit current are in terms of rms symmetrical current per NEMA Standard SG-3.

Example for Application Table

The application tables make it easy to select the proper General Electric breakers for use with distribution systems using various trip devices.

For example, a 1500-kVA transformer, with 750-MVA maximum primary short-circuit available and a 480-volt secondary, requires, as minimum, an AKRT-50H main secondary breaker shown in column 7 of the 480-volt application table.

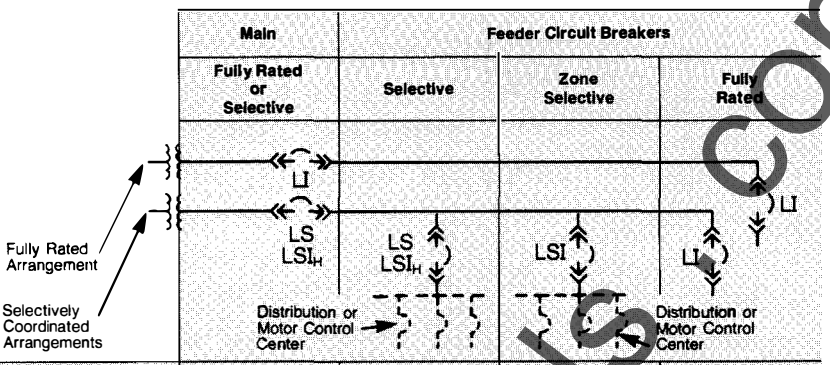
The Load Center Principle (Continued)

Full utilization of a load center transformer with dual temperature rise (such as 55/65°C) capability or forced (fan) cooling capability would require a larger frame size breaker — or an AKR-75 in this example.

The appropriate feeder circuit breaker is found in columns 8, 9, or 10, depending on the combination of long-time, short-time, and instantaneous trips required by the system design. In this example, the same type breakers (AKR-30H) are required regardless of the type of trip device utilized, although a larger frame breaker may be required in order to meet the continuous load requirement of a particular feeder.

Application Tables

Table 28.1 480 volts, three phase



Transformer Rating 3-phase kVA and Impedance Percent	Maximum Short-circuit Mva Available From Primary System	Full load Continuous Current (amperes) ①	Short-circuit Rating Symmetrical Current (ampe s)			Long-time Instantaneous or Long-time Short-time	Long-time Short-time	Long-time Short-time Instantaneous	Long-time Instantaneous
			Trans-former Alone	100% Motor Load	Combined	Minimum Rating Breaker			
						Breaker	Breaker	B aker	Breaker
1	2	3	4	5	6	7	8	9	10
300 4.5% ②	50	361	7100	1400	8500	AKR-30S	AKR-30S	AKR-30S	AKR-30S
	100		7500		8900				
	150		7700		9100				
	250		7800		9200				
	500		7900		9300				
	750		7900		9300				
	Unlimited		8000		9400				
500 4.5% ②	50	601	10900	2400	13300	AKR-30S	AKR-30S	AKR-30S	AKR-30S
	100		12000		14400				
	150		12400		14800				
	250		12800		15200				
	500		13100		15500				
	750		13200		15600				
	Unlimited		13400		15800				
750 5.75%	50	902	12500	3600	16100	AKR-50	AKR-30S	AKR-30S	AKR-30S
	100		13900		17500				
	150		14400		18000				
	250		14900		18500				
	500		15300		18900				
	750		15400		19000				
	Unlimited		15700		19300				
1000 5.75%	50	1203	15500	4800	20300	AKR-50	AKR-30S	AKR-30S	AKR-30S
	100		17800		22600				
	150		18800		23600				
	250		19600		24400				
	500		20200		25000				
	750		20500		25300				
	Unlimited		20900		25700				
1000 8.0%	50	1203	12100	4800	16900	AKR-50	AKR-30S	AKR-30S	AKR-30S
	100		13400		18200				
	150		14000		18800				
	250		14400		19200				
	500		14700		19500				
	750		14900		19700				
	Unlimited		15100		19900				
1500 5.75%	50	1804	20600	7200	27800	AKRT-50	AKR-30H	AKR-30S	AKR-30S
	100		24900		32100		AKR-30H	AKR-30H	AKR-30H
	150		26700		33900				
	250		28400		35600				
	500		29800		37000				
	750		30800		37500				
	Unlimited		31400		38600				
2000 5.75%	50	2406	24700	9600	34300	AKR-75	AKR-30H	AKR-30H	AKR-30H
	100		31100		40700				
	150		34000		43600		AKR-50	AKR-50	AKR-50
	250		36700		46300				
	500		39100		48700				
	750		40000		49600				
	Unlimited		41900		51500		AKR-50H	AKR-50H	AKR-50H
2500 5.75%	50	3008	28000	12000	40000	AKR-75	AKR-50	AKR-50	AKR-50
	100		36400		48400				
	150		40500		52500		AKR-50H	AKR-50H	AKR-50H
	250		44500		56500				
	500		48100		60100				
	750		49500		61500				
	Unlimited		52300		64300				
3000 5.75%	50	3607	30700	14400	45100	AKR-100	AKR-50	AKR-50	AKR-50
	100		41200		55600		AKR-50H	AKR-50H	AKR-50H
	150		46500		60900				
	250		51900		66300		AKR-100	AKR-100	AKR-100
	500		56800		71200				
	750		58700		73100				
	Unlimited		62700		77100				

① With transformer operating on base temperature rise, without fans. Larger frame size main breaker may be required when dual temperature rise or forced cooled transformers are utilized.
② Minimum impedance.

L = Long-time delay trip (overload tripping).
S = Short-time delay trip (selective fault tripping).
I = Instantaneous trip (high fault current fast tripping).
I_H = High range instantaneous permits a fully selective system, plus a fully rated system.

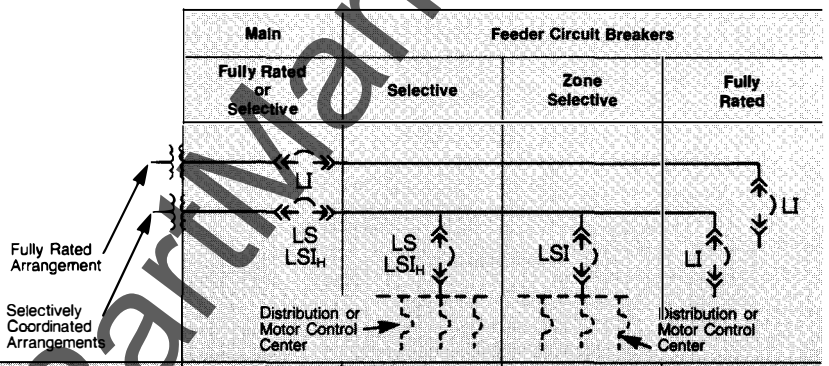


Table 29.1 240 volts, three phase

Transformer Rating 3-phase kVA and Impedance Percent	Maximum Short-circuit Mva Available From Primary System	Full load Continuous Current (amperes) ①	Short-circuit Rating Symmetrical Current (amperes)			Main	Feeder Circuit Breakers		
			Trans-former Alone	100% Motor Load	Combined	Long-time Instantaneous or Long-time Short-time	Long-time Short-time	Long-time Short-time Instantaneous	Long-time Instantaneous
						Minimum Rating Breaker			
						Breaker	Breaker	Breaker	Breaker
1	2	3	4	5	6	7	8	9	10
300 4.5% ②	50	722	14200	2900	17100	AKR-30S	AKR-30S	AKR-30S	AKR-30S
	100		15000		17900				
	150		15400		18300				
	250		15600		18500				
	500		15800		18700				
	750		15900		18800				
	Unlimited		16000		18900				
500 4.5% ②	50	1203	21900	4800	26700	AKR-50	AKR-30H	AKR-30S	AKR-30S
	100		24000		28800				
	150		24900		29700				
	250		25600		30400		AKR-30H		
	500		26100		30900				
	750		26300		31100				
	Unlimited		26700		31500				
750 5.75%	50	1804	24900	7200	32100	AKRT-50	AKR-30H	AKR-30S	AKR-30S
	100		27800		35000				
	150		28900		36100				
	250		29800		37000				
	500		30600		37800				
	750		30800		38000				
	Unlimited		31400		38600				
1000 5.75%	50	2406	31100	9600	40700	AKR-75	AKR-30H	AKR-30S	AKR-30S
	100		35700		45300		AKR-50	AKR-30H	AKR-30H
	150		37500		47100				
	250		39100		48700				
	500		40500		50100		AKR-50H	AKR-50	AKR-50
	750		41000		50600				
	Unlimited		41900		51500				
1500 5.75%	50	3609	41300	14400	55700	AKR-100	AKR-50H	AKR-50	AKR-50
	100		49800		64200				
	150		53500		67900		AKR-100	AKR-75	AKR-75
	250		56900		71300				
	500		59700		74100				
	750		60600		75000				
	Unlimited		62800		77200				

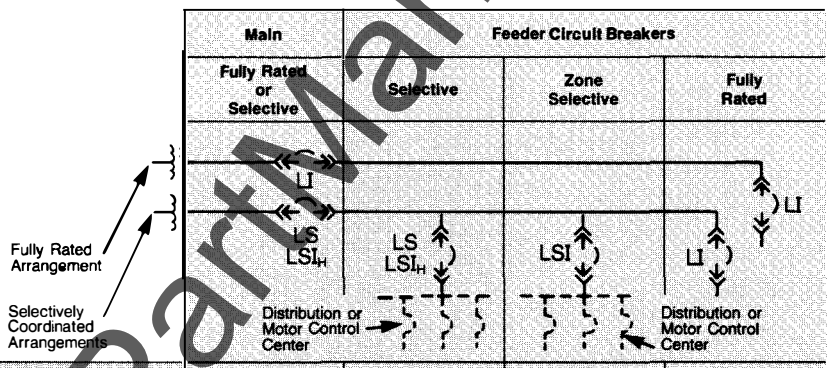
① With transformer operating on base temperature rise, without fans. Larger frame size main breaker may be required when dual temperature rise or forced cooled transformers are utilized.

② Minimum impedance.

L = Long-time delay trip (overload tripping).
S = Short-time delay trip (selective fault tripping).
I = Instantaneous trip (high fault current fast tripping).
I_H = High range instantaneous permits a fully selective system, plus a fully rated system.

Table 30.1 208 volts, three phase

Transformer Rating 3-phase kVA and Impedance Percent	Maximum Short-circuit Mva Available From Primary System	Full load Continuous Current (amperes) ①	Short-circuit Rating Symmetrical Current (amperes)			Main	Feeder Circuit Breakers		
						Fully Rated or Selective	Selective	Zone Selective	Fully Rated
			Transformer Alone	50% Motor Load	Combined	Long-time Instantaneous or Long-time Short-time	Long-time Short-time	Long-time Short-time Instantaneous	Long-time Instantaneous
						Minimum Rating Breaker			
						Breaker	Breaker	Breaker	Breaker
1	2	3	4	5	6	7	8	9	10
300 4.5% ②	50	833	16300	1700	18000	AKR-50	AKR-30S	AKR-30S	AKR-30S
	100		17300		19000				
	150		17700		19400				
	250		18000		19700				
	500		18300		20000				
	750		18400		20100				
	Unlimited		18500		20200				
500 4.5% ②	50	1388	25300	2800	28000	AKR-50	AKR-30H	AKR-30S	AKR-30S
	100		27800		29600				
	150		28700		31500		AKR-30H		
	250		29500		32300				
	500		30200		33000				
	750		30400		33200				
	Unlimited		30800		33600				
750 5.75%	50	2080	28700	4200	32900	AKR-75	AKR-30H	AKR-30S	AKR-30S
	100		32000		36200				
	150		33300		37500				
	250		34400		38600				
	500		35200		39400				
	750		35600		39800				
	Unlimited		36200		40400				
1000 5.75%	50	2780	35800	5600	41400	AKR-75	AKR-30H	AKR-30S	AKR-30S
	100		41100		46700		AKR-50	AKR-30H	AKR-30H
	150		43200		48800				
	250		45100		50700		AKR-50H	AKR-50	AKR-50
	500		46600		52200				
	750		47300		52900				
	Unlimited		48200		52800				
	50	4160	47600	8300	55900	No main breaker available	AKR-50H	AKR-50	AKR-50
	100		57500		65800		AKR-100	AKR-75	AKR-75
	150		61700		70000				
	250		65600		73900				
	500		68800		77100				
	750		69900		78200				
	Unlimited		72400		80700				



①perating on base temperature rise, without fans. Larger frame size main ·uired when dual temperature rise or forced cooled transformers are

L = Long-time delay trip (overload tripping).
S = Short-time delay trip (selective fault tripping).
I = Instantaneous trip (high fault current fast tripping).
I_H = High range instantaneous permits a fully selective system, plus a fully rated system.

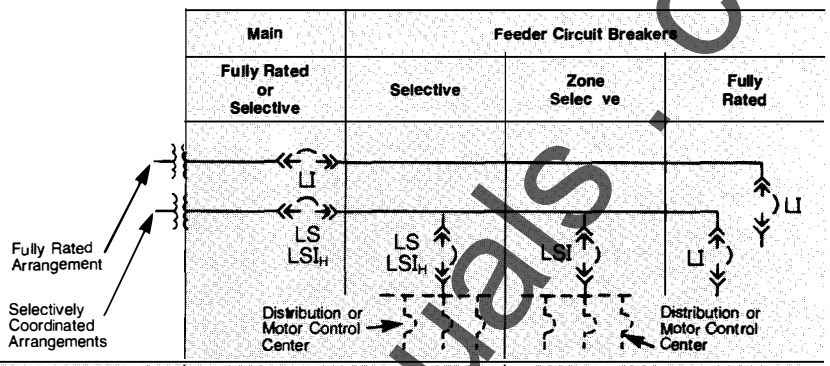


Table 31.1 600 volts, three phase

Transformer Rating 3-phase kVA and Impedance Percent	Maximum Short-circuit Mva Available From Primary System	Full load Continuous Current (amperes) ①	Short-circuit Rating Symmetrical Current (amperes)			Long-time instantaneous or Long-time Short-time	Long-time Short-time	Long-time Short-time Instantaneous	Long-time Instantaneous
			Trans-former Alone	100% Motor Load	Combined	Minimum Rating Breaker			
						Breaker	Breaker	Breaker	Breaker
1	2	3	4	5	6	7	8	9	10
300 4.5%	50	289	5700	1200	6900	AKR-30S	AKR-30S	AKR-30S	AKR-30S
	100		6000		7200				
	150		6100		7300				
	250		6200		7400				
	500		6300		7500				
	750		6400		7600				
	Unlimited		6400		7600				
500 4.5% ②	50	481	8700	1900	10600	AKR-30S	AKR-30S	AKR-30S	AKR-30S
	100		9600		11500				
	150		10000		11900				
	250		10200		12100				
	500		10500		12400				
	750		10500		12400				
	Unlimited		10700		12600				
750 5.75%	50	722	9900	2900	12800	AKR-30S	AKR-30S	AKR-30S	AKR-30S
	100		11100		14000				
	150		11500		14400				
	250		11900		14800				
	500		12200		15100				
	750		12300		15200				
	Unlimited		12500		15400				
1000 5.75%	50	962	12500	3800	16300	AKR-50	AKR-30S	AKR-30S	AKR-30S
	100		14300		18100				
	150		15000		18800				
	250		15700		19500				
	500		16200		20000				
	750		16400		20200				
	Unlimited		16800		20600				
1500 5.75%	50	1444	16500	5800	22300	AKR-50	AKR-30H	AKR-30H	AKR-30H
	100		19900		25700				
	150		21400		27200				
	250		22700		28500				
	500		23800		29600				
	750		24200		30000				
	Unlimited		25100		30900		AKR-30H	AKR-30H	AKR-30H
2000 5.75%	50	1924	19700	7700	27400	AKRT-50	AKR-30	AKR-30	AKR-30
	100		24800		32500		AKR-30H	AKR-30H	AKR-30H
	150		27200		34900				
	250		29400		37100				
	500		31200		38900				
	750		32000		39700				
	Unlimited		33500		41200				
2500 5.75%	50	2406	22400	9600	32000	AKR-75	AKR-30H	AKR-30H	AKR-30H
	100		29200		38800				
	150		32400		42000				
	250		35700		45300		AKR-50H	AKR-50H	AKR-50H
	500		38500		48100				
	750		39600		49200				
	Unlimited		41900		51500		AKR-75	AKR-75	AKR-75
3000 5.75%	50	2886	24600	11500	36100	AKR-75	AKR-30H	AKR-30H	AKR-30H
	100		33000		44500		AKR-50H	AKR-50H	AKR-50H
	150		37300		48800				
	250		41600		53100		AKR-75	AKR-75	AKR-75
	500		45500		57000				
	750		47000		58500				
	Unlimited		50200		61700				

① With transformer operating on base temperature rise, without fans. Larger frame size main breaker may be required when dual temperature rise or forced cooled transformers are utilized.
② Minimum impedance.

L = Long-time delay trip (overload tripping).
S = Short-time delay trip (selective fault tripping).
I = Instantaneous trip (high fault current fast tripping).
I_H = High range instantaneous permits a fully selective system, plus a fully rated system.

Standards and Testing

Type AKR low voltage power circuit breakers are designed to meet ANSI Standards C37.13 and C37.16 and are tested to ANSI C37.50 and C37.14. The breakers are UL listed and labeled certifying compliance with the referenced ANSI Standards.

Interrupting capacity multiplying factors for power factors lower than test values.

The test circuit X/R rates and power factor required by ANSI C37.13 for unfused breakers is 6.6 with 15% power factor; for fused breakers is 4.9 with 20% power factor.

Temperature Derating Factors

The continuous current rating of AKR breakers is based on their use in an *enclosure in a 40°C ambient* and on a maximum breaker temperature of 105°C for Class A insulation. Continuous current ratings of AKR breakers must be derated for ambient temperatures above 40°C. (If MicroVersaTrip programmer is used the *programmer ambient* is limited to 70°C.)

Altitude Correction Factors

Rating correction factors for low voltage power circuit breakers are listed in ANSI C37.13 - 1981. They are as listed above.

When applying low voltage power circuit breakers at altitudes greater than 6600 ft., their continuous current rating must be modified because a higher temperature use will be experienced for a given current rating. The voltage ratings must also be modified because of the lower dielectric strength. The short time and short circuit current ratings are not affected by altitude. However, the short-current current rating should not exceed that of the voltage class prior to derating.

Humidity and Fungus

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

Current carrying parts are silver or tin plated for corrosion protection and to assume electrical connections.

Tropical treatment is optionally available and consists of the application of a fungus resistant varnish to those insulating materials that are not inherently fungus proof.

Table 32.1
Selection of Multiplying Factor

System Short Circuit Power Factor (%)	System X/R Ratio	Multiplying Factor for Breaker Short Circuit Current Rating	
		Unfused Bkr	Fused
20	4.9	1.00	1.00
15	6.6	1.00	0.938
12	8.27	0.966	0.902
10	9.95	0.938	0.875
8.5	11.72	0.920	0.847
7	14.25	0.902	0.826
5	20.0	0.875	0.794

Table 32.2
Continuous Current Derating Factors

Ambient Temp	Derating Factor
40°C	1.00
45°C	.95
50°C	.89
55°C	.84 (MicroVersaTrip max.)
60°C	.77
65°C	.71
70%	.63

Table 32.3
Altitude Correction Factors

Altitude		Rating Correction Factor	
Meters	Ft.	Continuous Current	Voltage
2000	6600 (and below)	1.00	1.00
2600	8500	0.99	0.95
3900	13000	0.96	0.80

Table 33.1
Charging and Closing Operating Currents

Nominal Control Voltage	Freq. Hz	Voltage Range	Min. (Volts) Pick-up	Anti-pump Relay "E" Rated Amps		Min. (Volts) Pick-up	Control Relay "K" Rated Amps		Min. (Volts) Pick-up	Closing Solenoid Rated Amps		Fuse Selection
				Inrush	Sealed		Inrush	Sealed		Inrush	Sealed	
				Open	Closed		Open	Closed		Open	Closed	
48V	DC	38-56	38	.063	.063	30	4.1	4.1	38	95	95	20A
125V	DC	100-140	85	.024	.024	90	1.05	1.05	100	43.6	43.6	10A
250V	DC	200-280	170	.015	.015	180	.53	.53	200	23.9	23.9	6A
120V	60	104-127	95	.090	.052	95	1.0	.14	98	153	78.4	30A
120V	50			.090	.052		1.0	.15		142	63.4	30A
120V	25			.047	.032		6.85	1.27		70.6	45.5	15A
208V	60	180-220	175	.050	.029	175	.45	.063	177	90.8	37.4	15A
208V	50			.050	.029		.55	.083		103	46.9	15A
208V	25			.032	.018		3.86	.76		45.3	27.3	10A
240V	60	208-254	190	.064	.036	190	.50	.07	196	67.5	27.6	15A
240V	50			.064	.036		.50	.08		74.8	30.3	15A
240V	25			.035	.023		3.42	.64		43.1	23.5	6A

Table 33.2
Shunt Trip and Undervoltage Device Operating Currents

Nominal Control Voltage	Frequency Hz	Shunt Trip Operating Voltage Range		Shunt Trip Current (Amps) Inrush Open	Shunt Trip Current (Amps) Sealed Closed	Undervoltage Operating Voltage Range	Undervoltage Current (Amps) Inrush Open	Undervoltage Current (Amps) Sealed Closed
24	DC	14	30	8.3	8.3	Pickup at 85% of Nominal Control Voltage, Dropout at 30-60% of Nominal Control Voltage	.38	.38
48	DC	28	60	4.5	4.5		.19	.19
125	DC	70	140	2.0	2.0		.08	.08
250	DC	140	280	1.0	1.0		.04	.04
70	60	59	132	—	—		N/A	N/A
120	60	95	127	12.3	10.8		.66	.24
120	50	95	127	7.6	6.7		.75	.25
208	60	175	220	3.2	2.6		.51	.17
208	50	175	220	3.8	3.1		.30	.10
240	60	190	254	3.9	3.4		.37	.12
240	50	190	254	4.7	4.1		.34	.11
240	40	190	254	5.8	5.1		N/A	N/A
380	50	315	410	2.9	2.6		.22	.08
480	60	380	508	3.4	3.1		.23	.08
480	50	380	508	7.5	7.3		.17	.06
575	60	475	625	2.8	2.5		.16	.06
575	50	475	625	5.1	4.7		.14	.06

Electrical Characteristics — AKR-30S (Continued)

Table 34.1
Coil Resistance — DC Ohms @ 25°C

Nominal Control Voltage	Frequency Hz	Anti-Pump Relay "E"	Control Relay "K"	Shunt Trip	Undervoltage	Closing Solenoid
24V	DC	N/A	N/A	3	64	N/A
48V	DC	802	12	11	240	.49
125V	DC	5000	119	64	1600	2.76
250V	DC	16400	476	260	6700	10.50
120V	60	450	54	3.9	25.4	.248
120V	50	450	75	7.15	33	.316
208V	60	1450	216	25.4	64	.825
208V	50	1450	300	25.4	146	.825
240V	60	1450	300	25.4	100	.930
240V	50	1450	300	25.4	146	1.27
380V	50	N/A	N/A	64	370	3.17
480V	60	N/A	N/A	64	370	4.10
480V	50	N/A	N/A	32	580	5.10
575V	60	N/A	N/A	100	580	5.85
575V	50	N/A	N/A	64	918	8.00

Table 34.2
Accessories

Bell Alarm Contact Ratings				Auxiliary Switch Control Ratings①			Auxiliary Switch Contact Sequence		
Control Voltage		Rating (Amperes)		Control Voltage		Rating (Amperes)			
		Inrush	Continuous			Non-Inductive	Inductive	CB Main Contacts	"A" Contact	"B" Contact
dc	125 250	2.5 0.9	2.5 0.9	dc	48 125 250	25 11 2	— 6.3 1.8	Open or Tripped	Open	Closed
60 Hz ac	120 240 480	30 15 7	10 5 3	60 Hz ac	115 240 480	75 50 25	50 25 12	Closed	Closed	Open

① Limited to 20A continuous ratings of switch on all breakers and to 15A continuous rating of #16 wire on draw out breakers.

Electrical Characteristics — AKR-30/50/T50

Table 35.1
Charging and Closing Operating Currents

Nominal Control Voltage	Freq. Hz	Voltage Range	Motor Current (Amps)		Anti-pump Relay "W"			Control Relay "X"			Closing Solenoid			Fuse Selection	Charging Time (Sec.)
			Inrush	Sustained	Min. (Volts) Pick-up	Rated Amps Inrush Open	Rated Amps Sealed Closed	Min. (Volts) Pick-up	Rated Amps Inrush Open	Rated Amps Sealed Closed	Min. (Volts) Pick-up	Rated Amps Inrush Open	Rated Amps Sealed Closed		
48V	DC	38-56	40	10	38	.063	.063	30	4.1	4.1	38	3.58	3.58	15A	1.5
125V	DC	100-140	27	5	85	.024	.024	90	1.05	1.05	100	1.75	1.75	6A	1.0
250V	DC	200-280	13	3	170	.015	.015	180	.53	.53	200	.88	.88	6A	1.0
120V	60					.090	.052		1.0	.14		2.6	.35	6A	0.9
120V	50	104-127	25	5	95	.090	.052	95	1.0	.15	98	2.2	.29	6A	0.9
120V	25					.047	.032		6.85	1.27		1.1	.17	6A	0.9
208V	60					.050	.029		.45	.063		1.5	.19	6A	0.9
208V	50	180-220	15	3.5	175	.050	.029	175	.55	.083	177	1.2	.16	6A	0.9
208V	25					.032	.018		3.86	.76		.60	.08	6A	0.9
250V	60					.064	.036		50	.07		1.3	.17	6A	0.9
250V	50	208-254	12	3	190	.064	.036	190	.50	.08	196	1.1	.15	6A	0.9
250V	25					.035	.023		3.42	.64		.54	.08	6A	0.9

Table 35.2
Shunt Trip and Undervoltage Device Operating Currents

Nominal Control Voltage	Frequency Hz	Shunt Trip Operating Voltage Range		Shunt Trip Current (Amps) Inrush Open	Shunt Trip Current (Amps) Sealed Closed	Undervoltage Operating Voltage Range	Undervoltage Current (Amps) Inrush Open	Undervoltage Current (Amps) Sealed Closed
24	DC	14	30	8.3	8.3	Pickup at 80% of Nominal Control Voltage Drop out at 30-60% of Nominal Control Voltage	.38	.38
48	DC	28	60	4.5	4.5		.19	.19
125	DC	70	140	2.0	2.0		.08	.08
250	DC	140	280	1.0	1.0		.04	.04
70	60	59	132	—	—		N/A	N/A
120	60	95	127	12.3	10.8		.66	.24
120	50	95	127	7.6	6.7		.75	.25
120	25	95	127	4.7	4.1		.31	.10
208	60	175	220	3.2	2.6		.51	.17
208	50	175	220	3.8	3.1		.30	.10
208	25	175	220	2.1	1.9		.14	.05
240	60	190	254	3.9	3.4		.37	.12
240	50	190	254	4.7	4.1		.34	.11
240	40	190	254	5.8	5.1		N/A	N/A
240	25	190	254	2.1	1.9		.16	.06
380	50	315	410	2.9	2.6		.22	.08
480	60	380	508	3.4	3.1		.23	.08
480	50	380	508	7.5	7.3		.17	.06
480	25	380	508	3.5	3.3		.11	.05
575	60	475	625	2.8	2.5		.16	.06
575	50	475	625	5.1	4.7		.14	.06
575	25	475	625	3.1	3.0		.10	.05

Table 36.1
Coil Resistance — DC Ohms @ 25°C

Nominal Control Voltage	Frequency Hz	Anti-Pump Relay "W"	Control Relay "X"	Shunt Trip	Undervoltage
24V	DC	N/A	N/A	3	64
48V	DC	802	12	11	240
125V	DC	5000	119	64	1600
250V	DC	16400	476	260	6700
120V	60	450	54	3.9	25.4
120V	50	450	75	7.15	33
120V	25	1450	75	25.4	146
208V	60	1450	216	25.4	64
208V	50	1450	300	25.4	146
208V	25	3900	300	64	580
240V	60	1450	300	25.4	100
240V	50	1450	300	25.4	146
240V	25	6000	300	64	580
380V	50	N/A	N/A	64	370
480V	60	N/A	N/A	64	370
480V	50	N/A	N/A	32	580
480V	25	N/A	N/A	100	1600
575V	60	N/A	N/A	100	580
575V	50	N/A	N/A	64	918
575V	25	N/A	N/A	146	3200

Table 36.2
Remote Close Solenoid Ratings

Control Voltage		Amperes	
		Inrush	Sustained
Dc	48 125 250	2.7 1.3 0.68	0.58 0.32 0.15
60 Hz Ac	120 240	2 1	0.4 0.2

Table 36.3
Accessories

Bell Alarm Contact Ratings				Auxiliary Switch Control Ratings①				Auxiliary Switch Contact Sequence		
Control Voltage		Rating (Amperes)		Control Voltage		Rating (Amperes)		CB Main Contacts	"A" Contact	"B" Contact
		Inrush	Continuous			Non-Inductive	Inductive			
dc	125 250	2.5 0.9	2.5 0.9	dc	48 125 250	25 11 2	— 6.3 1.8	Open or Tripped	Open	Closed
60 Hz ac	120 240 480	30 15 7	10 5 3	60 Hz ac	115 240 480	75 50 25	50 25 12	Closed	Closed	Open

① Limited to 20A continuous ratings of switch on all breakers and to 15A continuous rating of #16 wire on draw-out breakers.

Table 37.1
Charging and Closing Operating Currents

Nominal Control Voltage	Freq. Hz	Voltage Range	Motor Current (Amps)		Anti-pump Relay "W"			Control Relay "X"			Closing Solenoid			Fuse Selection	Charging Time (Sec.)
			Inrush	Sustained	Min. (Volts) Pick-up	Rated Amps Inrush Open	Rated Amps Sealed Closed	Min. (Volts) Pick-up	Rated Amps Inrush Open	Rated Amps Sealed Closed	Min. (Volts) Pick-up	Rated Amps Inrush Open	Rated Amps Sealed Closed		
48V	DC	38-56	22	16.5	38	.063	.063	30	4.1	4.1	38	2.7	2.7	20A	2.0
125V	DC	100-140	25	7	85	.024	.024	90	1.05	1.05	100	1.3	1.3	20A	1.7
250V	DC	200-280	13	3.2	170	.015	.015	180	.53	.53	200	.68	.68	20A	1.7
120V	60	104-127	25	8.1	95	.090	.052	95	1.0	1.4	98	2.6	.35	20A	1.5
120V	50					.090	.052		1.0	.15		2.2	.29	20A	1.5
120V	25					.047	.032		6.85	1.27		1.1	.17	20A	1.5
208V	60	180-220	10.3	3.5	175	.050	.029	175	.45	.063	177	1.5	.19	20A	1.7
208V	50					.050	.029		.55	.083		1.2	.16	20A	1.7
208V	25					.032	.018		3.86	.76		.60	.08	20A	1.7
250V	60	208-254	11.7	3.5	190	.064	.036	190	.50	.07	196	1.3	.17	20A	1.3
250V	50					.064	.036		.50	.08		1.1	.15	20A	1.3
250V	25					.035	.023		3.42	.64		.54	.08	20A	1.3

Table 37.2
Shunt Trip and Undervoltage Device Operating Currents

Nominal Control Voltage	Frequency Hz	Shunt Trip Operating Voltage Range		Shunt Trip Current (Amps) Inrush Open	Shunt Trip Current (Amps) Sealed Closed	Undervoltage Operating Voltage Range	Undervoltage Current (Amps) Inrush Open	Undervoltage Current (Amps) Sealed Closed
24	DC	14	30	8.3	8.3	Pickup at 80% of Nominal Control Voltage Drop out at 30-60% of Nominal Control Voltage	.38	.38
48	DC	28	60	4.5	4.5		.19	.19
125	DC	70	140	2.0	2.0		.08	.08
250	DC	140	280	1.0	1.0		.04	.04
70	60	59	132	—	—		N/A	N/A
120	60	95	127	12.3	10.8		.66	.24
120	50	95	127	7.6	6.7		.75	.25
120	25	95	127	4.7	4.1		.31	.10
208	60	175	220	3.2	2.6		.51	.17
208	50	175	220	3.8	3.1		.30	.10
208	25	175	220	2.1	1.9		.14	.05
240	60	190	254	3.9	3.4		.37	.12
240	50	190	254	4.7	4.1		.34	.11
240	40	190	254	5.8	5.1		N/A	N/A
240	25	190	254	2.1	1.9		.16	.06
380	50	315	410	2.9	2.6		.22	.08
480	60	380	508	3.4	3.1		.23	.08
480	50	380	508	7.5	7.3		.17	.06
480	25	380	508	3.5	3.3		.11	.05
575	60	475	625	2.8	2.5		.16	.06
575	50	475	625	5.1	4.7		.14	.06
575	25	475	625	3.1	3.0		.10	.05

Table 38.1
Coil Resistance — DC Ohms @ 25°C

Nominal Control Voltage	Frequency Hz	Anti-Pump Relay "W"	Control Relay "X"	Shunt Trip	Undervoltage
24V	DC	N/A	N/A	3	64
48V	DC	802	12	11	240
125V	DC	5000	119	64	1600
250V	DC	16400	476	260	6700
120V	60	450	54	3.9	25.4
120V	50	450	75	7.15	33
120V	25	1450	75	25.4	146
208V	60	1450	216	25.4	64
208V	50	1450	300	25.4	146
208V	25	3900	300	64	580
240V	60	1450	300	25.4	100
240V	50	1450	300	25.4	146
240V	25	6000	300	64	580
380V	50	N/A	N/A	64	370
480V	60	N/A	N/A	64	370
480V	50	N/A	N/A	32	580
480V	25	N/A	N/A	100	1600
575V	60	N/A	N/A	100	580
575V	50	N/A	N/A	64	918
575V	25	N/A	N/A	146	3200

Table 38.2
Accessories

Bell Alarm Contact Ratings				Auxiliary Switch Control Ratings①				Auxiliary Switch Contact Sequence		
Control Voltage		Rating (Amperes)		Control Voltage		Rating (Amperes)		CB Main Contacts	"A" Contact	"B" Contact
		Inrush	Continuous			Non-Inductive	Inductive			
dc	125 250	2.5 0.9	2.5 0.9	dc	48 125 250	25 11 2	— 6.3 1.8	Open or Tripped	Open	Closed
60 Hz ac	120 240 480	30 15 7	10 5 3	60 Hz ac	115 240 480	75 50 25	50 25 12	Closed	Closed	Open

① Limited to 20A continuous ratings of switch on all breakers and to 15A continuous rating of #16 wire on draw-out breakers.

Repetitive Duty

Circuit breakers are designed primarily to perform the function of circuit interruption under short-circuit conditions. Nevertheless modern circuit breaker mechanisms are capable of many operations under full-load operation and inrush conditions such as encountered in motor starting applications. Industry standards have been established for the minimum performance which is indicated in Table 39.1. With adequate maintenance, GE breakers can be expected to exceed the standards.

Power operated circuit breakers, when operating under usual service conditions, shall be capable of operating the number of times specified in the following table. The operating conditions are the permissible effect of such operations upon the breaker are given in the following lettered paragraphs. For each column, all paragraphs listed in the column heading must be given consideration.

This standard applies to all parts of a circuit breaker that function during normal operation. It does not apply to other parts, such as overcurrent tripping devices, that function only during infrequent abnormal circuit conditions.

Table 39.1
Repetitive Duty and Normal Maintenance

Circuit Breaker Frame Size (Amperes)	Number of Operations Between Servicing	Number of Operations Rated Continuous Current Switching ①③④⑤⑥⑦⑧⑩	Number of Operations No-Load Closing and Opening ①②③④⑤⑥⑦	Number of Operations In-Rush Current Switching ③④⑤⑥⑦⑨⑩
800	1750	2800	9700	1400
1600	500	800	3200	400
2000	500	800	3200	400
3200	250	400	1100	—
4000	250	400	1100	—

① Servicing consists of adjusting, cleaning, lubricating, tightening, etc., as recommended by the manufacturer. When current is interrupted, dressing of contacts may be required as well. The operations listed are on the basis of servicing at intervals of 6 months or less.

② When closing and opening no-load.

③ With rated control voltage applied.

④ Frequency of operation not to exceed 20 in 10 minutes or 30 in an hour. Rectifiers or other auxiliary devices may further limit the frequency of operation.

⑤ Servicing at no greater intervals than shown in Column 2 above.

⑥ No functional parts should have been replaced during the listed operations.

⑦ The circuit breaker should be in a condition to carry its rated continuous current at rated maximum voltage and perform at least one opening operation at rated short-circuit current. After completion of this series of operations, functional part replacement and general servicing may be necessary.

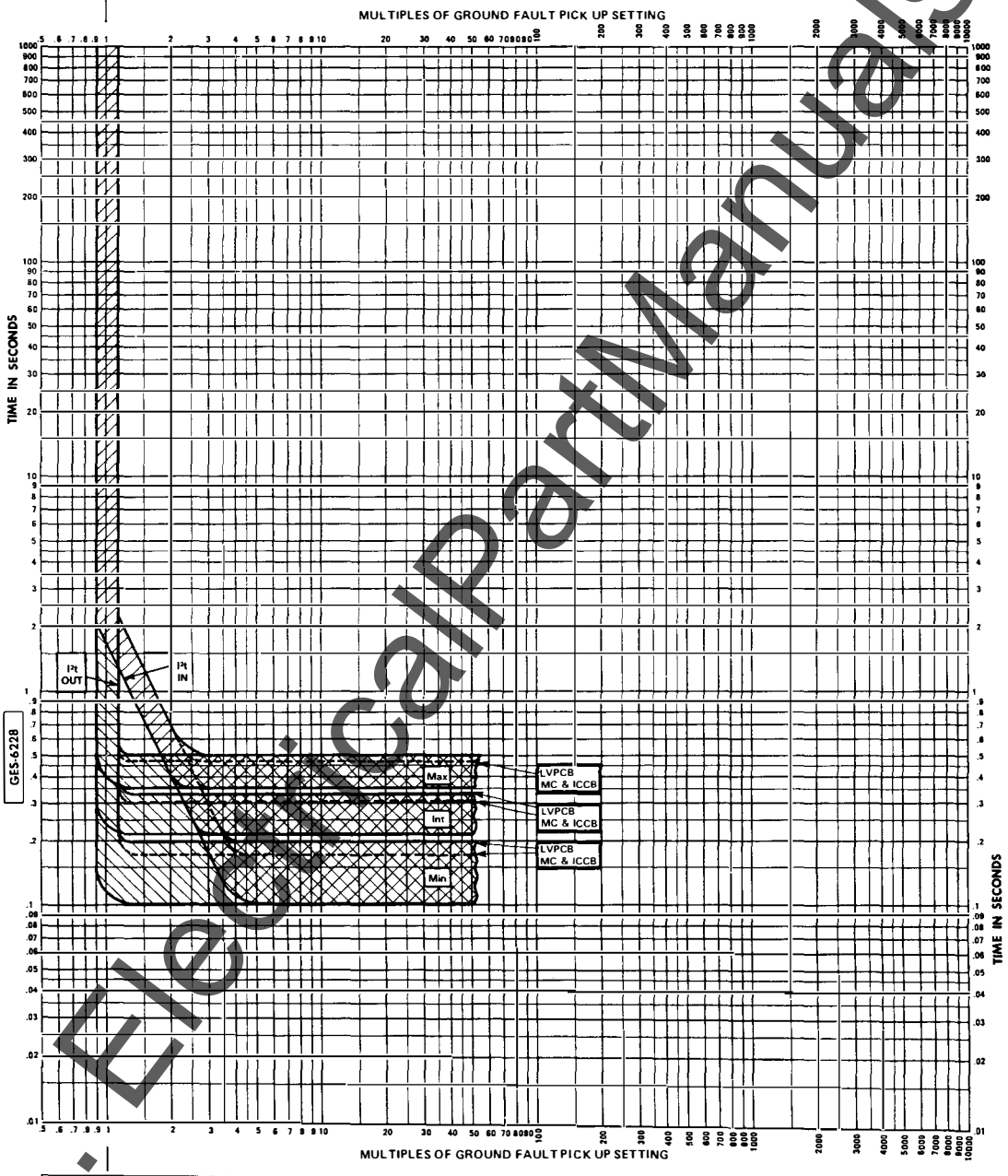
⑧ When closing and opening current up to the continuous current rating of the circuit breaker at voltages up to the rated maximum voltage and at 85% of the power factor or higher.

⑨ When closing currents up to 600% and opening currents up to 100% (80% power factor or higher) of the continuous current rating of the circuit breaker at voltages up to the rated maximum voltage.

When closing currents up to 600% and opening currents up to 600% (50% power factor or less) of the continuous current rating of the circuit breaker at voltages up to rated maximum voltage, the number of operations shown shall be reduced to 10% of the number listed.

⑩ If a fault operation occurs before the completion of the listed operations, servicing is recommended and possible functional part replacements may be necessary, depending on previous accumulated duty, fault magnitude, and expected future operations.

Time Current Curves (Continued)



GENERAL ELECTRIC

LOW-VOLTAGE POWER CIRCUIT BREAKERS
TYPE AKR
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-6228

Available Ratings (Amperes)

Breaker Type	Breaker Model	Frame	Current Sensor (S)
MCCB	TJH/TJL	400	150, 300, 400,
		600	600
	TKH/TKL	800	800
		1200	1200
ICCB	TP/THP/TC/THC	800	200, 400, 800
		1600	1000, 1600
		2000	2000
		2500	1000, 2000, 2500
		3000	3000
		4000	4000
LVPCB	AKR-30S/30H	800	150, 400, 800
	AKR-50/50H	1600	800, 1600
	AKRT-50H	2000	2000
	AKR-75	3200	3200
	AKR-100	4000	4000

S = Current Sensor Amps

Programmer Adjustments

Ground FaultFunction:

Pickup settings in multiples of current sensor amps (S):
0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5 and 0.6 for 150 thru 800 amp sensors (S)
0.2, 0.22, 0.24, 0.26, 0.28, 0.30, and 0.34 2500 thru 3200 amp sensors (S)
0.2, 0.22, 0.24, 0.26, 0.28 and 0.30 for 4000 amp sensors (S)

Delay bands:
Min, Int, Max; I^2t IN/OUT

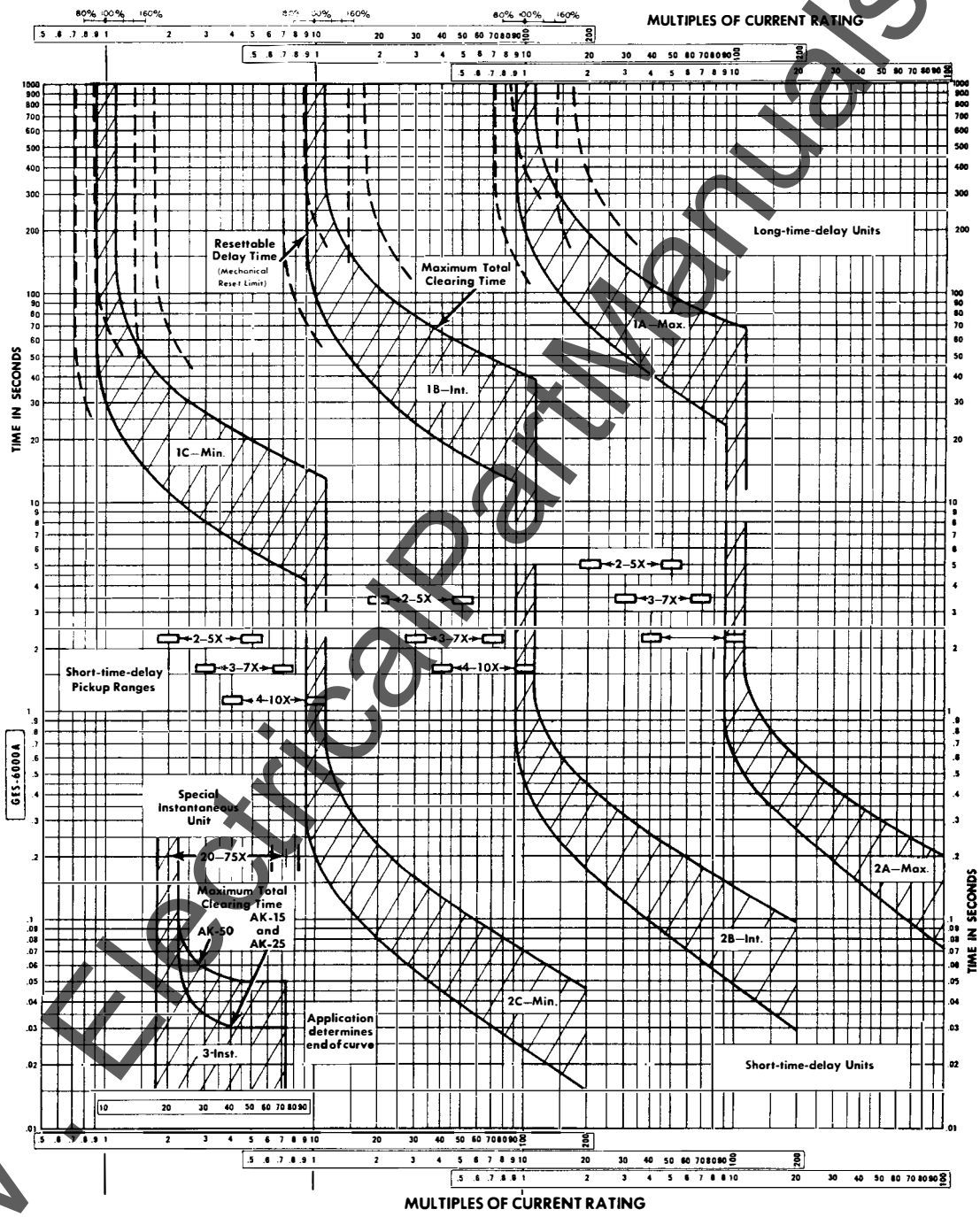
NOTE: Operation above 60 Hertz requires thermal and interrupting derating of the circuit breaker.

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

8/86 (3M)

GENERAL ELECTRIC CO, CONSTRUCTION EQUIPMENT BUSINESS OPERATIONS, PLAINVILLE, CT

Time Current Curves (Continued)



GENERAL ELECTRIC

TYPE AK LOW-VOLTAGE POWER CIRCUIT BREAKER

EC-1 SERIES TRIP DEVICE

Long-time-delay, Short-time-delay and Instantaneous Time-current Curves

(Curves apply at 60 cycles for ambient temperature of 25 C)

GES-6000A

Current Ratings (Amperes)

AK-15 15, 20, 30, 40, 50, 70, 90, 100, 125 150, 175, 200, 225
AK-25 40, 50, 70, 90, 100, 125, 150, 175 200, 225, 250, 300, 350, 400, 500 600
AK-50 200, 225, 250, 300, 350, 400, 500 600, 800, 1000, 1200, 1600

Adjustments

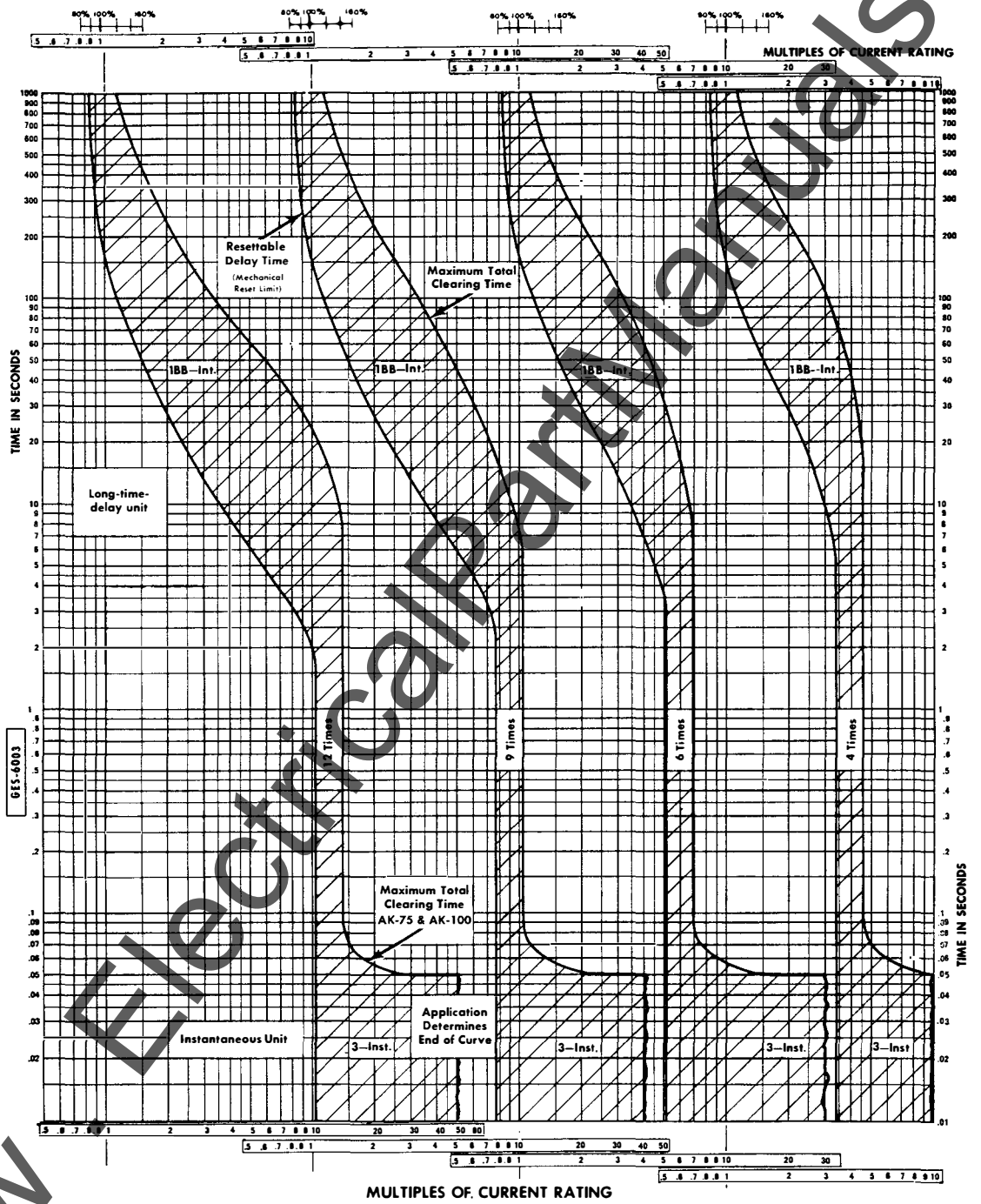
Long-time-delay Unit: Pickup current settings are 80 to 160% of rating. (Settings higher than 100% do not increase the continuous current rating.)
Short-time-delay Unit: Pickup current settings are 2 to 5X, or 3 to 7X, or 4 to 10X of ratings.
Instantaneous Unit: Special pickup current settings are 20–75X of ratings

11-81 (3M)

GENERAL ELECTRIC CO., DISTRIBUTION EQUIPMENT DIVISION, PLAINVILLE, CONN. 06062

11-638055

Time Current Curves (Continued)



GENERAL ELECTRIC

TYPE AK LOW-VOLTAGE POWER CIRCUIT BREAKER

EC-1B SERIES TRIP DEVICE

GES-6003

Current Ratings (Amperes)

AK-75	2000, 2500, 3000
AK-100	2000, 2500, 3000, 4000

1BB-3 Long-time-delay and Instantaneous Time-current Curves

(Curves apply at 60 cycles for ambient temperature of 25 C)

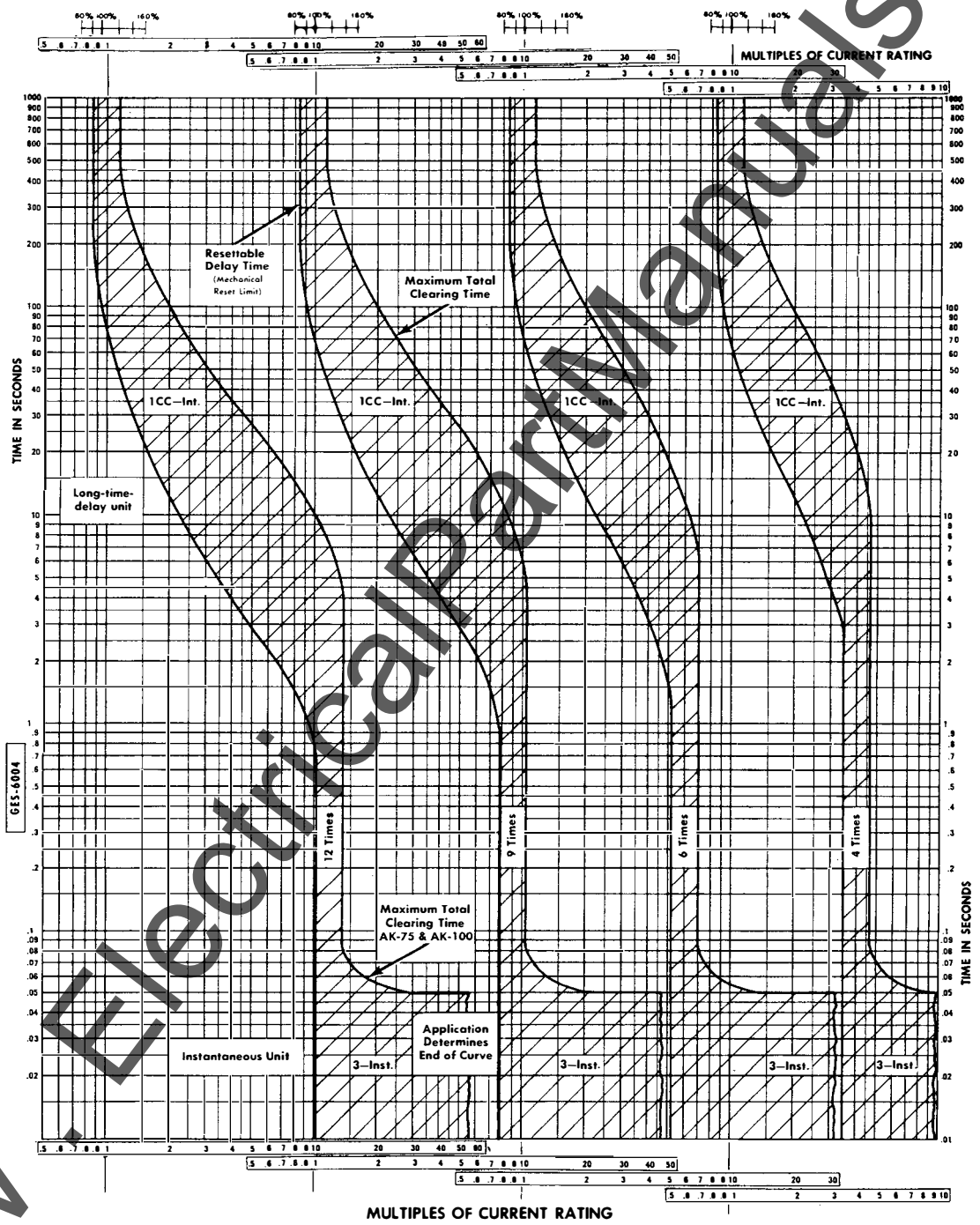
Adjustments

Long-time-delay Unit: Pickup settings are 80 to 160% of rating. (Settings higher than 100% do not increase the continuous current rating.)

Instantaneous Unit: Pickup settings are 4 to 9X, or 6 to 12X (std.), or 9 to 15X of rating.

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

Time Current Curves (Continued)



GENERAL ELECTRIC

TYPE AK LOW-VOLTAGE POWER CIRCUIT BREAKER

EC-1B SERIES TRIP DEVICE

GES-6004

Current Ratings (Amperes)

AK-75	2000, 2500, 3000
AK-100	2000, 2500, 3000, 4000

1CC-3 Long-time-delay and Instantaneous Time-current Curves

(Curves apply at 60 cycles for ambient temperature of 25 C)

Adjustments

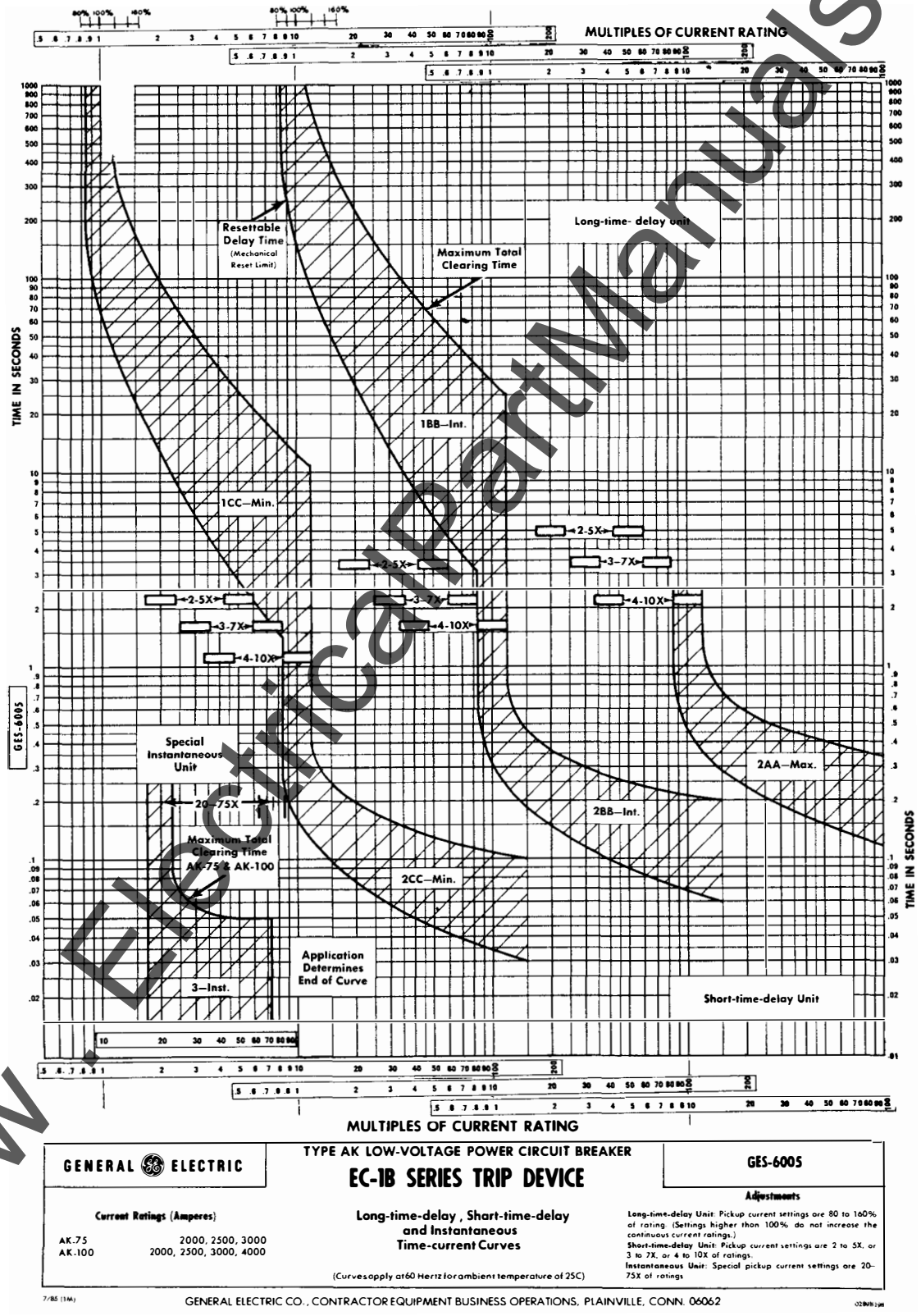
Long-time-delay Unit: Pickup settings are 80 to 160% of rating. (Settings higher than 100% do not increase the continuous current rating.)
Instantaneous Unit: Pickup settings are 4 to 9X, or 6 to 12X (std.), or 9 to 15X of rating.

7-'85 (2M)

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

0329B2687

Time Current Curves (Continued)



GENERAL ELECTRIC

TYPE AK LOW-VOLTAGE POWER CIRCUIT BREAKER

EC-1B SERIES TRIP DEVICE

GES-6005

Current Ratings (Amperes)

AK-75	2000, 2500, 3000
AK-100	2000, 2500, 3000, 4000

Long-time-delay, Short-time-delay and Instantaneous Time-current Curves

(Curves apply at 60 Hertz for ambient temperature of 25C)

Adjustments

Long-time-delay Unit: Pickup current settings are 80 to 160% of rating. (Settings higher than 100% do not increase the continuous current ratings.)

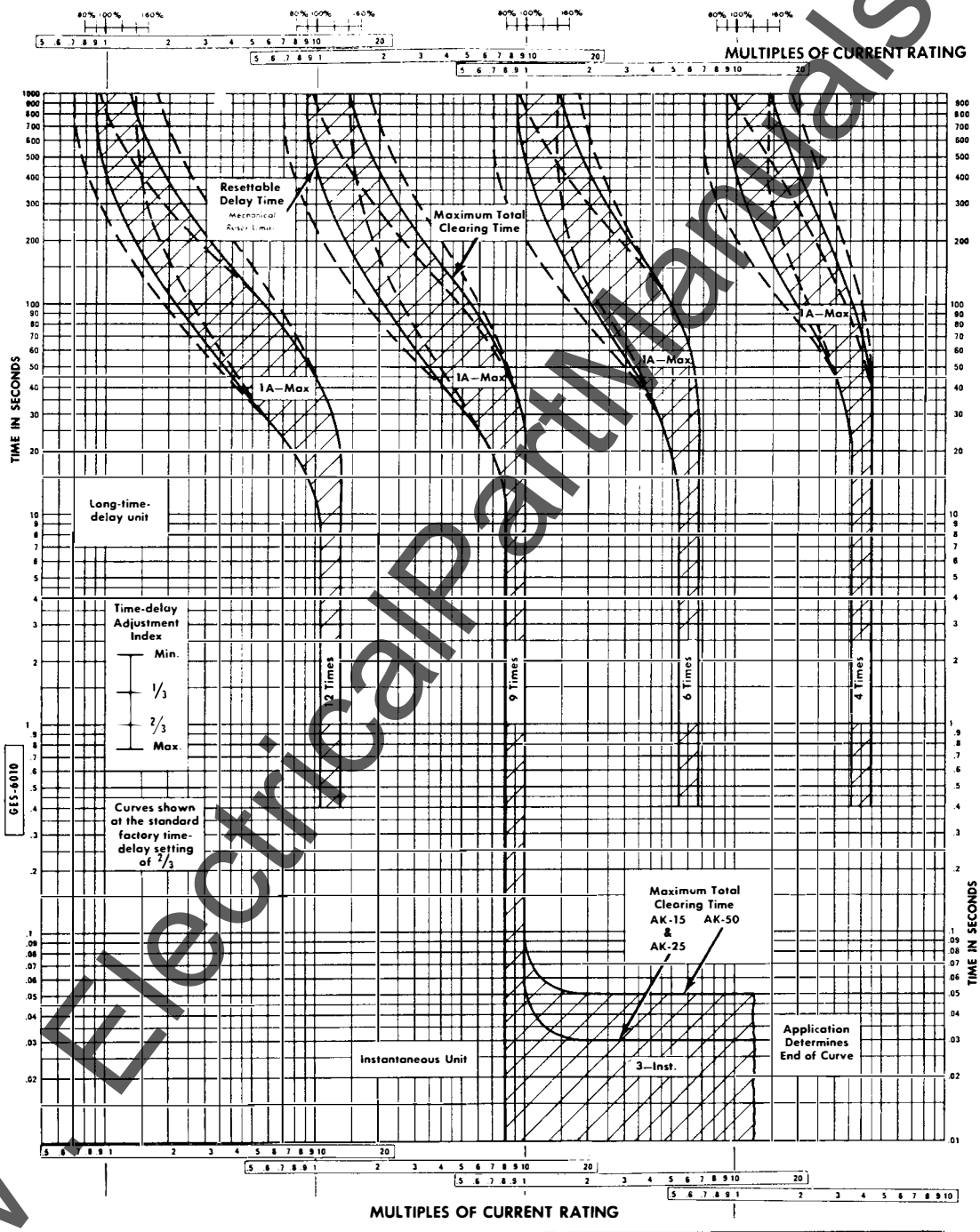
Short-time-delay Unit: Pickup current settings are 2 to 5X, or 3 to 7X, or 4 to 10X of ratings.

Instantaneous Unit: Special pickup current settings are 2–7.5X of ratings

7/85 (1M)

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

Time Current Curves (Continued)



GENERAL ELECTRIC

TYPE AK LOW-VOLTAGE POWER CIRCUIT BREAKER

EC-2 & EC-2A SERIES TRIP DEVICE

GES-6010

Current Ratings (Amperes)

AK-15	15, 20, 30, 40, 50, 70, 90, 100 125, 150, 175, 200, 225
AK-25	40, 50, 70, 90, 100, 125, 150, 175 200, 225, 250, 300, 350, 400, 500 600
AK-50	200, 225, 250, 300, 350, 400, 500 600, 800, 1000, 1200, 1600

1A-3 Long-time-delay and Instantaneous Time-current Curves

(Curves apply at 60 Hertz for ambient temperature of 25 C)

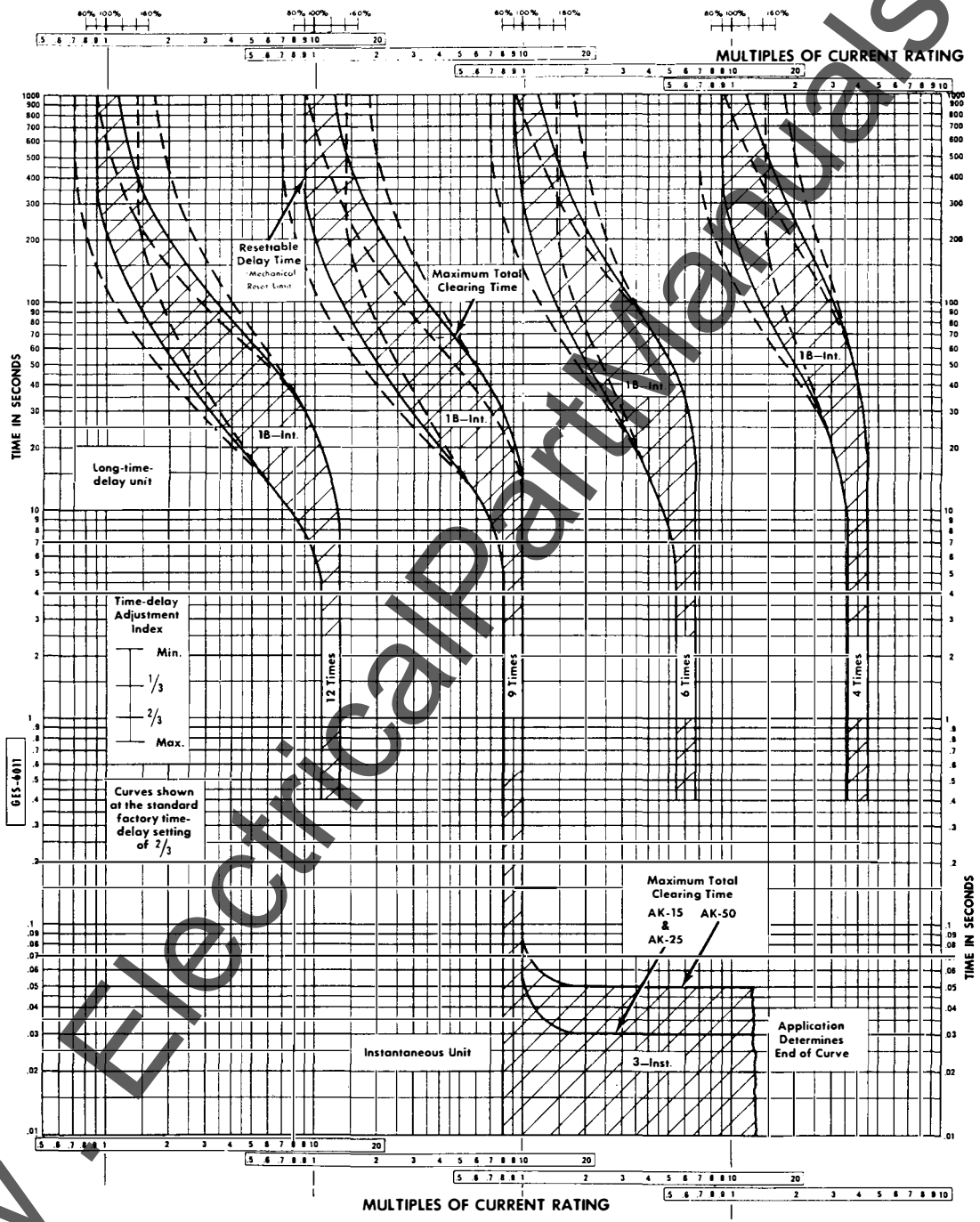
Adjustments

Long-time-delay Unit: Pickup settings are 80 to 160% of rating. (Settings higher than 100% do not increase the continuous current rating.) **Instantaneous Unit:** Pickup settings are 4 to 9X, or 6 to 12X (std.), or 9 to 15X of rating.

7/65 (2.5M)

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

Time Current Curves (Continued)



GENERAL ELECTRIC

TYPE AK LOW-VOLTAGE POWER CIRCUIT BREAKER

EC-2 & EC-2A SERIES TRIP DEVICE

GES-6011

Current Ratings (Amperes)

AK-15	15, 20, 30, 40, 50, 70, 90, 100 125, 150, 175, 200 225
AK-25	40, 50, 70, 90, 100, 125, 150, 175 200, 225, 250, 300, 350, 400, 500 600
AK-50	200, 225, 250, 300, 350, 400, 500 600, 800, 1000, 1200, 1600

1B-3 Long-time-delay and Instantaneous Time-current Curves

(Curves apply at 60 Hertz for ambient temperature of 25 C)

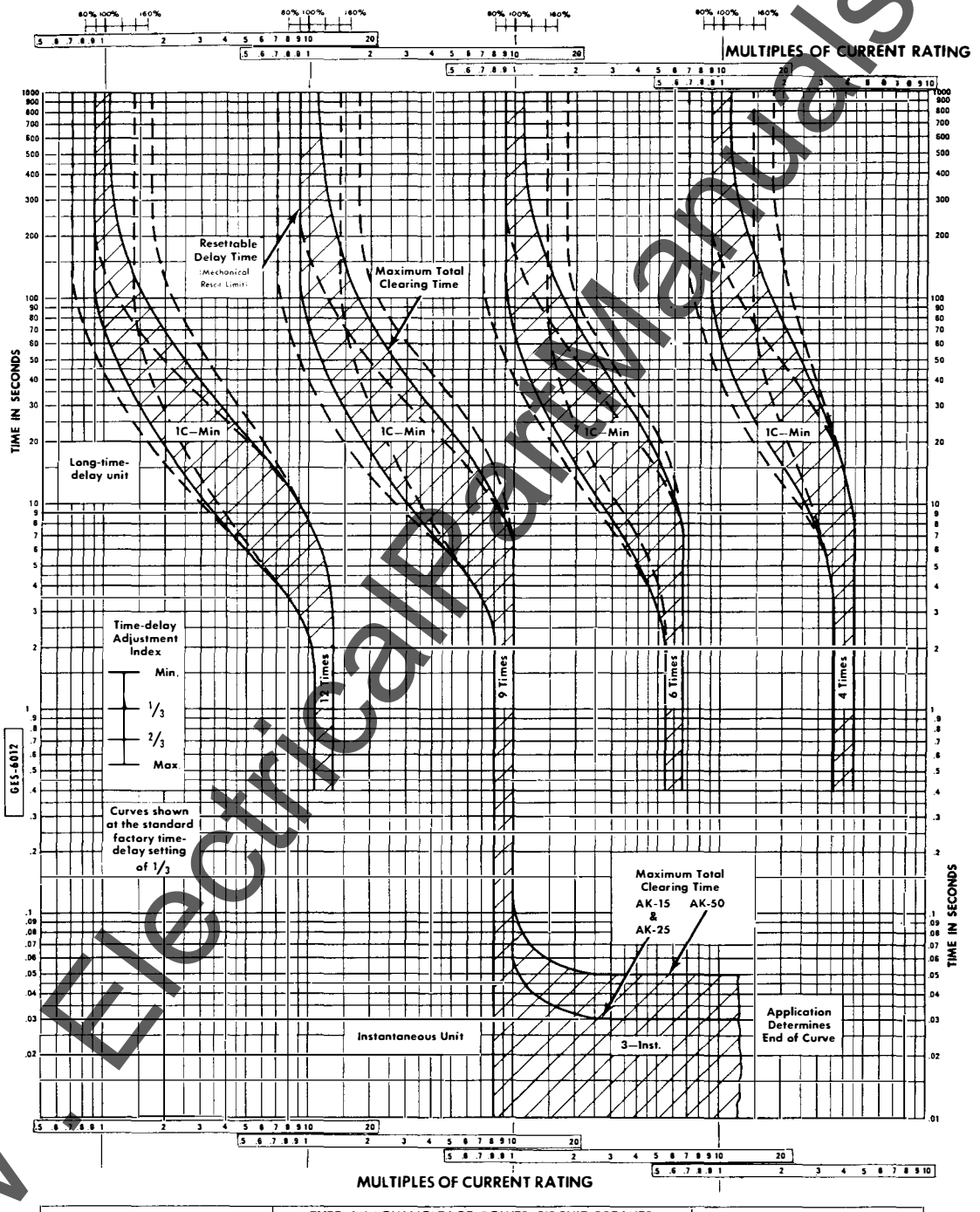
Adjustments

Long-time-delay Unit: Pickup settings are 80 to 160% of rating. (Settings higher than 100% do not increase the continuous current rating.) Instantaneous Unit: Pickup settings are 4 to 9X, or 6 to 12X (std.), or 9 to 15X of rating.

7/85 (25M)

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

Time Current Curves (Continued)



GENERAL ELECTRIC

TYPE AK LOW-VOLTAGE POWER CIRCUIT BREAKER

EC-2 & EC-2A SERIES TRIP DEVICE

GES-6012

Current Ratings (Amperes)

AK-15	15, 20, 30, 40, 50, 70, 90, 100 125, 150, 175, 200, 225
AK-25	40, 50, 70, 90, 100, 125, 150, 175 200, 225, 250, 300, 350, 400, 500 600
AK-50	200, 225, 250, 300, 350, 400, 500 600, 800, 1000, 1200, 1600

1C-3 Long-time-delay and Instantaneous Time-current Curves

(Curves apply at 60 Hertz for ambient temperature of 25C)

Adjustments

Long-time-delay Unit: Pickup settings are 80 to 160% of rating. (Settings higher than 100% do not increase the continuous current rating.) **Instantaneous Unit:** Pickup settings are 4 to 9X, or 6 to 12X (std.), or 9 to 15X of rating.

10-84(1.5M)

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

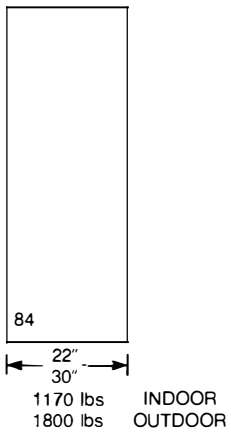
Dimensional Data

Typical AC Switchgear Sections — 635 VAC Maximum 50/60 Hz Equipment

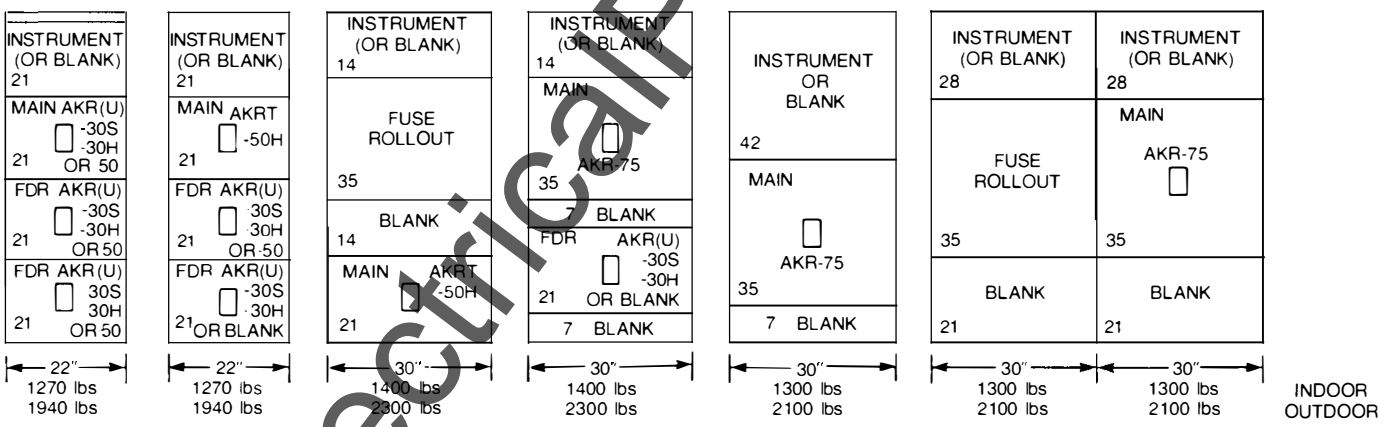
Standard depth is 60″ with all breakers *except* the AKRU-50, which requires a 67″ deep section. Depth of line-up is that of the deepest section.

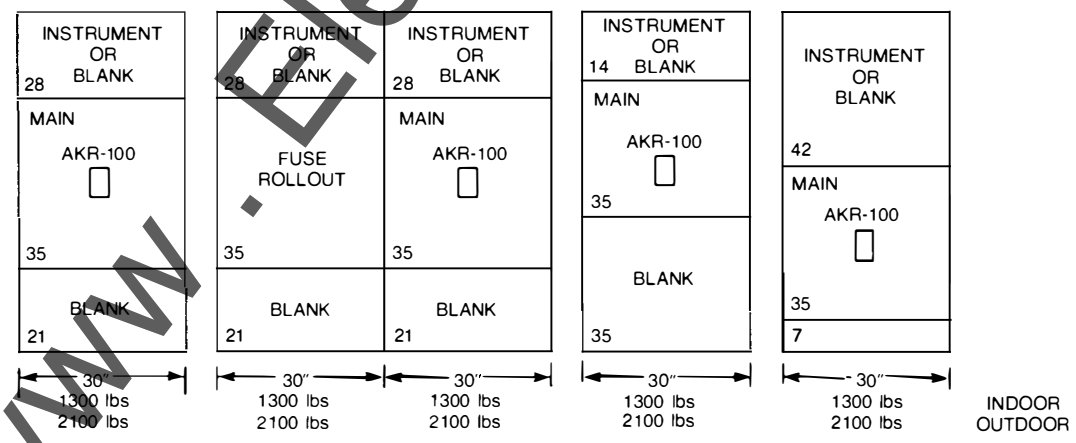
Auxiliary Section

- Transition to transformer (22″).
- Cable or busway entrance unit for free standing switchgear equipment (22″ or 30″). No breakers can be mounted in these sections. Instruments and meters may be mounted in these sections.
- Power company metering (30″ or 38″).



Main Breaker Sections



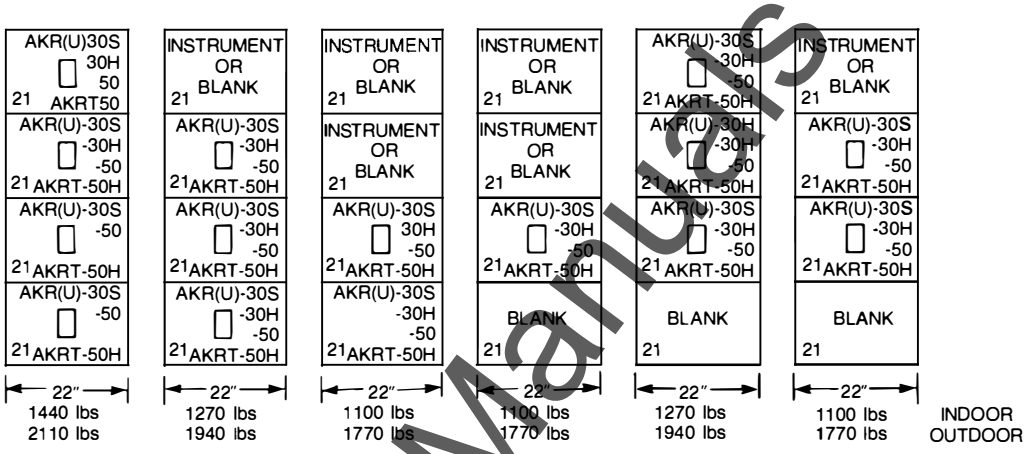


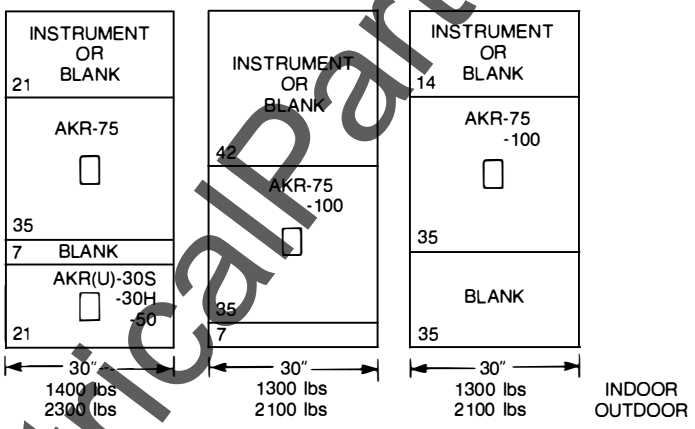
Typical AC Switchgear Sections — 635 VAC Maximum 50/60 Hz Equipment (Continued)

Feeder Breaker Sections

Stacking considerations:

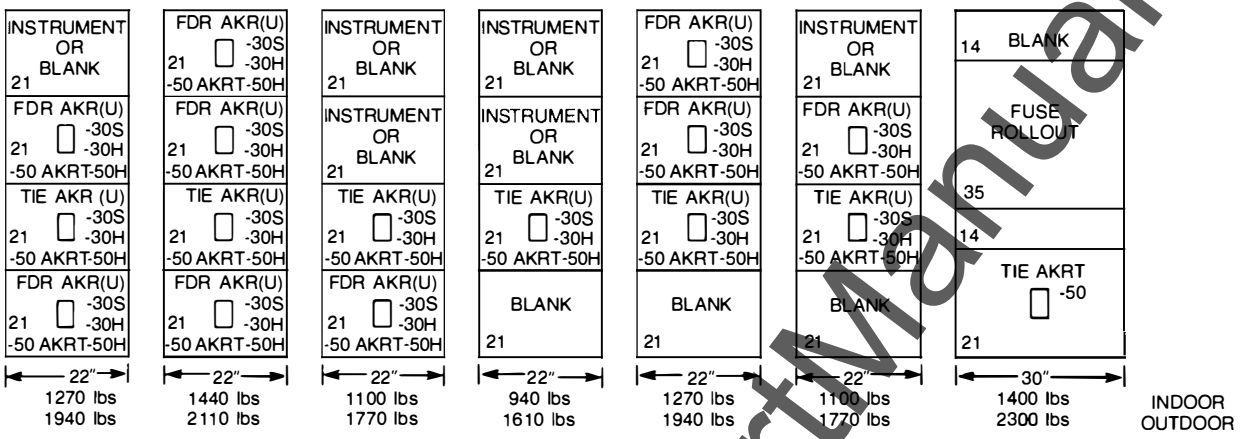
- Devices (such as meters, lights, selector and control switches) cannot be mounted on breaker doors.
- Limited devices (such as AM, AS, PB, special annunciator) may be mounted in draw-out tray. Ammeter is edgewise meter.
- Feeder busway is limited to one or two depending on size. Top compartment must be instrument or space.
- Customer allowable cumulative loading is as recommended in ANSI C37.20.1.
- Standard depth of section is 60″ except the AKRU-50, which requires a 67″ deep section. Depth of the line-up is that of the deepest section.



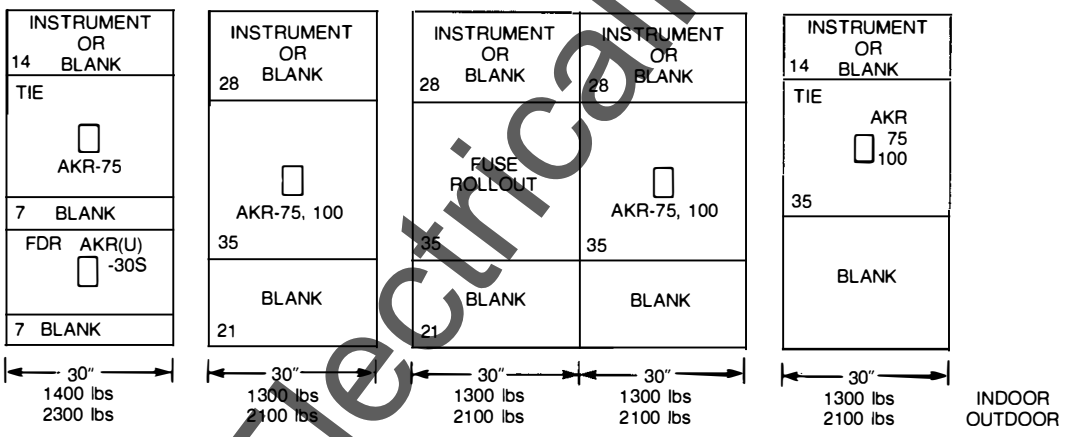


Typical AC Switchgear Sections — 635 VAC Maximum 50/60 Hz Equipment (Continued)

Tie Breaker Sections — AKR(U)-30S, AKR-30H, AKR(U)-50, AKRT-50H



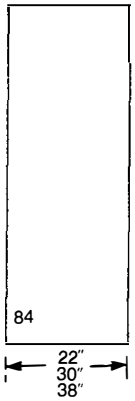
Tie Breaker Sections — AKR-75 and AKR-100



Typical DC Switchgear Sections — 300 VDC Maximum

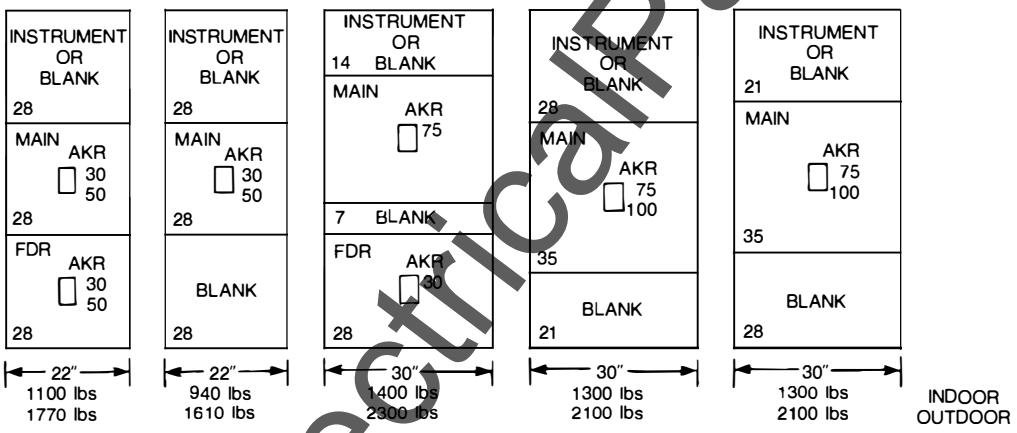
Auxiliary Section

Auxiliary section cable or busway entrance unit for free standing switchgear equipment (22″ or 30″). No breakers can be mounted in these sections. Instruments may be mounted in these sections.



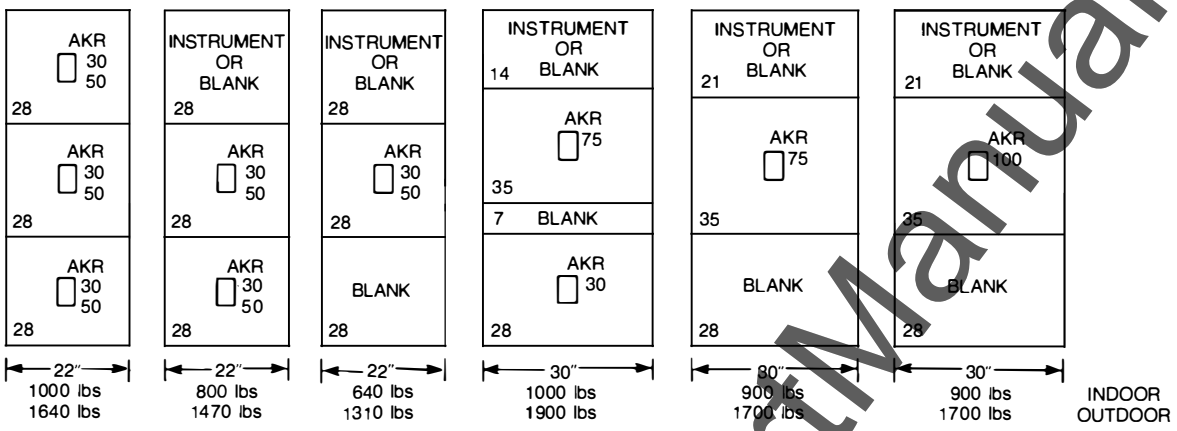
INDOOR 1170 lbs
OUTDOOR 1800 lbs

Main Breaker Sections

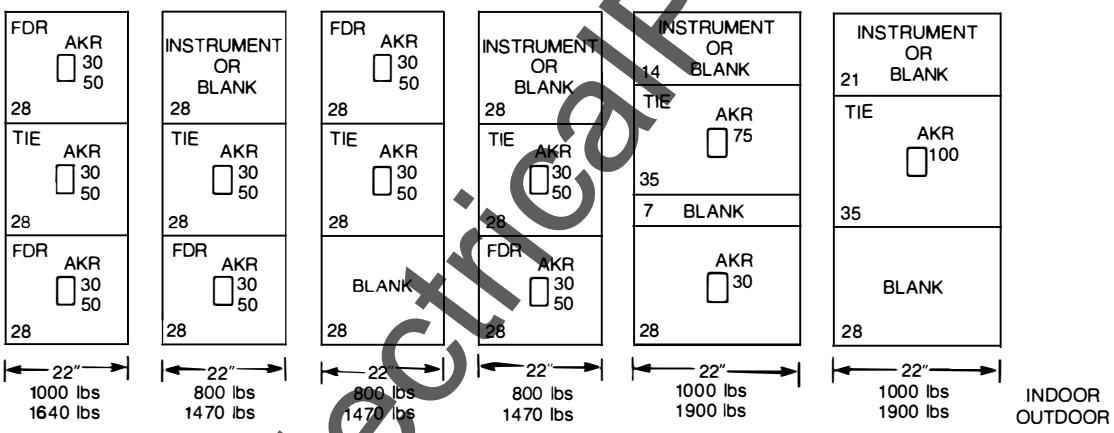


Typical DC Switchgear Sections — 300 VDC Maximum (Continued)

Feeder Breaker Sections



Tie Breaker Sections



Breaker Weights

Table 55.1
Breaker Weights (lbs) (Add to Switchgear Section Weight)

Type	AKR-30S	AKR-30/30H	AKR-50/50H	AKRT-50H	AKR-75	AKR-100
Manual	70	200	210	220	420	495
Electrical	90	205	215	225	480	555

Table 55.2
Fused Breaker and Fused Rollout Weights (lbs)
(Add to Switchgear Section Weight)

Type	AKRU-30S	AKRU-50	Fused Rollout For Use With AKRT-50H, -75	Fused Rollout For Use With AKR-100 BKR
Manual	90	255	300	400
Electrical	110	260		

Other Dimensional Data

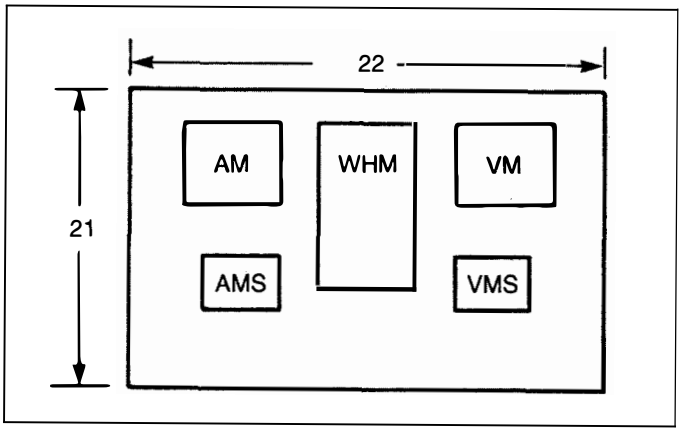


Fig. 56.1 Typical Instrument Panel

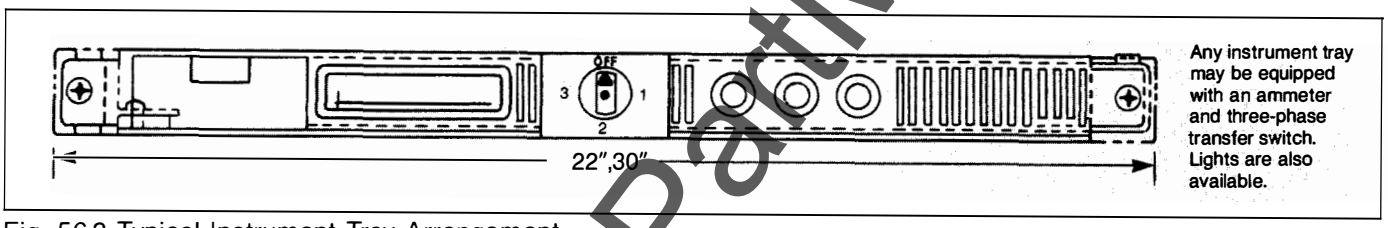


Fig. 56.2 Typical Instrument Tray Arrangement

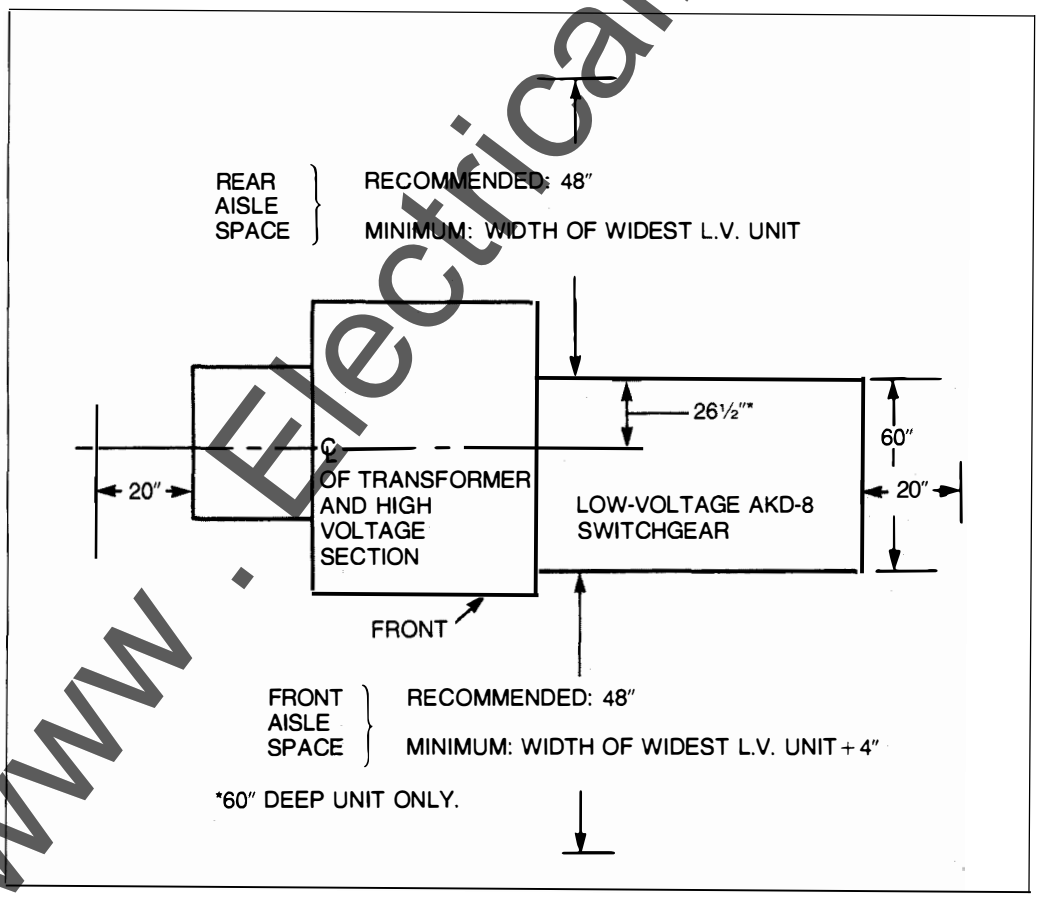
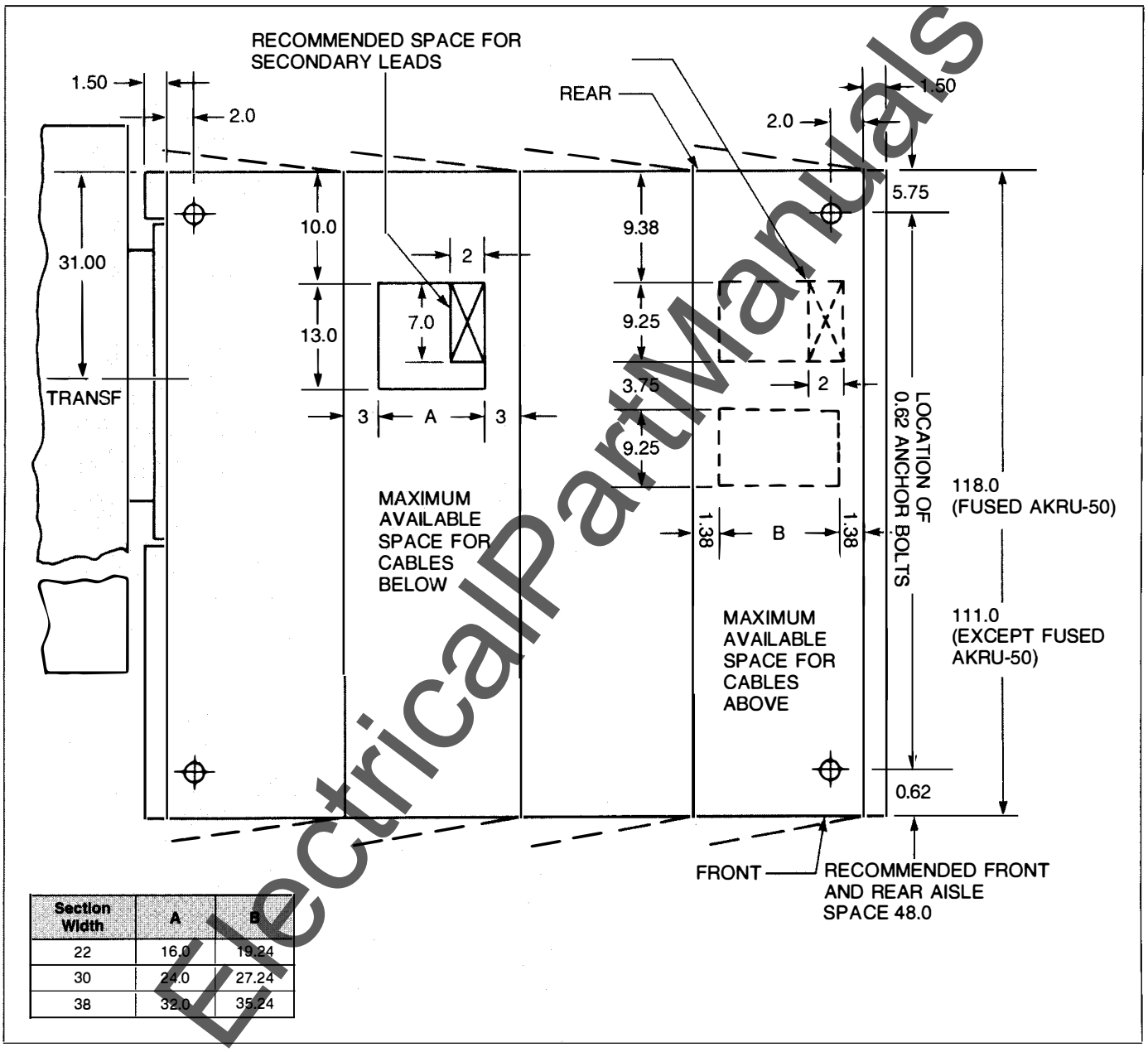


Fig. 56.3 Typical Floor Plan Indoor

Floor Plans



Section Width	A	B
22	16.0	19.24
30	24.0	27.24
38	32.0	35.24

Fig. 57.1 Floor Plan and Cable Space Outdoor Equipment

Floor Plans (Continued)

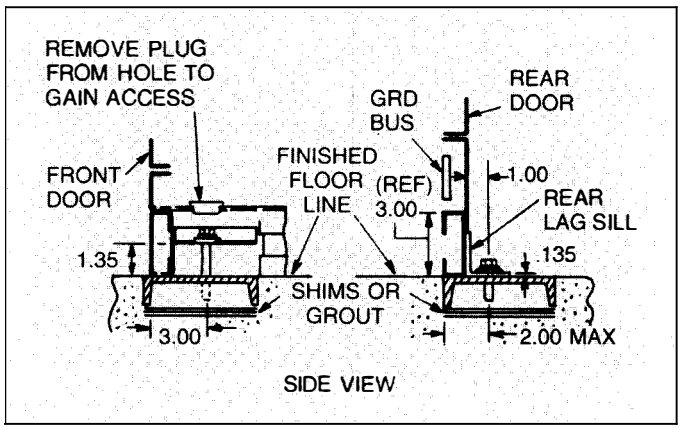
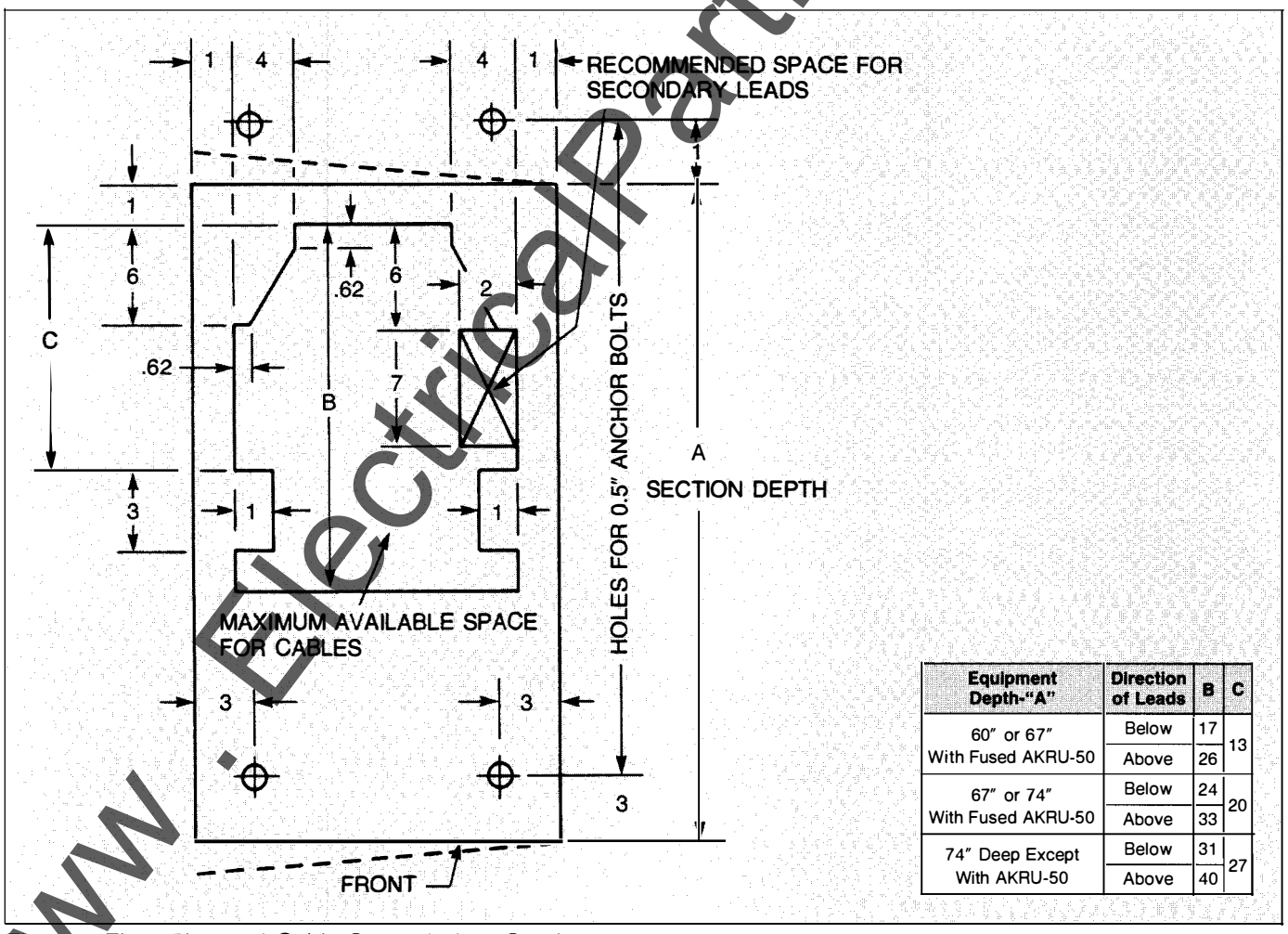
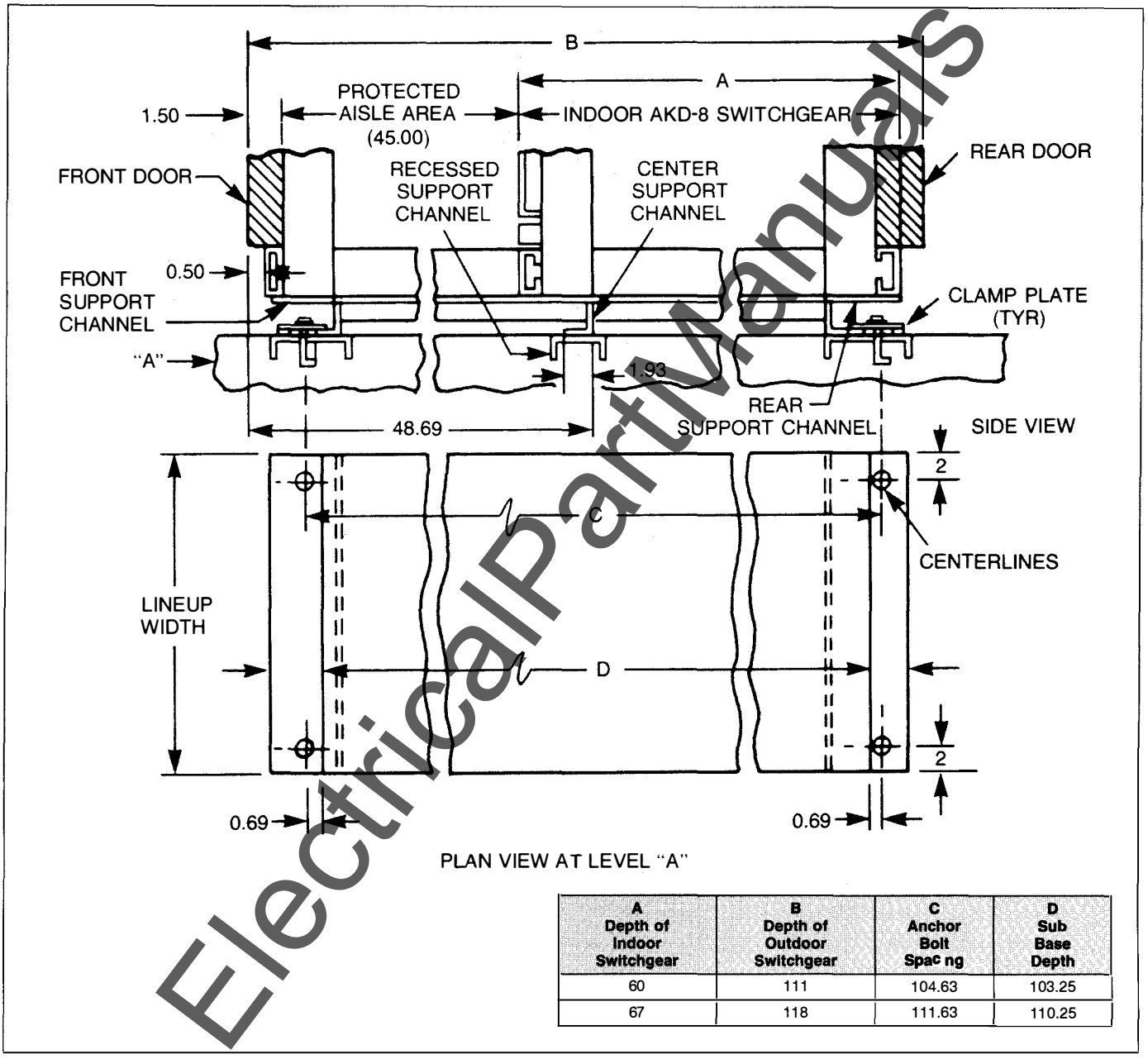


Fig. 58.1 Indoor Method of Anchoring



Equipment Depth-"A"	Direction of Leads	B	C
60" or 67" With Fused AKRU-50	Below	17	13
	Above	26	
67" or 74" With Fused AKRU-50	Below	24	20
	Above	33	
74" Deep Except With AKRU-50	Below	31	27
	Above	40	

Fig 58.2 Floor Plan and Cable Space Indoor Sections



A Depth of Indoor Switchgear	B Depth of Outdoor Switchgear	C Anchor Bolt Spac ng	D Sub Base Depth
60	111	104.63	103.25
67	118	111.63	110.25

Fig 59.1 Outdoor Method of Anchoring

Side Views

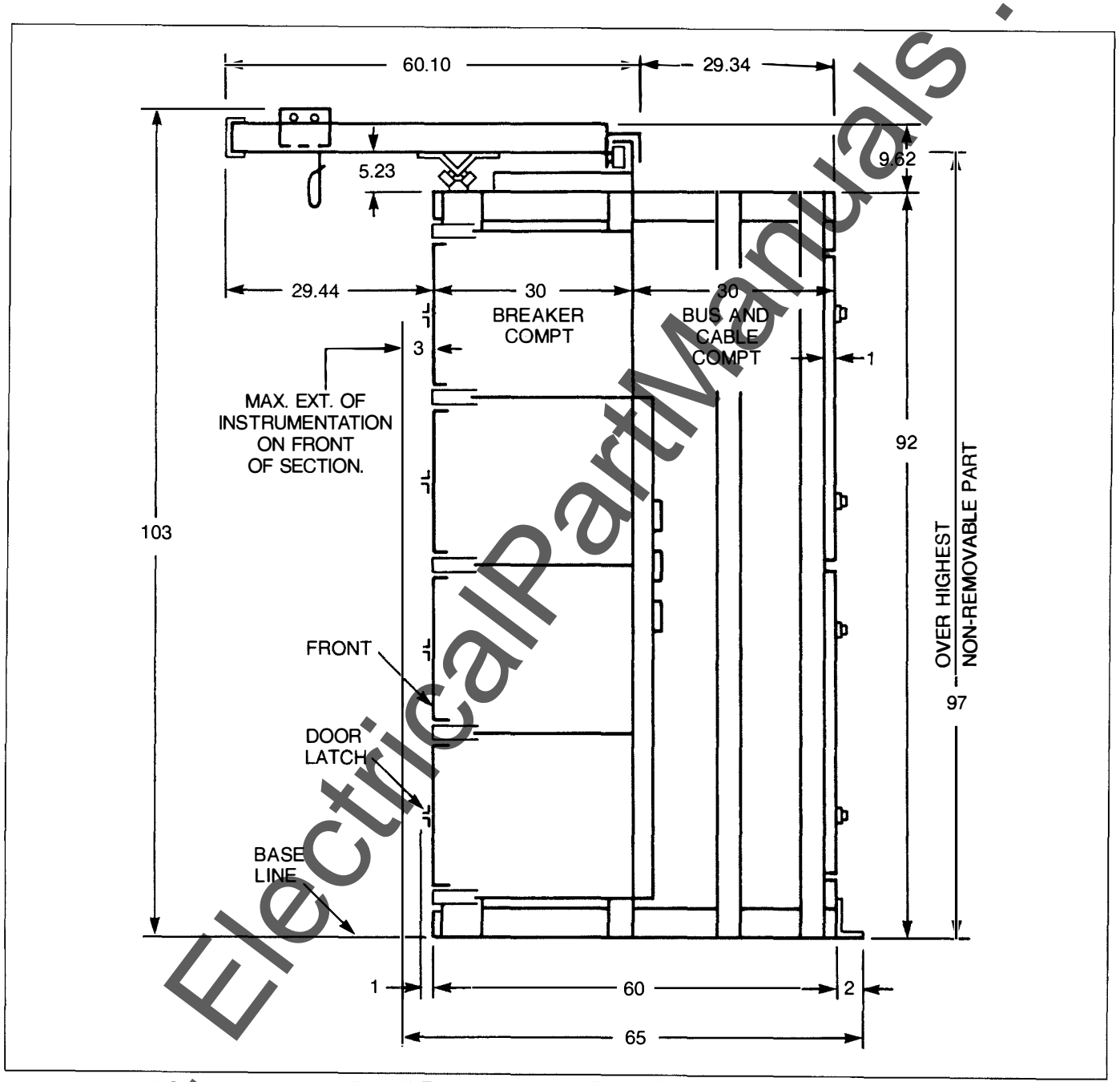


Fig. 60.1 Typical Side View (Indoor) For All Except AKRU-50 Fused Breakers

Side Views (Continued)

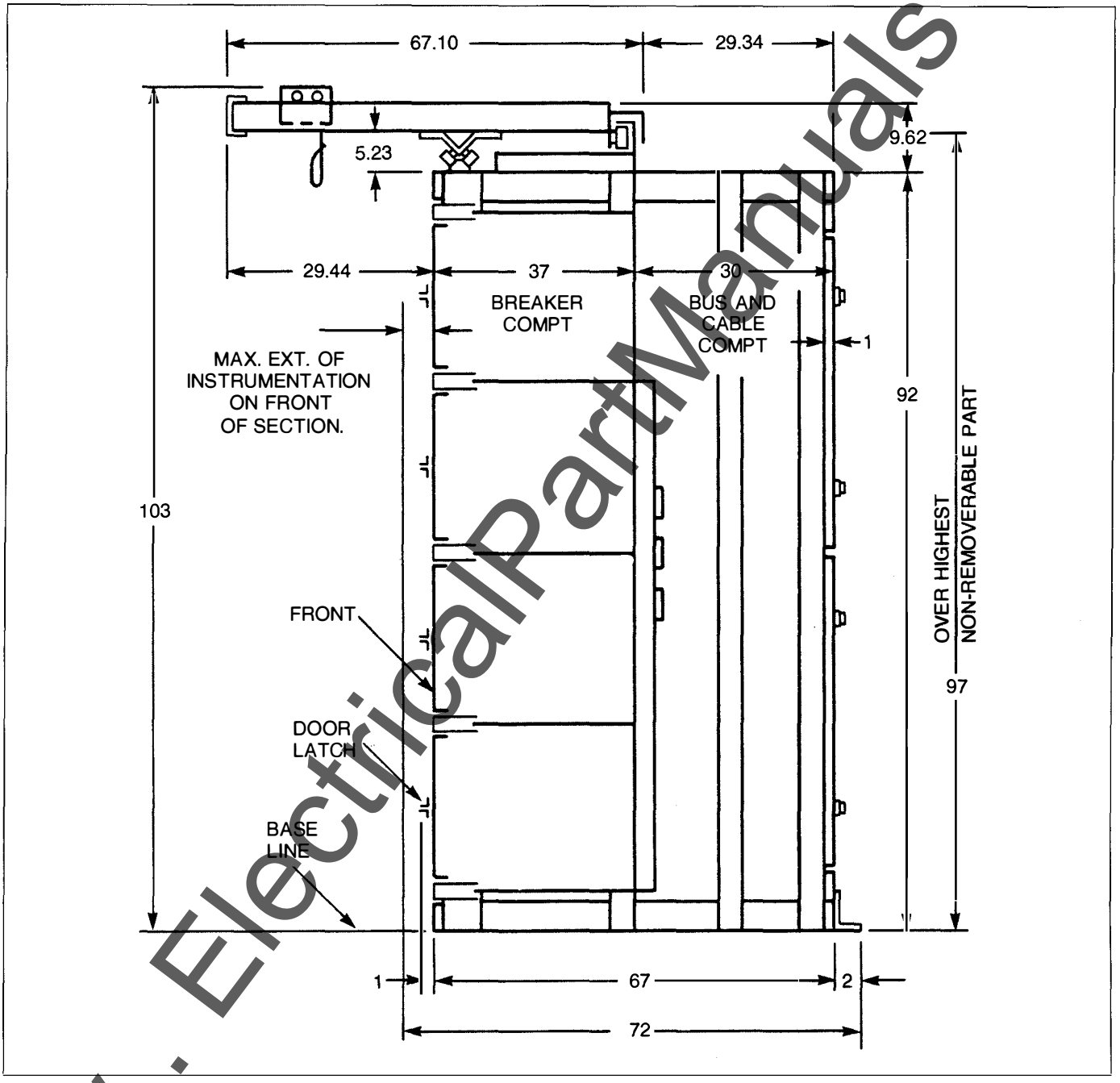


Fig. 61.1 Typical Side View (Indoor) for AKRU-50 Fused Breakers

Side Views (Continued)

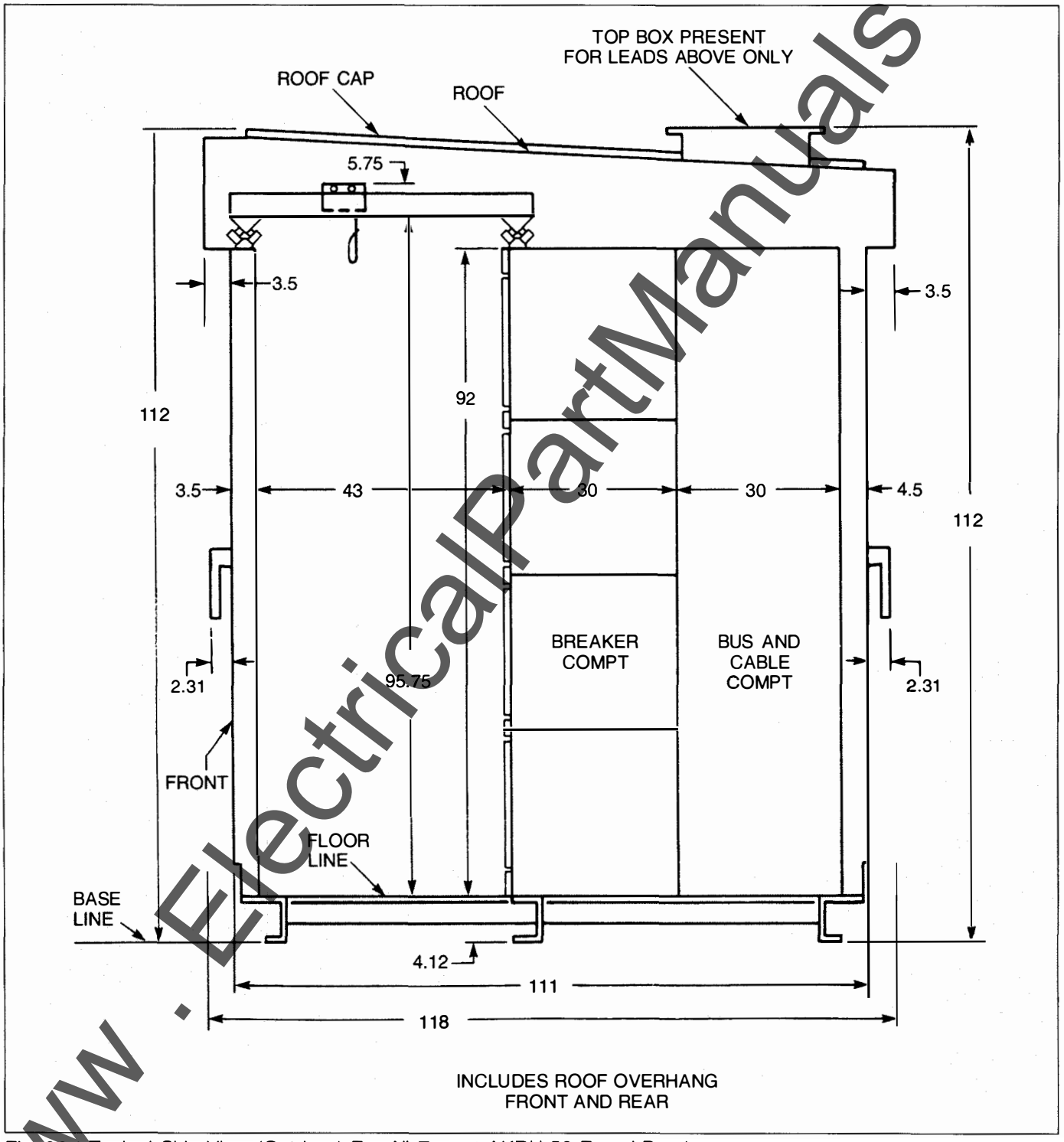


Fig. 62.1 Typical Side View (Outdoor) For All Except AKRU-50 Fused Breakers

Side Views (Continued)

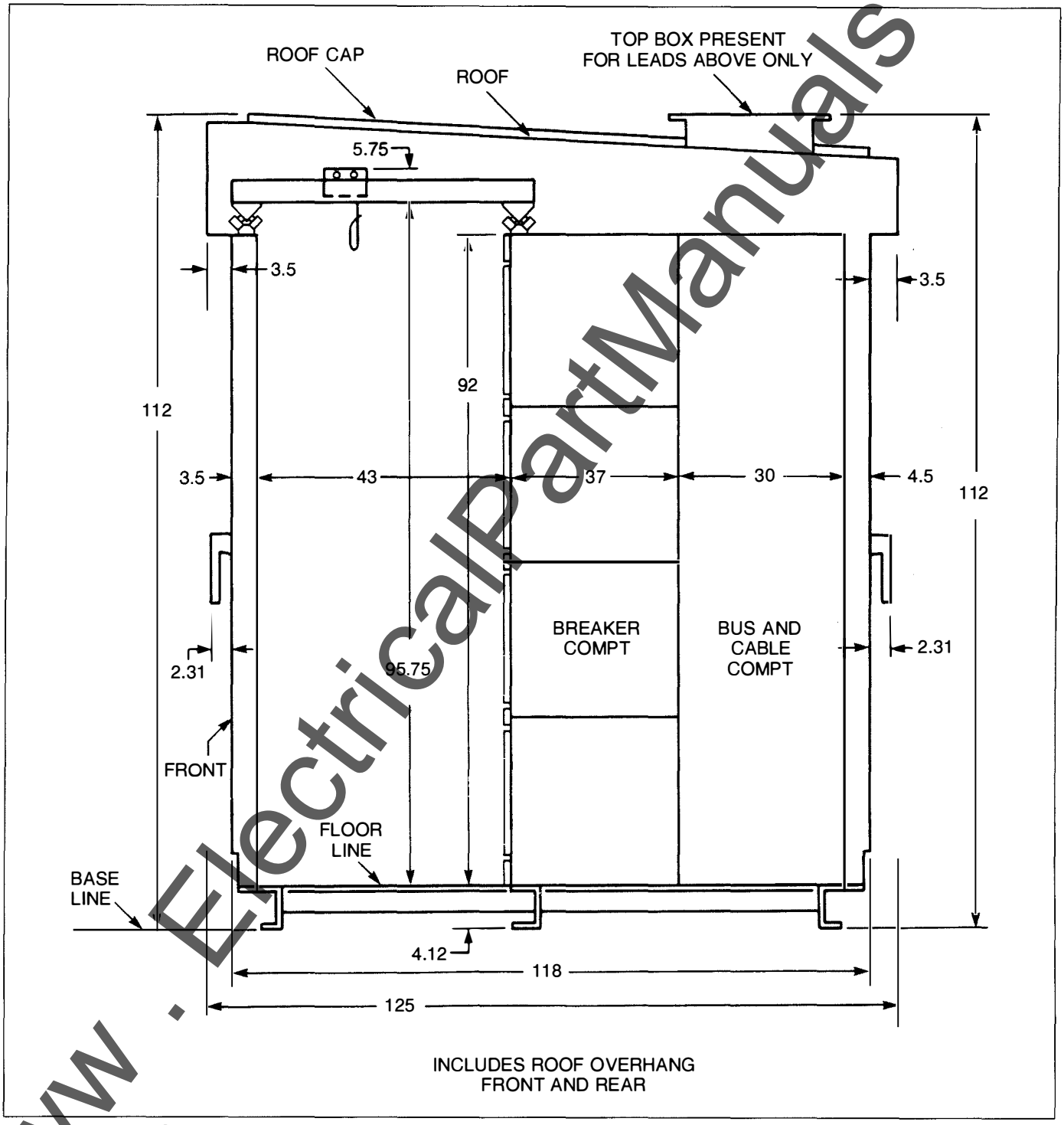
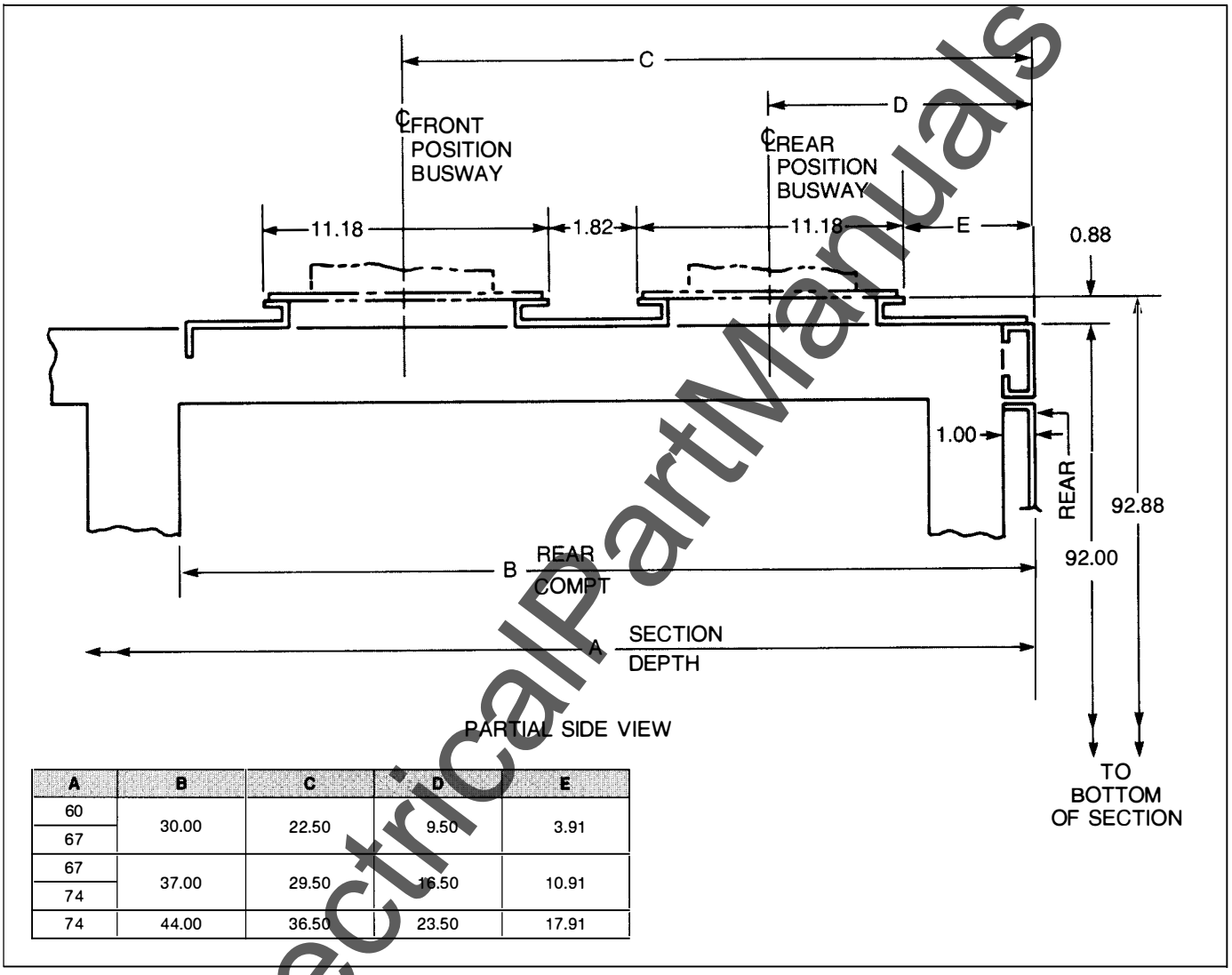


Fig. 63.1 Typical Side View (Outdoor) For AKRU-50 Fused Breakers

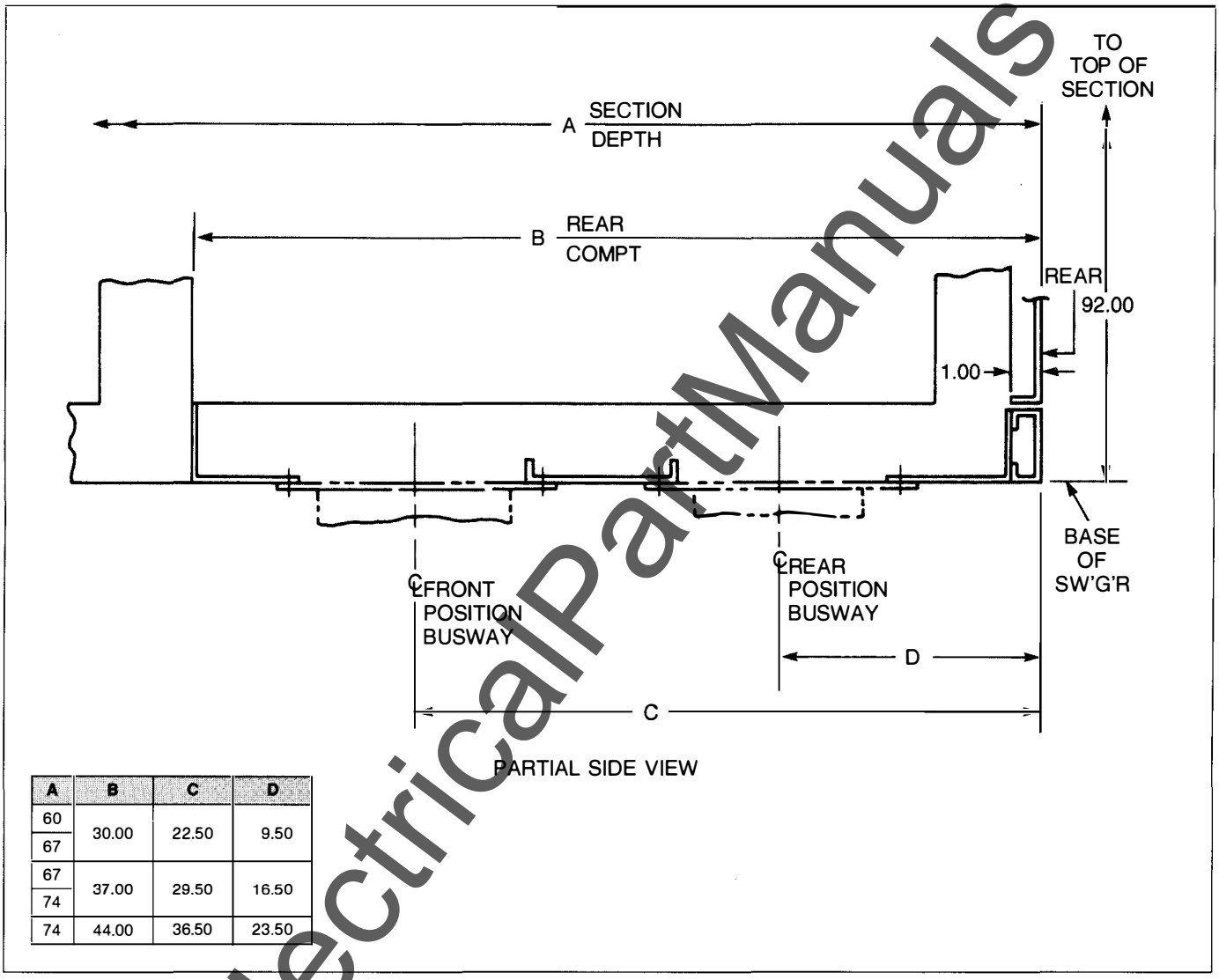
Side Views (Continued)



A	B	C	D	E
60	30.00	22.50	9.50	3.91
67				
67	37.00	29.50	16.50	10.91
74				
74	44.00	36.50	23.50	17.91

Fig. 64.1 Indoor Top-Connected Armor-Clad® Busway (Front Position Busway Is Preferred Location)

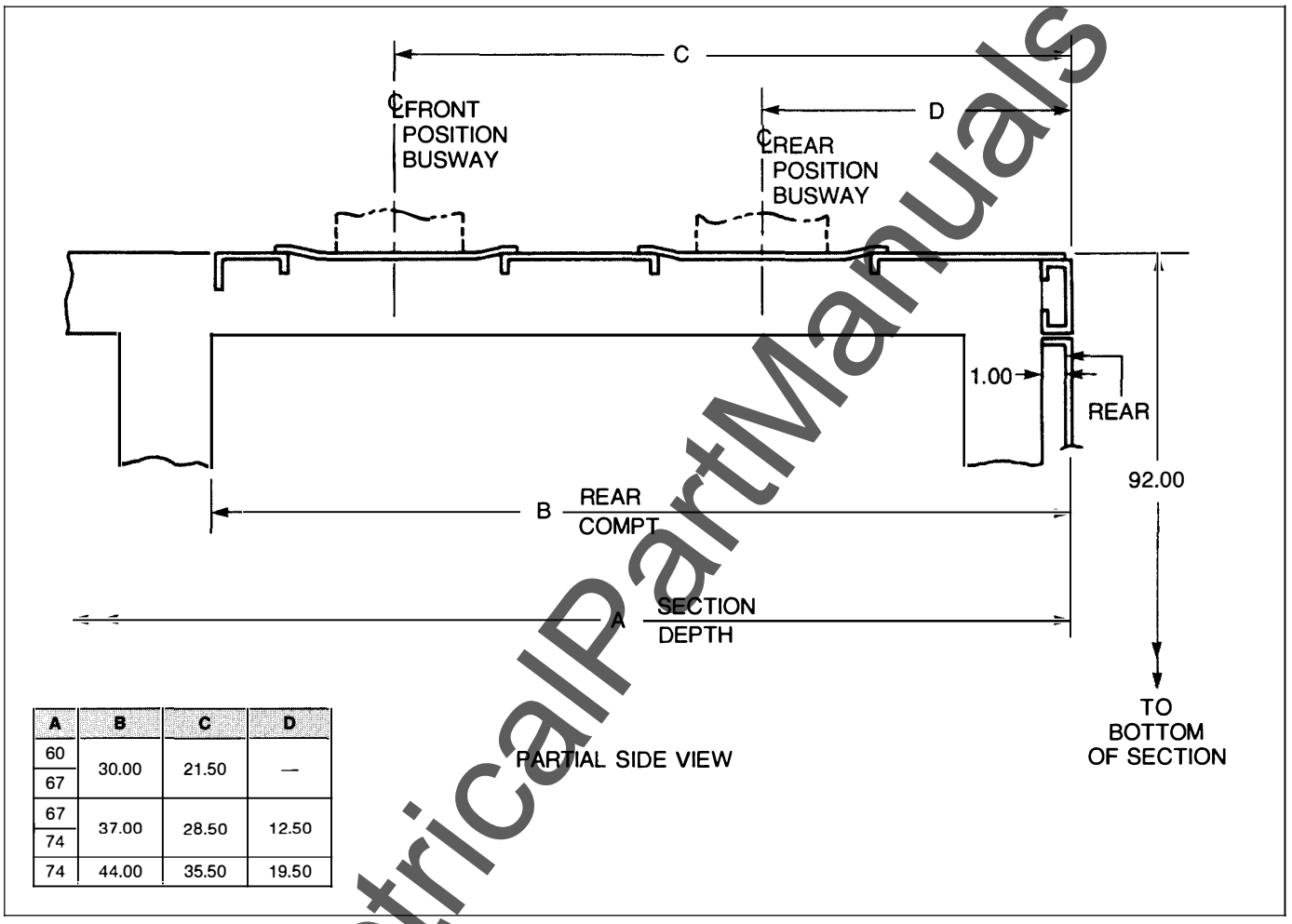
Side Views (Continued)



A	B	C	D
60	30.00	22.50	9.50
67			
67	37.00	29.50	16.50
74			
74	44.00	36.50	23.50

Fig. 65.1 Indoor Bottom-Connected Armor-Clad® Busway (Front Position Busway Is Preferred Location)

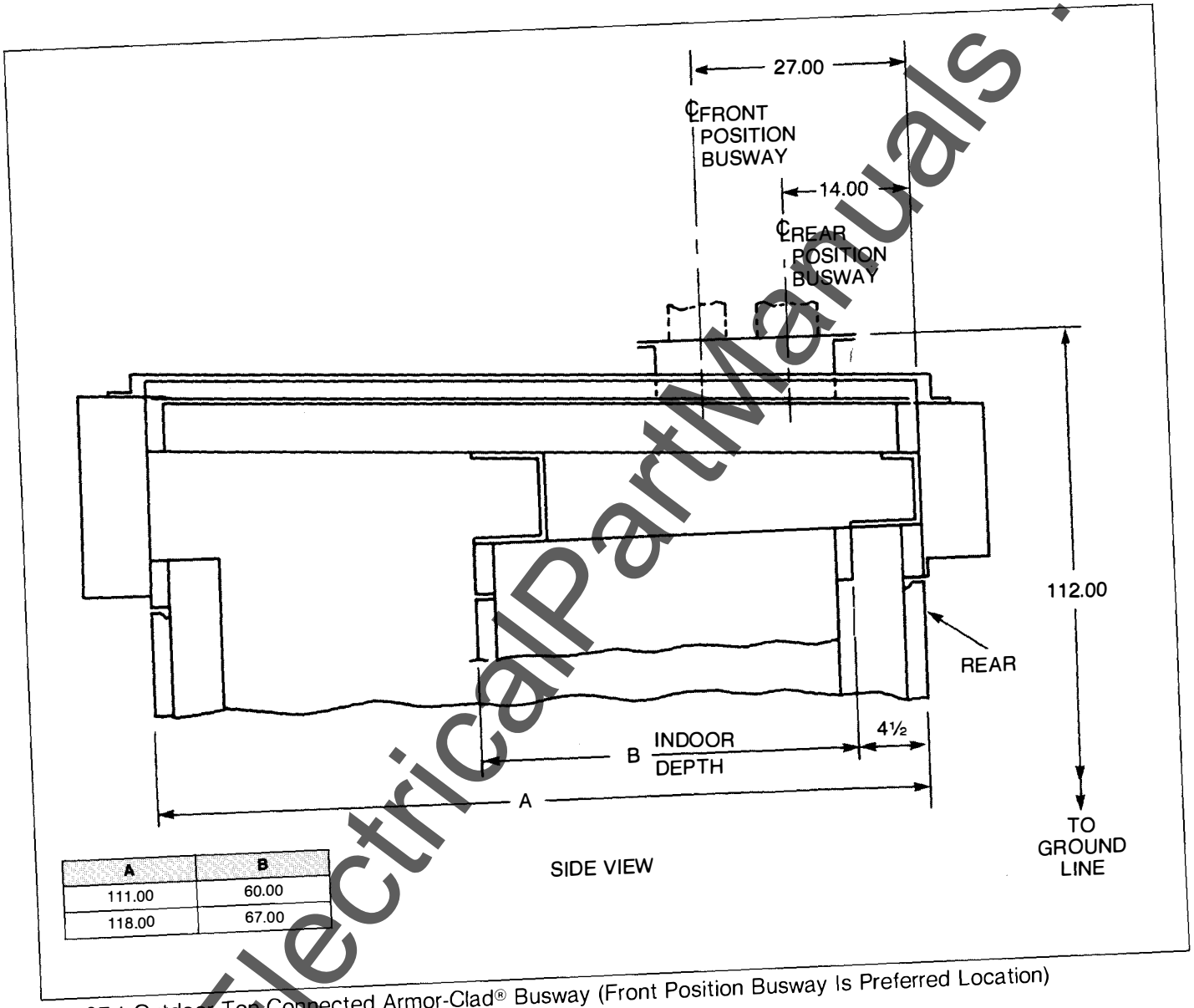
Side Views (Continued)



A	B	C	D
60	30.00	21.50	—
67			
67	37.00	28.50	12.50
74			
74	44.00	35.50	19.50

Fig. 66.1 Indoor Top-Connected DNSP Busway (Front Position Busway Is Preferred Location)

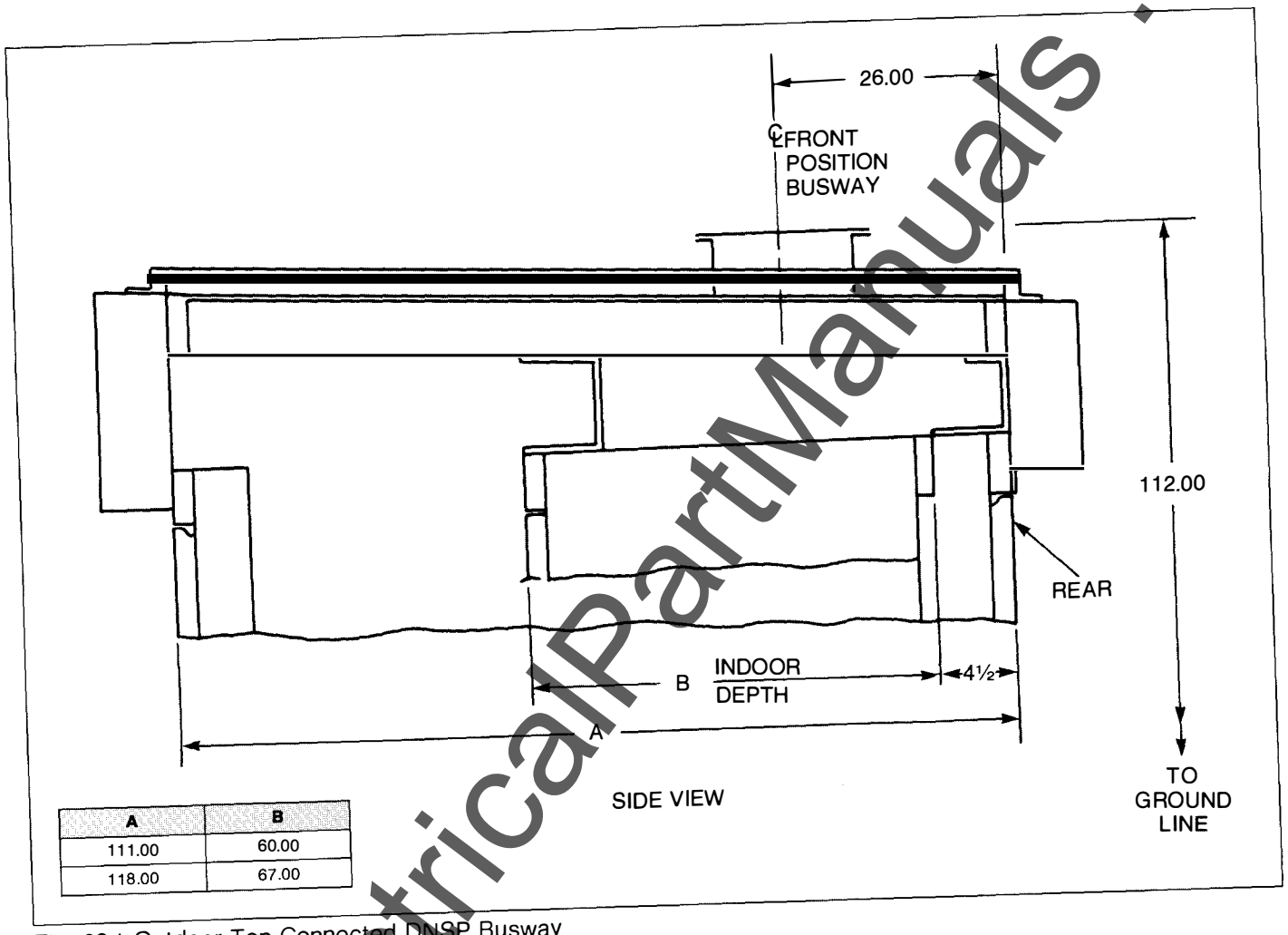
Side Views (Continued)



A	B
111.00	60.00
118.00	67.00

Fig. 67.1 Outdoor Top-Connected Armor-Clad® Busway (Front Position Busway Is Preferred Location)

Side Views (Continued)



A	B
111.00	60.00
118.00	67.00

Fig. 68.1 Outdoor Top-Connected DNSP Busway

Guide Form Specifications

Rating

The Type AKD-8 Low Voltage Power Circuit Breaker Switchgear shall be rated [ ] volts, 3-phase, [3-wire] [4-wire with 50% neutral] [4-wire with 100% neutral], [50] [60] Hertz.

Enclosure

The switchgear shall be furnished with an [indoor NEMA l] [outdoor NEMA 3R] enclosure.

General

The switchgear shall be completely factory assembled and metal enclosed consisting of functionally compartmentalized units for the removable power circuit breaker elements. The switchgear structure and breaker shall be the product of a single manufacturer.

Standards

Equipment will be designed, manufactured, and tested in accordance with ANSI-C37.20 and NEMA SG-5 switchgear standards and listed by Underwriter's Laboratories, Inc. Low Voltage Power Circuit Breakers shall conform to ANSI-C37.13 and NEMA SG-3 standards and UL listed [labeled where possible].

Utility Metering

A utility metering compartment shall be supplied to meet the requirements of [ ].

Service Entrance

Service Entrance shall comply with U.L. Service Entrance requirements which include service entrance label, incoming line isolation barriers, and neutral connection to switchgear ground.

Incoming Line Section

Incoming Line Section shall be [3W] [4W], [800A] [1600A] [2000A] [3200A] [4000A] [Main Cable Connection] [# and Size/Phase] [Size Conductor] [Copper] [Aluminum] Mechanical Lugs [Standard] [Compression Lugs] [Transition to GE Transformer] [Busway Connection which will include cutout in switchgear, bus riser or other internal connections, and phase collected type switchgear bus-stub].

Main Metering

Provide [[hinged instrument panel for] main metering in the top of [ ] compartment. The meter panel shall be hinged. [A second hinged panel shall be located behind the hinged instrument door and shall contain .] The instrument panel shall contain the following devices:

[Ammeter Switchboard Type, 1% ANSI Accuracy, 250° Scale]

[Voltmeter Switchboard Type, 1% ANSI Accuracy, 250° Scale ANSI C39.1]

[Ammeter Switch]

[Voltmeter Switch] [3W] [4W]

[Wattmeter]

[Varmeter]

[Power Factor Meter]

[Watthour Meter] [2] [2½] [3] [Element] [With Demand Register]

[Test-Disconnects Semi-Flush Mounted]

[3 Ground Detection Lamps, Pushbuttons, Transformers 480 - 120V]

[Test Block and Plug] [PK-2] [Other] [Current] [Voltage]

[Alarm] [Bell] [Horn] Mounted on Switchgear

[Potential Transformers with Primary Fuses] [2] [3]

[Current Transformer to 5A]

[Transducer] [Current] [Voltage] [Watts] [Vars]

[Pilot Light]

[Breaker Control Switch]],

or

provide [an Epic MicroVersa-Trip™ system for an integrated electronic control and protection package. Refer to publication GET-6963 for guide form specifications].

Structure

The structure shall be listed under UL-1558 and be labeled where possible. All live components shall be contained in a grounded metal enclosure 92″ high and [60] [67] [74] [81] inches deep of 11-gauge modular designed steel frame with removable plates. Individual vertical sections 22″ and 30″ [other] wide shall be constructed of bolted steel frames. Each breaker compartment shall be isolated completely from other breaker compartments by grounded metal barriers. Breaker compartment doors shall be furnished without ventilation slots and the door shall remain closed when racking the breaker to any of its three positions: disconnected, test, connected. Barriers shall isolate the breaker compartment from the bus bar system.

The switchgear shall be arranged for [close coupling to the transformer secondary through a transition compartment] [connection to the supply source by cable] [connection to the supply source by busway] [UL service entrance label] [incoming line isolation] [side barriers between section].

[Pull box shall be supplied the width and depth of cable compartment] [15] [22] [29] [ ] inches high to include screw cover plates].

[Cable supports for each vertical section shall be provided]. [Provide drip-proof roof for the indoor equipment). (Note: LEADS out below only and no integral breaker lifting device].

[Integral breaker lifting device shall be rail mounted on top of equipment, hand operated and movable.]

[Bolted covers] [Hinged rear covers, which can be bolted closed,] shall be provided for each cable compartment. A front hinged door shall be provided for each breaker and metering compartment.

[Space heaters shall be provided in each vertical section]. (250W @ 120V-U.L.) [250W @ 120V (1000W/240V @ 120V-Non-U.L.)].

Paint shall be light gray [epoxy electrodeposition] ANSI 61. [Paint process shall meet paint configuration tests to insure adequacy of finishes to inhibit the buildup of rust on ferrous metal materials used for enclosures] [Paint qualification test shall be per UL-1558 and ANSI C37.20].

[Auxiliary] [transition] section[s] shall be supplied and shall be equipped with [devices as shown on the plans] [auxiliary relays] [fuse cutouts (open — NEC fuses, enclosed — CLF fuses)] [potential transformers] [control power transformer] [compartment(s)]. The section shall have hinged doors over each compartment.

Provide a rear cable and terminal compartment for cable installation and termination. The cable bending space shall meet the requirements of the National Electrical Code.

Outdoor Switchgear

Outdoor switchgear shall be similar to indoor, except that it shall be fully weatherproof, housed in a factory assembled outdoor enclosure, have lifting plates at the base of the structure, hinged aisle doors with rubber gaskets and padlocking provisions, asphalt base undercoating on the exterior bottom, interior light[s], space heater per vertical section, outlets, and light switch and space heater switch. [Provide walk-in enclosure to in-

Guide Form Specifications (Continued)

clude front aisle space for breaker maintenance and inspection running the full length of the equipment, sloping roof, rear bolted hinged doors, breaker lifting device, and storage provision for the hoist operating crank] [hinged rear doors gasketed with lockable T-handles and three point catch]. Provide wire mesh over louvers and rodent guards [thermostat] [humidistat] [control power (local kVA), (remote)].

Bus Bars

Main bus and riser bus will be fully isolated from the breaker, instrument and auxiliary compartments. The bus bar material shall be [bolted] [welded] aluminum at the connections between the vertical bus and horizontal bus, and welded at the point of connection on the vertical bus where the bus bars supply power to the circuit breaker compartments. All bolted joints for bus, interconnections and external connections to the equipment shall be [tin or silver plated aluminum] [bolted copper with ring silver plating at the bolt joint]. The bus shall be arranged to permit future additions.

The vertical bus shall be held rigid in a support structure of short-circuit resistant molded glass reinforced polyester base and shall provide solid insulation between adjacent vertical phase buses.

[Provide a barrier system that fully insulates and isolates each phase of the main and vertical busbars from one another and from the cable area so that no live connections are accessible in the rear of each section except the breaker load side connections. Accessibility to joints shall be provided by replaceable covers].

The horizontal and vertical bus [shall be barriered to protect against accidental contact by people or foreign objects] [and to inhibit the spread of arcing faults] [shall be insulated/isolated to protect against spread of arcing faults and accidental contact by people or foreign objects] [shall be phased isolated in the rear of the section]. [The vertical buses shall be phase isolated and insulated from themselves and the main buses] [by glass reinforced polyester solid insulation between vertical phases buses and flat polyester sheets over the rear surface providing an envelope of insulation]. [The main horizontal buses shall be phase isolated and insulated from each other and from the device load lugs] [by means of a fluidized epoxy coating and a noryl insulated cover with removable molded glass polyester joint covers].

The continuous current rating of the non-tapered bus will be determined by temperature rise as limited by ANSI standards and will be demonstrated by design tests. If a [main circuit breaker] [bus tie circuit breaker] [incoming bus duct] is provided, the continuous rating of the bus will be equivalent to the frame size rating of the [main breaker] [bus tie breaker] [incoming bus duct]. All run-ins and run-backs shall be rated to carry the full frame size continuous current rating of the breakers to which they are connected. In addition, breaker runbacks shall be [epoxy insulated] [copper], [aluminum].

Breaker primary connections shall be copper-to-copper.

The bus bars of the main bus will be braced to withstand mechanical forces exerted during a short circuit of [50,000] [100,000] [150,000] [200,000] amperes RMS symmetrical. Other buswork will be braced to withstand mechanical forces exerted during a short circuit equivalent to the maximum interrupting capacity of the associated circuit breakers, or the maximum let-through current in the case of the load size of a fused circuit breaker.

Where a bus sectionalizing breaker is present, the buses on the two sides of that breaker will be isolated from each other. Where an incoming line or main breaker is present, the incoming line conductors shall be isolated from the main bus.

Breaker Compartment

Each low voltage power circuit breaker will be mounted in an individual grounded metal barriered compartment [at the top, bottom, front and sides and with flame retardant, arc track resistant glass reinforced polyester base barrier at the rear]. Each compartment shall be equipped with draw-out rails, stationary breaker contacts, interlocks, and necessary control and indicating devices.

The draw-out mechanism shall retain the removable element in the connected position and shall overcome the mechanical resistance of making and breaking the contacts of the self coupling primary and secondary disconnecting contacts. Positive mechanical interlocks shall prevent the breaker from being racked in or out unless the breaker is tripped, and shall prevent the breaker from being closed while it is being racked in or out. The circuit breaker cannot be closed except in the connected, test, or disconnected position.

The draw-out mechanism shall provide for four distinct positions of the circuit breaker: connected, test, disconnected, and withdrawn. The mechanism shall be capable of being operated without opening the door over the circuit breaker [for test and disconnect position] and an indicator shall be provided to show the position of the circuit breaker. [Breaker doors shall be provided without ventilation slots].

Padlocking provisions on the rackout rails shall permit locking the breaker in either the test or disconnected position.

Grounding of the breaker frame to the steel frame shall be maintained throughout the travel of the draw-out mechanism.

Provide [position switch with [1] [2] [3] a/b contacts].

Compartment doors shall be capable of being padlocked.

Shutters shall be supplied to cover breaker primary line and load disconnects when the breaker [and fuse carriage] is removed from its compartment on main [and tie] breakers compartments of double ended substations [dual fed. switchgear] [and all feeder breakers].

The breaker compartment shall be equipped with [ammeter] [ammeter selector switch] [illuminated annunciator panel to indicate] [overload and short circuit] [timing light] [ground fault] [pilot light for breaker open] [pilot light for breaker closed]. Compartment instrumentation shall be mounted on the front of the switchgear compartment. [Control circuitry and feeder metering] [all breaker close and trip fuses, indicating lights, illuminated annunciator panel, rotary phase selector switch, and ammeter shall be accessible for routine maintenance from the front of the switchgear] [without opening associated breaker cubicle door] [by a slide-out instrument tray mounted above its associated breaker eliminating cross-hinge wiring].

Each breaker cubicle shall be designed so that only the breaker frame for which the cubicle was designed can be inserted.

When specified for future breakers, the compartment shall be completely equipped for the future addition of a

Guide Form Specifications (Continued)

power circuit breaker element including all specified electrical connections. A metal barrier shall be bolted across the face of the compartment, and the opening in the breaker compartment door shall be closed.

[When three phase four wire ground fault is required, the neutral sensor shall be equipped with a shorting means].

Circuit Breakers

Power circuit Breakers shall conform to ANSI-C37.13, -C37.16 and NEMA SG-3. Each breaker element will consist of a three-pole electrically and mechanically trip free power circuit breaker with self-aligning primary and secondary disconnecting contacts, integral solid state over-current trip programmer, arc quenchers, manual or electrical stored-energy closing mechanism, position indicator, and equipped for mounting on the drawout mechanism in the circuit breaker compartment.

Manual or electrical closing mechanisms shall employ the stored energy principle by interposing an energy storage spring between the operator and the breaker contacts. This spring provides constant closing speed not influenced by the operator or control power voltage level.

Manually operated breakers shall have front mounted handles for charging the closing springs. Closing the breakers shall be accomplished by depressing a mechanical close button the breaker escutcheon or by operating the breaker handle. Opening of the breaker shall be accomplished by depressing a mechanical trip button located on the breaker escutcheon.

Electrically operated breaker shall utilize a motor or solenoid to automatically charge the closing springs. An electrical [close push button] [shall be mounted on the breaker escutcheon] [and a] [close signal shall be remoted]. Opening of the breakers [shall be accomplished by a mechanical trip button located on the breaker escutcheon] [and] [or] [shall be accomplished by shunt trip device mounted on the breaker and activated remotely]. A manual charging handle shall be provided.

A maintenance handle shall be provided for the slow-closing motion required for contact adjustment procedures.

Fused Breakers Only

Fused power circuit breakers shall conform to ANSI C37.13 and NEMA SG-3. Circuit breakers equipped with current limiting fuses, integrally or separately mounted and coordinated with trip devices, so that faults within the rating of the circuit breaker will be interrupted by the breaker itself, while faults in excess of the breaker rating will be interrupted by the fuses.

Separately mounted fuses shall be mounted inside a drawout carriage similar to that used for the breaker. A hinged panel made of perforated steel shall be positioned in front of the fuses so that they cannot be reached if the compartment door is opened. The perforated steel shall be so interlocked to prevent it from being swung open unless the fuse rollout is fully withdrawn. A key interlock system shall be installed in the associated breaker compartment and fuse rollout compartment so as to keep the fuse rollout carriage in the connected or disconnected position unless the breaker associated with it is locked open. [The fuse rollout carriage compartment shall be equipped with shutters to cover the line and load disconnects when the carriage is removed from its compartment]. A rejection feature shall be furnished so that only the correct carriage can be inserted in a compartment.

Fused breakers shall be equipped with open fuse lockout device and indicator to protect against single phase and prevent reclosing until lockout device is reset.

Circuit breakers shall be equipped with solid state self powered trip devices which shall include protective programmers, flux-shift trip device, and current sensors.

The protective programmers shall be a micro-electronic processor which is automatic and self-contained and requires no external relaying, power supply, nor accessories. Its printed circuit cards shall resist moisture absorption, fungus growth, and signal leakage, and shall have [gold-plated contacts] [for] 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.

Current sensors shall be mounted on the breaker frame [and shall be constructed of molded epoxy] [to protect against damage and moisture]. The sensors shall be fixed. [For four-wire ground fault, a fourth current sensor shall be mounted near the neutral bar in the cable compartment and shall be constructed similar to the phase overcurrent sensors]. [Ground fault function shall contain a memory circuit which integrates arcing fault current with time essentially summing intermittent ground-current spikes].

Breakers

The quantity, type, and accessories of the low voltage power circuit breakers shall be (see table next page):

Guide Form Specifications (Continued)

Low Voltage Power Circuit Breaker Selection Table

Item	Main	Tie	Feeders
Continuous Current Rating: 800A 1600A 2000A 3200A 4000A			
Integral Fused Breaker: Fused Breaker with Separate Roll-Out Fuse Carriage:			
Interrupting Rating, rms: 30kA 42kA 50kA 65kA 85kA 130kA 200kA			
Manually Operated Electric Close, Voltage Electric Trip, Voltage			
Trip Characteristics Adjustable: Current Setting Long-Time Delay Long-Time Pick-Up Light Short-Time Pick-Up Short-Time Delay, I^2T In or Out Instantaneous High Range Instantaneous (with short-time function) Switchable Instantaneous/Ground Fault Ground Fault Pick-Up & Delay, I^2T In or Out 3-Wire 4-Wire			
Zone Selective Interlock Short-time & Ground Fault Ground Fault Only			
Trip Indication Targets Overload Short Circuit Ground Fault			
Shunt Trip, Voltage			
Current Sensors Fixed Rating			
Rating Plug Rating			
Undervoltage Instantaneous Time Delay			
Capacitor Trip			
Bell Alarm Contacts [with lockout]			
Electric Lockout			
Operations Counter			
Auxiliary Switches [4] [10]			
Mechanical Cable Terminals [standard] [compression terminals] for load cables.			
Epic MicroVersaTrip™ System: Standard RS232 Port RS232 Port on Phone Modem Discrete Input Terminals			

Guide Form Specifications (Continued)

Devices

Switchgear will include all protective devices and equipment as listed on drawings with necessary interconnections, instrumentation and control wiring.

Wiring

Control wiring shall be #14 type SIS [#12SIS], enclosed in top and vertical [metal] wiring troughs and front-to-rear [insulating material] wiring troughs, necessary fuse blocks and terminal blocks within the switchgear will be furnished when required. All groups of control wires for interconnection within or leaving the switchgear will be provided with terminal blocks in a metal enclosed steel wiring trough mounted in the rear cable compartment, easily accessible, away from the runbacks and cable terminals, and with a bolted steel cover over the terminal blocks.

Control wires shall be provided with suitable numbering strips when leaving switchgear. [Control wire markers shall be marked with origin/destination].

Interconnection control wiring across shipping splits shall be accomplished by terminal blocks in the control wiring trough on top of the equipment.

Ground Bus

A [copper (800A- ¼″ × 3″) (1600A 2-¼″ × 3″)] [aluminum (800A ⅜″ × 3″) (1600A 2-⅜″ × 3″)] ground bus will be furnished and will be secured to each vertical section structure. It will extend the entire length of the switchgear and will be equipped with a 4/0 terminal for connection to purchaser's ground system. A lug strap shall be provided for each vertical feeder section.

Handling

Switchgear will be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.

Tie Breaker Control

Automatic throw-over control equipment with [single-phase] [three-phase] undervoltage sensing for automatic transfer to the emergency source tie breaker and [manual] [automatic] return to the normal power source. [Timers 1.5-15 sec.] [Timers 3-30 min.] [other sensing devices].

Control power automatic throw-over equipment to transfer the control bus from one control power source to another when one is de-energized.

Miscellaneous

[ ] Portable Breaker Lifting Device

[ ] Portable Static Full Function Test set to check the time current characteristics of the programmer at an infinite number of points along its curves, programmer circuitry, current sensor continuity, and flux shifter.

Prints

Provide outlines and elementary connection diagrams for approval and final record. Connection diagrams will be provided for final record.

Standards and References

Underwriters' Laboratories, Inc.

UL1558, Metal-enclosed low-voltage power circuit breaker switchgear. Order from UL Publications Stock, 333 Pfingsten Road, Northbrook, IL 60062.

National Electrical Manufacturers Association (NEMA)

SG-5, — Power switchgear assemblies; SG-3, low-voltage power circuit breakers. Order from NEMA Publications, 155 East 44th Street, New York, New York 10017.

American National Standards Institute

ANSI-C37.20.1 — Metal-enclosed low voltage power circuit breaker switchgear.
ANSI-C37.51 — Conformance testing of metal-enclosed low-voltage AC power circuit breaker switchgear assemblies.
ANSI-C37.13 — Low-voltage AC power circuit breakers used in enclosures.
ANSI-C37.50 — Test procedure for low-voltage AC power circuit breakers used in enclosures.
ANSI-C37.16 — Preferred ratings, related requirements and application. Recommendations for low-voltage power circuit breakers and AC power circuit protectors.

Order from Sales Department, American National Standards Institute, 1430 Broadway, New York, New York 10018.

National Electrical Code (NEC)

1984 Issue. Order from National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269

Other Appropriate Publications

Technical Bulletins

GEA-11315	AKR-30S, ARKU-30S Low Voltage Power Circuit Breakers
GET-6218	Type AKR Low Voltage Power Circuit Breakers
GET-6963	The Epic MicroVersaTrip™ System

General Installation and Maintenance

GEH-4674	AKD-8 Low Voltage Switchgear
GEH-5019	AKR-30S, AKRU-30S
GEK-64459	AKR-30/50/T50
GEK-64460	AKR-75/100

Installation and Operating Instructions

GEI-86150	AKR-30/50/T50
GEI-86151	AKR-75/100
GEI-86157	EC-1/1B/2A Trip Devices

Renewal Parts Bulletins

GEF-4527	AKR-30/50/T50
GEF-4552	AKR-75/100

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