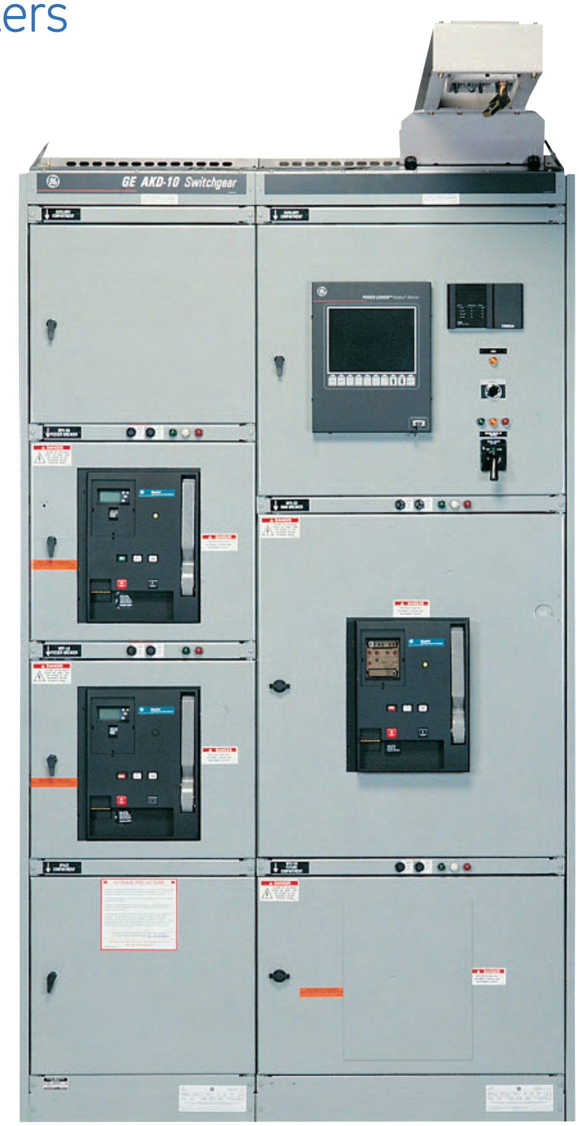
GE Consumer & Industrial
Electrical Distribution

AKD-10 Application Guide

Featuring WavePro™ Low Voltage Power Circuit Breakers



imagination at work

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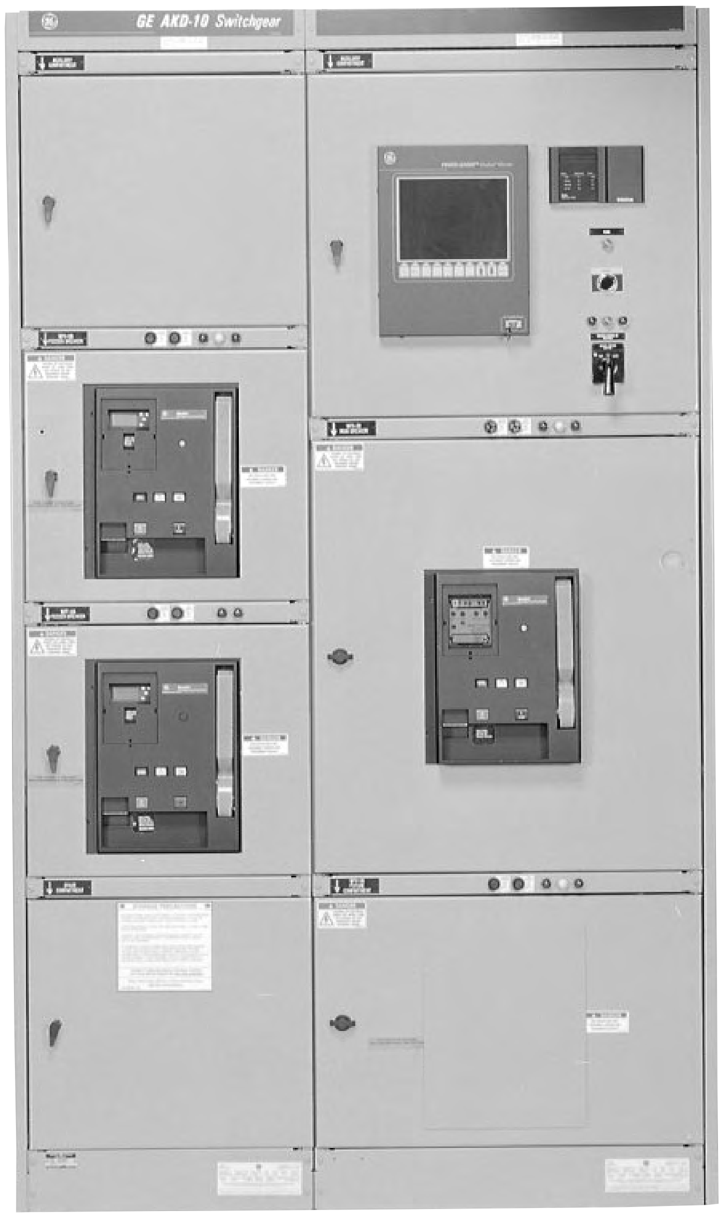

GE AKD-10 Switchgear

General description

AKD-10 Switchgear is industrial-duty equipment built to ANSI standards and uses 100% rated WavePro™ Low Voltage Power Circuit Breakers. 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, 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, WavePro circuit breakers provide full selectivity with each other and with other protective devices. The bus sizing is based on temperature rise rather than on current density (as with switchboard construction).

AKD-10 switchgear is available with the following maximum nominal ratings:
- 600 Vac
- 5000 Amps ac
- 50/60 Hz
- 2200 Vac RMS dielectric
- 200 kA symmetrical short circuit

AKD-10 switchgear sections are provided in either 22", 30" or 38" widths. It is designed to be operated in an ambient temperature between -30°C and 40°C (-22°F and 104°F).

WavePro low voltage power circuit breakers are available for AKD-10 switchgear in six frame sizes:
- 800A WPS/WPH/WPX/WPF-08
- 1600A WPS/WPH/WPF-16
- 2000A WPS-20
- 3200A WPS/WPH/WPX-32
- 4000A WPS/WPX-40
- 5000A WPS/WPX-50

All breakers can be equipped with current limiting fuses. WPF-08 and WPF-16 are provided with integrally mounted fuses, while a separate fuse carriage is required for WPS-20, WPS-32, WPS-40, and WPS-50 type breakers.

Low voltage circuit breakers rated 800/1600/2000 amps can be stacked in four-high combinations resulting in reduced floor space requirements. The 11-gauge, bolted modular-designed steel frame permits flexibility in arrangements of breakers and associated components.

AKD-10 switchgear houses low voltage power circuit breakers, instrumentation, and other auxiliary circuit protective devices in single or multiple source configurations. AKD-10 switchgear can be applied either as a power distribution unit or as part of a unit substation in indoor or outdoor construction.

AKD-10 switchgear is manufactured in GE's ISO 9002 certified facility in Burlington, Iowa. It complies with ANSI standards C37.20.1 and NEMA SG-5, and it is UL listed to standard 1558, file no. E76012. The switchgear has been conformance tested according to ANSI C37.51. AKD-10 switchgear can also be labeled per CSA standard C22.2.

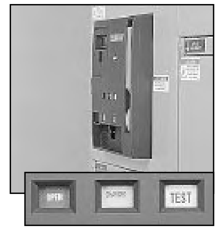
ANSI standards require that switchgear operates at the ratings of devices installed. Switchgear short circuit ratings are based on two 30-cycle withstand tests with 15-second interval, performed at 15% power factor and 635 Vac maximum. For switchboards, a single 3-cycle withstand test at 20% power factor and 600 Vac maximum is performed.

General Electric's AKD-10 Low voltage switchgear can help you meet today's challenges for greater productivity, increased operator safety and improved equipment reliability and maintainability.

Safety and reliability features

Standard and optional features are available with AKD-10 switchgear in order to meet the increasing industry emphasis on maximum uptime, 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 drawout**
  True closed-door drawout construction is standard with all AKD-10 equipment. The breaker compartment doors remain stationary and closed while the breaker is racked out from the connect position, through test, to the disconnect position. Doors are secured with rugged 1/4-turn latches.

- **Closed-door control circuit accessibility**
  Standard AKD-10 construction provides a metal instrument panel above each circuit breaker. This panel is used for mounting a variety of control circuit devices. Fuses for the breaker close and trip circuits are front mounted in dead-front, bayonet-type fuse holders. Up to three indicating lights can be mounted in the panel — with lamps replaceable from the front. Toggle switches used for testing the breaker close and trip circuits can also be mounted in the panel. The panel is removable for gaining access to the wiring terminations. An engraved circuit nameplate for the breaker is also provided on the panel.

- **Closed-door trip unit setup and display**
  All WavePro™ breakers used in AKD-10 switchgear have front-mounted trip units. This puts all trip unit information out where operators can have full and safe access to it without opening the breaker door. Depending on the trip unit supplied, the following information is available at the front of the breaker:
  - Trip unit type
  - Breaker trip rating
  - Trip targets (optional on Power+™)
  - Phase 1-2-3 current readings (MicroVersaTrip Plus/PM)
  - Current sensor rating
  - Trip unit settings **(LT, ST, INST, GF)
  - Trip counter (MicroVersaTrip Plus™/PM™)
  - Additional metering (MicroVersaTrip PM) —
    Voltage [L-L, L-N]
    Total power [kVA]
    Energy [kWh]
    Real power [kW]
    Demand and peak demand [kW]
    Frequency [Hz]
  - Protective relaying settings ** (MicroVersaTrip PM) — Pickup and delay for undervoltage, overvoltage, voltage unbalance, current unbalance, power reversal
  - Communication address ** (MicroVersaTrip PM)
  - Port for portable test kit (TVRMS2) or portable battery pack (TVPBP)

**Trip units have a sealable cover so that trip unit settings can be viewed but not changed

Easy-to-use breaker interlocking and locking features minimize the risk of operational errors:

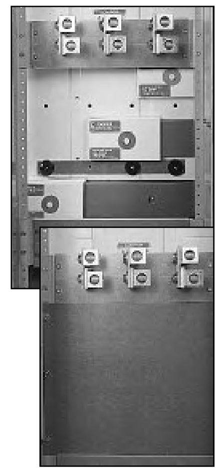
- **Low-voltage power circuit breaker locking**
  As a standard feature, the low-voltage power circuit breaker can be padlocked in the open position with up to three 1/4" - 3/8" shank padlocks to prevent unauthorized closing.

- **Breaker insertion and withdrawal interlocks**
  ① Interlocks prevent racking of the breaker in or out when the breaker contacts are closed. ② Breakers are trip free when not in the CONNECT or TEST position.

A superior bus system offers different levels of protection:

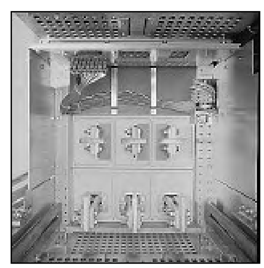
- **Fully tin-plated copper bus**
  Fully tin-plated copper main and riser bus is a standard feature on AKD-10 equipment. Tin plating provides superior corrosion protection, especially for application in the pulp and paper and waste treatment industries where corrosive agents routinely exist. GE's bus bars are tin-plated after forming and punching to ensure completely plated bolt holes and bar edges. Sliding contact surfaces, such as breaker stab tips, are fully silver-plated. Fully silver-plated bus is available as an option.

- **Bus system**
  Bare bus is provided as standard on AKD-10 switchgear. In this configuration, there are no covers to remove, so all bus connections are easily accessible for maintenance. Note that a horizontal isolation barrier is provided between the vertical buses at every main and tie breaker for added safety in the event of a fault. An insulated/isolated bus system that fully insulates the horizontal main bus with a fluidized epoxy coating and isolates each phase of the vertical riser bus is available as an option. Accessibility to main bus joints is provided by replaceable covers and no live connections are reachable from the rear except the breaker load side terminals. Bus compartmentation is also available as an optional feature on AKD-10 switchgear. Vertical and horizontal buses are isolated from the cable compartment by glass reinforced polyester barriers.



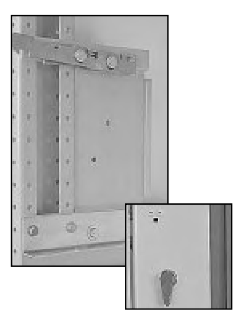
The breaker compartment is designed to provide operator and system safety options:

- **Isolated breaker compartment (standard)**
  Each circuit breaker is located in a completely enclosed ventilated compartment with grounded steel barriers to minimize the possibility of fault communication between compartments. A breaker position switch is optionally available.



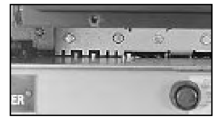
- **Safety shutters**
  Safety shutters are optionally available in breaker compartments. They protect operators from accidental contact with live conductors when the breaker is withdrawn. Safety shutters are provided as a standard feature on main and tie breakers in multi-source substations.

- **Defeatable door interlock**
  This option prevents inadvertent opening of the compartment door unless the breaker is in the TEST or DISCONNECT position. A provision is made for authorized defeat of interlock.



- **Padlockable door latch**
  This optional feature enables padlocking of the door latch in order to prevent unauthorized entry into the breaker compartment.

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



• Wheels and guidebar (standard)
All WavePro™ circuit breakers are equipped with wheels and a guidebar to provide easy and accurate drawout operation. When installing the breakers, they are lowered onto the extended drawout rails. Wheels on the side of the breaker allow the breaker to be easily rolled into the cubicle until the breaker engages the racking pins in the cubicle. The breaker is equipped with a rugged guidebar that ensures precise alignment of the primary and secondary disconnects during insertion and withdrawal.

• Drawout padlock provision (standard)
WavePro and AKD-10 offer an array of standard, safety locking features that provide extra measures of security when breaker, equipment, or load maintenance is performed. In addition to the padlocking feature on the breaker that keeps it open and tripfree, WavePro breakers are also equipped with provisions ① ② to padlock them in either the TEST or DISCONNECT position. Furthermore, breaker cubicles are furnished with padlocking provisions on the drawout rails ③ to prevent unauthorized installation of a breaker that has been removed from the cubicle for equipment or load maintenance.

This array of locking features should accommodate any type of “lockout - tagout” procedure a customer may have implemented at their facility. All of the padlock provisions on WavePro breakers and AKD-10 equipment will accept any combination of up to three padlocks with 1/4" to 3/8"
diameter shank.

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• Expansion capabilities
AKD-10 switchgear is designed to be easily expanded to handle increased loading. It is very common to specify “fully equipped future breaker” cubicles when ordering a substation or line-up. The fully equipped future breaker cubicle contains line and loadside primary disconnects, drawout rails and a cutout in the cubicle door. At time of manufacture, the cubicle can also be outfitted with any necessary metering, protection, and control devices if so specified or these can be added when the breaker is installed. Adding a new feeder can then be as simple as removing a cover from the cubicle door and installing the breaker.

If the breaker arrangement in a line-up of AKD-10 yields blank compartments, these can be specified as “field convertible blank compartments” or “space compartments.” The space compartment has the lineside bus installed in the cubicle but has neither the loadside bus nor the drawout rails. The cubicle door is furnished without a cutout. Converting the space compartment to accept a feeder breaker requires the addition of the loadside bussing, the drawout rails and a new cubicle door. All of these items are added from the front of the switchgear. Space compartments apply to 800 through 2000 amp frame breakers only.

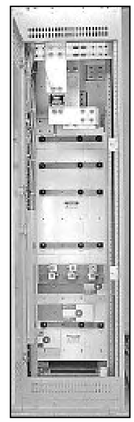
Standard bus configurations used in AKD-10 have provisions for future bus extension built in. Should the switchgear have no future breaker nor space compartments, additional vertical sections can be mechanically and electrically connected to the AKD-10 line-up without modifications or the use of transition sections. AKD-10 sections can also be added to existing AKD-8 equipment without the use of transition sections.

• **Key interlocks**
This option allows locking of the circuit 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 the primary switch and secondary main breaker such that the secondary main must be open before the primary switch can be operated. Single and double key locks are available. Key locking does not prevent operation when the breaker is in the test or disconnect position.

Installation and maintenance are made easy with these design features:

• **Accessibility**
Accessibility to equipment compartments provides easy maintenance of the breaker cubicle and control circuit elements (located in instrument panel), as well as convenient inspection of the bolted bus connections.

• **Cable space**
Conduit entrance area meets NEC requirements. Extended depth frame options are available in 7" and 14" sizes for applications requiring additional cable space. Section width can also be increased (from 22" to 30" or 30" to 38") for additional cable space.



• **Breaker lifting device**
Installed on top of the switchgear, this rail mounted hoist provides the means for installing and removing breakers from the equipment. This is a standard feature on outdoor walk-in construction and an optional feature on indoor construction.

• **Control circuit isolation**
Control wires are run between compartments in steel riser channels ①. Customer terminal blocks are located in metal enclosed wire troughs in the rear cable area ②. Intercubicle wiring is run in a wireway on top of the switchgear where interconnection terminal blocks are located ③.

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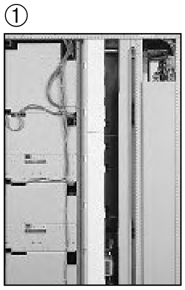

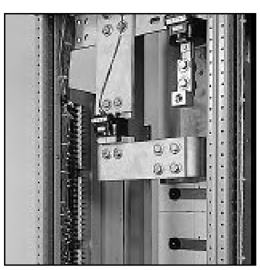

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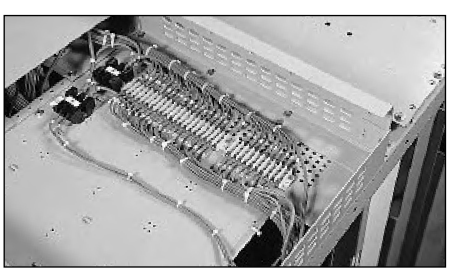

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Enhancements for greater operator safety during maintenance operations

- **IR scanning windows**
  Optional Infrared (IR) Scanning Windows can be provided in the switchgear rear covers to facilitate the use of IR cameras for thermally scanning cable terminations. Use of the IR windows minimizes exposure to live conductors while performing this preventative maintenance operation. The IR windows are available in two formats – an IR "transparent" mesh type and a crystal type. The transparent mesh is suitable for NEMA 1 indoor applications. The crystal type is used for outdoor NEMA 3R applications and can also be specified for indoor applications. Both types of IR windows have a gasketed cover plate secured with tamper-resistant hardware. Quantity and location of the IR windows are dependent on the breaker stacking arrangement.

- **Remote racking**
  All WavePro circuit breakers now include provisions to accept a remote racking device that allows the operator / electrician to move the breaker anywhere between the DISCONNECT and CONNECT positions without standing in front of the circuit breaker cubicle. The remote racking device attaches to the circuit breaker escutcheon (800-2000A frame) or to the circuit breaker frame (3200-5000A frame) without opening the cubicle door, and it is powered from any standard 120 volt AC receptacle. A switch on the remote racking device sets the direction of travel and the racking motor is provided with thermal overload protection. The control box on the end of the 30-foot cord has a single pushbutton to control the operation of the remote racking device, providing the operator the capability to stand outside the arc flash boundary while racking a circuit breaker into or out of its cubicle.

GE's manufacturing processes and testing set the quality standards in the switchgear industry:

- **Paint finish**
  AKD-10 switchgear is protected by the "E-coat" paint system consisting of 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, switchgear parts are conveyed through a seven-stage washing process, where they are thoroughly cleaned, surface prepared, sealed and rinsed. Next, the parts are immersed in an electrocoating tank, where they receive an epoxy coating 0.7 to 0.8 mil thick on every surface. After a rinse, the parts enter a curing oven, where the coating is baked, fusing it to the metal and ensuring a hard, uniform finish. The resulting ANSI-61 light gray paint finish far exceeds the requirements of UL 1558 and ANSI C37.20.1, which requires, at a minimum, passing a 200-hour salt spray test. Periodic testing by an independent laboratory subjects the "E-coat" to a minimum of 500 hours of a 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 tests. These tests prove that AKD-10 switchgear can handle different severe operating environments.

- **Seismic Certification**

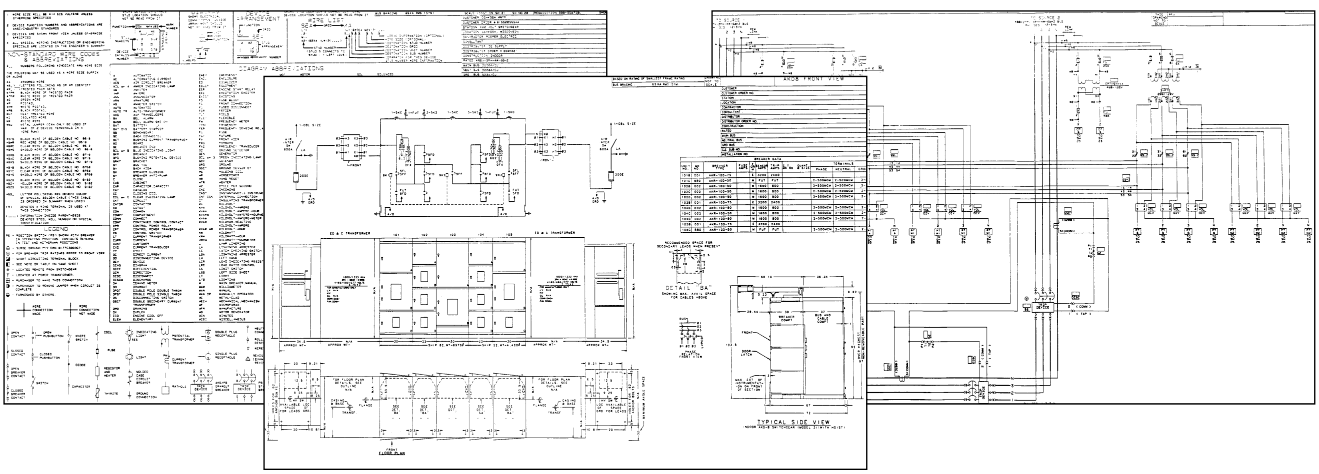
  AKD-10 switchgear with WavePro circuit breakers has been shake-table tested in accordance with ICC-ES-AC156 to the requirements of IBC-2003. IBC is the International Building Code, first released in 2000 by the International Code Council (ICC). IBC incorporates and replaces the NBC, SBC and UBC.

  AKD-10 has been tested to the following ratings:

  S_{ds} = 1.4g, S_s = 206%, I_p = 1.5, for z/h > 0
  S_{ds} = 2.0g, S_s = 300%, I_p = 1.5, for z/h = 0, where

  S_s is the maximum considered earthquake response in a certain region
  S_{ds} is a measure of ground acceleration for given site and location conditions, and is dependent on Ss (this is similar to specifying a UBC seismic zone)
  I_p is the importance factor, measuring the criticality of the equipment to life safety. Equipment with an I_p of 1.5 must be functional after a seismic event, whereas equipment with an I_p of 1.0 does not need to be functional.
  z/h specifies the location of the switchgear, z, in relation to the height of the structure, h. z/h = 0 indicates the switchgear is installed at ground level. z/h > 0 indicates the switchgear may be installed anywhere in the building.

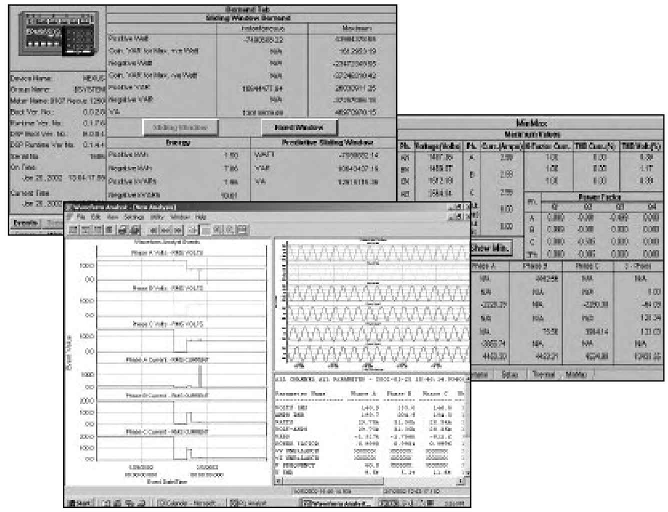
  AKD-10 has been certified for use in all IBC-2003 Seismic Use Groups, Occupancy Importance Factors and Seismic Design Categories. In addition, AKD-10 has been qualified to IEEE-693-1997 for Moderate and High Seismic loading conditions.



- **Complete and accurate documentation**

  The AKD-10 design makes extensive use of computer-aided engineering and design. All customer documentation is generated via linked engineering and production systems for seamless ordering of materials and manufacturing of parts. This integration and linking of systems assures consistently accurate customer and manufacturing documentation and optimized equipment designs, all driven by the engineer's system inputs. Customer documentation includes a set of mechanical and electrical drawings plus a bill of materials for the switchgear. The mechanical drawings show the switchgear elevation with one-line diagram and floorplan, circuit breaker schedule with trip ratings and cable data, and layouts for all doors and panels that are used for device mounting. The electrical drawings include three-line diagrams showing metering and relaying circuits, schematics for breaker control and auxiliary circuits, and wiring diagrams showing the switchgear internal wiring. The bill of materials provides catalog and rating information for the protection, instrumentation and control devices as well as details on the WavePro circuit breakers. Electronic files of the mechanical and electrical drawings are available for customers who are integrating the switchgear drawings into their plant electronic documentation.

POWER LEADER™ Power Management System



Power management at its best

Inside every switchgear lineup flows a large amount of information. The data is in the form of power (volts, amps, waveforms) passing through the equipment. With the proper devices and GE Enervista Power Management Control System (PMCS), you can selectively access this wealth of information. PMCS software is the easy-to-use software package that turns a desktop computer into a virtual window for tracking and controlling facility power. This system can help you increase productivity, decrease downtime, improve predictive maintenance, increase facility safety and diagnose power quality problems. With just a few clicks of a mouse, you can gain real-time access to the family of GE Multilin and POWER LEADER™ devices and most third party devices or systems. With PMCS's powerful analytical tools, you can perform advanced power quality analysis, monitor energy consumption, and even manage loads. These features are all available through sophisticated graphics and a highly intuitive interface. Enervista PMCS is both ModBusRTU® and ModbusTCPIP Ethernet compatible. It all adds up to the most flexible, open-architecture, high-performance power management system available today.

Additional features include:

- Built on the market-leading, industry-standard SCADA software, CIMPLICITY and InTouch™
- Easy integration to existing SCADA/DCS systems using published protocols (OPC and DDE)
- Dynamic, real-time graphic displays of component status and operation
- Extensive device library
- Sophisticated waveform analysis tools
- Comprehensive alarm and event reporting to immediately diagnose electrical system problems
- Energy cost management
- Predictive maintenance
- Power quality analysis
- Technical assistance, start-up support and on-site training

It should come as no surprise that virtually all switchgear is now shipped with power management features.

Software options include the Enervista Energy Aggregator module, which is offered separately or as an add-on to the PMCS system. This package allows the user to look into energy cost management and facility power quality.

New Suite of EPM and PQM devices

We are proud to announce the introduction of the latest suite of high technology EPM devices: EPM 6000 series and EPM 9000 series. These devices boast a broad range of capabilities for a variety of uses including: usage monitoring, cost allocation, load monitoring, demand tracking, common couplings with utilities, load and process control, and power quality monitoring. This range of products has solid representation on the moderate range of the metering spectrum, providing solutions for panel mount and submetering applications (EPM 6000), as well as on the high end of the power quality spectrum (EPM 9450Q and 9650Q). These newly introduced meters greatly enhance GE's PowerLeader™ EPM portfolio, from both price and functionality standpoints. The GE Power Quality Meter System, PQM II, is also available for applications requiring a feature set between the EPM 6000 and EPM 9000 offerings.

Power+™, Enhanced MicroVersaTrip Plus™ and MicroVersaTrip PM™ trip unit systems

There are three trip unit systems available for WavePro™ Low Voltage Power Circuit Breakers — Power+, and enhanced MicroVersaTrip Plus and MicroVersaTrip PM. All three systems consist of the trip unit, the trip actuator, current sensors and rating plugs. The term "trip unit systems" applies to the combination of these four components, which form the circuit breaker solid-state tripping system.

The Power+ trip unit is a new addition to the list of trip units available on GE low voltage power circuit breakers. It continues to use GE's proven technique of measuring true rms currents of both sinusoidal and harmonically distorted waveforms. The frequent sampling (48 times per cycle per phase) allows precise calculations of true rms current. The sampling rate allows waveform measurements up to the 11th harmonic. True rms sensing avoids potential under- or over-protection problems associated with peak-sensing tripping systems.

The Power+ trip unit is identified by its plug-in modules and rotary switches. The optional "target module" provides LED targets for overload, short circuit and ground fault trips. View and Reset push buttons are also provided to monitor status, including a battery check LED. Standard 3-volt lithium batteries, in the target module, power the indicating LED's (batteries are not required for trip unit operation). The "rating plug module" serves the dual purpose of providing the trip rating for the circuit breaker as well as ground fault protection when required. All pickup and delay settings are selected with detented rotary switches.

Standard functions:
- Rating plug with test port

Protection
- Long-time
- Instantaneous

Optional functions:

Protection
- Short-time protection, with selectable I^2t
- Ground fault protection, with selectable I^2t
- Defeatable ground fault (not UL)

Target module
- View and Reset buttons
- Battery check LED
- Longtime pickup/trip unit "health" LED
- LED's for overload, short circuit, ground fault trips

Enhanced MicroVersaTrip Plus and MicroVersaTrip PM trip units also measure true rms currents (and voltages for MicroVersaTrip PM trip units). The higher sampling rate (64 times per cycle) allows waveform measurements up to the 31st harmonic to achieve accuracy of 99%.

MicroVersaTrip Plus and MicroVersaTrip PM trip units contain a digital liquid crystal display with a five-button keypad for local setup and readout of trip settings. The trip units have a lithium battery for cold setup capability and viewing of targets without external power. The LCD and keypad also provide a three-phase ammeter and trip indicators.

The enhanced MicroVersaTrip (MVT) PM trip unit adds power management system capability, including advanced metering and protective relaying to the basic functions of the MVT Plus. The MVT PM can be interfaced with either Modbus RTU or Ethernet TCP/IP compatible systems.

All trip units utilize a series of interchangeable rating plugs to establish the current rating of the breaker.

Standard functions:
- Rating plug with test port

Protection
- Long-time
- Instantaneous

Status
- Trip target (trip type)
- Trip information (magnitude and phase)
- Trip operations counters

Metering display
- Phase current (selectable among phases)

Optional functions:
- Short-time protection, with selectable I^2t
- Ground fault protection, with selectable I^2t
- Defeatable ground fault (not UL)
- Switchable instantaneous/short time and ground fault (not UL)
- Zone-selective interlock, for ground fault only or for both ground fault and short-time protection

Additional functions available only with MicroVersaTrip PM trip unit:

Communication and metering
Communication, metering and protective relaying

Communication:

Remote communication with POWER LEADER™ Power Monitoring and Control System (PMCS) software

Metering:
- Voltage (V)
- Energy (kWh/MWh/GWh)
- Real power (kW/MW)
- Total power (kVA/MVA)
- Demand power (kW/MW)
- Peak demand power (kW/MW)
- Frequency (Hz)

Protective relaying:
- Undervoltage
- Overvoltage
- Voltage unbalance
- Current unbalance
- Power reversal

Refer to the tables on page 53 for a listing of the overcurrent functions available on Power+, MicroVersaTrip and PM trip units.

Application data

Basic ratings

WavePro™ low voltage power circuit breakers are available in various levels of interrupting capacity (IC) and are identified with a suffix in the model number. WPS indicates "standard IC," WPH indicates "high IC," WPX indicates "extended IC" and WPF indicates "integrally fused."

High IC and extended IC breakers are used with larger kVA substation transformers as well as in parallelling applications. Fused circuit breakers take the IC rating to 200kA rms symmetrical for the highest short circuit applications.

Refer to Table 12.1 for the interrupting capacity (IC) of WavePro breakers at system operating voltages.

WPS — Standard IC WPH — High IC
WPX — Extended IC WPF — Integrally fused (200kAIC)

Table 12.2 Breaker/Sensor/Rating Plug Combinations for Power+™, and MicroVersaTrip Plus™/PM™

Breaker Frame Rating (Amps)	Sensor Rating	Available Rating Plugs
800	150	60 ①, 80, 100, 125, 150
800	400	150 ①, 200, 225, 250, 300, 400
800/1600	800	300 ①, 400, 450 ①, 500, 600, 700, 800
1600	1600	600 ①, 800, 1000, 1100 ①, 1200, 1600
2000	2000	750 ①, 800 ①, 1000, 1200, 1500 ①, 1600, 2000
3200	3200	1200, 1600, 2400, 3200
4000	4000	1600, 2000, 2500, 3000, 3600 ①, 4000
5000 ②	5000 ②	3200 ①, 4000 ①, 5000 ①

① These rating plugs values are not available on Power+ trip units.
② Power+ trip unit is not available on WPS-50 (5000A) breaker.

Table 12.1 WavePro Breaker Interrupting Ratings

Rated AC Voltage, Nominal (max)	Breaker Type	Frame Size (amps)	Short-Circuit Ratings RMS Symmetrical kA Short-Time Withstand	With Instantaneous Trip	Without Instantaneous Trip
600 (635)	WPS-08	800	30	30	30
	WPH-08	800	42	42	42
	WPX-08	800	50	50	50
	WPS-16	1600	42	42	42
	WPH-16	1600	65	65	65
	WPS-20	2000	65	65	65
	WPS-32	3200	65	65	65
	WPH-32	3200	85	85	85
	WPX-32	3200	85	85	85
	WPS-40	4000	85	85	85
	WPX-40	4000	85	85	85
	WPS-50	5000	85	85	85
	WPX-50	5000	85	85	85
480 (508)	WPS-08	800	30	30	30
	WPH-08	800	42	42	42
	WPX-08	800	65	65	65
	WPS-16	1600	50	50	50
	WPH-16	1600	65	65	65
	WPS-20	2000	65	65	65
	WPS-32	3200	65	65	65
	WPH-32	3200	85	85	85
	WPX-32	3200	100	100	100
	WPS-40	4000	85	85	85
	WPX-40	4000	100	100	100
	WPS-50	5000	85	85	85
	WPX-50	5000	100	100	100
240 (254)	WPS-08	800	30	42	30
	WPH-08	800	42	50	42
	WPX-08	800	65	65	65
	WPS-16	1600	50	65	50
	WPH-16	1600	65	65	65
	WPS-20	2000	65	65	65
	WPS-32	3200	65	85	65
	WPH-32	3200	85	130	85
	WPX-32	3200	100	130	100
	WPS-40	4000	85	130	85
	WPX-40	4000	100	130	100
	WPS-50	5000	85	130	85
	WPX-50	5000	100	130	100

Table 12.3 shows the minimum and maximum fuse ratings allowed for WavePro breakers based on the breaker frame size and rating plug. Maximum fuse ratings protect the circuit breaker under short circuit conditions with up to 200kA available. Minimum fuse sizes are established based on UL continuous current tests when the fuse is mounted on the circuit breaker.

Table 12.3 Allowable current limiting fuse sizes for WavePro low voltage power circuit breakers (600Vac Max, 50/60 HZ)

Breaker Type	Frame Size	Sensor Rating	Rating Plug	Gould-Shawmut Fuse Range ①
WPF-08	800A		Below 150A	300 / 350 / 400 / 450 / 500 / 600 / 800* / 1000* / 1200* / 1600*A
		150A	150A	
			225A	
			300A	
		400A	400A	400 / 450 / 500 / 600 / 800* / 1000* / 1200* / 1600*A
			600A	600 / 800* / 1000* / 1200* / 1600*A
			700A	800* / 1000* / 1200* / 1600*A
		800A	800A	1000* / 1200* / 1600*A
WPF-16 ③	1600A		400A and below	450 / 500 / 600 / 800* / 1000* / 1200* / 1600* / 2000* / 2500A ③
			500A	500 / 600 / 800* / 1000* / 1200* / 1600* / 2000* / 2500A ③
			600A	600 / 800* / 1000* / 1200* / 1600* / 2000* / 2500A ③
			700A	800* / 1000* / 1200* / 1600* / 2000* / 2500A ③
		800A	800A	
			1000A	1000* / 1200* / 1600* / 2000* / 2500A ③
			1200A	1600* / 2000* / 2500A ③
		1600A	1600A	2500A ③
WPS-20 ②	2000A	2000A	2000A and below	2000 / 2500A
WPS-32 ②	3200A	3200A	3200A and below	2000 / 2500 / 3000 / 4000A
WPS-40 ②	4000A	4000A	4000A and below	2000 / 2500 / 3000 / 4000 / 5000A
WPS-50 ②	5000A	5000A	5000A and below	

* These fuse sizes are also available as "Welder Limiters."
① Class L fuses less than 800A are not UL or CSA listed. Use Class J fuses for 600A and below. The maximum fuse rating is the largest fuse that tests show will result in proper performance of the breaker and fuse in combination under short-circuit conditions. Only Gould- Shawmut fuses should be used for proper coordination.
② Fuses are mounted in a separate roll-out element (fuses shipped as "XS" material).
③ Integrally fused 1600A frame breakers (WPF-16) equipped with 2500A fuses can be furnished with rating plugs from 300-1600A. Breakers equipped with 2500A fuses cannot be modified to accept lower rated fuses. WPF-16 breakers equipped with 2000A and lower fuses cannot be upgraded to 2500A fuses. The maximum trip rating for a WPF-16 breaker is 1200A when furnished with other than 2500A fuses (see chart for min-max fuse rating for each rating plug value). 2500A fuses preclude the use of shutters in the breaker cubicle.

Accessories

Auxiliary Switch –
Field installable kit available
(Breaker accessory)
The auxiliary switch is used for indication of breaker main contact position. It is available on manually and electrically operated breakers in either a 4-stage or 7-stage configuration. The 4-stage switch yields 3NO and 3NC contacts while the 7-stage switch yields 6NO and 6NC contacts. Normally open (NO) contacts follow the breaker primary contact position while normally closed (NC) contacts operate opposite the breaker primary contacts. All auxiliary switch contacts feature rugged double-break construction. Refer to breaker wiring diagram 10057403P1 for contact configurations and secondary disconnect terminations. Ratings of the auxiliary switch contacts are shown in Table 13.1.

Table 13.1 Auxiliary switch ratings and contact operation

Auxiliary Switch Ratings ①			
		Rating (Amperes)	
Control Voltage		Non-inductive	Inductive
DC	24	15	10
	125	10	5
	250	5	5
AC - 60Hz	120	15	15
	240	10	10

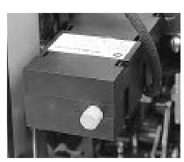
① 20A continuous rating of switch limited to 15A continuous rating of #16AWG wire on drawout breakers

Table 13.2

Auxiliary switch contact operation		
Breaker primary contacts	"a"-contact (NO)	"b"-contact (NC)
Open or tripped	Open	Closed
Closed	Closed	Open

Table 13.3

Field installable auxiliary switch kit catalog numbers			
Auxiliary switch	WP-08 / 16 / 20	WP-32 / 40	WP-50
Four stage	WPAUXSF4STG	WPAUXLF4STG	WPAUXXF4STG
Seven stage	WPAUXSF7STG	WPAUXLF7STG	WPAUXXF7STG



Bell Alarm with/without Lockout –
Field installable kit available
(Breaker accessory)
The bell alarm device is provided with two C-form contacts — each C-form contact is 1NO and 1NC contact with a common connection. The bell alarm device operates whenever the breaker trips due to a protective function of the trip unit. It can be used to provide remote indication of a fault trip and/or disable electrical operation of breakers that may have automatic control.

For Power+™ and MicroVersaTrip Plus™ trip units, the bell alarm will operate for overload, short circuit and ground fault trips. For MicroVersaTrip PM™ trip units, the bell alarm will operate for the same overcurrent trips plus any of the protective relay trips that are enabled in the trip unit. Tripping via the manual trip button, shunt trip, undervoltage device or open fuse lockout will not operate the bell alarm.

The bell alarm can be furnished with a mechanical lockout feature that will prevent the breaker from being manually closed until the lockout is reset. Reset of the contacts and lockout feature is accomplished by pushing the yellow "reset" button on the breakerescutcheon. The reset button also serves as a target indicator that the bell alarm has been operated. Ratings of the bell alarm contacts are shown in Table 13.4

Table 13.4 Bell alarm contact ratings

Bell Alarm Contact Ratings	
AC Ratings	DC Ratings
6A @ 240Vac	0.5A @ 125Vdc 0.25A @ 250Vdc

Table 13.5

Field Installable Bell Alarm Kit Catalog Numbers *(kit provides choice of with or without lockout)*	
WP-08 / 16 / 20	WP-32 / 40 / 50
WPBASF	WPBALF

Electrical Lockout – Field installable kit available
(Breaker accessory)
The electrical lockout device provides a means to electrically enable or disable manual closing of a circuit breaker. This device must be energized prior to attempting to manually close the breaker. Once the breaker is closed, loss of voltage will not trip the breaker. A manual bypass interlock is provided for initial startup. Refer to the undervoltage device for ratings and coil characteristics. (Note: Interlocking of electrically operated breakers does not require an electrical lockout device.)

Table 13.6

Field installable electrical lockout kit catalog numbers		
Control voltage	WP-08 / 16 / 20	WP-32 / 40 / 50
120Vac 50/60Hz	WPELSF56120	WPELLF56120
240 Vac 50/60Hz	WPELSF56240	WPELLF56240
24Vdc	WPELSFDC024	WPELLFDC024
48Vdc	WPELSFDC048	WPELLFDC048
110Vdc	WPELSFDC110	WPELLFDC110
125Vdc	WPELSFDC125	WPELLFDC125
250Vdc	WPELSFDC250	WPELLFDC250

Fuse and Fan – WP-50 *(Breaker accessory)*
The WP-50 breaker is provided with integrally mounted cooling fans. Fan control is initiated by the trip unit which signals a fan controller to turn the fans on and off when the load current exceeds or drops below 4200 amperes. The fan motors require 120Vac and the fan controller requires 24Vdc auxiliary power. Both the fans and the fan controller are wired to the breaker secondary disconnect. The 24Vdc source can be the POWER LEADER™ power supply used for MicroVersaTrip PM™ trip units. 120Vac is normally provided by the switchgear control power transformer. Power requirement for each fan is 0.2amps @ 120Vac (two fans installed).

Fuse Roll-out – Fuse carriage *(Equipment accessory)*
A fuse roll-out is used in conjunction with breakers that do not have integral fusing and are applied in high available short circuit current systems. The fuse roll-out is equipped with wiring and a secondary disconnect for blown fuse sensing. The sensing wiring is connected to the breaker-mounted Open Fuse Lockout (OFLO). The OFLO will trip the circuit breaker whenever a fuse in the roll-out opens due to short circuit interruption. Note that the WavePro breaker

(WPS-20, 32, 40 or 50) must be ordered with the open fuse lockout — character 3 in the breaker catalog number — when it is to be used in a high short circuit application requiring current limiting fuses. Key interlocking must also be ordered for both the circuit breaker and fuse roll-out to prevent removal or insertion of the fuse roll-out unless the circuit breaker is open. Refer to the key interlock accessory for details.

Table 14.1 WavePro™ Breaker Fuse Roll-outs

Fuse roll-out catalog numbers and ratings		
For use with breaker frame size	**Fuse roll-out catalog number**	**Gould-Shawmut fuse range***
2000A (WPS-20)	WP32FRE	2000 / 2500A
3200A (WPS-32)	WP32FRE	2000 / 2500 / 3000 / 4000A
4000A (WPS-40)	WP40FRE	2000 / 2500 / 3000 / 4000 / 5000A
5000A (WPS-50)	WP50FRE	2000 / 2500 / 3000 / 4000 / 5000A

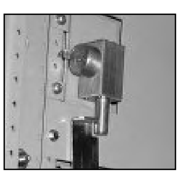
*Fuses are shipped as "XS" material

Hidden-On Button and Push Button Covers –
Field installable kit available *(Breaker accessory)*
All electrically operated WavePro breakers are provided with a manual close button on the escutcheon. For applications where manual closing is not desirable, the Hidden-On close button can replace the standard manual close button. This feature provides limited access to the mechanical close mechanism. For emergency or supervised operation, a 0.100" diameter rod can be inserted through a hole in the Hidden-On button to manually close the breaker. The Hidden-On feature provides double insulation between the operator and any live parts in the breaker. This feature is typically used on a breaker that is electrically interlocked with other breakers, such as in an automatic transfer scheme.

Sealable covers can be provided for the CLOSE and OPEN buttons on the breaker escutcheon. These covers help prevent accidental manual operation of the circuit breaker. Applications include supply breakers for fire pumps (to prevent access to the OPEN button) or critical feeders where accidental operation may have a serious impact on a process. The push button covers can be applied to either the CLOSE or OPEN buttons or both.

Table 14.2

Field Installable Kit Catalog Numbers	
WP-08 / 16 / 20 / 32 / 40 / 50	
Hidden-On Button WPHIDONKIT1	Sealable Push Button Covers (Qty. 2) WPPBCVRKIT2



Key Interlocks – *(Equipment accessory)*
Optional provisions for a key interlock are located on the left side of the breaker cubicle. Key interlocks are used to supervise the closing of a circuit breaker or the operation of upstream or downstream devices. Typical applications include interlocking main and tie breakers to prevent paralleling, and interlocking secondary main breakers with primary air switches. Breakers can be locked in the open position only. Normally, the key is removable when the lock bolt is extended, holding the breaker in a trip-free condition. Certain key interlock applications require the key to be removable when the breaker is able to be closed or when the lock bolt is withdrawn. Up to two key positions can be accommodated in each breaker cubicle.

Table 14.3 Key Interlock Applications

Breaker application	Key interlock description
WP-08 / 16 / 20 / 32 / 40 / 50	Single key - key removable when breaker is locked open
	Double key - both keys removable when breaker is locked open
	Double key - one key removable and one key captive when breaker is locked open
Fuse Roll-out	Single key - key removable when fuse roll-out is racked in to CONNECT position

Lifting Tool – (*Equipment accessory)*
The lifting tool is the interface between the breaker and the overhead breaker lifting device or any other portable lifting means that may be used for installing and removing the WavePro drawout breakers. It attaches to the breaker to provide stability when lifting the breaker from its drawout rails. Pickup points on the breaker and lifting tool are designed for center-of-gravity lifting so that the breaker is not subject to excess movement when removed from the cubicle.

The lifting tool for 800-2000A frame breakers features 3-point lifting for easier installation of fused and unfused breakers. Separate lifting tools are used for 3200-4000A breakers and for 5000A breakers and fuse roll-outs.

Table 14.4 WavePro Breaker Lifting Tools

	WP-08 / 16 / 20	WP-32 / 40	WP-50	Fuse Roll-out 2000 / 3200 / 4000A	Fuse Roll-out 5000A
Lifting Tool	0324B4551G001	0247B8961G001	0247B8961G003	0247B8961G004	0247B8961G005

Open Fuse Lockout – OFLO *(Breaker accessory)*
The open fuse lockout device is provided with any fused breaker. The OFLO consists of an individual trip solenoid for each pole, connected directly across the fuse in that phase. When any fuse blows, the solenoid is energized and trips the breaker to prevent single-phasing. The breaker is mechanically locked out and cannot be reclosed until the fuse is replaced and the target indicator of the phase involved is reset.

When the fuses are mounted in a separate fuse roll-out (used with WPS-20, WPS-32, WPS-40, WPS-50) the open fuse lockout is wired to the fuses through secondary disconnects on the roll-out and on the breaker. The OFLO utilizes dedicated secondary disconnect points, so no other breaker accessories are affected.

Operations Counter –
Field installable kit available *(Breaker accessory)*
The operations counter mounts on the breaker as a five-digit, non-resettable counter actuated by the breaker closing mechanism.

Table 15.1 Field Installable Operations Counter Kit catalog number

WP-08 / 16 / 20	WP-32 / 40 / 50
WPCTRSFKIT1	WPCTRLFKIT1

"PM-Ready" – *(Breaker accessory)*
In its most basic form, a manually operated WavePro breaker, with a Power+™ or MicroVersaTrip Plus™ trip unit and no other accessories, may be able to be supplied without secondary disconnect points. The "PM-Ready" option equips the breaker with a secondary disconnect and inputs for 24Vdc auxiliary power, communications and 3-phase voltage signals. If the breaker is already equipped with any combination of ground fault protection, zone selective interlocking, shunt trip, auxiliary switch, bell alarm, undervoltage device, electric lockout, MicroVersaTrip PM™ or is electrically operated, the PM-ready wiring is automatically included and does not have to be specified. This "PM-Ready" option makes upgrading a WavePro breaker to MicroVersaTrip PM as simple as changing the trip unit.

Position Switch – By-pass switch or TOC truck-operated-contact *(Equipment accessory)*
This accessory is available with either two NO and two NC or six NO and six NC electrically separate contacts. The switch changes state when the breaker is racked from the CONNECT to the TEST position. The position switch is used to indicate the drawout position of the breaker, enable/disable control circuits, and/or bypass auxiliary contacts when the breaker is in the TEST/DISCONNECT/WITHDRAWN positions.

Table 15.2 Position switch ratings

Position Switch Ratings			
Control Voltage		Rating (Amperes)	
		Non-inductive	Inductive
AC - 60Hz	120	10	6
	240	10	6

Racking Tool – *(Equipment accessory)*
The racking tool is a special drive wrench with a square ½" socket that engages the racking mechanism on the breaker. One racking tool is used for all WavePro™ circuit breakers.

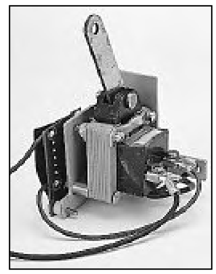
0324B4721G001
Without universal joint – all applications except as noted below (standard)

0324B4724G001
With universal joint – must use for outdoor applications when there is a large frame (3200 – 5000A) breaker or fuse rollout on the extreme right end of the line-up. Can be used on all other breaker applications, also.

Remote Charge Indicator Switch –
Field installable kit available *(Breaker accessory)*
The remote charge indicator switch is a normally open or normally closed dry contact that changes state when the closing springs of the breaker are fully charged. This option is available on manually or electrically operated breakers. The contact is rated 4.0 amps at 120Vac and 0.5 amps at 125Vdc.

Table 15.3 Field Installable Remote Charge Indicator Switch Kit catalog numbers

Breaker Frame and Operation		Normally Open	Normally Closed
WP-08 / 16 / 20	Manually or Electrically Operated	WPRCISFKIT1	WPRCISFKIT2
WP-32 / 40 / 50	Electrically Operated	WPRCILFKIT1	WPRCILFKIT3
WP-32 / 40 / 50	Manually Operated	WPRCILFKIT2	WPRCILFKIT4



Remote Close Accessory with One-Shot Electronic Close Circuit – Field installable kit available *(Breaker accessory)*
The remote close accessory is an electrically operated solenoid, which when energized, closes the breaker. It is suitable for control interlock schemes in which manual closing capability would not be convenient or would be too slow. It is an optional accessory for a manually operated breaker but is always supplied with electrically operated breakers. The remote close accessory consists of the "one-shot" electronic close circuit, with built-in anti-pump feature, and the closing solenoid. The remote close accessory is continuously rated and operates as follows.

Applying control voltage to the close circuit produces a 250msec pulse to the closing coil which in turn releases the energy stored in the closing springs. The anti-pump feature prevents the breaker from repeatedly closing if the close signal is maintained. A momentary close signal (1/2 second duration) is sufficient to close the breaker — but if the close signal is maintained while the breaker is closed, the signal must be removed and then reapplied in order to reclose the breaker. Reset time for the anti-pump circuit is approximately 2.5 seconds. For applications requiring rapid reclosure of a circuit breaker, a momentary close signal should be used. This allows the anti-pump circuit to reset while the closing springs are recharging and the breaker is then ready to reclose without any additional time delays. A close signal applied to a closed breaker will provide a pulse to the close coil, but the closing mechanism is mechanically blocked thereby preventing the closing springs from discharging. The close signal must be removed as stated above before the breaker can be reclosed. Control power requirements for electrically charging and closing the breaker are shown in Tables 15.3 and 16.1.

Table 16.1 WP-08 / 16 / 20 circuit breakers

Nominal control voltage	Voltage range	Spring charging motor (amps)		Closing coil	Charge / close fuse (amps)	Charging time (sec)
		Inrush	Sustained	Inrush (amps)		
120v-60Hz	104-127	25.0	5.0		15	0.9
120v-50Hz	104-127	25.0	5.0		15	0.9
240v-60Hz	208-254	12.0	3.0		15	0.9
240v-50Hz	208-254	12.0	3.0		15	0.9
48Vdc	38-56	40.0	10.0		15	1.5
110/125Vdc	100-140	27.0	5.0		15	1.0
250Vdc	200-280	13.0	3.0		15	1.0

Table 16.2 WP-32 / 40 / 50 circuit breakers

Nominal control voltage	Voltage range	Spring charging motor (amps)		Closing coil	Charge / close fuse (amps)	Charging time (sec)
		Inrush	Sustained	Inrush (amps)		
120v-60Hz	104-127	25.0	8.1		15	1.5
120v-50Hz	104-127	25.0	8.1		15	1.5
240v-60Hz	208-254	11.7	3.5		15	1.3
240v-50Hz	208-254	11.7	3.5		15	1.3
48Vdc	38-56	22.0	16.5		15	2.0
110/125Vdc	100-140	25.0	7.0		15	1.7
250Vdc	200-280	13.0	3.2		15	1.7

Table 16.3 Field Installable Remote Close Accessory Kit catalog numbers

Control voltage	WP-08 / 16 / 20	WP-32 / 40 / 50
120v-60Hz	WPRCSF60120	WPRCLF60120
120v-50Hz	WPRCSF50120	WPRCLF50120
240v-60Hz	WPRCSF60240	WPRCLF60240
240v-50Hz	WPRCSF50240	WPRCLF50240
48Vdc	WPRCSFDC048	WPRCLFDC048
110Vdc	WPRCSFDC110	WPRCLFDC110
125Vdc	WPRCSFDC125	WPRCLFDC125
250Vdc	WPRCSFDC250	WPRCLFDC250

Secondary Disconnect – Field installable kit available *(Breaker and Equipment accessory)*
Inputs and outputs to the circuit breaker are wired through secondary disconnects located on the top of the breaker. The plug-style secondary disconnects engage mating disconnects in the breaker cubicle when the breaker is in the TEST or CONNECT position. Up to 72 dedicated points are available so that all breaker accessories can be wired to dedicated disconnect points. Refer to the breaker wiring diagrams shown on pages 51 and 52 for breaker accessory wiring.

Table 16.4 Field Installable Secondary Disconnect catalog numbers

	WP-08 / 16 / 20	WP-32 / 40 / 50
Breaker side (female)	WPSDSUBF1	WPSDSUBF1
Cell side (male)	WPSDSUBM1	WPSDSUBM2

Shunt Trip – Field installable kit available *(Breaker accessory)*
The shunt trip allows remote electrical tripping of the circuit breaker. It is usually controlled by a switch or push button and may also be used in conjunction with protective relays for automatic tripping (the breaker trip units do not require the use of a shunt trip). The shunt trip coil is rated for intermittent duty and is supplied with an auxiliary switch contact that automatically removes control power following a breaker trip. A shunt trip is always supplied on electrically operated breakers. A redundant or 2nd shunt trip is available on 800-4000A frame breakers for special control applications. See Table 16.5 for shunt trip operating characteristics.

Table 16.5 Shunt Trip Operating Characteristics

Nominal control voltage	Operating voltage range, V	Inrush current, A	Sealed current, A
70v-60Hz	70-127	3.75	3.75
120v-60Hz	95-127	12.3	10.8
120v-50Hz	95-127	7.6	6.7
208v-60Hz	165-220	3.2	2.6
208v-50Hz	165-220	3.8	3.1
240v-60Hz	190-254	3.9	3.4
240v-50Hz	190-254	4.7	4.1
24Vdc	14-30	8.3	8.3
48Vdc	28-60	4.5	4.5
110/125Vdc	70-140	2.0	2.0
250Vdc	140-280	1.0	1.0

Table 16.6 Field Installable Shunt Trip 1 Kit catalog numbers

Control voltage	WP-08 / 16 / 20	WP-32 / 40 / 50
70v-60Hz	WPS1SF60070	WPS1LF60070
120v-60Hz	WPS1SF60120	WPS1LF60120
120v-50Hz	WPS1SF50120	WPS1LF50120
208v-60Hz	WPS1SF60208	WPS1LF60208
208v-50Hz	WPS1SF50208	WPS1LF50208
240v-60Hz	WPS1SF60240	WPS1LF60240
240v-50Hz	WPS1SF50240	WPS1LF50240
24Vdc	WPS1SFDC024	WPS1LFDC024
48Vdc	WPS1SFDC048	WPS1LFDC048
110/125Vdc	WPS1SFDC125	WPS1LFDC125
250Vdc	WPS1SFDC250	WPS1LFDC250

Table 16.7 Field Installable Shunt Trip 2 Kit catalog numbers

Control voltage	WP-08 / 16 / 20	WP-32 / 40 / 50
120v-60Hz	WPS2SF60120	WPS2LF60120
240v-60Hz	WPS2SF60240	WPS2LF60240
24Vdc	WPS2SFDC024	WPS2LFDC024
110-125Vdc	WPS2SFDC125	WPS2LFDC125
250Vdc	WPS2SFDC250	WPS2LFDC250

Spring Charging Motor – *(Breaker accessory)*
The spring charging motor is supplied on all electrically operated breakers. The breaker closing springs are charged automatically when control voltage is applied to the breaker. When the springs are fully charged, a cutoff switch de-energizes the motor. The closing springs will recharge automatically after the breaker closes unless an external switch contact is wired into the spring charging circuit. If control power is lost during the spring charging cycle, spring charging can be completed using the integral manual pump handle. The optional remote charge indicator contact can be supplied to provide a contact closure when the springs are fully charged.

Refer to Tables 16.1 and 16.2 for spring charging motor operating characteristics.

Test kit – *(Equipment accessory)*
The test kit, catalog number TVRMS2, is a portable, battery-or ac-powered unit that is used for trip unit health checks and also provides functional trip and no-trip tests of the trip unit. It can be used to defeat the ground fault function of the trip unit when performing high current tests on the circuit breaker. The test kit supplies 24Vdc auxiliary power for cold set-up and viewing of trip targets on trip units not equipped with on-board batteries. The display on the test kit can be used to verify pickup and delay settings that have been programmed into the trip unit. This test kit is designed for use with all Power+™, MicroVersaTrip Plus™ and MicroVersaTrip PM™ trip units.

Undervoltage Device – Field installable kit available *(Breaker accessory)*
The undervoltage device protects against harmful drops or complete loss of voltage by automatically tripping the breaker. The undervoltage device can be used to sense the drop or loss of bus voltage through the use of voltage transformers or it can monitor a control voltage source. This device is set to pick-up at approximately 85% of rated voltage and will drop out instantaneously between 30 and 60% (nonadjustable) of rated voltage. An electronic module on the undervoltage device provides accurate and repeatable operating characteristics. The undervoltage device is available with an optional static time delay unit. This unit offers a field-adjustable two- to six-second delay between undervoltage occurrence and breaker trip, thus preventing potential nuisance tripping due to momentary loss of voltage. The time delay unit is mounted externally to the breaker. It is rated 125Vdc or 250Vdc or 208/240Vac, 50/ 60Hz. For any other AC source voltage, a control power transformer with a 240v secondary, rated at least 100VA, is required. Refer to Table 17.1 for undervoltage device operating characteristics.

Table 17.1 Undervoltage device operating characteristics

Nominal control voltage	Operating voltage range	Holding current, A
120Vac	Pickup at 80% of nominal control voltage, drop out at 30-60% (non-adj) of nominal control voltage	0.15
240Vac		0.07
24Vdc		0.58
48Vdc		0.32
110/125Vdc		0.15
250Vdc		0.07

Table 17.2 Field Installable Undervoltage Device Kit catalog numbers

Control voltage	WP-08 / 16 / 20	WP-32 / 40 / 50
120Vac 50/60Hz	WPUVSF56120	WPUVLF56120
240Vac 50/60Hz	WPUVSF56240	WPUVLF56240
24Vdc	WPUVSFDC024	WPUVLFDC024
48Vdc	WPUVSFDC048	WPUVLFDC048
110Vdc	WPUVSFDC110	WPUVLFDC110
125Vdc	WPUVSFDC125	WPUVLFDC125
250Vdc	WPUVSFDC250	WPUVLFDC250

Table 17.3 Field Installable Time Delay Undervoltage Device Kit catalog numbers (order Static Time Delay Unit separately)

Control voltage	WP-08 / 16 / 20	WP-32 / 40 / 50
208/240Vac 50/60Hz	WPUVSFTD240	WPUVLFTD240
125Vdc	WPUVSFTD125	WPUVLFTD125
250Vdc	WPUVSFTD250	WPUVLFTD250

Table 17.4 Static Time Delay catalog numbers

Nominal control voltage	Catalog number
125Vdc	TAKYUVT-1
250Vdc	TAKYUVT-2
240Vac	TAKYUVT-4
208Vac	TAKYUVT-5

Repetitive duty

Circuit breakers are designed primarily to perform the function of circuit interruption under short-circuit conditions. Nevertheless, modern circuit breakers' mechanisms are capable of many operations under full-load operation and in-rush conditions such as those encountered in motor starting applications. Industry standards have been established for the minimum performance, as indicated in Table 18.1. With adequate maintenance, GE breakers can be expected to exceed the standards. WavePro™ breakers have been designed and tested to allow the user to extend the normal maintenance service interval up to two times the ANSI recommendation — a significant benefit for continuous process and 7-X-24 operations. See Table 18.1 for additional information.

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 and the permissible effect of such operations upon the breaker are listed in Table 18.1 and the footnotes. For instance, the breaker should be operated with rated control voltage applied. The frequency of operation should not exceed 20 in 10 minutes or 30 in an hour (rectifiers or other auxiliary devices may further limit the frequency of operation). Servicing consisting of adjusting, cleaning, lubricating, tightening, etc., as recommended by the maintenance manual, is to be done at no greater interval than shown in the column titled "Number of operations between servicing" in Table 18.1. No functional parts should require replacement during the listed operations. The circuit breaker should be in 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.

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 18.1 Repetitive duty and normal maintenance (from ANSI C37.16 Table 5)

Circuit breaker frame size (amperes)	Number of operations between servicing	Number of operations rated continuous current switching ① ② ④	Number of operations on-load closing and opening ①	Number of operations in-rush current switching ③ ④
800	1750	2800	9700	1400
1600	500	800	3200	400
2000	500	800	3200	400
3200	250	400	1100	—
4000	250	400	1100	—
5000	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 six months or less.

② With closing and opening currents up to the continuous current rating of the circuit breaker at voltages up to the rated maximum voltage (85% or higher power factor).

③ The number of operations was determined with 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. With closing 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 should be reduced to 10% of the number listed in the column.

④ If a fault operation occurs before the completion of the listed number of operations, servicing is recommended and possible functional part replacement may be necessary depending on previous accumulated duty, fault magnitude, and expected future operations.

Design considerations

Standards and testing

WavePro™ low voltage power circuit breakers are designed and tested to meet ANSI Standards C37.13, C37.16, C37.17 and C37.50. The breakers are listed to UL 1066 and CSA C22.2, and labeled to certify compliance with the above referenced standards.

Power factors lower than test values affect the circuit breaker's short-circuit current rating. The test circuit X/R ratio and power factor required by ANSI C37.13 is 6.6 and 15% for unfused breakers and 4.9 and 20% for fused breakers.

Table 18.2 Derating factor for systems with power factors lower than test values

System short-circuit power factor (%)	System X/R ratio	Derating factors for breaker short-circuit current rating	
		Unfused	Fused
20	4.90	1.000	1.000
15	6.60	1.000	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	20.00	0.875	0.794

Temperature derating factors

The continuous current rating of WavePro breakers is based on their use in an enclosure at 40° C ambient temperature and 105° C maximum breaker temperature for Class A insulation. Continuous current ratings of WavePro breakers must be derated for ambient temperatures above 40° C. (Trip unit ambient is limited to 70° C.)

Table 18.3 Continuous current derating factors

Ambient temperature (°C)	Derating factor
40	1.00
45	0.95
50	0.89
55	0.84 ①
60	0.77
65	0.71
70	0.63

① Trip unit maximum

Altitude correction factors

When applying low voltage power circuit breakers at altitudes greater than 6,600 feet, 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 of the air. The short-time and short-circuit current ratings are not affected by altitude. However, the short-circuit current ratings shall not exceed that of the voltage class before derating.

Table 18.4 Altitude correction factors (as listed in ANSI C37.13)

Altitude		Rating correction factor	
Meters	Feet	Continuous current	Voltage
2000	6600 (and below)	1.00	1.00
2600	8500	0.99	0.95
3900	13000	0.96	0.80

Humidity

Ferrous parts are zinc-plated for corrosion protection except for some parts made from alloy steels that are inherently corrosion resistant. Current-carrying parts are silver- or tin-plated for corrosion protection and to assure electrical continuity. Heaters may be added to indoor sections operating in high humidity environments. Heaters are mounted in the bus/ cable compartment in the rear of each section.

Table 18.5 Insulation values (Dielectric test)

	kV
Breaker	2.2
Control Wiring	1.5
Closing Motor	0.9

Table 18.6 Operating time (Same for all frame sizes)

Close Time from energizing closing circuit until contacts touch	Electrically operated	5 Cycles
Open Maximum clearing time	With instantaneous overcurrent trip	3 Cycles
	With shunt trip	3.5 Cycles

Time current tripping characteristics

WavePro™ low voltage power circuit breaker time current curves are the engineering documents that define technical performance characteristics of the devices. Multiples of circuit breaker trip rating are shown on the top and bottom horizontal axis, with time in seconds on the vertical axis. Minimum and maximum clearing time is readily determined through the characteristic curves. Tripping characteristics meet ANSI, NEMA and UL standards for rating and calibration.

Table 19.1 Time current curves

Trip device	Trip elements	Curve	REF
Power+™ MicroVersa Trip Plus™ MicroVersa Trip PM™	LSI	DES-001	pg. 20
	G	DES-002	pg. 21
MicroVersa Trip Plus or PM	Non-std. G F	DES-026	pg. 22

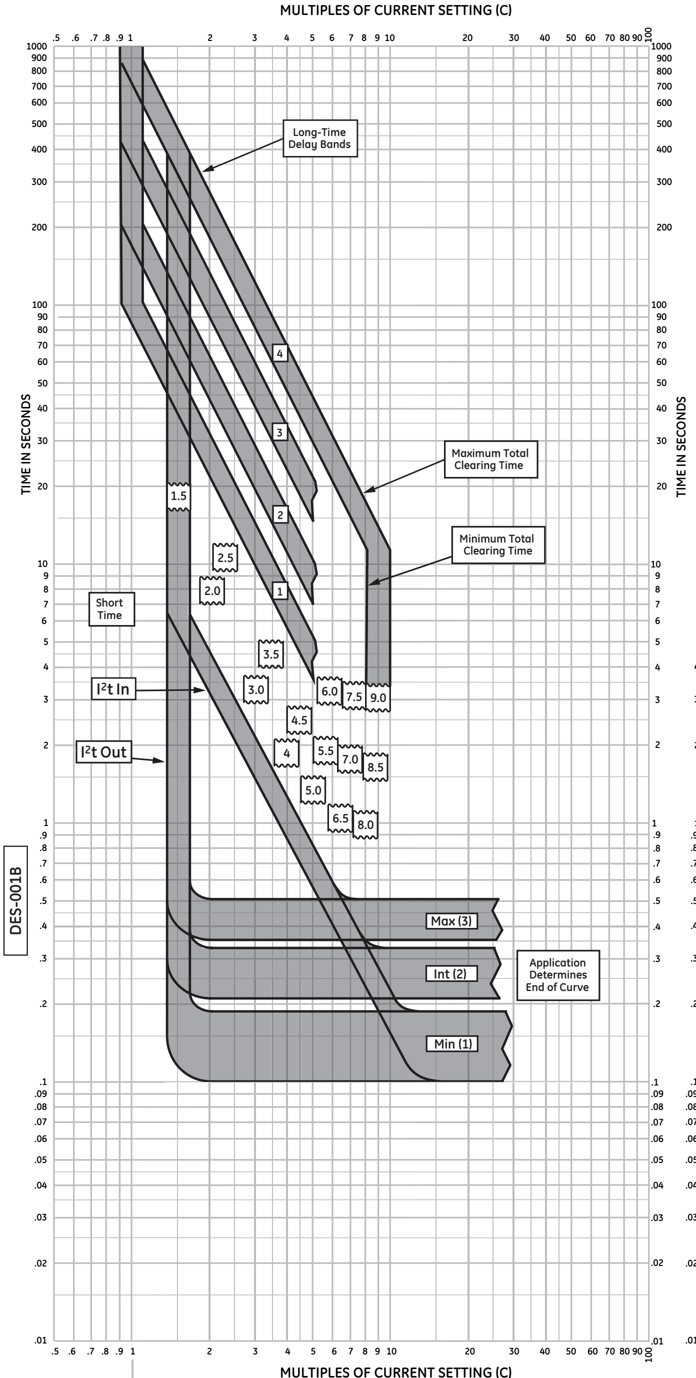
Cable terminations

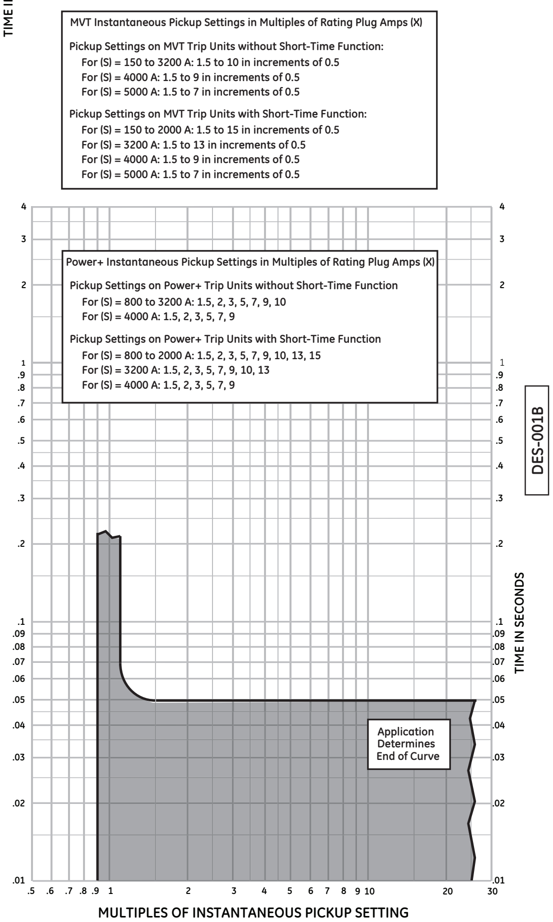
Cables used for low voltage power circuit breaker terminations in AKD-10 must have minimum 90°C insulation while the cables' ampacity will be based on a 75°C rating. This meets the requirements of ANSI C37.20.1, UL1558 and the National Electrical Code. Refer to the example for typical cable ampacities (derating factors that may apply are not shown).

Table 19.2 Example (from NEC Table 310.16)

Cable size	90°C rating (ref.)	75°C rating (of 90°C cable)
500kcmil	430 Amps	**380 Amps**
600kcmil	475 Amps	**420 Amps**

Time current tripping characteristics





GE Consumer & Industrial -
Electrical Distribution

Low-Voltage Power Circuit Breakers

DES-001B

Available Ratings (Amperes)

Breaker			Current Sensor	
Type	Model	Frame	(S) = CT	Rating Plug (X) = I_n
LVPCB	WP08	800	150	60*, 80, 100, 125, 150
			400	150*, 200, 225, 250, 300, 400
			800	300*, 400, 450*, 500, 600, 700, 800
	WP16	1600	800	300*, 400, 450*, 500, 600, 700, 800
			1600	600*, 800, 1000, 1100*, 1200, 1600
	WP20	2000	2000	750*, 800*, 1000, 1200, 1500*, 1600, 2000
	WP32	3200	3200	1200, 1600, 2400, 3200
	WP40	4000	4000	1600, 2000, 2500, 3000, 3600*, 4000
	WP50*	5000	5000	3200, 4000, 5000

* Not available for Power+™

Voltage Rating: 600 Vac, nominal

Type WavePro™ with Enhanced MicroVersaTrip Plus™, MicroVersaTrip PM™ (Series RMS-9D), or Power+™ Digital RMS Trip Units

Long-Time Delay, Short-Time Delay, and Instantaneous Time-Current Curves

Curves apply at 50 to 60 Hertz and from -20°C to 55°C Breaker ambient. -20°C to 70°C trip unit ambient.

Settings Glossary

S or CT = Current Sensor Rating in amps
C or LT = Current Setting in amps
X or I^n = Rating Plug Rating in amps

MicroVersaTrip Plus & PM Adjustments

Long-Time Function:
- Current settings (C): 0.5 to 1.1 in 0.05 increments and are multiples of the rating plug amps (X). Delay bands: 1, 2, 3, and 4

Short-Time Function
- Pickup settings: 1.5 to 9.0 in 0.5 increments and are multiples of the current setting (C). Delay bands (I^2t In & Out): 1 = Min, 2 = Int, 3 = Max

Instantaneous Function:
- See table and curve above.

Power+ Adjustments

Long-Time Function:
- Current settings (C): 0.5, .6, .7, .8, .9, .95, 1, 1.1 and are multiples of the rating plug amps (X). Delay bands: 1, 2, 3, and 4

Short-Time Function
- Pickup setting: 1.5, 2, 2.5, 3, 4, 5, 7, 9 and are multiples of the current setting (C). Delay bands (I^2t In & Out): 1 = Min, 2 = Int, 3 = Max

Instantaneous Function:
- See table and curve above.

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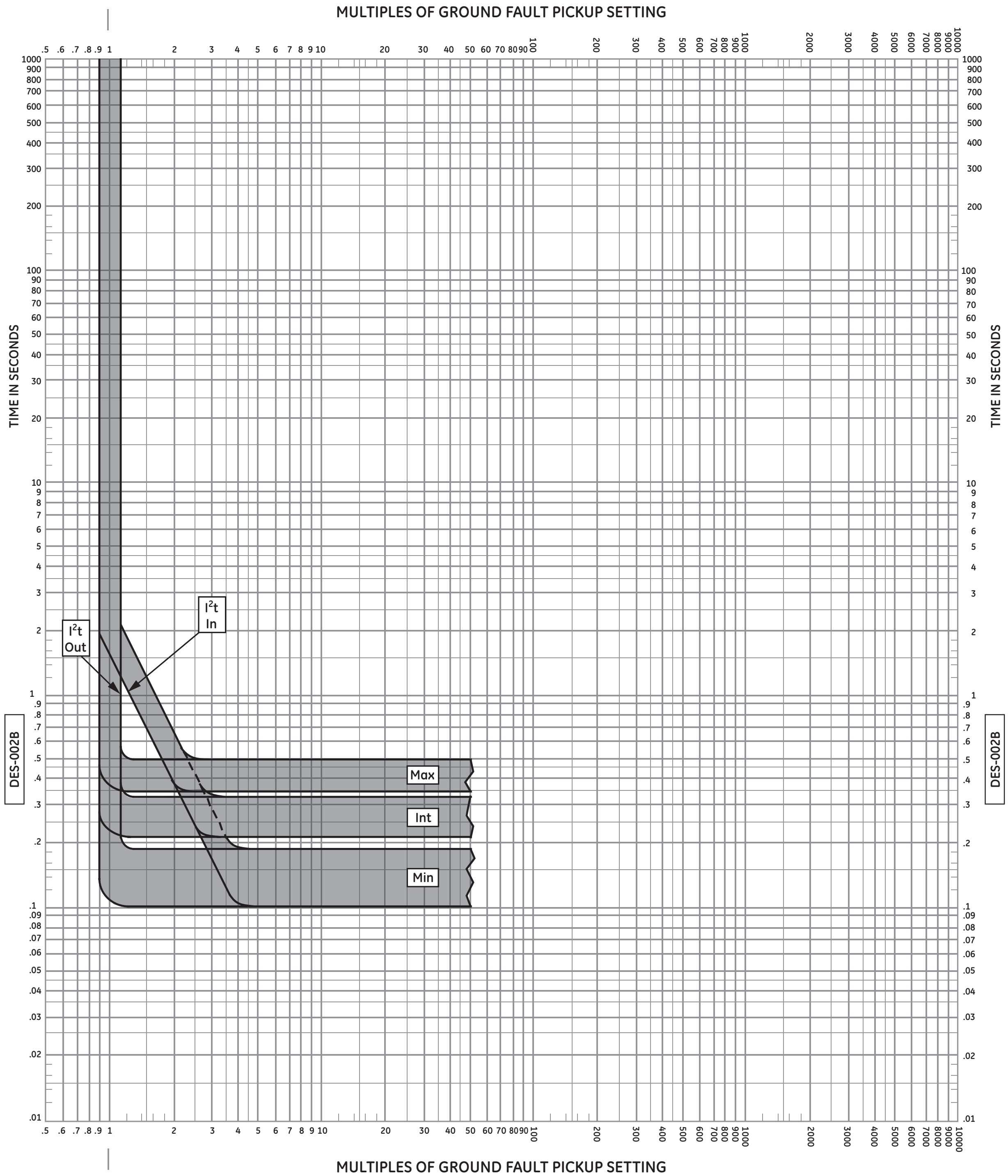

GE Consumer & Industrial -
Electrical Distribution

Low-Voltage Power Circuit Breakers

DES-002B

Available Ratings (Amperes)

Breaker Type	Breaker Model	Frame	Current Sensor (S) or CT
LVPCB	WP08	800	150, 400, 800
	WP16	1600	800, 1600
	WP20	2000	2000
	WP32	3200	3200
	WP40	4000	4000
	WP50	5000	5000

Voltage Ratings: 600 Vac, nominal

Type WavePro™ with Enhanced MicroVersaTrip Plus™, MicroVersaTrip PM™ (Series RMS-9D), or Power+™ Digital RMS Trip Units

Ground Fault Time-Current Curves

Curves apply at 50 to 60 Hertz
and from -20°C to 55°C breaker ambient.
-20°C to 70°C trip unit ambient.

Settings Glossary
S or CT = Current Sensor Rating in amps

MicroVersaTrip Plus & PM Adjustments

Ground Fault Function: Pickup settings in multiples of Current Sensor Rating (S)

(S) or CT in Amps	Pickup Setting in Increments of .01
150 - 2000	.2 - .6
3200	.2 - .37
4000	.2 - .3
5000	.2 - .24

Delay Bands (I^2t In & Out): 1 = Min, 2 = Int, 3 = Max

Power+ Adjustments

Ground Fault Function: Pickup settings in multiples of (S)

(S) In Amps	Current Sensor Rating
150 - 2000	.2, .25, .3, .35, .4, .45, .5, .6
3200	.2, .22, .24, .26, .28, .3, .34, .37
4000	.2, .22, .24, .26, .28, .30

Delay Bands (I^2t In & Out): Min, Int, Max

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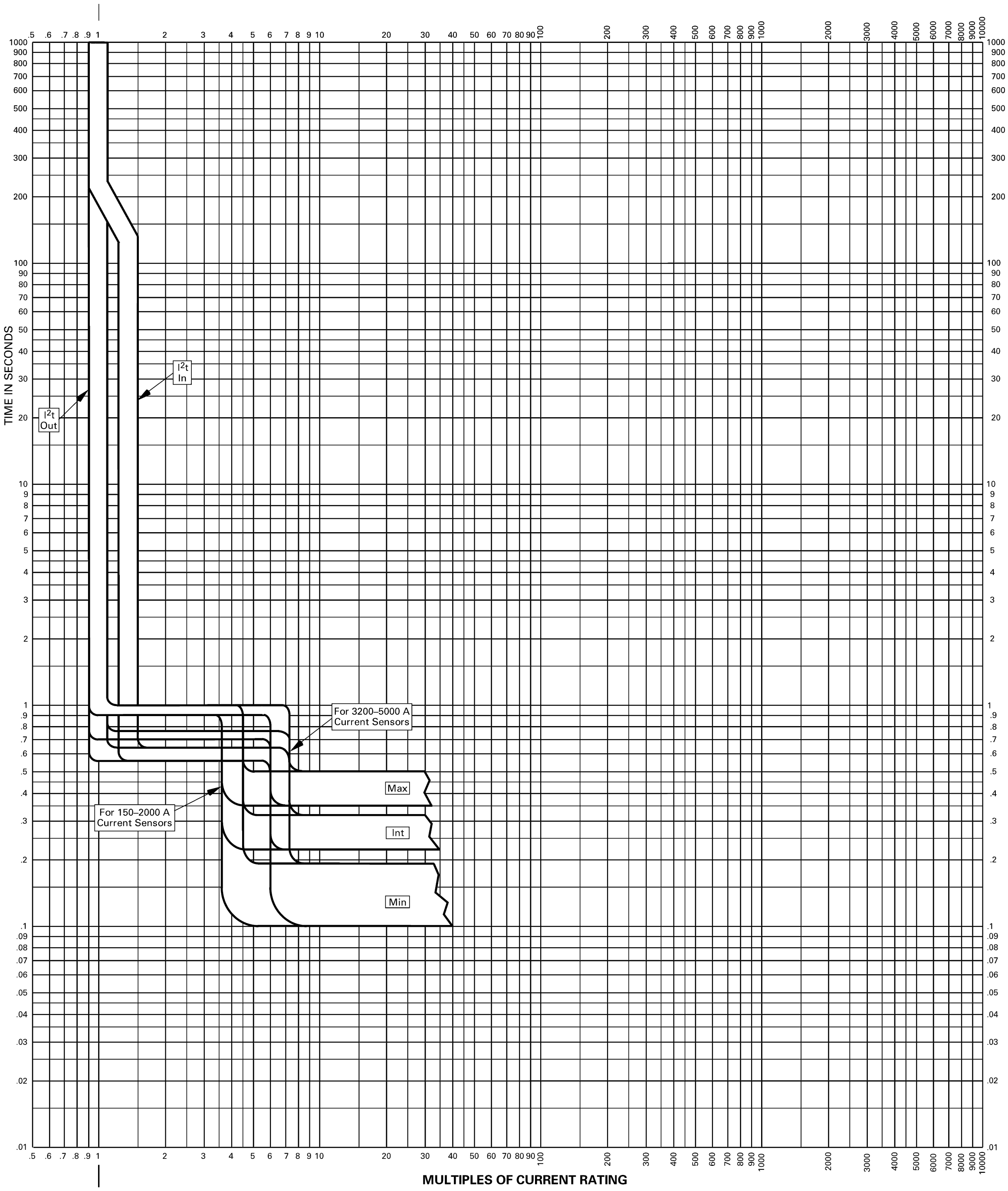


GE Consumer & Industrial

General Electric Company
41 Woodford Avenue, Plainville, CT 06062

Low-Voltage Power Circuit Breakers Type WavePro™ with Enhanced MicroVersaTrip Plus™ or MicroVersaTrip PM™ (Series RMS-9D) Digital RMS Trip Units

Nonstandard Ground Fault Time-Current Curves

DES-026

Available Ratings (Amperes)

Breaker Type	Breaker Model	Breaker Frame	Current Sensor (S) or CT
LVPCB	WPS/WPH/WPX/WPF08	800	150, 400, 800
	WPS/WPH/WPF16	1600	800, 1600
	WPS20	2000	2000
	WPS/WPH/WPX32	3200	3200
	WPS/WPX40	4000	4000
	WPS/WPX50	5000	5000

Voltage Rating: 600 volts ac, nominal

Curves apply at 50 to 60 Hertz and from –20° C to +55° C ambient, –20° C to +70° C trip unit ambient.

Note: *Operation above 60 Hz requires thermal and interrupting derating of the circuit breaker.*

MicroVersaTrip Plus & PM Adjustments

Ground Fault Function: Pickup settings in multiples of Current Sensor Rating (S)

(S) or CT in Amps	Pickup Settings in Increments of .01S
150–2000	.2–.6
3200	.2–.37
4000	.2–.3
5000	.2–.24

Delay Bands (I²t In & Out): 1 = Min, 2 = Int, 3 = Max

Settings Glossary

S or CT = Current Sensor Rating in amps

07/04

The Load Center Principle

Pioneered by General Electric, load center unit substations provide reliable equipment for power distribution in industrial plants and commercial buildings, power station auxiliaries and other applications requiring continuity of service.

GE offers a complete line of load center unit substations for indoor or outdoor installations. The unit consists of an incoming line, a transformer and low voltage sections. Load center unit substations are handled as a single packaged system, simplifying engineering coordination and application.

Standard design eliminates unnecessary purchasing and engineering details. Mechanical and electrical coordination results in greater reliability. Expert field engineering is available to ensure proper application, installation and operation.

How to select switchgear

The application tables on the following pages provide a list of low voltage power circuit breakers available for load center unit substation applications. The air power circuit breakers are coordinated with transformers and system capacities (electrically, thermally and mechanically). For analysis procedures on motor starting fused breakers, overcurrent trip details, short-circuit ratings, etc., refer to ANSI C37.13 and ANSI C37.16.

These tables should be used only as guidelines, taking into consideration voltage, temperature, power factor, altitude and other service conditions that may affect application on 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. This condition could also exist when a secondary selective system operates with one main breaker open and one main and one tie breaker closed so that the feeder breaker can see "twice" the normal motor contribution to a short circuit.

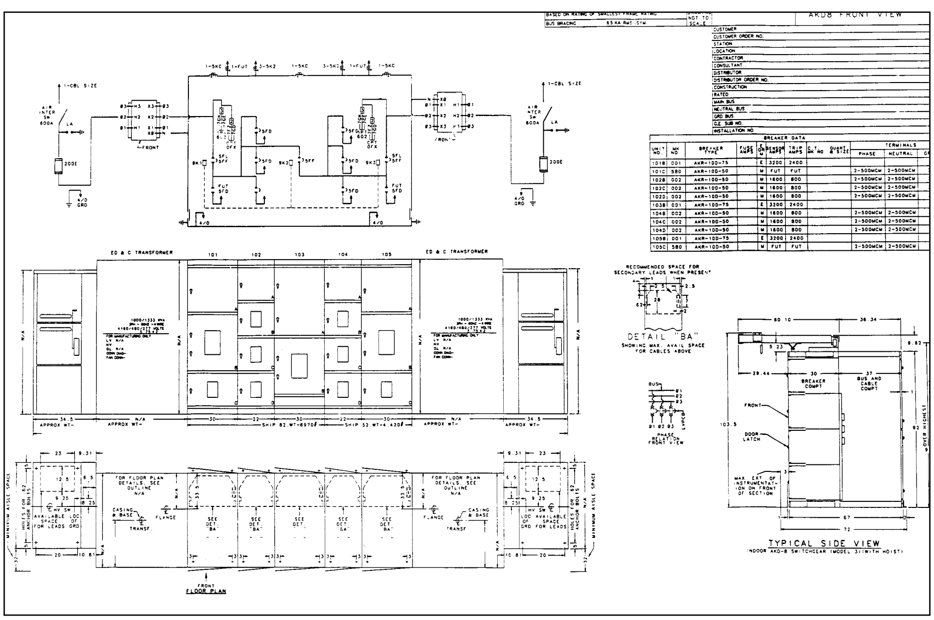
For these types of systems, the use of higher-rated or WPF fused circuit breakers may be required to stay within the short-circuit rating of the feeder breaker.

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 that 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 allowing the faulted feeder 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. WavePro™ circuit breakers do not require instantaneous trips to achieve their short time ratings. Therefore, there are no hidden instantaneous trip functions that would cause a loss of selectivity in this type of arrangement.

Selectivity can be carried a step further in the substation by specifying selective feeder circuit breakers that have long-time and short-time trip characteristics 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 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 current devices for lower fault current values. It 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.

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 they may have higher interrupting capabilities when provided with instantaneous trips (LI or LSI characteristics). The majority of 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.

Application tables

Application tables are based on the following factors:

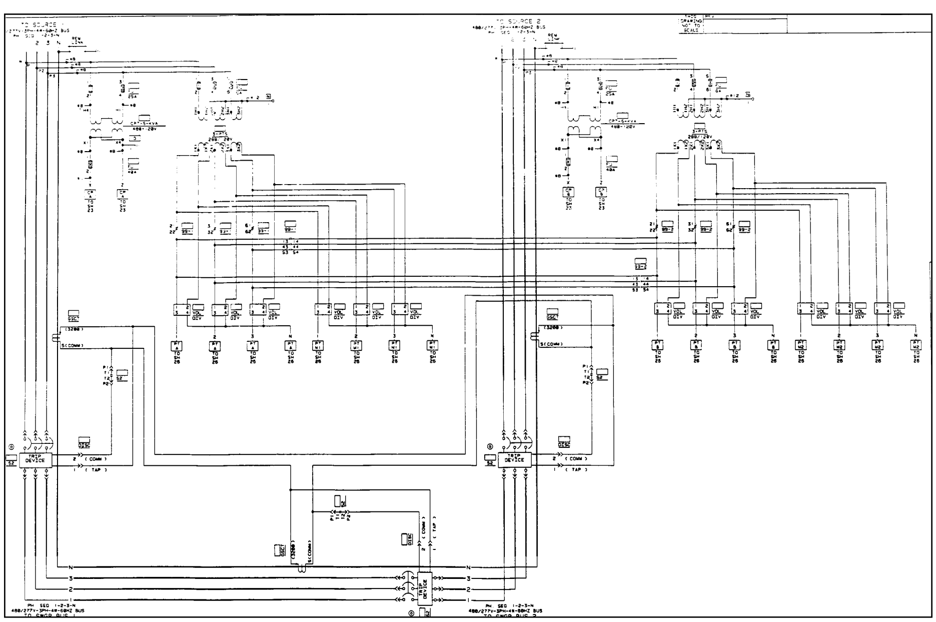
- A three-phase bolted fault at the low voltage terminals of the substation
- Transformer impedance listed in table (only source of power to the bus is the substation transformer)
- Total connected motor kVA does not exceed 50% of transformer rating at 208Y/120 volts and 100% of transformer rating at 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
- Tables estimate short circuit duty (Reference GET-3550 for short circuit calculation)

Example

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 1500kVA transformer, with 750MVA maximum primary short-circuit available and a 480V secondary, requires at least a WPS-20 main secondary breaker shown in column 7 of the 480V application table (page 27).

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 a WPS-32 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 (WPH-08) 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.



Power circuit breaker selection tables

Table 25.1 Transformer forced cooled ratings

Transformer type	Self-cooled kVA	% increase with fans
Liquid filled: 65° C rise	750-2000 2500-5000	15% 25%
Liquid filled: 55/65° C rise	750-2000 2500-5000	15% (fans) + 12% (65° C) 25% (fans) + 12% (65° C)
Ventilated dry	750-2500	33%
Cast coil	500-2500 3000-5000	40% 25%

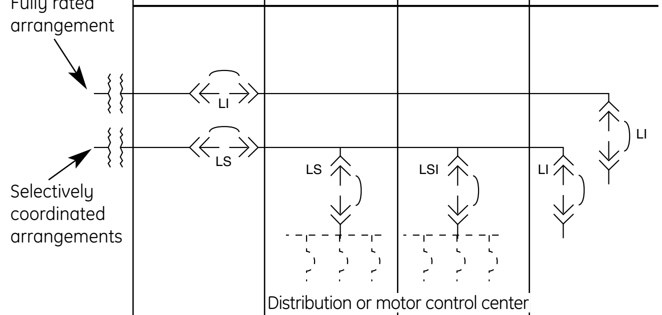


Table 25.2 208 volts, three phase

Transformer rating 3-phase kVA and impedance percent	Max short-circuit MVA available from primary system	Full load continuous current (amperes) ① ③	Short-circuit rating sym current (A)			Main	Feeder circuit breakers		
						Fully rated or selective	Selective	Zone selective	Fully rated
			Transformer alone	100% Motor load	Combined	Long-time inst. or long-time short-time ①	Long-time short-time	Long-time short-time inst.	Long-time inst.
	50		16300		18000				
	100		17300		19000				
300	150		17700		19400				
4.5%②	250	833	18000	1700	19700	WPS-16	WPS-08	WPS-08	WPS-08
	500		18300		20000				
	750		18300		20000				
	Unlimited		18500		20200				
	50		25200		28000		WPS-08		
	100		27800		30600				
500	150		28700		31500				
4.5%②	250	1388	29500	2800	32300	WPS-16	WPH-08	WPS-08	WPS-08
	500		30200		33000				
	750		30400		33200				
	Unlimited		30800		33600				
	50		28700		32900				
	100		32000		36200				
750	150	2082	33300		37500				
5.75%	250	③ (2915)	34400	4200	38600	WPS-32	WPH-08	WPS-08	WPS-08
	500		35300		39500				
	750		35600		39800				
	Unlimited		36200		40400				
	50		35800		41400		WPH-08	WPS-08	WPS-08
	100		41100		46700			WPH-08	WPH-08
1000	150	2776	43300		48900				
5.75%	250	③ (3886)	45100	5600	50700	WPS-32	WPX-08		
	500		46700		52300			WPX-08	WPX-08
	750		47200		52800				
	Unlimited		48300		53900				
	50		47600		55900		WPX-08	WPX-08	WPX-08
	100		57400		65700				
1500	150		61700		70000				
5.75%	250	4164	65600	8300	73900	WPS-50	WPH-32	WPS-32	WPS-32
	500		68800		77100				
	750	③ (5830)	70000		78300				
	Unlimited		72400		80700				

① With transformer operating on base temperature rise, without fans. Larger frame size main breaker may be required when dual temperature rise for forced cooled transformers are used.
② Minimum impedance.
③ Maximum forced cooled rating indicated in parentheses.
L = Long-time delay trip (overload tripping)
S = Short-time delay trip (selective fault tripping)
I = Instantaneous trip (high fault current fast tripping)

Table 26.1 Transformer forced cooled ratings

Transformer type	Self-cooled kVA	% increase with fans
Liquid filled: 65° C rise	750-2000 2500-5000	15% 25%
Liquid filled: 55/65° C rise	750-2000 2500-5000	15% (fans) + 12% (65° C) 25% (fans) + 12% (65° C)
Ventilated dry	750-2500	33%
Cast coil	500-2500 3000-5000	40% 25%

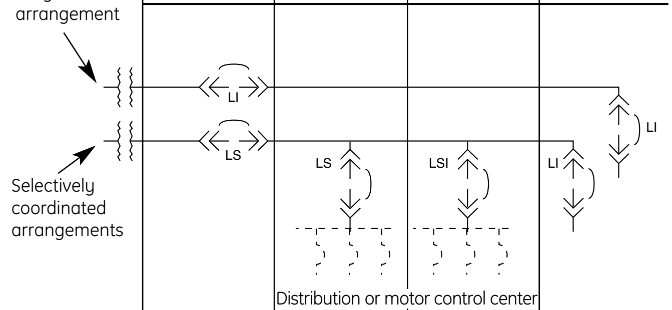


Table 26.2 240 volts, three phase

Transformer rating 3-phase kVA and impedance percent	Max short-circuit MVA available from primary system	Full load continuous current (amperes) ① ③	Short-circuit rating sym current (A)			Main	Feeder circuit breakers		
						Fully rated or selective	Selective	Zone selective	Fully rated
			Transformer alone	100% Motor load	Combined	Long-time inst. or long-time short-time ①	Long-time short-time	Long-time short-time inst.	Long-time inst.
300 4.5%②	50	722	14200	2900	17100	WPS-08	WPS-08	WPS-08	WPS-08
	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	WPS-16	WPS-08	WPS-08	WPS-08
	100		24100		28900				
	150		24900		29700				
	250		25600		30400		WPH-08		
	500		26100		30900				
	750		26300		31100				
	Unlimited		26700		31500				
750 5.75%	50	1804 ③ (2526)	24900	7200	32100	WPS-20	WPH-08	WPS-08	WPS-08
	100		27800		35000				
	150		28900		36100				
	250		29800		37000				
	500		30600		37800				
	750		30800		38000				
	Unlimited		31400		38600				
1000 5.75%	50	2406 ③ (3368)	31000	9600	40600	WPS-32	WPH-08	WPS-08	WPS-08
	100		35600		45200		WPX-08	WPH-08	WPH-08
	150		37500		47100				
	250		39100		48700				
	500		40400		50000			WPX-08	WPX-08
	750		40900		50500				
	Unlimited		41800		51400				
1500 5.75%	50	3608 ③ (5052)	41200	14400	55600	WPS-40	WPX-08	WPX-08	WPX-08
	100		49800		64200				
	150		53500		67900		WPH-32	WPS-32	WPS-32
	250		56800		71200				
	500		59600		74000				
	750		60600		75000				
	Unlimited		62800		77200				
2000 5.75%	50	4811	49300	19200	68500	WPS-50	WPH-32	WPS-32	WPS-32
	100		62100		81300				
	150		67900		87100		WPX-32	WPH-32	WPH-32
	250		73500		92700				
	500		78200		97400				
	750	③ (6735)	80000		99200				
	Unlimited		83700		102900		Fused breaker		

① With transformer operating on base temperature rise, without fans. Larger frame size main breaker may be required when dual temperature rise for forced cooled transformers are used.
② Minimum impedance.
③ Maximum forced cooled rating indicated in parentheses.
L = Long-time delay trip (overload tripping)
S = Short-time delay trip (selective fault tripping)
I = Instantaneous trip (high fault current fast tripping)

Table 27.1 Transformer forced cooled ratings

Transformer type	Self-cooled kVA	% increase with fans
Liquid filled: 65° C rise	750-2000 2500-5000	15% 25%
Liquid filled: 55/65° C rise	750-2000 2500-5000	15% (fans) + 12% (65° C) 25% (fans) + 12% (65° C)
Ventilated dry	750-2500	33%
Cast coil	500-2500 3000-5000	40% 25%

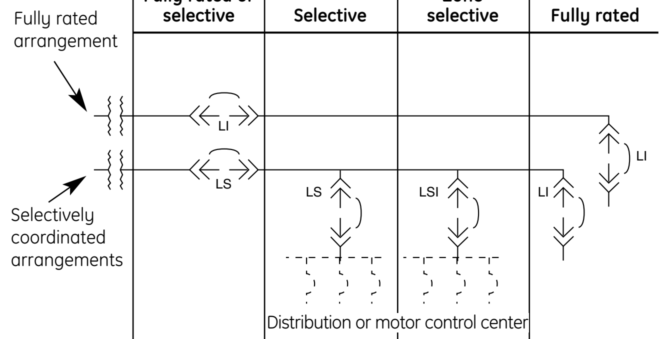


Table 27.2 480 volts, three phase

Transformer rating 3-phase kVA and impedance percent	Max short-circuit MVA available from primary system	Full load continuous current (amperes) ① ③	Short-circuit rating sym current (A) Transformer alone	100% Motor load	Combined	Main: Fully rated or selective — Long-time inst. or long-time short-time ¿	Feeder circuit breakers: Selective — Long-time short-time	Zone selective — Long-time short-time inst.	Fully rated — Long-time inst.
500 4.5% ②	50	601	10900	2400	13300	WPS-08	WPS-08	WPS-08	WPS-08
	100		12000		14400				
	150		12400		14800				
	250		12800		15200				
	500		13100		15500				
	750		13200		15600				
	Unlimited		13400		15800				
750 5.75%	50	902 ③ (1263)	12400	3600	16000	WPS-16	WPS-08	WPS-08	WPS-08
	100		13900		17500				
	150		14400		18000				
	250		14900		18500				
	500		15300		18900				
	750		15400		19000				
	Unlimited		15700		19300				
1000 5.75%	50	1203 ③ (1684)	15500	4800	20300	WPS-16	WPS-08	WPS-08	WPS-08
	100		17800		22600				
	150		18700		23500				
	250		19600		24400				
	500		20200		25000				
	750		20400		25200				
	Unlimited		20900		25700				
1000 8%	50	1203 ③ (1684)	12000	4800	16800	WPS-16	WPS-08	WPS-08	WPS-08
	100		13400		18200				
	150		13900		18700				
	250		14300		19100				
	500		14700		19500				
	750		14800		19600				
	Unlimited		15000		19800				
1500 5.75%	50	1804 ③ (2526)	20600	7200	27800	WPS-20	WPS-08	WPS-08	WPS-08
	100		24900		32100		WPH-08	WPH-08	WPH-08
	150		26700		33900				
	250		28400		35600				
	500		29800		37000				
	750		30300		37500				
	Unlimited		31400		38600				
2000 5.75%	50	2406 ③ (3368)	24700	9600	34300	WPS-32	WPH-08	WPH-08	WPH-08
	100		31000		40600				
	150		34000		43600		WPX-08	WPX-08	WPX-08
	250		36700		46300				
	500		39100		48700				
	750		40000		49600				
	Unlimited		41800		51400				
2500 5.75%	50	3007 ③ (4210)	28000	12000	40000	WPS-32	WPH-08	WPH-08	WPH-08
	100		36400		48400		WPX-08	WPX-08	WPX-08
	150		40500		52500				
	250		44500		56500				
	500		48100		60100				
	750		49400		61400				
	Unlimited		52300		64300				
3000 5.75%	50	3608 ③ (5052)	30700	14400	45100	WPS-40	WPX-08	WPX-08	WPX-08
	100		41200		55600				
	150		46600		61000				
	250		51900		66300		WPH-32	WPH-32	WPH-32
	500		56800		71200				
	750		58700		73100				
	Unlimited		62800		77200				
3750 5.75%	50	4511 ③ (6315)	34000	18000	52000	WPS-50	WPX-08	WPX-08	WPX-08
	100		47500		65500		WPH-32	WPH-32	WPH-32
	150		54700		72700				
	250		62200		80200				
	500		69400		87400		WPX-32	WPX-32	WPX-32
	750		72200		90200				
	Unlimited		78400		96400				

① With transformer operating on base temperature rise, without fans. Larger frame size main breaker may be required when dual temperature rise for forced cooled transformers are used.
② Minimum impedance.
③ Maximum forced cooled rating indicated in parentheses.
L = Long-time delay trip (overload tripping)
S = Short-time delay trip (selective fault tripping)
I = Instantaneous trip (high fault current fast tripping)

Table 28.1 Transformer forced cooled ratings

Transformer type	Self-cooled kVA	% increase with fans
Liquid filled: 65° C rise	750-2000 2500-5000	15% 25%
Liquid filled: 55/65° C rise	750-2000 2500-5000	15% (fans) + 12% (65° C) 25% (fans) + 12% (65° C)
Ventilated dry	750-2500	33%
Cast coil	500-2500 3000-5000	40% 25%

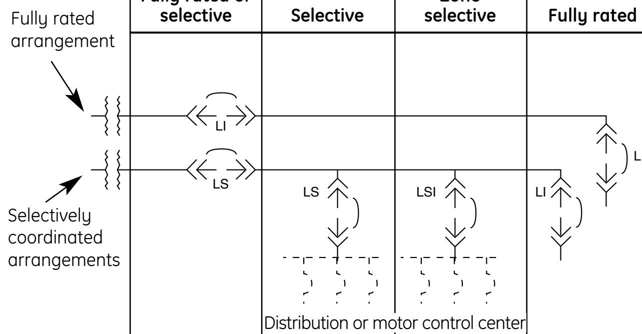


Table 28.2 600 volts, three phase

Transformer rating 3-phase kVA and impedance percent	Max short-circuit MVA available from primary system	Full load continuous current (amperes) ① ③	Short-circuit rating sym current (A): Transformer alone	Short-circuit rating sym current (A): 100% Motor load	Short-circuit rating sym current (A): Combined	Main: Fully rated or selective: Long-time inst. or long-time short-time ①	Feeder circuit breakers: Selective: Long-time short-time	Feeder circuit breakers: Zone selective: Long-time short-time inst.	Feeder circuit breakers: Fully rated: Long-time inst.
	50		8700		10600				
	100		9600		11500				
	150		10000		11900				
500 4.5% ②	250	481 ③ (674)	10200	1900	12100	WPS-08	WPS-08	WPS-08	WPS-08
	500		10500		12400				
	750		10500		12400				
	Unlimited		10700		12600				
	50		10000		12900				
	100		11100		14000				
	150		11500		14400				
750 5.75%	250	722 ③ (1010)	11900	2900	14800	WPS-08	WPS-08	WPS-08	WPS-08
	500		12200		15100				
	750		12300		15200				
	Unlimited		12600		15500				
	50		12400		16200				
	100		14300		18100				
	150		15000		18800				
1000 5.75%	250	962 ③ (1347)	15600	3800	19400	WPS-16	WPS-08	WPS-08	WPS-08
	500		16200		20000				
	750		16400		20200				
	Unlimited		16700		20500				
	50		16500		22300				
	100		19900		25700				
	150		21400		27200		WPS-08	WPS-08	WPS-08
1500 5.75%	250	1443 ③ (2021)	22700	5800	28500	WPS-16			
	500		23900		29700				
	750		24300		30100		WPH-08	WPH-08	WPH-08
	Unlimited		25100		30900				
	50		19700		27400		WPS-08	WPS-08	WPS-08
	100		24800		32500				
	150		27200		34900				
2000 5.75%	250	1925 ③ (2694)	29400	7700	37100	WPS-20	WPH-08	WPH-08	WPH-08
	500		31300		39000				
	750		32000		39700				
	Unlimited		33500		41200				
	50		22400		32000				
	100		29200		38800		WPH-08	WPH-08	WPH-08
	150		32400		42000				
2500 5.75%	250	2406 ③ (3368)	35600	9600	45200	WPS-32			
	500		38500		48100		WPX-08	WPX-08	WPX-08
	750		39500		49100				
	Unlimited		41800		51400		WPH-16	WPH-16	WPH-16
	50		24600		36100		WPH-08	WPH-08	WPH-08
	100		33000		44500		WPX-08	WPX-08	WPX-08
	150		37200		48700				
3000 5.75%	250	2887 ③ (4041)	41500	11500	53000	WPS-32			
	500		45500		57000		WPH-16	WPH-16	WPH-16
	750		46900		58400				
	Unlimited		50200		61700				
	50		27200		41600		WPH-08	WPH-08	WPH-08
	100		38000		52400				
	150		43700		58100		WPH-16	WPH-16	WPH-16
3750 5.75%	250	3608 ③ (5051)	49800	14400	64200	WPS-40			
	500		55500		69900				
	750		57700		72100		WPH-32	WPH-32	WPH-32
	Unlimited		62800		77200				
	50		30500		49700		WPX-08	WPX-08	WPX-08
	100		44800		64000		WPH-16	WPH-16	WPH-16
	150		53000		72200		WPH-32	WPH-32	WPH-32
5000 5.75%	250	4811	62100	19200	81300	WPS-50			
	500		71300		90500				
	750	③ (6735)	75000		94200		Fused breaker	Fused breaker	Fused breaker
	Unlimited		83700		102900				

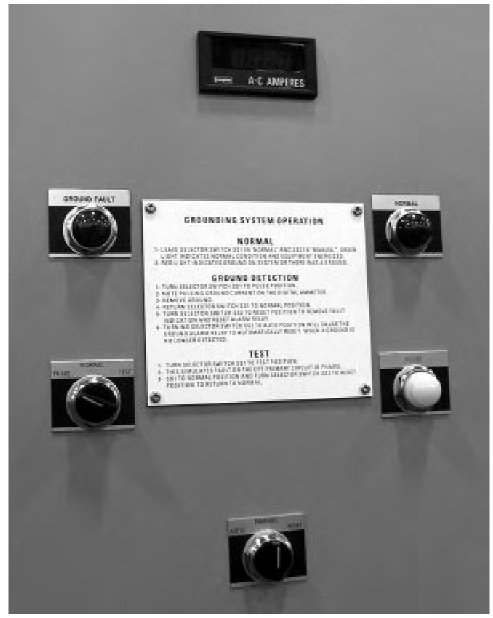
① With transformer operating on base temperature rise, without fans. Larger frame size main breaker may be required when dual temperature rise for forced cooled transformers are used.
② Minimum impedance.
③ Maximum forced cooled rating indicated in parentheses.
L = Long-time delay trip (overload tripping)
S = Short-time delay trip (selective fault tripping)
I = Instantaneous trip (high fault current fast tripping)

Ground detection considerations

High resistance pulsing ground detection system

This system provides a means for grounding the neutral of an ungrounded power system, utilizing the “high-resistance” method. It allows the switchgear to operate as an “ungrounded” system but eliminates the danger of high transient overvoltage during certain types of ground faults. For delta systems, a set of grounding transformers is provided for connection of the grounding resistor.

The high-resistance pulsing ground detection system uses a voltmeter relay with an adjustable set point to detect abnormal ground current through the grounding resistor. A green indicating light shows normal conditions, and a red indicating light indicates the presence of a phase-to-ground fault. Alarm contacts allow remote indication of the ground condition. The location of the fault is quickly determined using a pulsing current in conjunction with a sensitive clamp-on ammeter. This permits clearing of the ground fault before a second phase-to-ground fault causes an outage. After the fault is located and cleared, the system is reset and ready to detect the next ground fault.



Ground detection on ungrounded systems

This system provides visual indication of the presence of a phase-to-ground condition on a delta ungrounded system. Ground detection on ungrounded systems consists of one set of three potential transformers rated for full phase-to-phase voltage on the primary winding and 120-volt secondary winding. The primary is connected wye. The secondary connection is dependent on the type of ground indicators and alarm devices used. A loading or stabilizing resistor in the potential transformer primary connection to ground is used to prevent ferroresonance with the distributed capacitance of the system. Ground indication and alarm can be accomplished as described in the following tables:

Table 29.1 Operation with lights or voltmeters

Standard	Option	Operational description
Three 120V indicating lights with clear lenses (one per phase). Potential transformers with wye connected secondaries.	Three voltmeters instead of indicating lights. Potential transformers with wye connected secondaries.	Assuming rated system voltage on the primary of the potential transformers, the three lamps would glow about equally at subnormal brilliancy because the voltage across each lamp is 69.3 volts. Similarly, if voltmeters are used instead of lamps, each would read 69.3 volts. If one phase of the system becomes grounded, the potential transformer on the grounded phase would be short-circuited, and the voltage on the other two transformers would rise to approximately full phase-to-phase voltage. The lamp on the grounded phase would be dark and the other two lamps would glow at normal brilliancy. Similarly, the voltmeter on the grounded phase would read zero and the other two voltmeters would read 120 volts.

Table 30.1 Operation with alarm relay

Option	Operational description
An overvoltage relay coil rating of 199 to 208V, pickup range of 16-64V or 70-140V. Potential transformers with broken delta connected secondaries. *Note that either of the above mentioned indicating lights or voltmeters can be used as ground indicators with this option.*	Operation with the alarm relay is the same as described in Table 29.1, although the connections are different. Assuming rated system voltage on the potential transformers' primary, the three secondary voltages add up vectorially to zero. Thus, there is normally no voltage on the relay. If one phase of the system becomes grounded, the potential transformer on the grounded phase would be short-circuited and the voltages on the other two transformers would rise to full phase-to-phase voltage. The secondary voltages would also rise to the phase-to-phase values (120 volts). Because these two voltages are in series at an angle of 60 degrees under ground fault conditions, the voltage imposed on the relay is three times the voltage on each potential transformer secondary under normal conditions (208 volts).

General note

A combination of ground indication and metering or relaying on the same set of potential transformers is not recommended. Metering not only may require different primary and/or secondary connections; it also increases the probability of faults in the secondary circuits with consequent false indications of grounds on the primary system.

Table 30.2 Operation with test switch

Option	Operational description
Test switch. (For either lamp test or test-for-ground.)	The lamp test feature is performed using the normally closed contact of the test switch. The test-for-ground feature is performed using the normally open contact. The user must specify which test feature is to be furnished.

Ground fault protection on solidly grounded systems

The preferred method of providing ground fault protection on WavePro™ power circuit breakers is using the ground fault function on the Power+™, MicroVersaTrip Plus™ or MicroVersaTrip PM™ trip unit. This is referred to as integral ground fault protection and requires no external relaying or control power. Integral ground fault is applicable to 3-phase, 3-wire or 4-wire systems with single or multiple sources.

When multiple source systems are encountered, each source can be grounded upstream of the main secondary breakers in accordance with the NEC, eliminating the need for complex ground and neutral bus systems required for single-point grounding of the source neutrals.

Ground fault protection for large power systems can be very complex when there are multiple line-ups, each with multiple sources and tie breakers that interconnect the switchgear line-ups. Some of the complexity can be eliminated if the power system is designed as a 3-phase, 3-wire grounded wye system. This removes the interconnected neutral between switchgear line-ups and, as a result, eliminates the need for the interconnections between neutral sensors on the source and tie breakers. In many cases, there are few actual 4-wire loads and these can be served by small delta-wye lighting transformers located close to the 4-wire distribution panel.

Special consideration must be given to power systems having continuously paralleled sources or operating as networks. In some of these cases, ground fault protection is best accomplished by using the Ground Break system. This system consists of current sensors for each phase and/or neutral conductors, a relay with separate current pick-up and time delay settings, and a fault indicator/reset device. As an option, the fault indicator/reset device can be replaced by a Monitor Panel. In addition to providing the fault indication and reset functions, the Monitor Panel provides a feature that allows tripping or no tripping of the circuit breaker(s) in the ground fault scheme during testing. The Ground Break system requires a control power source and shunt trips on the circuit breakers.

Automatic transfer (throwover) equipment

Relay and control equipment can be provided to maximize continuity of service to a switchgear load bus by transferring the load bus to an alternate or emergency power source in the event of problems with the primary power source (undervoltage, loss of phase, etc.). Detection is typically provided by voltage relays (single- or three-phase undervoltage, phase sequence/undervoltage, voltage unbalance, or a combination of these). Breaker close and trip sequences may be executed by hard-wired relay logic for simple transfer schemes involving 2 or 3 circuit breakers. A programmable logic controller (PLC) can be used for more complex transfer schemes and provides maximum flexibility for modifications to the control sequence without the addition of relays, switches, and control wiring.

Interposing relays are provided for interfacing the PLC outputs with the circuit breaker close and trip circuits. If the control power source for the PLC is AC derived from within the switchgear, a dedicated power supply is provided for the PLC to ride through any momentary switching of the control power sources. The PLC programs are executed without interruption during an undervoltage (or loss of phase) condition.

After the undervoltage (or loss of phase) condition has been corrected, return to normal can be manual or automatic with a time delay. A closed transition with momentary paralleling can be provided as an option for return to normal and/or for maintenance of the main and bus tie breakers (synchronism check relay may be required).

Interlocking

WavePro™ power circuit breakers can be interlocked in several ways to prevent closing one breaker until another breaker is open. Manually and electrically operated breakers can be supplied with one single- or double-barrel key interlock mounted in the breaker compartment. Key interlocks may be used to prevent paralleling sources in a double-ended switchgear line-up. Only two keys are used for the three interlocked breakers (two main and one tie). The interlock without a key keeps the breaker mechanically trip-free, thus allowing only two of the three breakers to be closed at any given time.

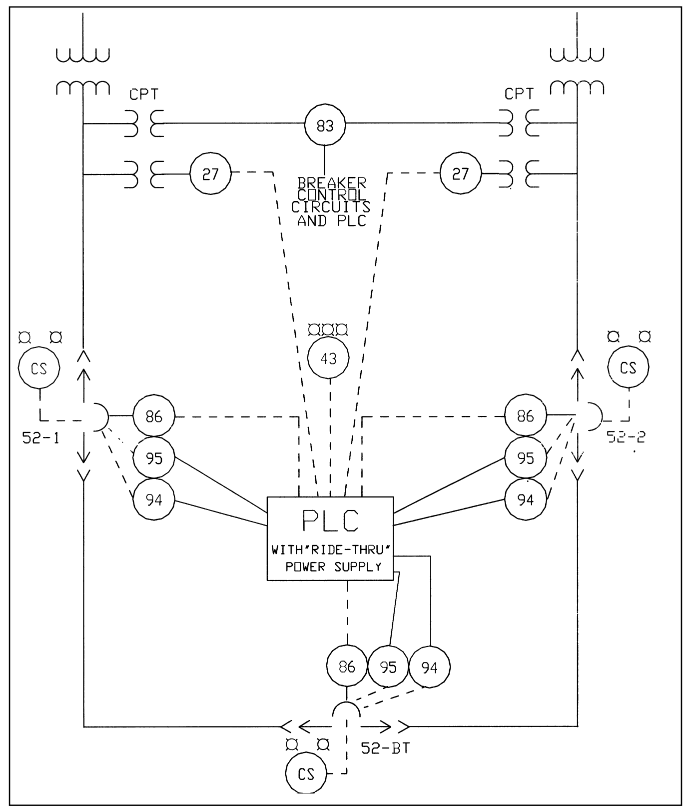
Key interlocks can also be provided on substation main secondary breakers for interlocking with a transformer primary air switch. Operation of the primary air switch (open or close) is blocked until the main secondary breaker is opened and locked out. The key from the main breaker interlock is then removed and inserted in the primary switch interlock thus allowing operation of the switch.

Electrical interlocks

In lieu of mechanical key interlocks, electrically operated breakers can be provided with hard-wired electrical interlocking using a combination of breaker auxiliary contacts (MOC) and position switch contacts (TOC). These contacts are wired in the breaker close circuits such that closing of a tie breaker, for example, is blocked or disabled until one of the main breakers is opened. The position switch contacts allow normal operation of the breakers during maintenance situations where one or more of the interlocked breakers may be racked out to the TEST or DISCONNECT position or withdrawn from the compartment.

A form of electrical interlocking can also be provided on manually operated breakers for control situations that require an electrical contact closure before closing the breaker. The electric lockout option on the circuit breaker blocks operation of the closing mechanism until the coil of the electric lockout is energized. De-energizing this coil after the breaker is closed does not trip the breaker.

PLC Transfer Scheme Inputs & Outputs



PLC inputs

- Source voltage status (as sensed by the voltage relays)
- Main and tie breaker status (open, closed, tripped on fault)
- Main and tie breaker drawout position (connected, test/disconnect)
- Transfer system status (automatic/manual)

PLC outputs

- Close signal to main and bus tie breakers
- Trip signal to main and bus tie breakers
- Additional outputs and indicating lights can be provided for local identification of transfer scheme status (auto-blue/manual-white) and PLC fault (amber)

Basic features of the PLC logic

- Interlocking of the main and bus tie breakers to prevent paralleling sources
- Time delay for initiating a transfer upon an undervoltage (or loss of phase) condition
- Blocking transfer if either of the main or bus tie breakers trips due to a fault

Sizing and dimensional data

Typical AC switchgear sections, 635V maximum, 50/60 Hz

Switchgear section and line-up sizing

AKD-10 indoor low voltage switchgear height is 92" (97" over the top wiring trough and 103.5" over the optional breaker hoist). The available breaker stacking space is 84". Optional 78"-high indoor equipment with a breaker stacking space of 70" is also available (contact factory for details).

Breaker frame size and type determine the width of the breaker sections and also the minimum depth of the switchgear line-up. Refer to Tables 31.1 and 31.2 for properly sizing AKD-10 line-ups. The depth of the entire line-up is determined by the deepest device in the line-up. For example, a line-up with a WPS-20 breaker with a fuse roll-out (depth - 60") and WPF-08 breakers (depth - 67") would be a minimum of 67" deep — the WPF-08 being the deepest device. Also refer to the section arrangements on the following pages for available breaker stacking configurations.

Table 32.1 Enclosure depth options

Enclosure type	Available depth options	
Front compartment	30"	37"
Rear compartment (Std depth or 7" or 14" rear extension)	30" (std) / 37" (7" ext) / 44" (14" ext)	30" (std) / 37" (7" ext) / 44" (14" ext)
Indoor (total indoor frame depth)	60" / 67" / 74"	67" / 74" / 81"
Outdoor (total indoor frame depth)	60"	74"
Walk-in (total enclosure depth)	108"	122"
Non-walk-in (total enclosure depth)	68"	82"

Table 32.2 AKD-10 Switchgear section sizing

Breaker type	Device combination or bus rating	Frame size (amperes)	Breaker cubicle vertical height (inches)	Minimum section width ③ (inches)	Minimum equipment depth [Front/Rear compt] (inches)	Optional equipment depth (inches)
WPS-08		800	21	22	60 [30 / 30]	67/74
WPH-08						
WPX-08						
WPF-08					67 [37 / 30]	74/81**
WPS-16		1600			60 [30 / 30]	67/74
WPH-16					60 [30 / 30]	67/74
WPF-16					67 [37 / 30]	74/81**
WPS-20		2000			60 [30 / 30]	67/74
	WPS-20 with fuse roll-out		56	30	60 [30 / 30]	67/74/81 ②
WPS-32		3200	35		60 [30 / 30]	67/74/81 ②
WPH-32					60 [30 / 30]	67/74/81 ②
WPX-32					60 [30 / 30]	67/74/81 ②
	WPS-32 with fuse roll-out		84	38	60 [30 / 30]	67/74/81 ②
WPS-40		4000	35	30	60 [30 / 30]	67/74/81 ②
WPX-40			35	30	60 [30 / 30]	67/74/81 ②
	WPS-40 with fuse roll-out		84	38	67 [37 / 30]	74/81**
WPS-50		5000	35	38	74 [37 / 37]	81**
WPX-50					74 [37 / 37]	81**
	WPS-50 with fuse roll-out ①				74 [37 / 37]	81**
	1600-4000A main bus rating	—	—	—	60 [30 / 30]	67/74
	5000A main bus rating	—	—	—	67 [30 / 37]	74/81 ②

① Breaker and fuse roll-out must be mounted in separate vertical sections
② 81" depth available only when these devices are used in a line-up with items identified with **
③ Section width can be increased for additional cable / conduit space. 22" sections can be increased to 30" wide, 30" wide sections can be increased to 38" wide.

Table 32.3 Switchgear weights

Procedure:

A) Add the weight of every vertical section in the lineup
B) Add the weight of each breaker and fuse roll-out in the lineup

Vertical section weights, Lb. [Kg]			
Section width	# of breaker compartments① in vertical section	Enclosure type	
		Indoor	Outdoor
22"	1	940 (426)	1610 (730)
	2	1100 (499)	1770 (803)
	3	1270 (576)	1940 (880)
	4	1440 (653)	2110 (957)
30"	1	1300 (590)	2100 (953)
	2	1400 (635)	2300 (1043)
38"	1	1660 (753)	2600 (1179)
	2	1900 (862)	2830 (1284)
22" or 30"	Auxiliary section	1170 (531)	1800 (816)

① Also includes number of fuse roll-outs in the vertical section.

Table 32.4 WavePro breaker and fuse roll-out weights

Device	Net Weight, lb. [kg]	
	Manual	Electrical
WPS / WPH-08	175 [79]	180 [82]
WPX-08	210 [95]	215 [98]
WPF-08	220 [100]	225 [102]
WPS / WPH-16	210 [95]	215 [98]
WPF-16	280 [127]	285 [129]
WPS-20	220 [100]	225 [102]
WPS / WPH / WPX-32	490 [222]	500 [227]
WPS / WPX-40	535 [243]	545 [247]
WPS / WPX-50	600 [272]	610 [277]
2000/3200A Fuse Roll-out (WP32FRE)	330 [150]	3 Fuses – add 75 [34]
4000A Fuse Roll-out (WP40FRE)	335 [152]	3 Fuses – add 90 [41]
5000A Fuse Roll-out (WP50FRE)	345 [156]	3 Fuses – add 90 [41]

Switchgear layout and sizing

Rules and examples

Switchgear layout considerations

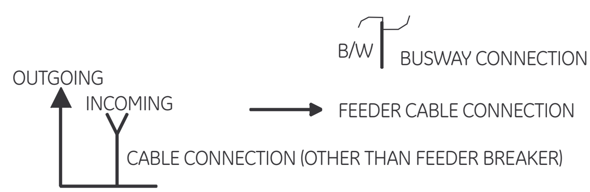
1. Sections can be bussed together if there are matching bus levels in the adjacent sections. Refer to the sample AKD-10 line-up below.
2. Any breaker compartment shown on the section drawings can be made blank to provide additional space for mounting protection, instrumentation, and control devices.
3. Any blank compartment greater than 7 inches high can be used for instrumentation (except vent compartments).
4. The ampere ratings shown beside each breaker symbol indicate the range of frame sizes that are allowed in the particular section arrangement. This takes into consideration the temperature rise in the section due to breaker loading. Refer to ANSI C37.20.1-1993 para 7.4.2.3 for cumulative circuit breaker loading guidelines.
5. Devices cannot be mounted on breaker cubicle doors. Refer to the instrument panel drawings on page 44 for breaker control device mounting.
6. 3200A, 4000A, and 5000A fuse roll-outs are the same size as their respective breakers, therefore any compartment shown with a 3200, 4000 or 5000 amp breaker will also accommodate a fuse roll-out and vice versa.
7. Front busway connections to a circuit breaker require a blank compartment above the breaker for busway above or a blank compartment below the breaker for busway below.
8. Use of fused breakers does not necessarily require 200kA bus bracing. Bus bracing should be based on the available short circuit current on the switchgear bus.
9. 200kA bus bracing can limit feeder breaker placement. 200kA bus bracing does not allow adjacent 22 inch wide sections.
10. Factory review of layout is required for bus bracing greater than 100kA
11. Some cable entrance designs are not suitable for service entrance. Consult the factory if service entrance is required for the incoming cable section.
12. Additional cable and conduit space is available by making breaker sections wider (22 inch wide to 30 inch wide or 30 inch wide to 38 inch wide) or by making the line-up deeper (7 or 14 inches). Refer to table 32.1 for switchgear depth options.
13. Maximum shipping section widths are 120 inches for indoor construction and 96 inches for outdoor construction.

Special considerations for 5000 amp equipment

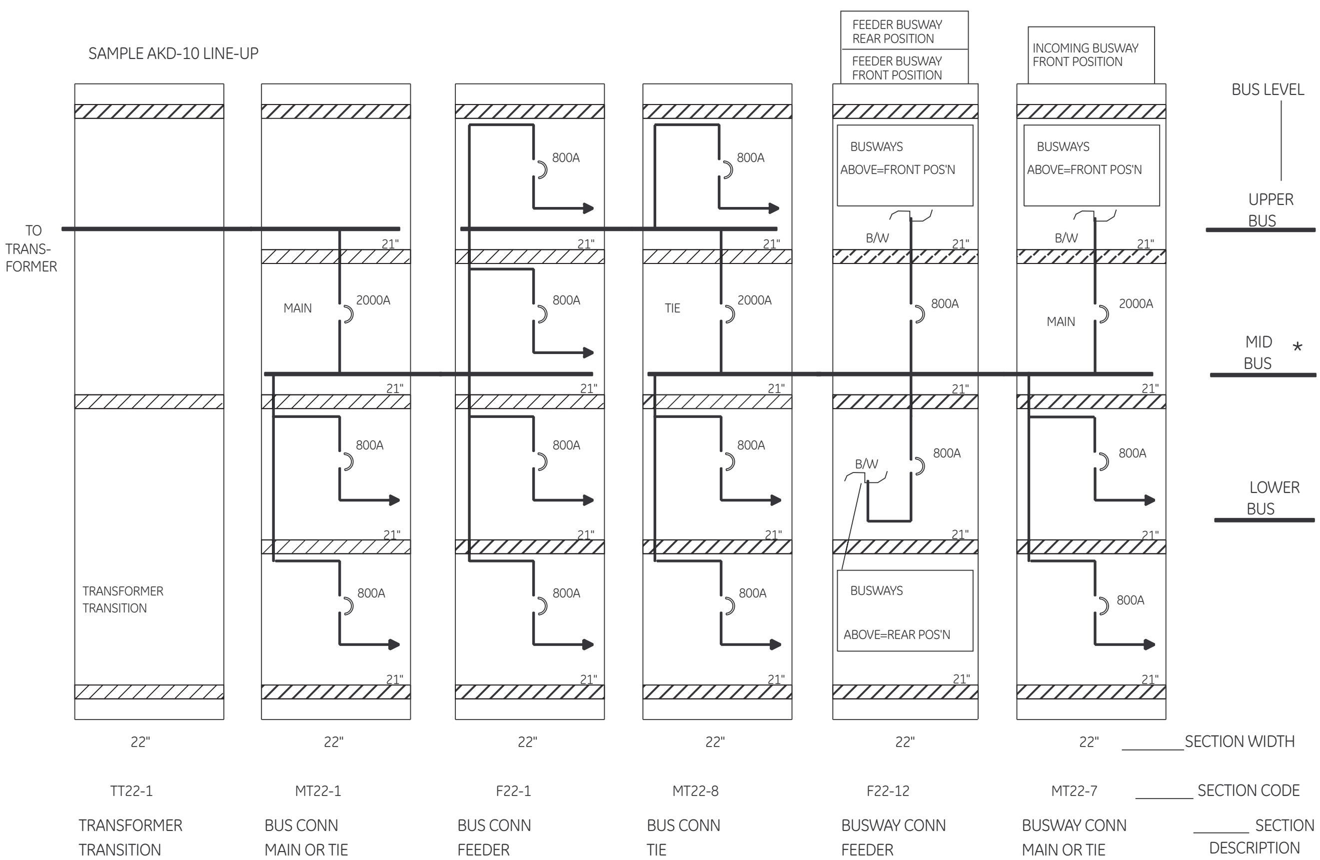
1. 5000 amp equipment is available in indoor or outdoor walk-in aisle construction only. 5000 amp breakers are not available in outdoor NEMA 3R non-walk-in construction.
2. Minimum depth of a 5000A breaker section is 74 inches.
3. Upper and lower bus levels are available at 5000 amps. The center bus level is not available at 5000 amps.
4. 5000 amp bus is available as a bare bus design or with bus compartment barriers. Insulated/isolated bus design is not available on 5000 amp equipment.
5. Sections adjacent to a 5000 amp transformer transition section must be 38 inches wide, minimum.

LEGEND & NOTES

* MID BUS LEVEL IS NOT AVAILABLE AT 5000A
(USE ONLY UPPER OR LOWER BUS LEVELS)



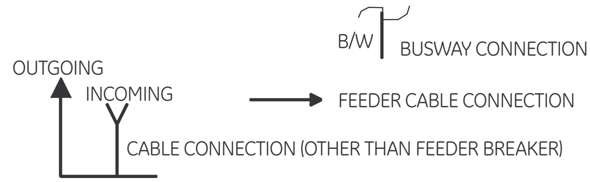
SAMPLE AKD-10 LINE-UP

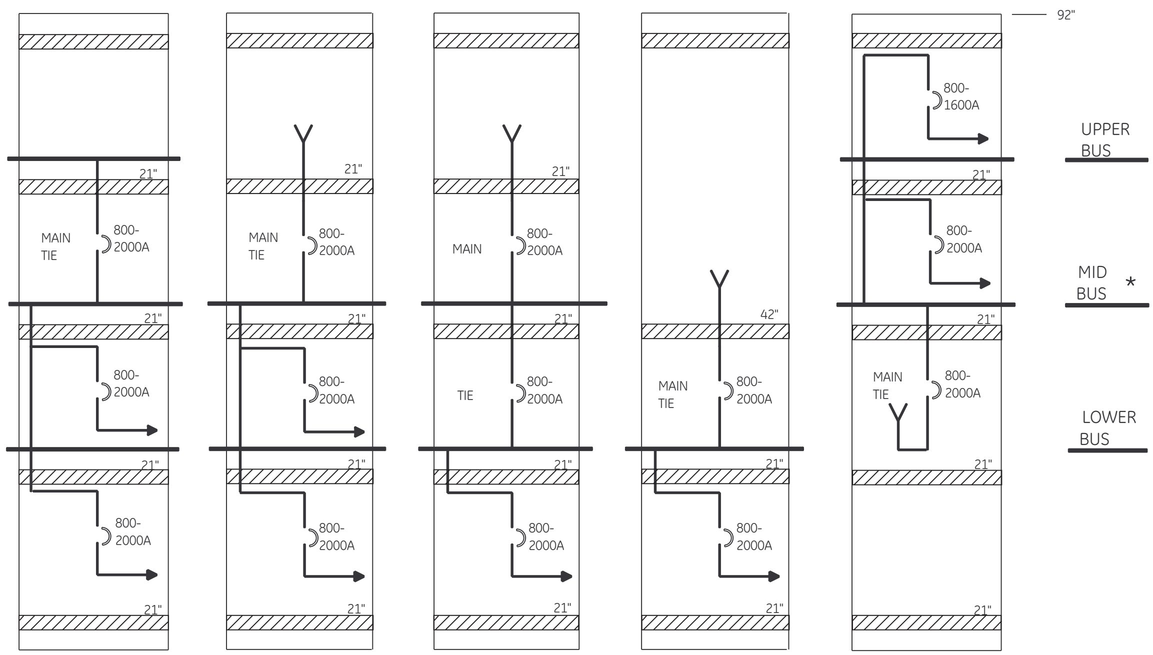


22" Main/tie sections

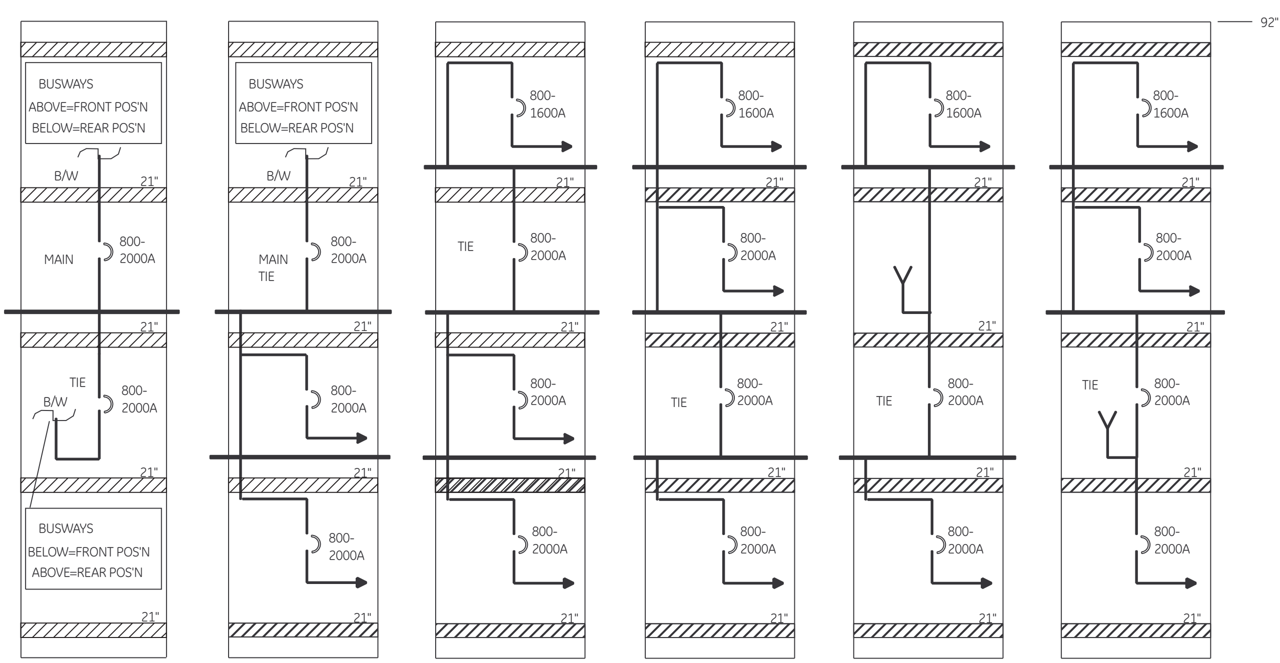
LEGEND & NOTES

* MID BUS LEVEL IS NOT AVAILABLE AT 5000A
(USE ONLY UPPER OR LOWER BUS LEVELS)





22"	22"	22"	22"	22"
MT22-1	MT22-2	MT22-3	MT22-4	MT22-5
BUS CONN MAIN OR TIE	CABLE CONN MAIN OR TIE	CABLE CONN MAIN	CABLE CONN MAIN OR TIE	CABLE CONN MAIN OR TIE

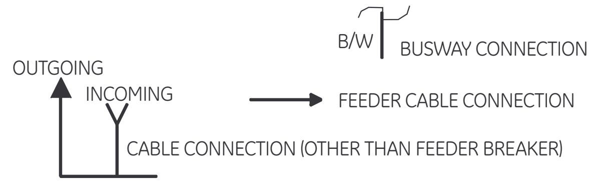


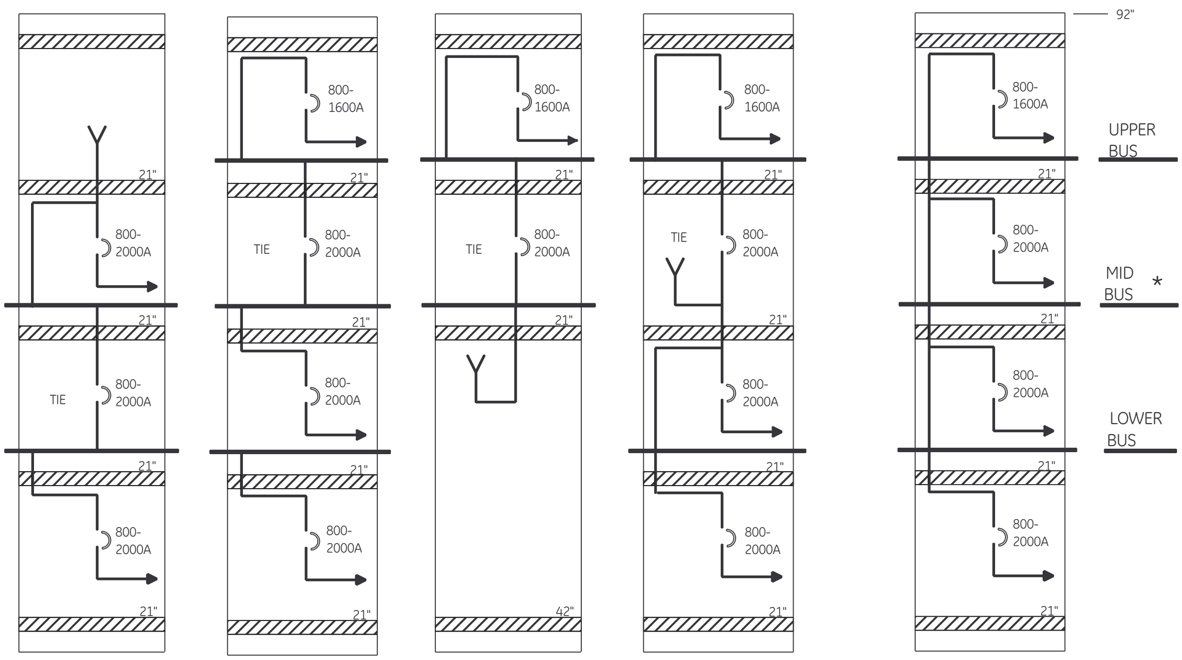
22"	22"	22"	22"	22"	22"
30" WIDE WITH 4-WIRE BUSWAY					
MT22-6	MT22-7	MT22-8	MT22-9	MT22-10	MT22-11
BUSWAY CONN MAIN AND TIE	BUSWAY CONN MAIN OR TIE	BUS CONN TIE	BUS CONN TIE	CABLE CONN TIE	CABLE CONN TIE

22" Main/tie and feeder sections

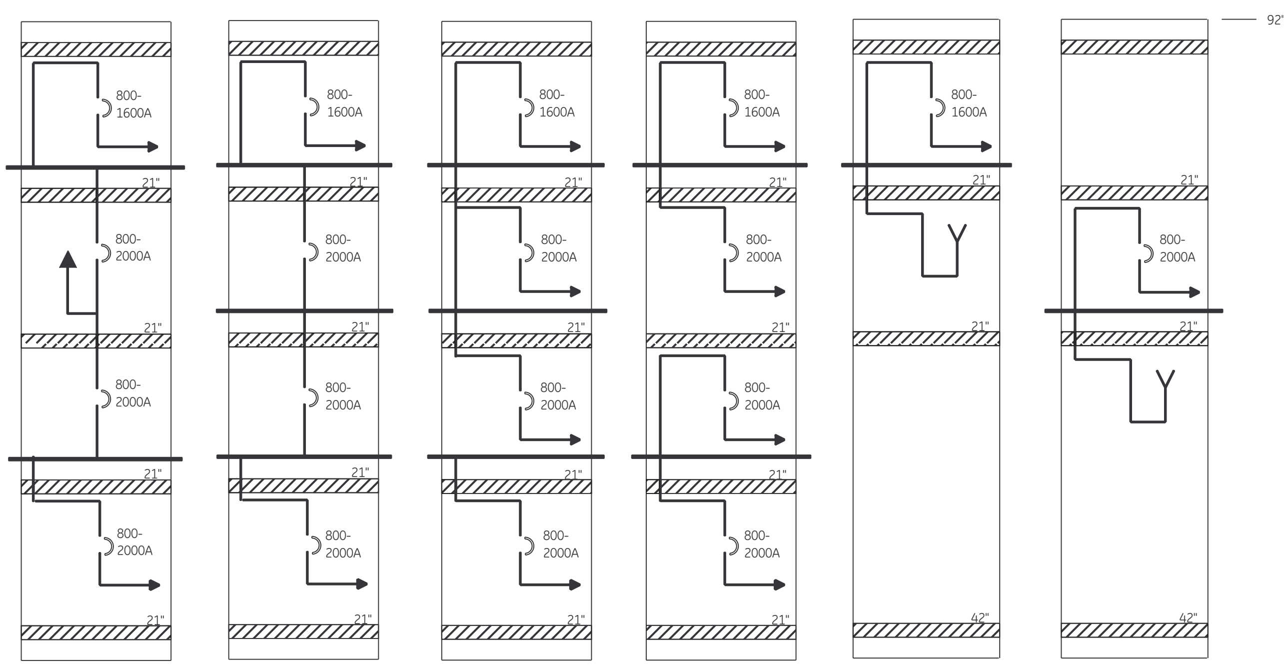
LEGEND & NOTES

* MID BUS LEVEL IS NOT AVAILABLE AT 5000A
(USE ONLY UPPER OR LOWER BUS LEVELS)





22"	22"	22"	22"	22"
MT22-12	MT22-13	MT22-14	MT22-15	F22-1
BUS CONN TIE	BUS CONN TIE W/ SPLIT RISER	BUS CONN TIE W/ CABLE TAP	CABLE CONN TIE	BUS CONN FEEDER

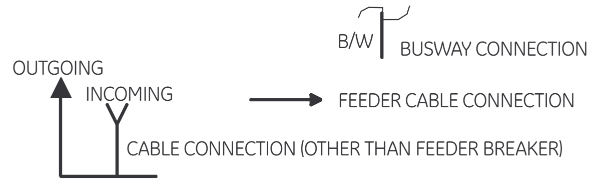


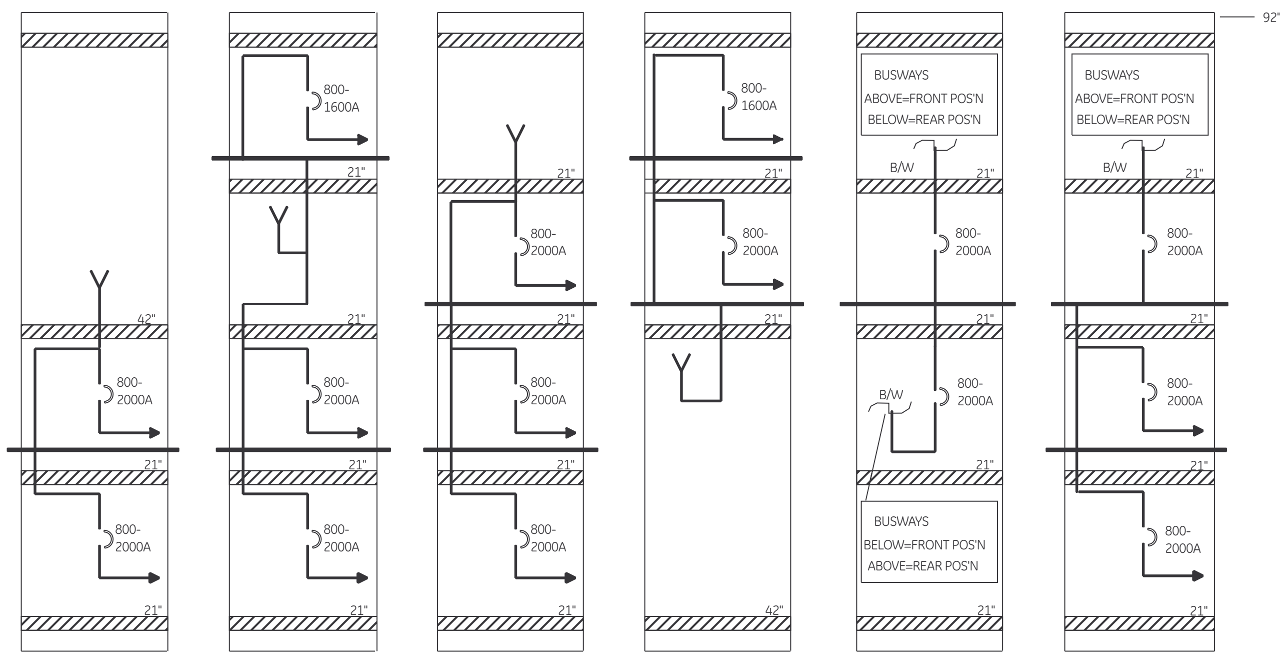
22"	22"	22"	22"	22"	22"
F22-2	F22-3	F22-4	F22-5	F22-6	F22-7
BYPASS FDR W/ CABLE TAP	BYPASS FDR W/ BUS CONN	BUS CONN FDR W/ SPLIT RISER	BUS CONN FDR W/ SPLIT RISER	BUS CONN FDR W/ CABLE TAP	BUS CONN FDR W/ CABLE TAP

22" Feeder sections, 22/30" auxiliary sections

LEGEND & NOTES

* MID BUS LEVEL IS NOT AVAILABLE AT 5000A
(USE ONLY UPPER OR LOWER BUS LEVELS)





22"
F22-8
BUS CONN FDR
W/ CABLE TAP

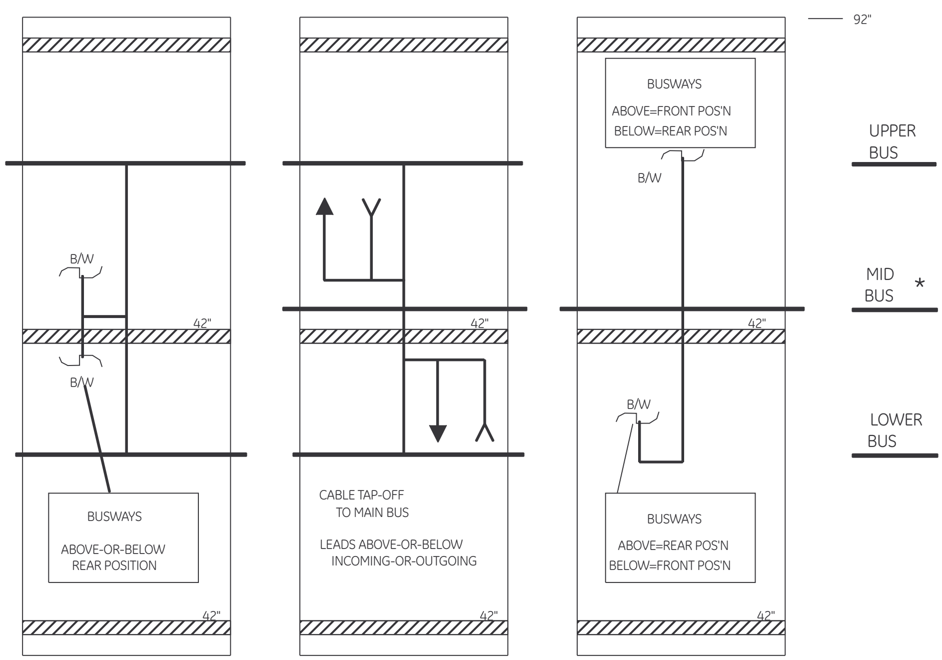
22"
F22-9
BUS CONN FDR
W/ CABLE TAP

22"
F22-10
BUS CONN FDR
W/ CABLE TAP

22"
F22-11
BUS CONN FDR
W/ CABLE TAP

22"
30" WIDE WITH 4-WIRE BUSWAY
F22-12
BUSWAY CONN
FEEDER

22"
F22-13
BUSWAY CONN
FEEDER



22 / 30" ①
AX2230-1
AUXILIARY WITH
BUSWAY

22 / 30" ②
AX2230-2
AUXILIARY WITH
CABLE TAP

22 / 30" ①
30" WIDE WITH 4-WIRE BUSWAY
AX2230-3
AUXILIARY WITH
BUSWAY

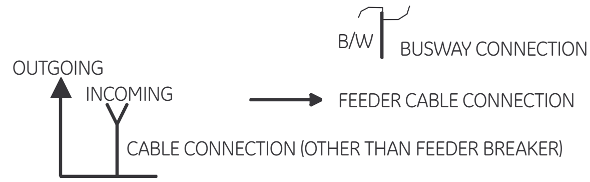
① Refer to page 45 for busway auxiliary section width vs busway ampere rating
② Section width vs cable tap-off rating

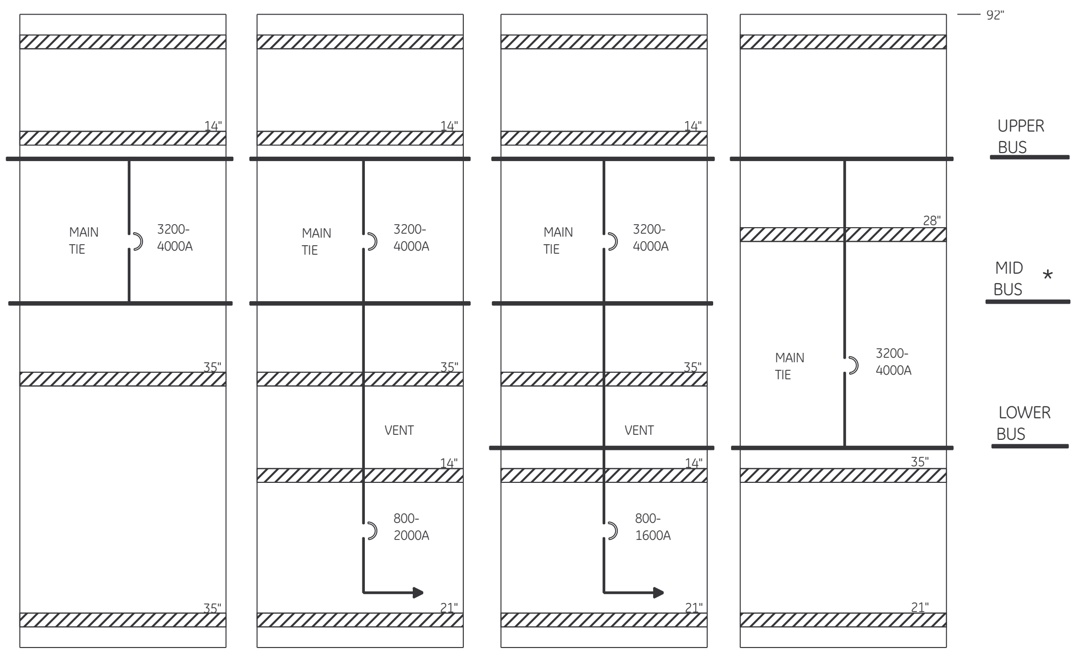
Cable tap-off rating	Minimum section width (inches)
1600-2000A	22
3200-4000A	30
5000A	See page 42

30" Main/tie sections

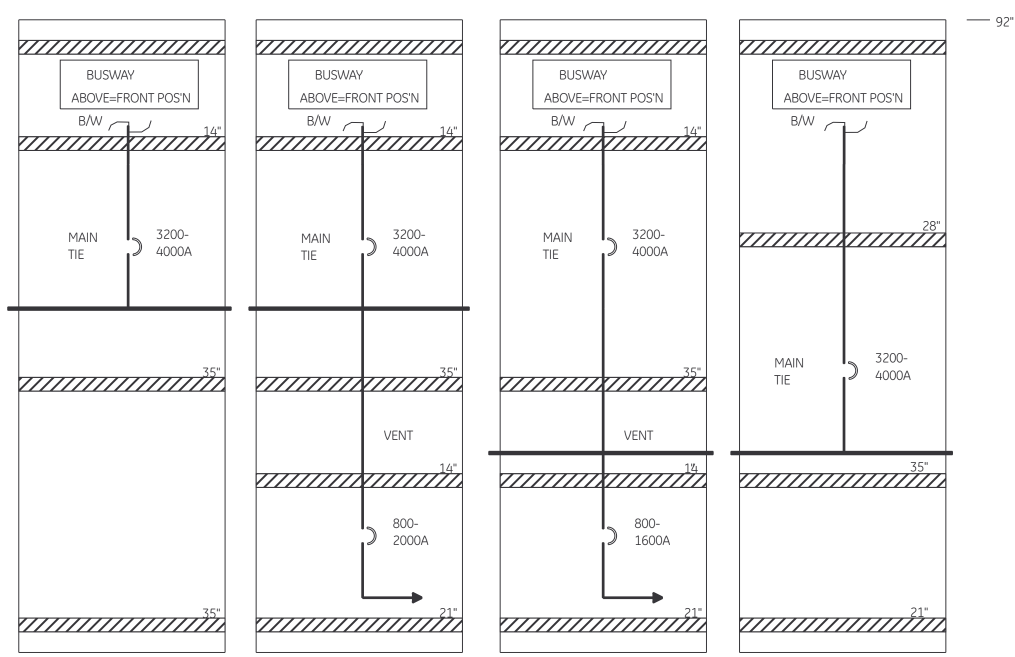
LEGEND & NOTES

* MID BUS LEVEL IS NOT AVAILABLE AT 5000A
(USE ONLY UPPER OR LOWER BUS LEVELS)





MT30-1	MT30-2	MT30-3	MT30-4
30"	30"	30"	30"
BUS CONNECTED MAIN OR TIE	BUS CONNECTED MAIN OR TIE	BUS CONNECTED MAIN OR TIE	BUS CONNECTED MAIN OR TIE



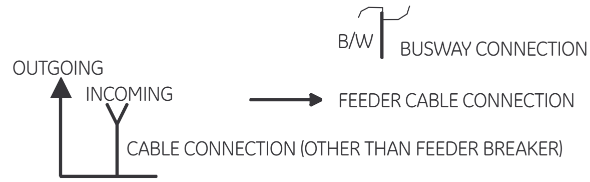
MT30-5	MT30-6	MT30-7	MT30-8
30"	30"	30"	30"
BUSWAY CONN MAIN OR TIE	BUSWAY CONN MAIN OR TIE	BUSWAY CONN MAIN OR TIE	BUSWAY CONN MAIN OR TIE

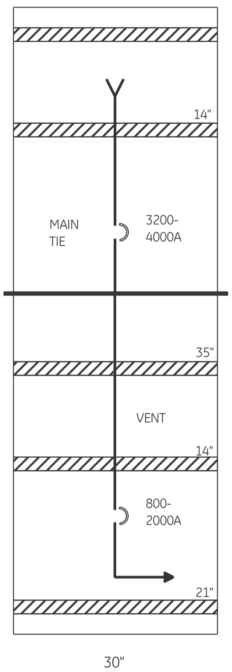
Note: 4000A NSP Busway requires a 38 inch wide section.

30" Main/tie sections

LEGEND & NOTES

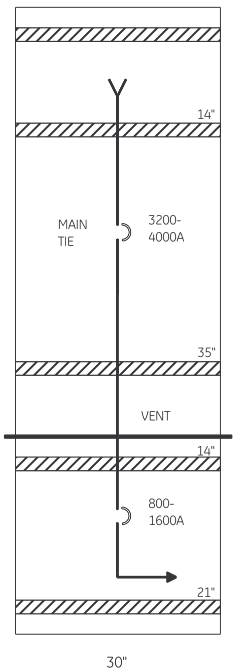
* MID BUS LEVEL IS NOT AVAILABLE AT 5000A (USE ONLY UPPER OR LOWER BUS LEVELS)





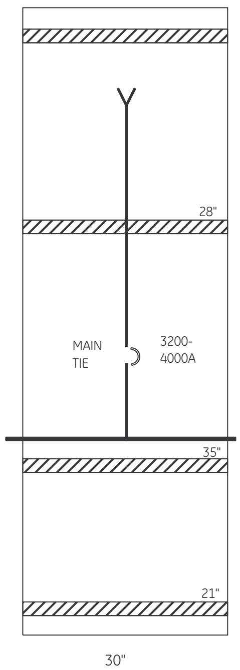
MT30-9

CABLE CONNECTED MAIN OR TIE



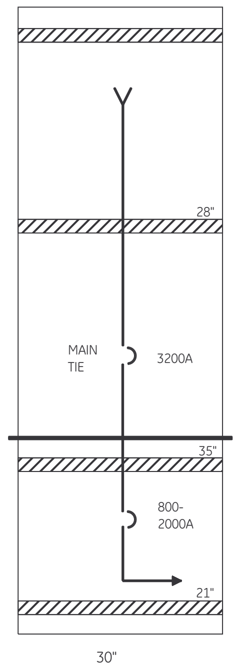
MT30-10

CABLE CONNECTED MAIN OR TIE



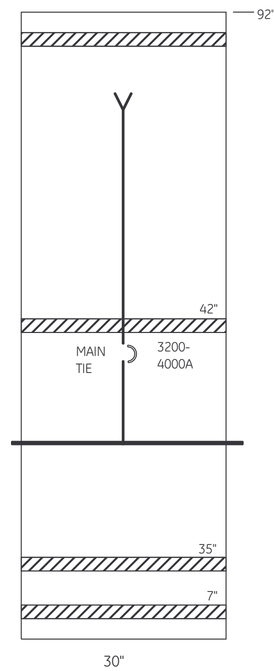
MT30-11

CABLE CONNECTED MAIN OR TIE



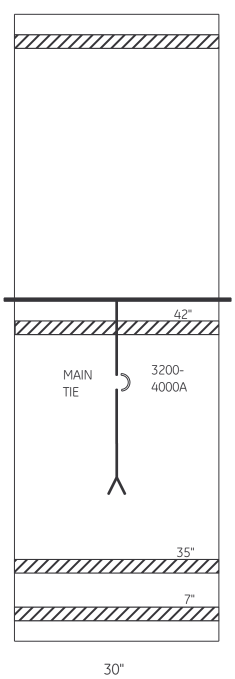
MT30-12

CABLE CONNECTED MAIN OR TIE



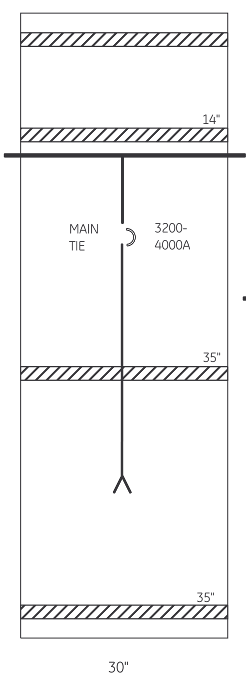
MT30-13

CABLE CONNECTED MAIN OR TIE



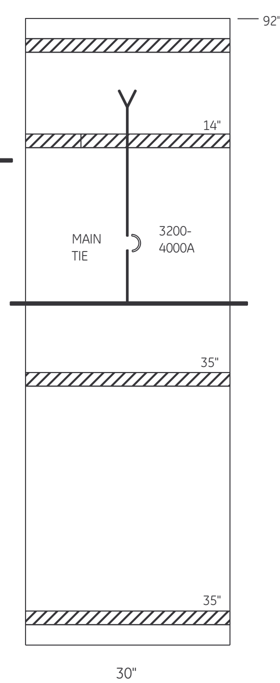
MT30-14

CABLE CONNECTED MAIN OR TIE



MT30-15

CABLE CONNECTED MAIN OR TIE



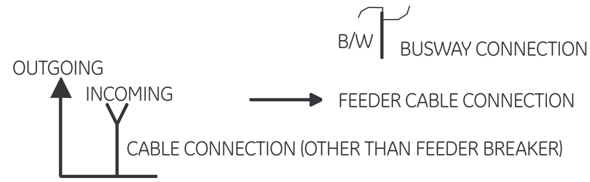
MT30-16

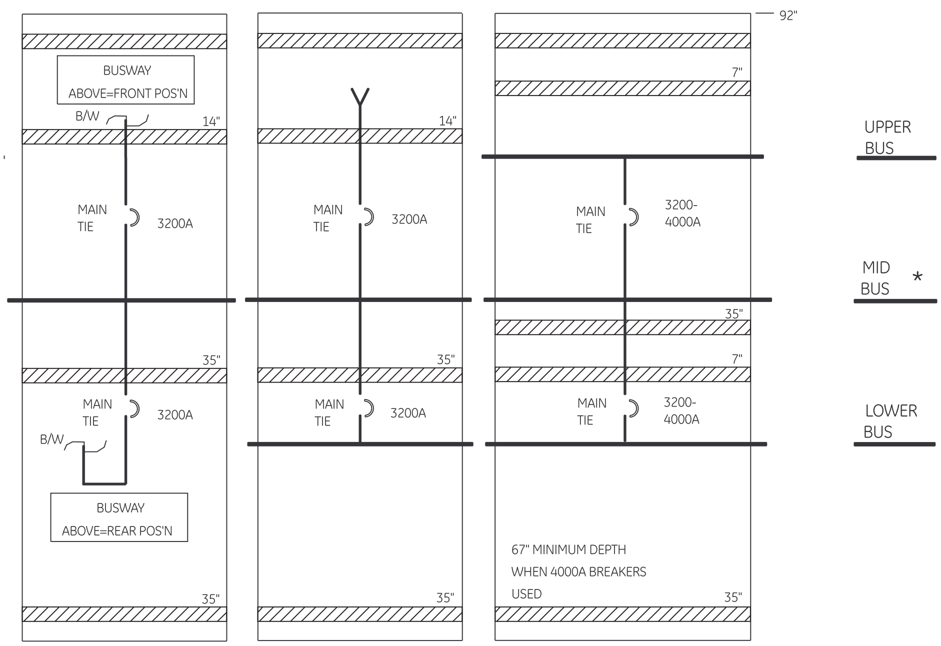
CABLE CONNECTED MAIN OR TIE

30/38" Main/tie sections

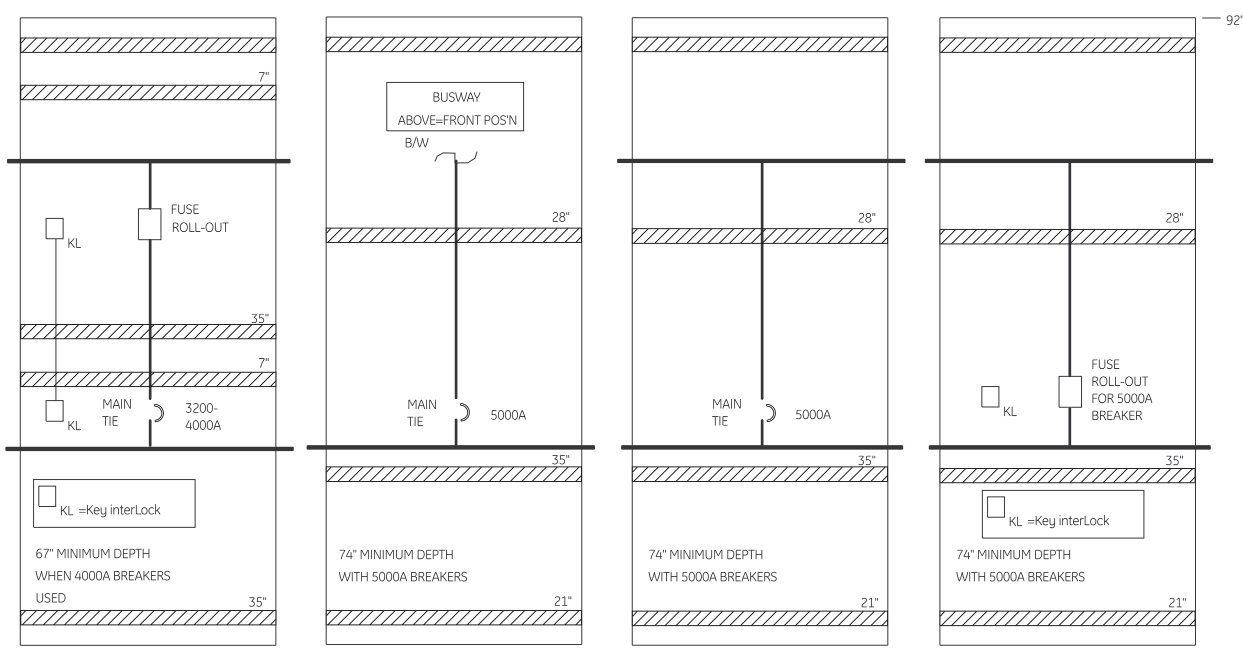
LEGEND & NOTES

* MID BUS LEVEL IS NOT AVAILABLE AT 5000A
(USE ONLY UPPER OR LOWER BUS LEVELS)





38"	38"	38"
MT38-18	MT38-19	MT38-1
BUSWAY CONN MAIN AND TIE	CABLE / BUS CONN MAIN AND TIE	BUS CONNECTED MAIN AND TIE - FULLY RATED



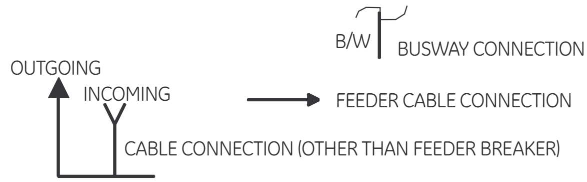
38"	38"	38"	38"
MT38-2	MT38-3	MT38-4	MT38-5
BUS CONNECTED BREAKER & FUSE	BUSWAY CONNECTED 5000A MAIN OR TIE	BUS CONNECTED 5000A MAIN OR TIE	BUS CONNECTED 5000A FUSE ROLL-OUT

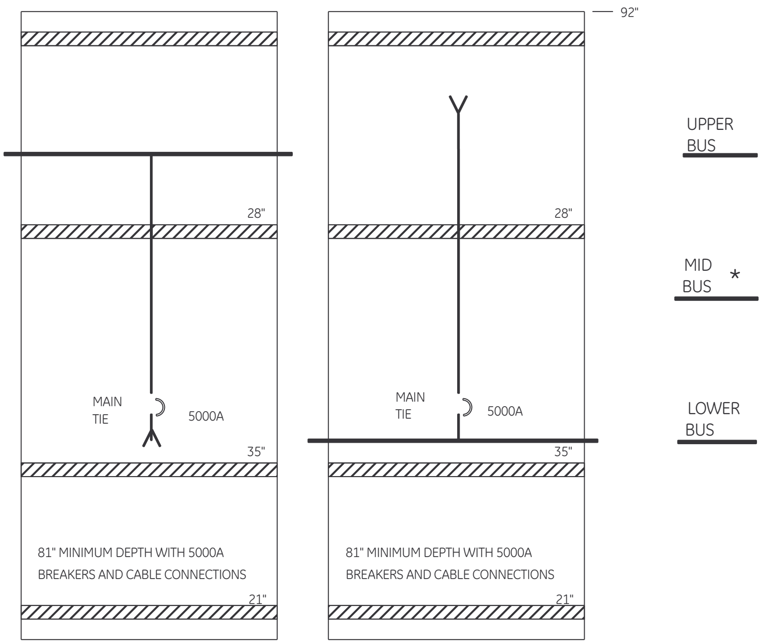
30/38" Main/tie sections

LEGEND & NOTES

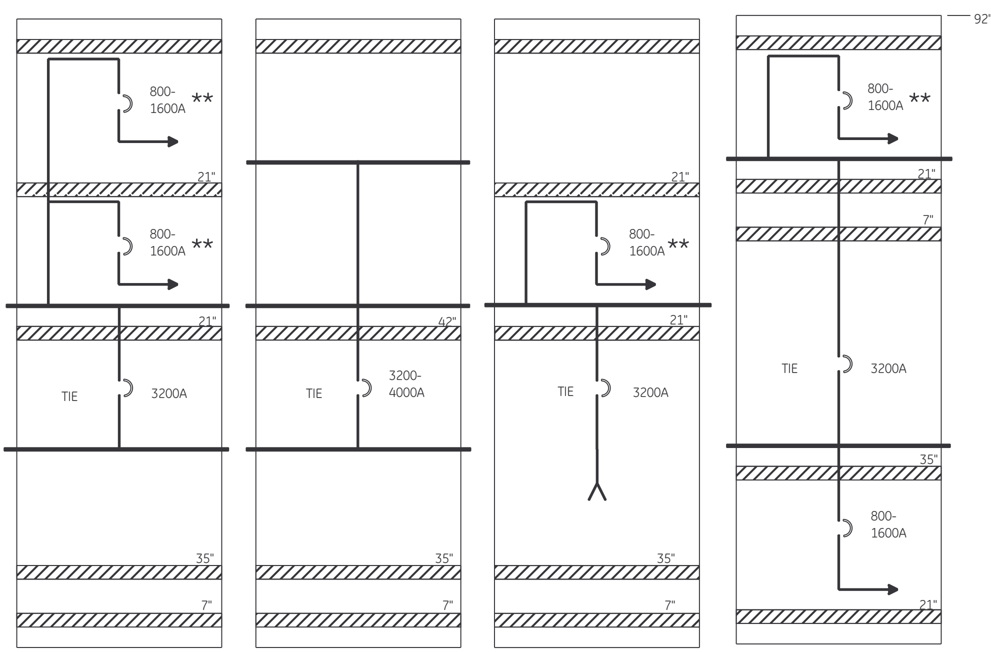
* MID BUS LEVEL IS NOT AVAILABLE AT 5000A (USE ONLY UPPER OR LOWER BUS LEVELS)

** FEEDER CUBICLES ARE NOT AVAILABLE WHEN 3200A AND 4000A BREAKERS HAVE 100KA SHORT CIRCUIT RATING





38"	38"
MT38-6	MT38-7
CABLE CONNECTED 5000A MAIN OR TIE	CABLE CONNECTED 5000A MAIN OR TIE



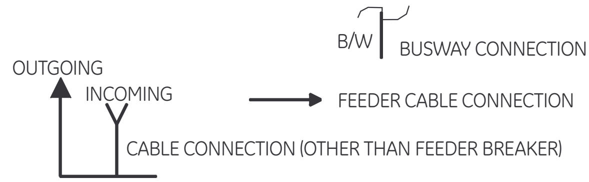
30"	30"	30"	30"
MT30-20	MT30-21	MT30-22	MT30-23
BUS CONNECTED TIE	BUS CONNECTED TIE	CABLE CONNECTED TIE	BUS CONNECTED TIE

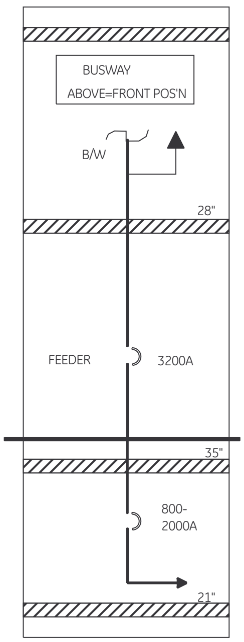
30" Feeder sections

LEGEND & NOTES

* MID BUS LEVEL IS NOT AVAILABLE AT 5000A (USE ONLY UPPER OR LOWER BUS LEVELS)

** FEEDER CUBICLES ARE NOT AVAILABLE WHEN 3200A AND 4000A BREAKERS HAVE 100KA SHORT CIRCUIT RATING

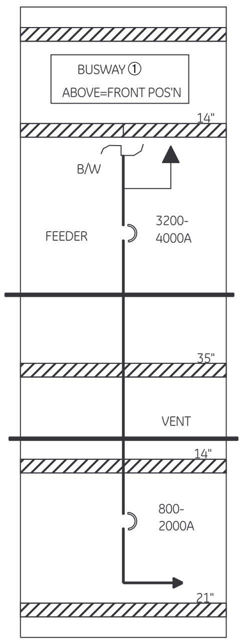




30"

F30-1

BUSWAY OR CABLE CONNECTED FDR

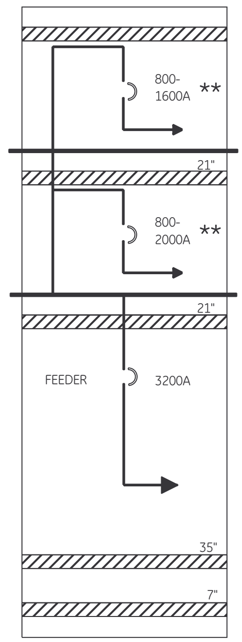


30"

F30-2

BUSWAY OR CABLE CONNECTED FDR

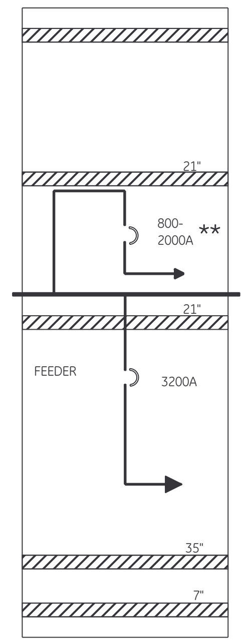
① 4000A NSP Busway requires a 38" wide section.



30"

F30-3

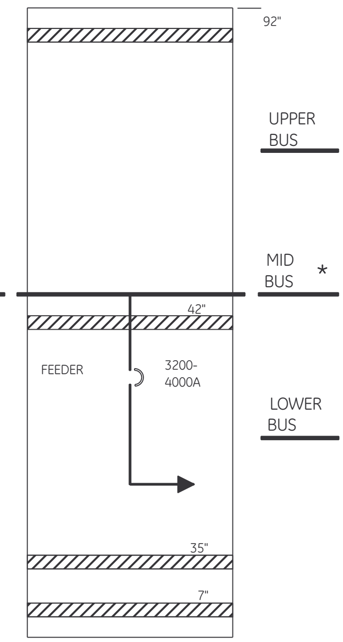
CABLE CONNECTED FEEDER



30"

F30-4

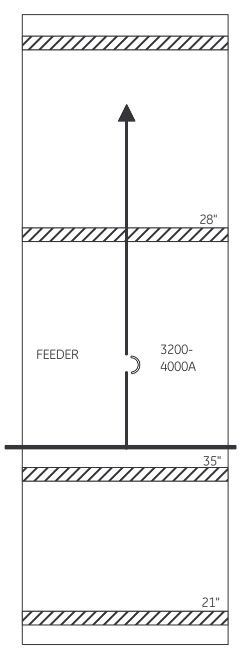
CABLE CONNECTED FEEDER



30"

F30-5

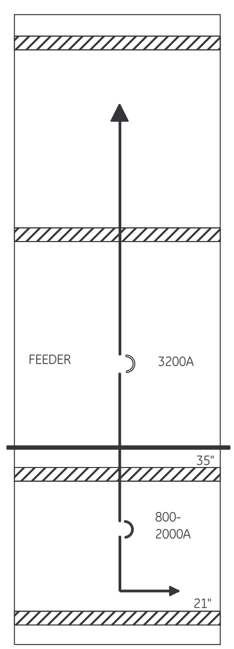
CABLE CONNECTED FEEDER



30"

F30-6

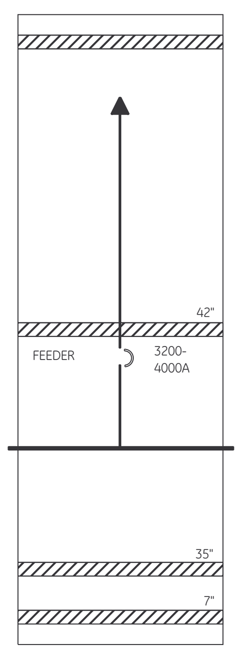
CABLE CONNECTED FEEDER



30"

F30-7

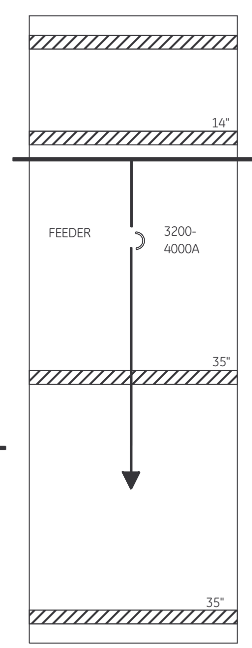
CABLE CONNECTED FEEDER



30"

F30-8

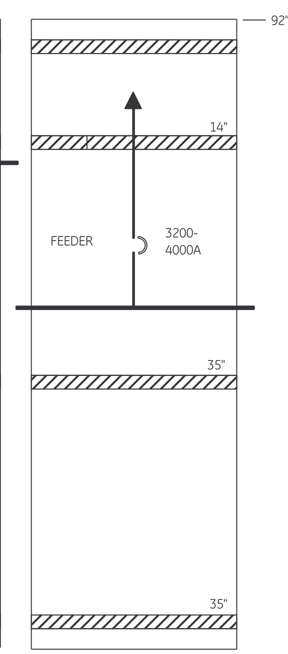
CABLE CONNECTED FEEDER



30"

F30-9

CABLE CONNECTED FEEDER



30"

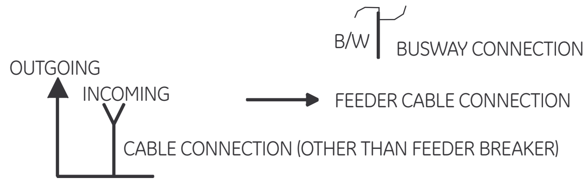
F30-10

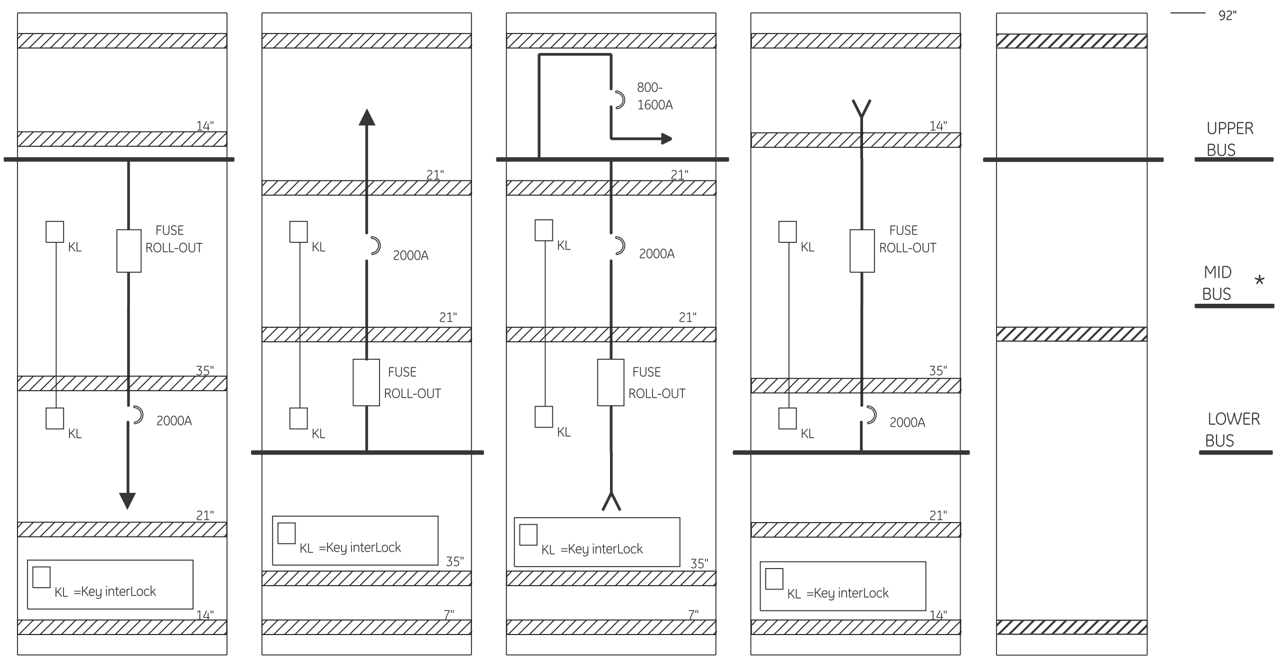
CABLE CONNECTED FEEDER

30" Main/tie/feeder sections, 38" auxiliary sections

LEGEND & NOTES

* MID BUS LEVEL IS NOT AVAILABLE AT 5000A
(USE ONLY UPPER OR LOWER BUS LEVELS)





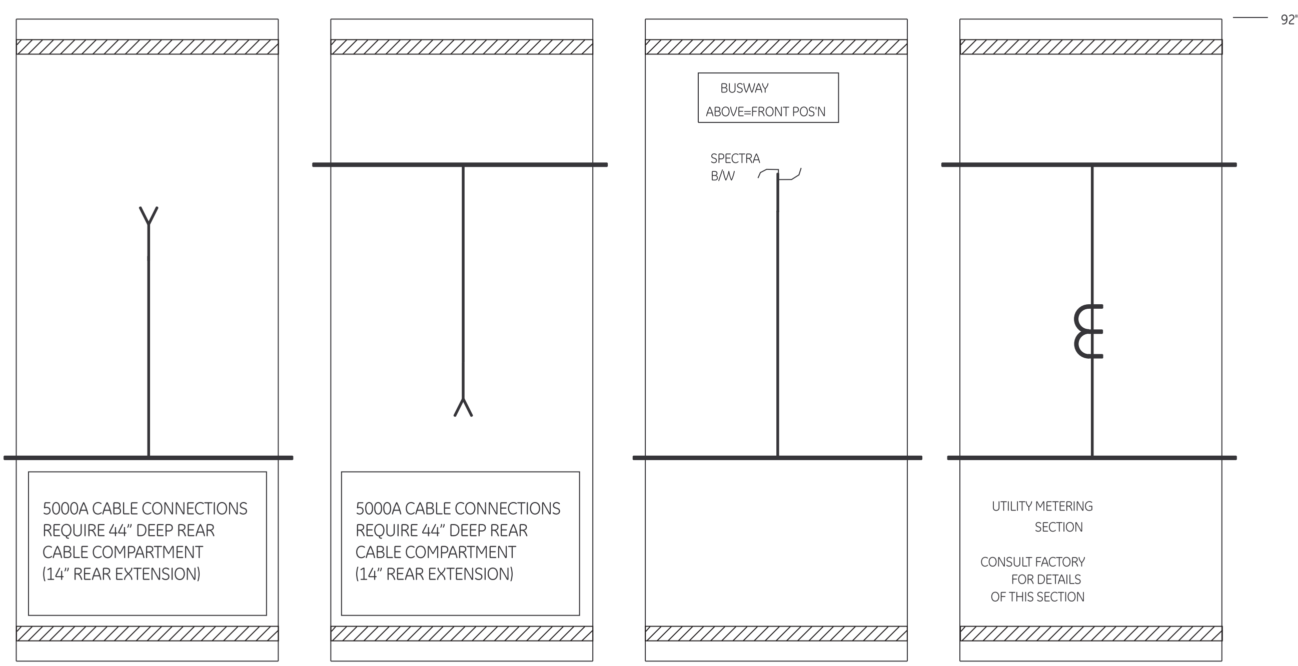
30" — MT30-24 — BUS CONNECTED BREAKER & FUSE

30" — MT30-25 — BUS CONNECTED BREAKER & FUSE

30" — F30-11 — CABLE CONNECTED BREAKER & FUSE

30" — F30-12 — CABLE CONNECTED BREAKER & FUSE

22" — TT22-1 — TRANSFORMER TRANSITION



38" — AX38-1 — 5000A CABLE TAP

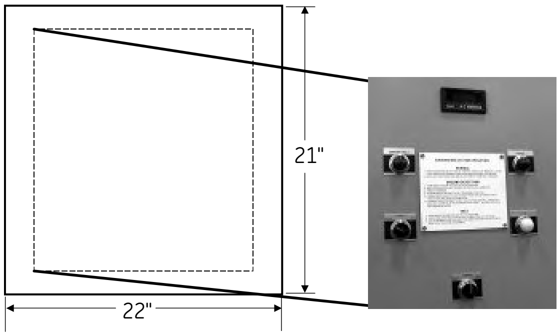
38" — AX38-2 — 5000A CABLE TAP

38" — AX38-3 — 5000A SPECTRA BUSWAY

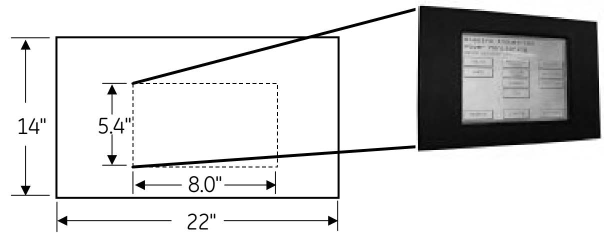
38 / 49" — UT3849-1 — UTILITY METERING

POWER LEADER™ instrument door (minimum compartment size)

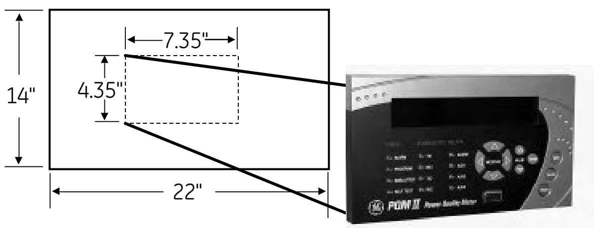
Pulsing High Resistance Ground System



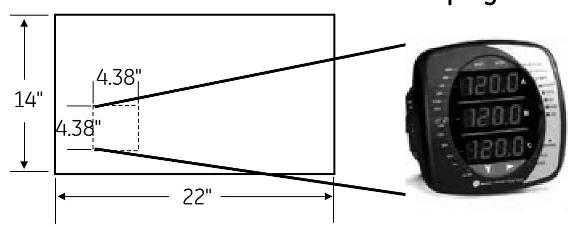
EPM9xxx & Nexus Touch Screen



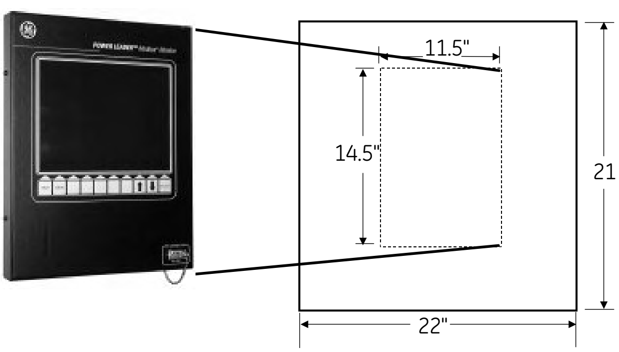
PQM II



EPM6000 Meter & EPM 9xxx 3-Line Display

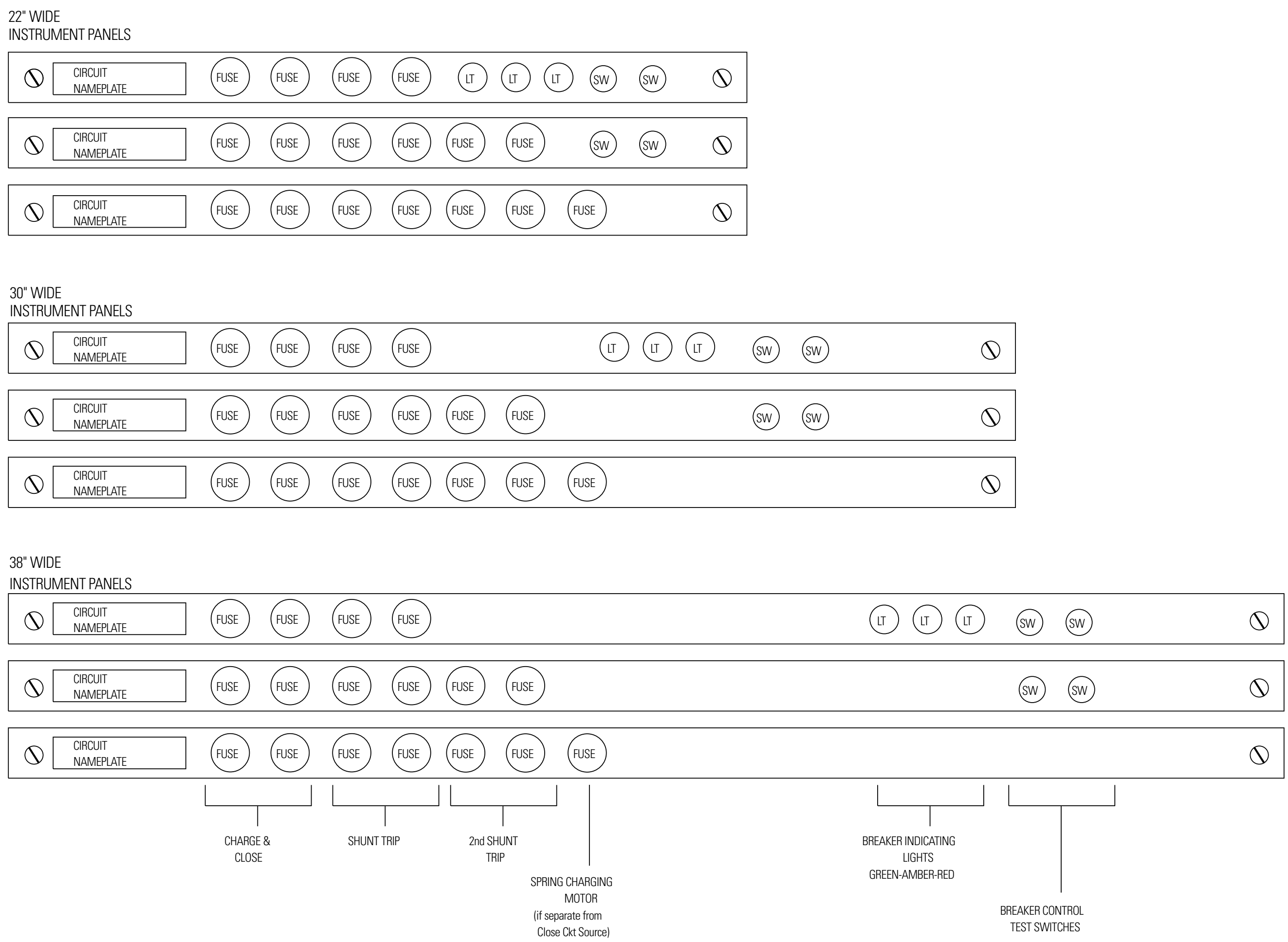


Power Leader Modbus Monitor



Instrument Panels

Instrument panels that house various control devices for WavePro™ breakers are furnished above each breaker cubicle. Deadfront fuse holders are provided for charge, close and trip circuits. When requested, green and red indicating lights can be provided to show the breaker open/close status. A third indicating light position can be used to show spring charge status or trip-on-fault. Lamps are replaceable from the front of the instrument panel. Optional toggle switches can be provided for exercising the breaker close and trip circuits when the breaker is in the TEST position. Space is provided on the left side of the panel for an engraved laminated plastic nameplate.

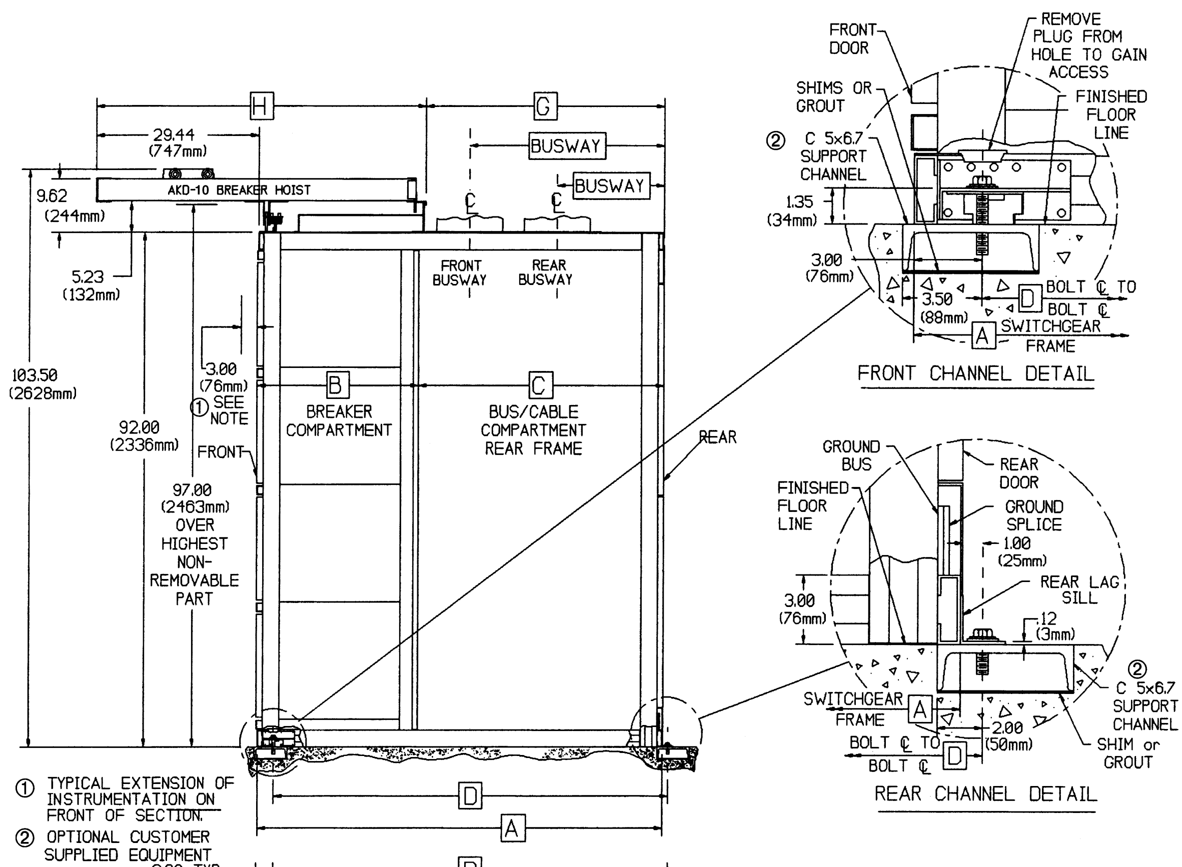


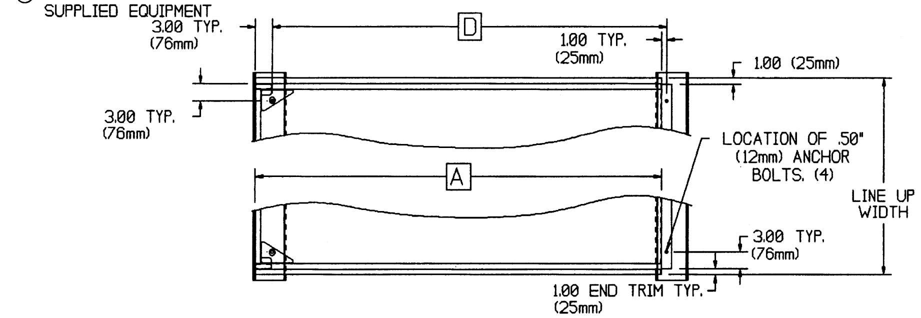
Floor plans and side views

AKD-10

NEMA 1 indoor — side view and anchoring details

Note: Refer to installation drawing and AKD-10 switchgear installation manual (DEH-194) for additional information





Busway Section Width Required	
Type and Amp Rating	Minimum Section Width
Spectra 800-3200	22.00 (558mm)
Spectra 4000	30.00 (762mm)
Spectra 5000	38.00 (965mm)
NSP 1200-2500	22.00 (558mm)
NSP 3200	30.00 (762mm)
NSP 4000	38.00 (965mm)

A Equipment Depth	B Breaker Compartment	C Rear Frame Depth	D Anchor Bolt Spacing	G Back of Hoist to Rear Frame	H Hoist Length	Busway Locations				
						Front			Rear	
						Spectra 800-4000 Amp NSP 1200-3200 Amp	NSP 4000 Amp	Spectra 5000 Amp	Spectra 800-4000A	NSP 1200-3200A
60.00 (1524mm)	30.00 (762mm)	30.00 (762mm)	58.00 (1473mm)	29.34 (745mm)	60.10 (1526mm)	21.50 (546mm)	19.50 (495)	N/A	9.50 (241)	N/A
67.00 (1701mm)	30.00 (762mm)	37.00 (938mm)	65.00 (1651mm)	36.34 (923mm)	60.10 (1526mm)	28.50 (723mm)	26.50 (673)	23.50 (596)	16.50 (419)	12.50 (317)
67.00③ (1701mm)	37.00③ (939mm)	30.00③ (762mm)	65.00③ (1651mm)	29.34③ (745mm)	67.10③ (1704mm)	21.50③ (546mm)	19.50③ (495)	N/A③	9.50③ (241)	N/A③
74.00 (1879mm)	30.00 (762mm)	44.00 (1117mm)	72.00 (1828mm)	43.34 (1100mm)	60.10 (1526mm)	35.50 (901mm)	33.50 (850)	30.50 (774)	23.50 (596)	19.50 (495)
74.00④ (1879mm)	37.00④ (939mm)	37.00④ (939mm)	72.00④ (1828mm)	36.34④ (923mm)	67.10④ (1704mm)	28.50④ (723mm)	26.50④ (673)	23.50④ (596)	16.50④ (419)	12.50④ (317)
81.00④ (2057mm)	37.00④ (939mm)	44.00④ (1117mm)	79.00④ (2006mm)	43.34④ (1100mm)	67.10④ (1704mm)	35.50④ (901mm)	33.50④ (850)	30.50④ (774)	23.50④ (596)	19.50④ (495)

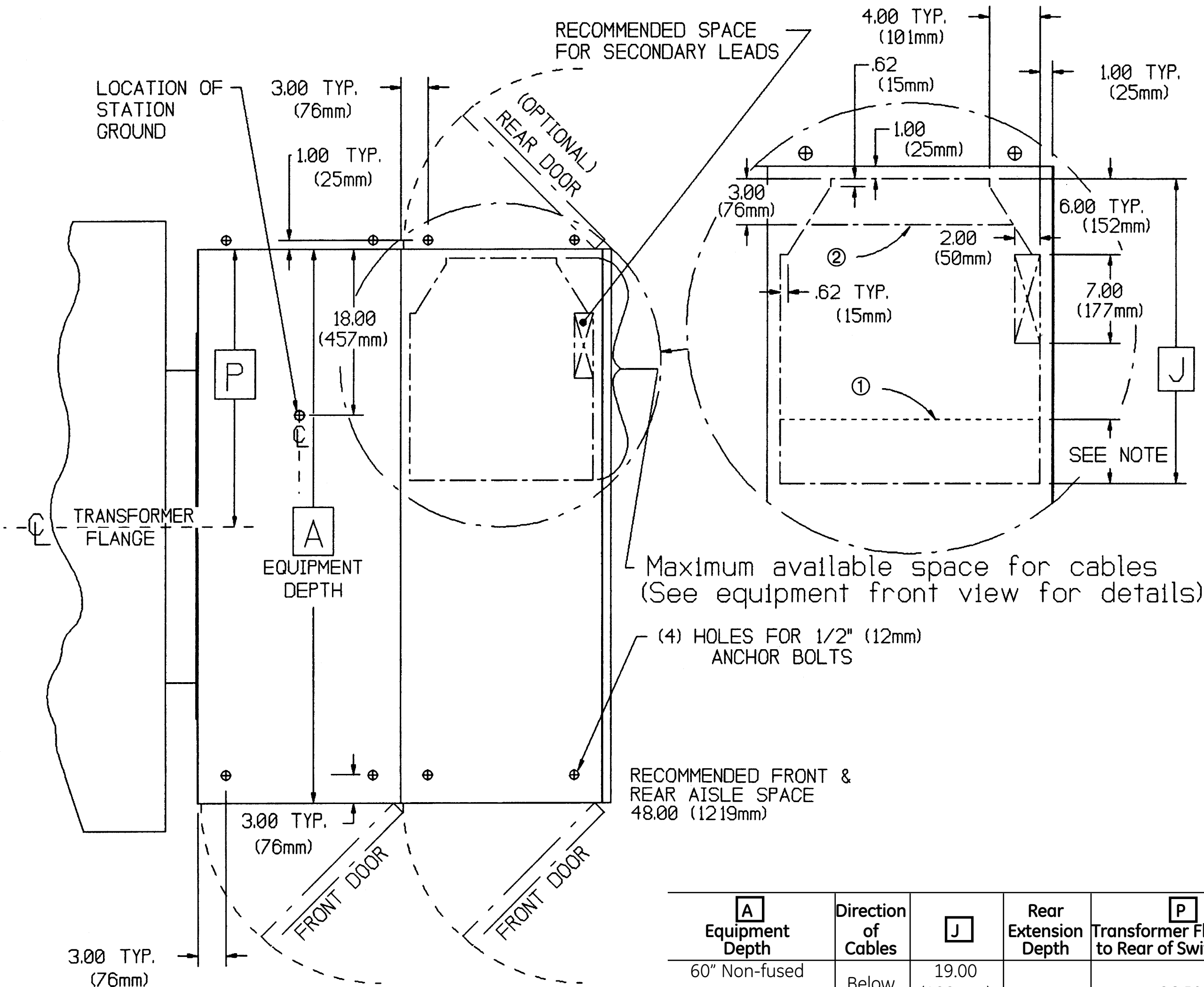
③ If line-up includes any WPF-08/16 breakers

④ If line-up includes any WPS/WPX-50 or WPF-08/16 breakers

Refer to Table 32.1 and 32.2 for equipment depth options.

NEMA 1 indoor — floor plan and cable space details

Note: Refer to installation drawing and AKD-10 switchgear installation manual (DEH-194) for additional information



A Equipment Depth	Direction of Cables	J	Rear Extension Depth	P Transformer Flange CL to Rear of Switchgear
60" Non-fused or 67" with Fused WPF-08 / 16	Below	19.00 (482mm)	None	26.50 (673mm)
	Above	24.00 (609mm)		
67" Non-fused or 74" with Fused WPF-08 / 16	Below	26.00 (660mm)	7.00 (177mm)	33.50 (851mm)
	Above	31.00 (787mm)		
74" Non-fused or 81" with Fused WPF-08 / 16	Below	33.00 (838mm)	14.00 (355mm)	40.50 (1029mm)
	Above	38.00 (965mm)		
74" with WPS / WPX-50	Below	19.00 (482mm)	None	26.50 (673mm)
	Above	24.00 (609mm)		
81" with WPS / WPX-50	Below	26.00 (660mm)	7.00 (177mm)	33.50 (851mm)
	Above	31.00 (787mm)		
67" w/ 5000 Amp Bus w/o WPS / WPX-50 w/o WPF-08 / 16	Below	19.00 (482mm)	None	29.50 (749mm)
	Above	24.00 (609mm)		
74" w/ 5000 Amp Bus w/o WPS / WPX-50 w/o WPF-08 / 16	Below	26.00 (660mm)	7.00 (177mm)	36.50 (927mm)
	Above	31.00 (787mm)		

Refer to Table 32.1 and 32.2 for equipment depth options.

NOTES:

① CABLES ABOVE – AVAILABLE SPACE FOR CABLES REDUCED BY 5.00" (127mm) IF BUS COMPARTMENT BARRIERS ARE PROVIDED

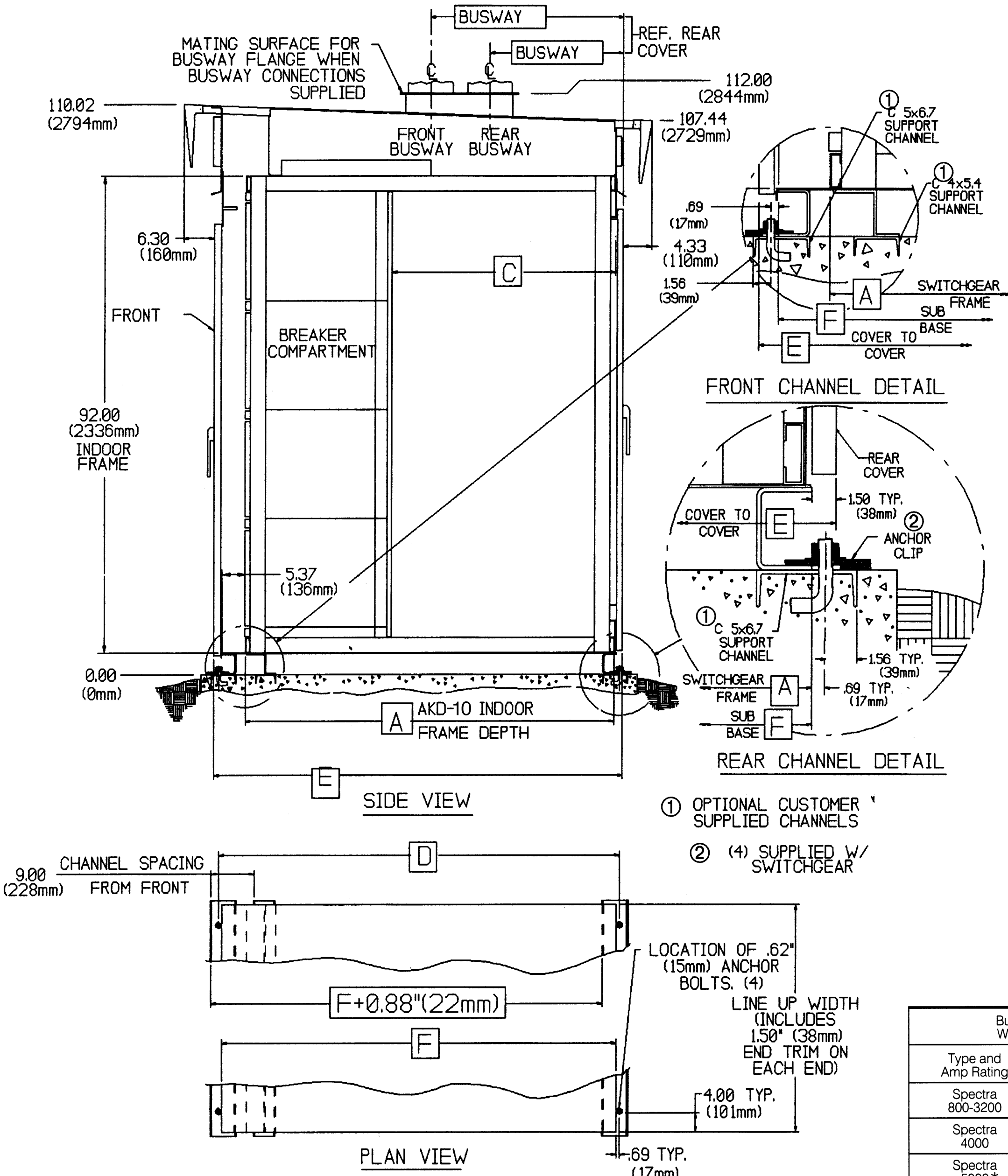
CABLES BELOW – AVAILABLE SPACE FOR CABLES REDUCED BY 4.00 (101mm) IF 800-2000A BREAKER IS LOCATED IN BOTTOM COMPARTMENT.

CABLES ABOVE OR BELOW – AVAILABLE SPACE FOR CABLES REDUCED BY 3.00" (76mm) FOR ANY SECTION CONTAINING A 5000A BREAKER AND BARE 5000A BUS (IF BUS COMPARTMENT BARRIERS ARE SUPPLIED, SEE NOTE ABOVE)

② SPACE REQUIRED FOR UPPER NEUTRAL WITH LEADS ABOVE OR LOWER NEUTRAL WITH LEADS BELOW

NEMA 3R outdoor, non-walk-in — side view and anchoring details

Note: Refer to installation drawing and AKD-10 switchgear installation manual (DEH-194) for additional information



Busway Section Width Required	
Type and Amp Rating	Minimum Section Width
Spectra 800-3200	24.00 (609mm)
Spectra 4000	32.00 (812mm)
Spectra 5000*	40.00 (1016mm)
NSP 1200-2500	24.00 (609mm)
NSP 3200	32.00 (812mm)
NSP 4000	40.00 (1016mm)

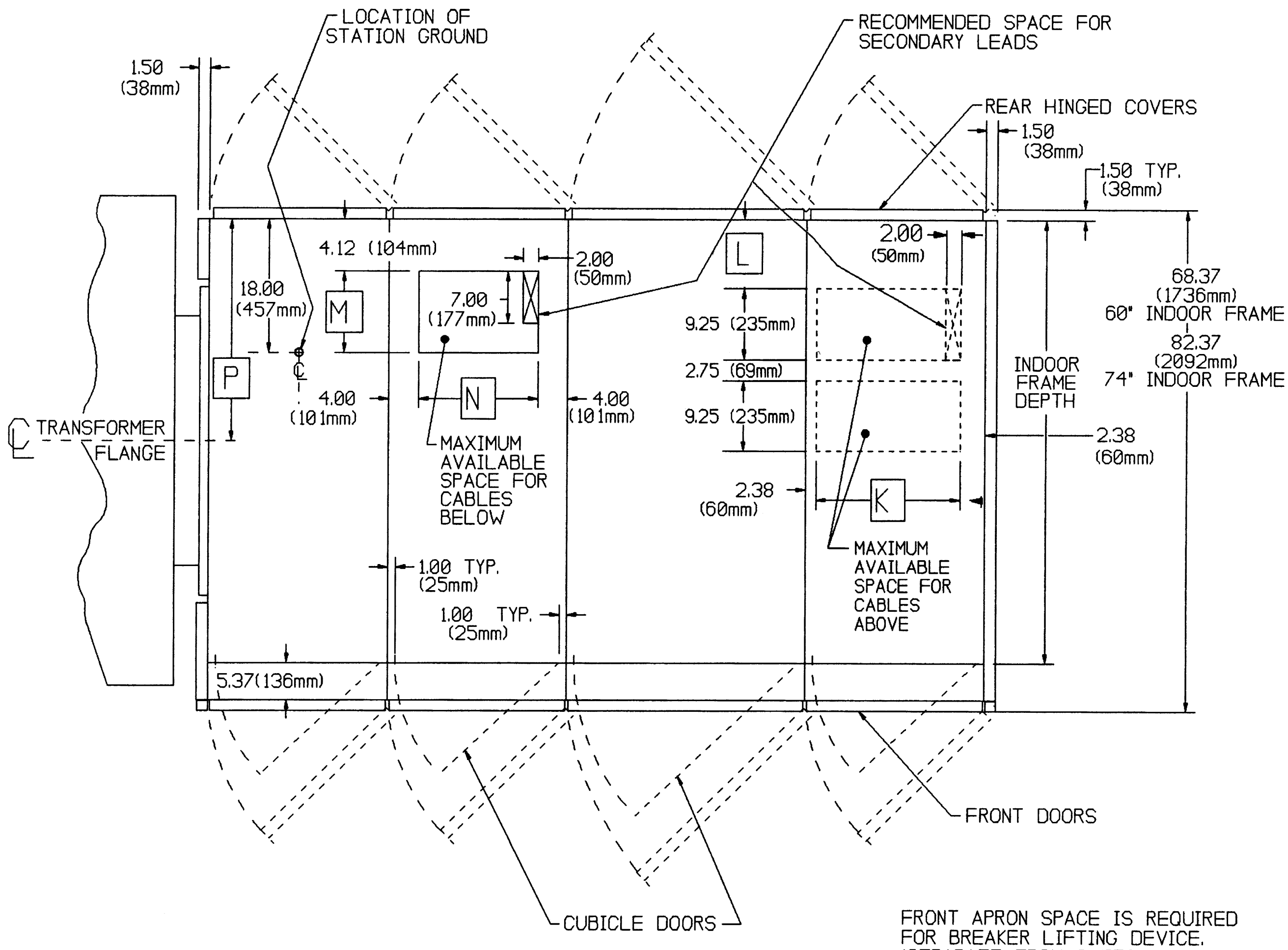
A Depth of Indoor Switchgear	C Rear Frame Depth	D Anchor Bolt Spacing	E Depth of Outdoor Switchgear	F Sub Base Depth	Busway Locations			
					Front			Rear
					Spectra 800-4000 Amp NSP 1200-3200 Amp	NSP 4000 Amp	Spectra 5000 Amp*	Spectra 800-4000A
60.00 (1524mm)	30.00 (762mm)	66.38 (1686mm)	68.37 (1736mm)	65.00 (1651mm)	23.00 (584mm)	21.00 (533)	N/A	11.00 (279)
74.00 (1889mm)	37.00 (939mm)	80.38 (2041mm)	82.37 (2092mm)	79.00 (2006mm)	30.00 (762mm)	28.00 (711)	25.00 (635)	18.00 (457)
	44.00 (1117mm)				37.00 (939mm)	35.00 (889)	32.00 (812)	25.00 (635)

*Busway to main bus only, 5000A breaker not available in outdoor non-walk-in construction.

Refer to Table 32.1 and 32.2 for equipment depth options.

NEMA 3R outdoor, non-walk-in — floor plan and cable space details

Note: Refer to installation drawing and AKD-10 switchgear installation manual (DEH-194) for additional information



FRONT APRON SPACE IS REQUIRED FOR BREAKER LIFTING DEVICE. (SEPARATE FROM SWITCHGEAR)

Section Width	K	N
24" (609mm)	19.25 (489mm)	16.00 (406mm)
32" (812mm)	27.25 (692mm)	24.00 (609mm)
40" (1016mm)	35.25 (895mm)	32.00 (812mm)

Indoor Frame	L	M	P
60" (1524mm)	4.28 (124mm)	11.00 (279mm)	26.50 (673mm)
74" ① (1879mm)	18.88 (479mm)	25.00 (635mm)	40.50 (1029mm)
74" ② (1879mm)	11.88 (301mm)	18.00 (457mm)	33.50 (851mm)
74" ③ (1879mm)	4.88 (124mm)	11.00 (279mm)	26.50 (673mm)
74" ④ (1879mm)	11.88 (301mm)	18.00 (457mm)	36.50 (927mm)

① Non-fused breakers (14" rear extension)

② With WPF-08/16 (7" rear extension)

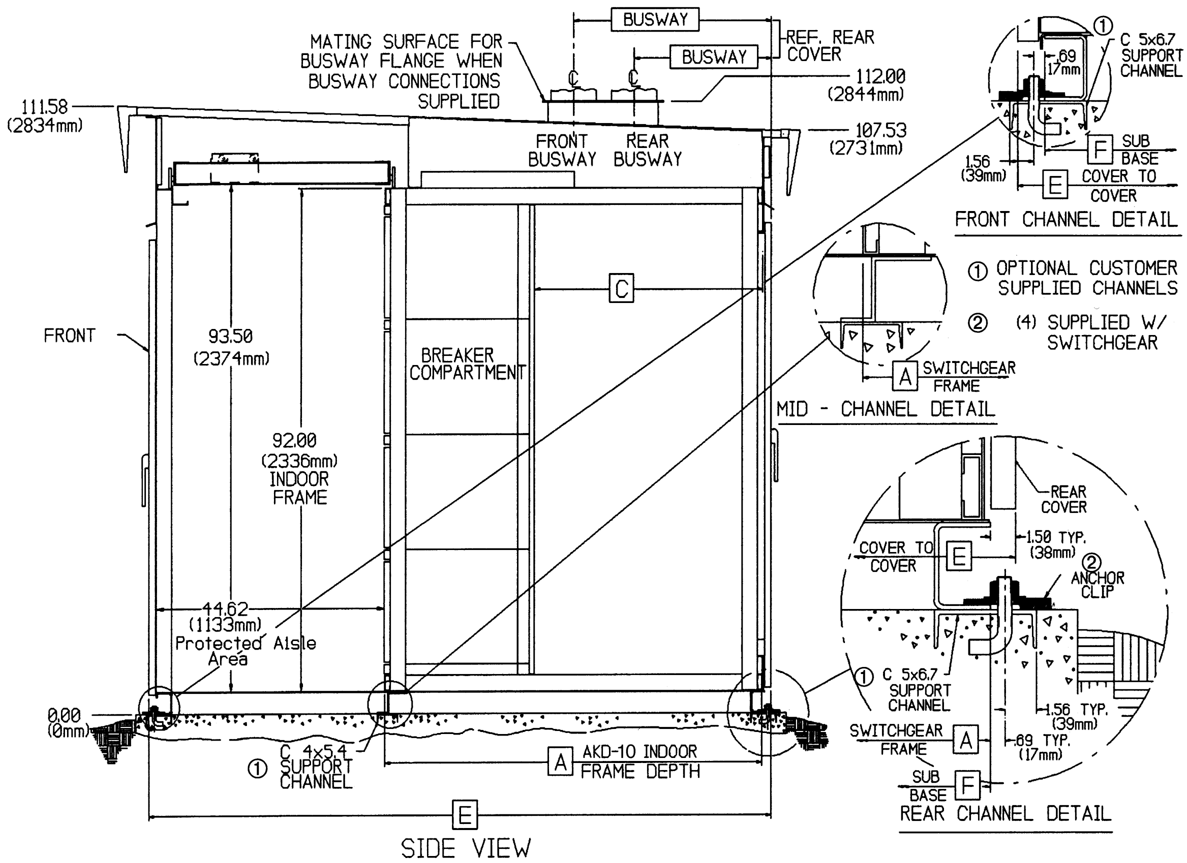
③ With 5000 Amp Main Bus and WPF-08/WPF-16

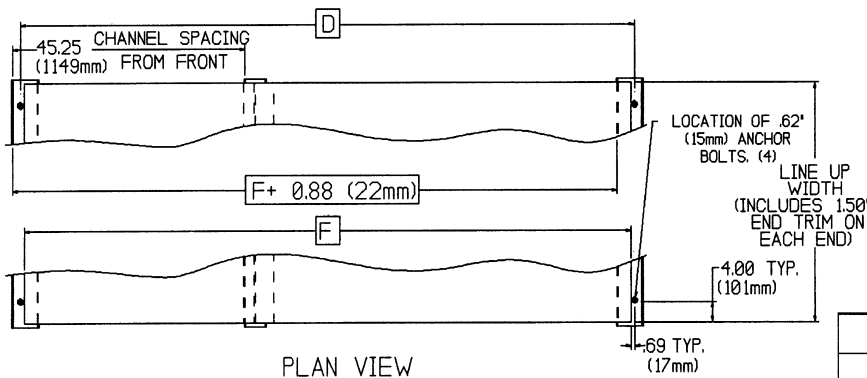
④ 5000 Amp Bus w/o WPS/WPX-50 and w/o WPF-08/16 (7" rear extension)

Refer to Table 32.1 and 32.2 for equipment depth options.

NEMA 3R outdoor, walk-in protected aisle — side view and anchoring details

Note: Refer to installation drawing and AKD-10 switchgear installation manual (DEH-194) for additional information





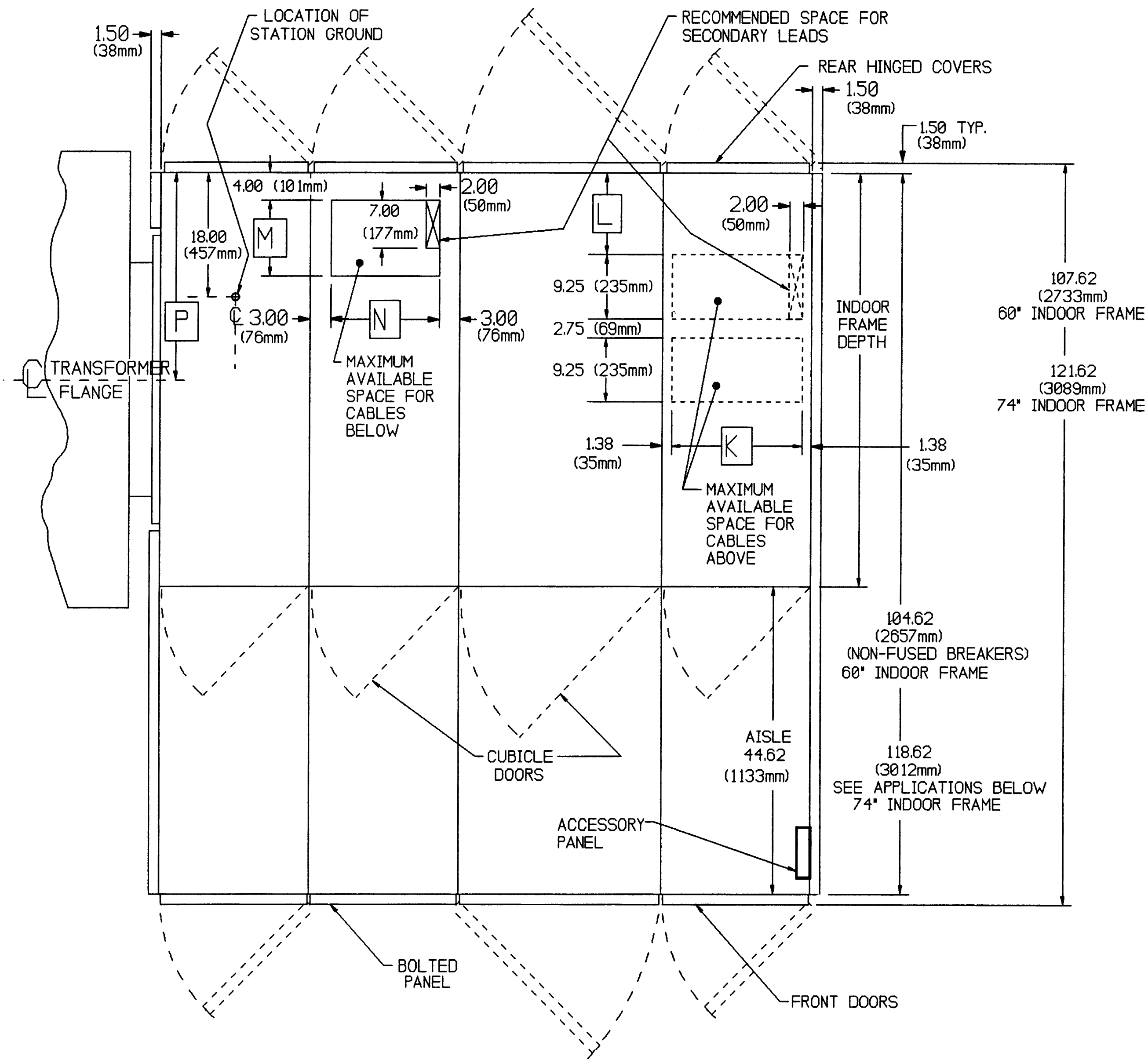
Busway Section Width Required	
Type and Amp Rating	Minimum Section Width
Spectra 800-3200	22.00 (558mm)
Spectra 4000	30.00 (762mm)
Spectra 5000	38.00 (965mm)
NSP 1200-2500	22.00 (558mm)
NSP 3200	30.00 (762mm)
NSP 4000	38.00 (965mm)

A Depth of Indoor Switchgear	C Rear Frame Depth	D Anchor Bolt Spacing	E Depth of Outdoor Switchgear	F Sub Base Depth	Busway Locations			
					Front			Rear
					Spectra 800-4000 Amp NSP 1200-3200 Amp	NSP 4000 Amp	Spectra 5000 Amp	Spectra 800-4000A
60.00 (1524mm)	30.00 (762mm)	106.00 (2692mm)	107.62 (2733mm)	104.62 (2657mm)	23.00 (584mm)	21.00 (533)	N/A	11.00 (279)
74.00 (1889mm)	37.00 (939mm)	120.00 (3048mm)	121.62 (3089mm)	118.62 (3012mm)	30.00 (762mm)	28.00 (711)	25.00 (635)	18.00 (457)
	44.00 (1117mm)				37.00 (939mm)	35.00 (889)	32.00 (812)	25.00 (635)

Refer to Table 32.1 and 32.2 for equipment depth options.

NEMA 3R outdoor, walk-in protected aisle — floor plan and cable space details

Note: Refer to installation drawing and AKD-10 switchgear installation manual (DEH-194) for additional information



Section Width	K	N
22" (558mm)	19.25 (489mm)	16.00 (406mm)
30" (762mm)	27.25 (692mm)	24.00 (609mm)
38" (965mm)	35.25 (895mm)	32.00 (812mm)

Indoor Frame	L	M	P
60" (1524mm)	4.88 (124mm)	11.00 (279mm)	26.50 (673mm)
74" ① (1879mm)	18.88 (479mm)	25.00 (635mm)	40.50 (1029mm)
74" ② (1879mm)	11.88 (301mm)	18.00 (457mm)	33.50 (851mm)
74" ③ (1879mm)	4.88 (124mm)	11.00 (279mm)	26.50 (673mm)
74" ④ (1879mm)	11.88 (301mm)	18.00 (457mm)	36.50 (927mm)

① Non-fused breakers (14" rear extension)

② With WPF-08/16 (7" rear extension)

③ With 5000 Amp Main Bus and WPS/WPX-50

④ 5000 Amp Bus w/o WPS/WPX-50 and w/o WPF-08/16 (7" rear extension)

Refer to Table 32.1 and 32.2 for equipment depth options.

Breaker Wiring Diagram

Notes:

(1) BREAKER SHOWN IN THE OPEN POSITION WITH THE CLOSING SPRINGS DISCHARGED, BELL ALARM RESET.

(2) THIS DRAWING SHOWS ELECTRICAL CONNECTIONS ONLY. THE EXACT LOCATION OF COMPONENTS CANNOT BE DETERMINED FROM THIS DRAWING.

(3) THIS DRAWING DEPICTS STANDARD WIRING DIAGRAM ONLY.

(4) DEFINITIONS: E/O-ELECTRICALLY OPERATED CIRCUIT BREAKER; M/O-MANUALLY OPERATED CIRCUIT BREAKER.

(5) M/O BKRS WITH REMOTE CLOSE OPTION (WITH ONE SHUNT TRIP DEVICE) AND ALL E/O (WITH ONE SHUNT TRIP DEVICE ONLY) REQUIRE A 4-STAGE (MINIMUM) AUXILIARY SWITCH.

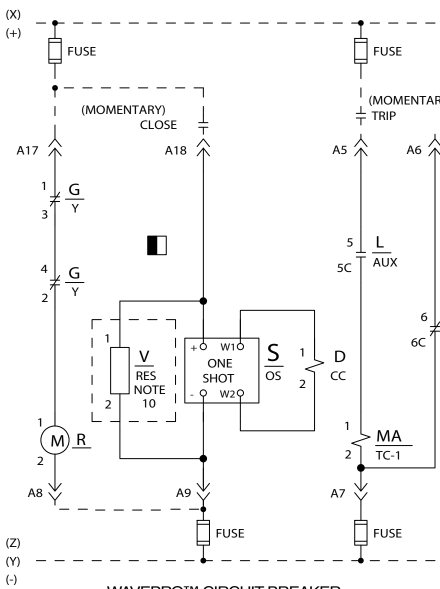
(6) TWO SHUNT TRIP DEVICES REQUIRE A 7-STAGE AUXILIARY SWITCH.

(7) A SECOND SHUNT DEVICE IS NOT AVAILABLE FOR WPS-50 TYPE BREAKERS.

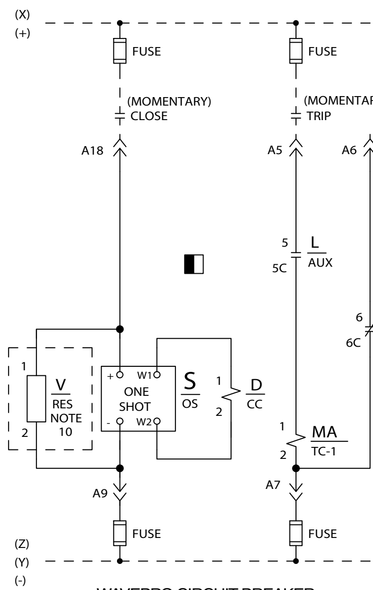
(8) THE FOLLOWING DEVICES ARE NOT APPLICABLE ON BKRS SUPPLIED WITH A POWER+™ TRIP UNIT; T/(COMM), T/(ZSI), T/(VC), AND T/(CP).

(9) THE FOLLOWING DEVICES ARE NOT APPLICABLE ON BKRS SUPPLIED WITH A MICROVERSATRIP PLUS™ TRIP UNIT: T/(COMM), AND T/(VC).

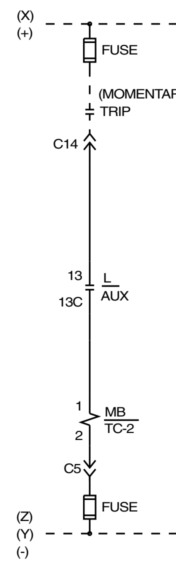
(10) RESISTOR PROVIDED FOR AC CLOSE ONLY 1KOHM/25WATT FOR 120VAC, 4KOHM/25WATT FOR 240VAC.



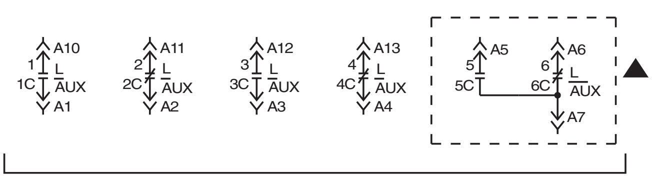
WAVEPRO™ CIRCUIT BREAKER
ELECTRICALLY OPERATED



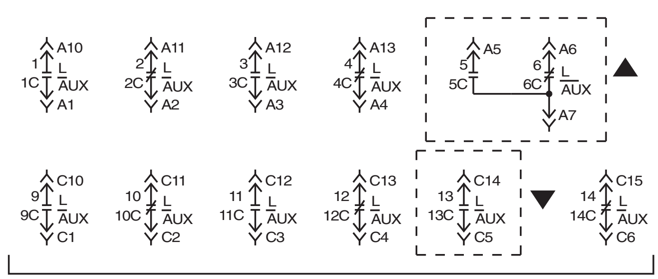
WAVEPRO CIRCUIT BREAKER
MANUALLY OPERATED
(SHOWN WITH OPTIONAL REMOTE CLOSE
DEVICE AND SHUNT TRIP DEVICE)



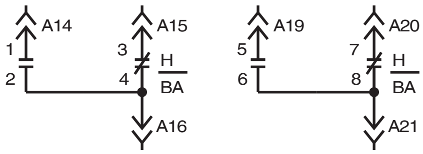
WAVEPRO CIRCUIT BREAKER
ELEC. & MAN. OPERATED
(OPTIONAL SECOND SHUNT TRIP DEVICE)



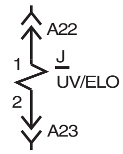
4-STAGE AUXILIARY SWITCH CONTACTS
▲ - CONTACT NOT AVAILABLE WITH FIRST SHUNT TRIP DEVICE OPTION.



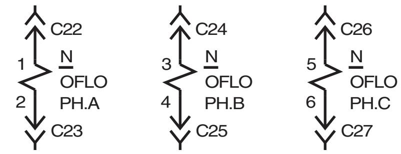
7-STAGE AUXILIARY SWITCH CONTACTS
▲ - CONTACT NOT AVAILABLE WITH FIRST SHUNT TRIP DEVICE OPTION.
▼ - CONTACT NOT AVAILABLE WITH SECOND SHUNT TRIP DEVICE OPTION.



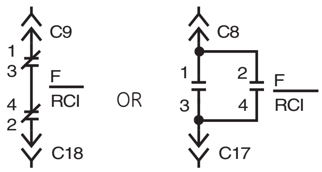
BELL ALARM CONTACTS
(SHOWN WITH OR WITHOUT
LOCKOUT OPTION)



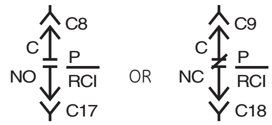
UNDERVOLTAGE OR
ELECTRIC LOCKOUT



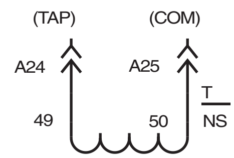
OPEN FUSE LOCKOUT
(WPS-20, WPS-32, WPS-40,
& WPS-50 FRAMES ONLY)



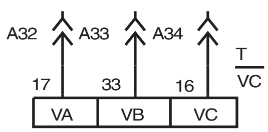
REMOTE CHARGE INDICATOR –
NORMALLY OPEN OR CLOSED CONTACT
(WPS/H/X-32, WPS/X-40, WPS/X-50 ONLY).



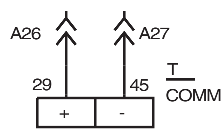
REMOTE CHARGE INDICATOR –
NORMALLY OPEN OR CLOSED CONTACT
(WPS/H/X/F-08, WPS/H/F-16,
WPS-20 ONLY).



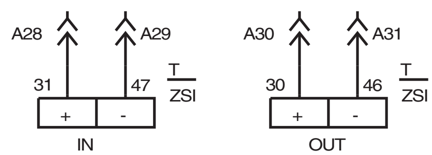
TRIP UNIT
NEUTRAL SENSOR
INPUT



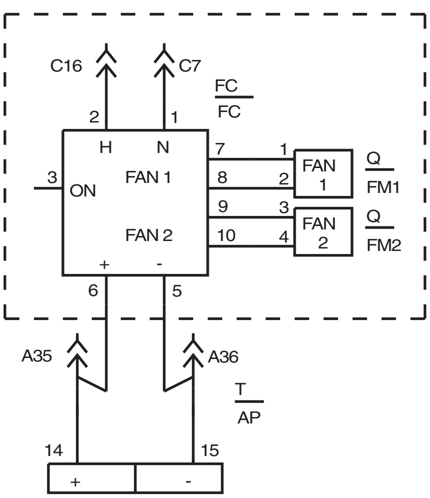
TRIP UNIT
VOLTAGE CONDITIONER
INPUT
(MVT PM & "PM READY" ONLY)



TRIP UNIT
COMMUNICATION
INPUT
(MVT PM & "PM READY" ONLY)



TRIP UNIT
ZONE SELECTIVE
INTERLOCKING INPUT/OUTPUT
(MVT PLUS / PM and "PM READY" ONLY)



FANS & FAN CONTROL
(WPS/X-50 BKRS ONLY)

TRIP UNIT
24VDC AUXILIARY
POWER INPUT
(MVT PM & "PM READY",
WPS/X-50)

DRAWING NO. 10057403P1

THIS DRAWING SHOWS ALL AVAILABLE BREAKER ACCESSORIES. REFER TO BREAKER CATALOG NUMBER FOR ACCESSORIES INCLUDED WITH THE BREAKER.

WavePro™ Breaker Catalog Number Guide

Equipment Usage		Frame Sizes & Interrupting Rating		Trip Unit Type, Characteristics & Trip Rating		
W	E	2	D	A	Q	D
1	2	3	4	5	6	7

Usage	Code
AKD10/PBII/AV3 Access Equipment	WE
Special "dead front shield" for use in AKD-10/PBII/AV3 Access Equipment	W1

Interrupting Capability/ Fuse Type		Fuse Link on Phase B	Code	Silver "L" Fuse
Standard	(ex. WPS)		1	
High	(ex. WPH)		2	
Extended	(ex. WPX)		3	
OFLO only			4	
300A	Class "J" fuse		A	
350A	Class "J" fuse		B	
400A	Class "J" fuse		C	
450A	Class "J" fuse		D	
500A	Class "J" fuse		E	
600A	Class "J" fuse	S	F	
800A	Class "L" fuse	T	G	5
1000A	Class "L" fuse	U	H	6
1200A	Class "L" fuse	V	J	7
1600A	Class "L" fuse	W	K	8
2000A	Class "L" fuse	Y	L	9
2500A	Silver "L" fuse		M	
800A	"Welder" limiter		N	
1200A	"Welder" limiter		P	
1600A	"Welder" limiter		Q	
2000A	"Welder" limiter		R	

Frame &	Sensor	Code (See Note 1)
800	none	A
	150	B
	400	C
	800	D
1600	none	E
	800	F
	1600	G
2000	none	H
	2000	J
3200	none	K
	3200	L
4000	none	M
	4000	N
5000	none	P
	5000	R

Note 1: If 4 wire GF is required then the "A-Disc" [character position 14] must be selected and the 4th wire (neutral) sensor must be ordered separately. Refer to DEP-080 Product Catalog.

Sensor = "none" for non-automatic breakers

Trip Unit type	Code
none (non-automatic)	X
MVT Plus	A
MVT M (metering & communications)	B
MVT PM (relaying, metering & communications)	C
MVT Plus (w/special GF curve)	D
MVT M (w/special GF curve)	E
MVT PM (w/special GF curve)	F
Power + ①	G
Power + (w/GF) ① ③	H
Power + (w/Defeatable GF) ① ② ③	J
Power + (w/targets) ①	K
Power + (w/targets & GF) ① ③	L
Power + (w/targets & Defeatable GF) ① ② ③	M

① Power + is not available for 5000A frame breakers
② Not UL Listed ③ GF is 3w/4w (See Note 1 below)

Trip unit codes (See Table A)

TU function	Code	TU function	Code
none	X	LIGDZ1 ① ③	N
LS ②	A	LSI ②	P
LSG ③	B	LSIG ③	Q
LSGZ1 ③	C	LSIGX ① ③	R
LSGZ2 ③	D	LSIGZ1 ③	S
LSGD ① ③	E	LSIGZ2 ③	T
LSGDZ1 ① ③	F	LSIGD ① ③	V
LSGDZ2 ① ③	G	LSIGDZ1 ① ③	W
LI ②	J	LSIGDZ2 ① ③	Y
LIG ③	K		
LIGZ1 ③	L		
LIGD ① ③	M		

① Not UL Listed
② Power+ available with LI, LS or LSI only
③ GF is 3w/4w (See Note 1 below)

Sensor	Rating Plug	Code
	none	X
150	60 ①	1
	80	2
	100	3
	125	4
	150	5
400	150 ①	5
	200	6
	225	7
	250	8
	300	9
	400	A
800	300 ①	9
	400	A
	450 ①	B
	500	C

Sensor	Rating Plug	Code
800	600	D
	700	E
	800	G
1600	600 ①	D
	800	G
	1000	H
	1100 ①	J
	1200	K
	1600	M
2000	750 ①	F
	800 ①	G
	1000	H
	1200	K
	1500 ①	L
	1600	M
	2000	N

Sensor	Rating Plug	Code
3200	1200	K
	1600	M
	2400	P
	3200	S
4000	1600	M
	2000	N
	2500	Q
	3000	R
	3600 ①	T
	4000	V
5000	3200 ①	S
	4000 ①	V
	5000 ①	W

① Rating plug value not available on Power+ trip unit

Table A
L = Long Time (LT)
S = Short Time (ST)
I = Instantaneous (Inst)
G = Ground Fault (GF)
GD= Defeatable GF
X = Switchable ST or Inst and GF
Z1 = Zone Selective Interlocking—GF
Z2 = Zone Selective Interlocking—GF and ST

Breaker Operation & Control Voltages		Breaker Mounted Accessories					
F	**1**	**X**	**B**	**B**	**X**	**Q**	**X**
8	9	10	11	12	13	14	15

Position 8

Operation Charge & Close	Code
manual	X
manual with remote close ①	
Close voltage	
120v-60Hz	1
240v-60Hz	3
120v-50Hz	4
240v-50Hz	6
48v -DC	A
110v-DC	B
125v-DC	C
250v-DC	D
electrical ①	
Charge / Close	
48v-DC	E
120v-60Hz	F
120v-50Hz	H
120v-50/60/48v-DC	N
110v-DC	P
125v-DC	Q
250v-DC	R
240v-60Hz	T
240v-50Hz	W

① (Requires min 4 stage auxiliary switch and shunt trip)

Position 9

Shunt Trip-1 (Requires 4 or 7 stage aux. switch)

	Code		Code
none	X	24VDC ①	B
120VAC, 60Hz ①	1	48VDC	D
208VAC, 60Hz	2	110 / 125VDC ①	E
240VAC, 60Hz ①	3	250VDC ①	F
70VAC, 60Hz	4		
120VAC, 50Hz	5		
208VAC, 50Hz	6		
240VAC, 50Hz	7		

① Coil ratings available for Shunt Trip-1 or Shunt Trip-2. All other ratings apply to Shunt Trip-1 only.

Position 10

Undervoltage (UV) or Electric Lockout (ELO) ***(See Note 2 Below)***

	Code		
	UV	**UV w/TD**	**ELO**
none	X	X	X
120V-50/60Hz	1		4
208V-50/60Hz		3 (TAKYUVT-5)	
240V-50/60Hz	2	3 (TAKYUVT-4)	5
24VDC	A		G
48VDC	B		H
110VDC	C		J
125VDC	C	E (TAKYUVT-1)	J
250VDC	D	F (TAKYUVT-2)	K

Note 2: Order Static Time Delay Unit (TAKYUVT-1,2,4,5) separately

Position 11

Accessory	Code
none	X
Aux switch 4 stages	A
Aux switch 7 stages	B

Position 12

Accessory Bell Alarm	Accessory Push Button Cover	Code
no	no	X
yes	no	A
yes, with lockout	no	B
no	CLOSE pb	C
yes	CLOSE pb	D
yes, with lockout	CLOSE pb	E
no	OPEN pb	F
yes	OPEN pb	G
yes, with lockout	OPEN pb	H
no	CLOSE & OPEN pb	J
yes	CLOSE & OPEN pb	K
yes, with lockout	CLOSE & OPEN pb	L

Position 13

Accessory	Code	
none	X	
Shunt Trip-2 (Requires 7 stage aux. switch)	n	(See "Shunt Trip-1" codes—only those marked ① are available for 2nd shunt trip)

Position 14

"A - Disc" *(See Note 3 Below)*	Hidden Close PB (E/O only)	Operation Counter	Remote Charge Indicator	Code
No	No	No	No	X
No	No	No	Yes (N.O.)	A
No	No	Yes	No	B
No	No	Yes	Yes (N.O.)	C
No	Yes	No	No	D
No	Yes	No	Yes (N.O.)	E
No	Yes	Yes	No	F
No	Yes	Yes	Yes (N.O.)	G
Yes	No	No	No	H
Yes	No	No	Yes (N.O.)	J
Yes	No	Yes	No	K
Yes	No	Yes	Yes (N.O.)	L
No	No	No	Yes (N.C.)	R
No	No	Yes	Yes (N.C.)	S
No	Yes	No	Yes (N.C.)	T
No	Yes	Yes	Yes (N.C.)	V
Yes	No	No	Yes (N.C.)	W
Yes	No	Yes	Yes (N.C.)	Y

Note 3: "A-Disconnect" (A-Disc) — the 36 point A-Disc is automatically supplied whenever any of the following accessories/features are ordered: **zone selective interlock, shunt trip, auxiliary switch, bell alarm, under-voltage, electric lockout, E/O, MVT PM.** Select the A-Disc if 4-wire GF is required or if a breaker is to be "PM Ready" and none of the above accessories/features are ordered. **"PM Ready" wiring includes inputs for 24vDC auxiliary power, communications, and 3 phase voltage.**

Position 15

Future use

Guideform Specifications

Legend

[a/b/c] - Required items or features
(Must select either a, b, or c)
< > - Optional items or features
(May select one or more of these items)
( ) - Specification notes, clarifications
(No selection applicable)

Rating

The type AKD-10 Low Voltage Switchgear shall be rated { } Volts, 3-phase, [3-wire/4-wire with 50% neutral/4-wire with 100% neutral], [50/60] Hz.

Enclosure

The switchgear shall be furnished with an [indoor NEMA 1/ non-walk-in outdoor NEMA 3R/walk-in outdoor NEMA 3R] enclosure.

General

The switchgear shall be completely factory assembled and metal enclosed. It shall consist 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 shall be designed, manufactured, and tested in accordance with ANSI C37.20.1 switchgear standards and shall be listed and labeled to UL-1558 <and CSA C22.2>. Low voltage power circuit breakers shall conform to ANSI C37.13 standards and shall be UL listed and labeled.

Utility metering

A utility metering compartment shall be supplied to meet the requirements of {name of the utility}.

Service entrance

Service entrance shall comply with UL 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 [3- wire/4-wire], [800A/1600A/2000A/ 3200A/4000A/5000A], [main cable connection with [mechanical/compression] lugs/transition to a GE transformer/ Spectra busway connection which will include cutout in the switchgear top plate].

Main metering

Provide hinged instrument panel for main metering in the top compartment. The instrument panel shall contain the following devices:

Multi-function digital devices (select all that apply):

- GE POWER LEADER™ Modbus® Monitor
- GE POWER LEADER EPM 6000
- GE POWER LEADER EPM 9xxx Series
- GE-Multilin PQM II Power Quality Meter

Discrete analog devices (select all that apply):

- Ammeter switchboard type, 1% Accuracy, 250° scale
- Voltmeter switchboard type, 1% Accuracy, 250° scale
- Ammeter switch
- Voltmeter switch
- Wattmeter
- Varmeter
- Power factor meter
- Watthour meter [2/2½/3] elements <with demand register>
- Current/voltage test block and plug PK-2
- Potential transformers with primary fuses
- Current transformer {Primary rating} to 5A
- Transducer <current> <voltage> <Watts> <Vars>
- Pilot lights
- Breaker control switch

Structure

The structure shall be listed under UL-1558 <CSA C22.2> 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. Individual vertical sections 22", 30" and 38" wide shall be constructed of bolted 11-gauge modular designed steel frames with removable plates. Each breaker compartment shall be isolated completely from other breaker compartments by grounded metal barriers. Barriers shall isolate the breaker compartment from the busbar system.

The switchgear shall be provided with <UL service entrance label> <incoming line isolation> < side barriers between section>.

<Pull boxes shall be supplied for the width and depth of the cable compartment and shall be [15/22/29] inches high and include screw cover plates.>

<Cable supports for each vertical section shall be provided.> <Drip-proof roof for the indoor equipment is to be provided.> (Note: LEADS out below only and no integral breaker lifting device when drip-proof construction is supplied). <Integral breaker lifting device shall be rail mounted on top of equipment, hand-operated and movable.>

[Bolted covers/ Full-height hinged covers which can be bolted closed] shall be provided for each cable compartment. A front hinged door with quarter-turn latch <and padlock provision> shall be provided for each breaker and metering compartment.

<Space heaters shall be provided in each vertical section (1000W 240V@ 120V).>

Paint shall be light gray epoxy electrodeposition ANSI 61. Paint qualification test shall be per UL-1558 and ANSI C37.20.1.

Auxiliary/transition section(s) shall be supplied and equipped with [devices as shown on the appropriate drawings/devices as herein described/ all necessary devices requested to perform the specified breaker and equipment functions] including

<auxiliary relays> <primary and control circuit fuse blocks> <potential transformers> <control power transformer>. The section(s) shall have hinged doors over each compartment.

Rear cable and terminal compartment for cable installation and termination shall be provided. 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 pad-locking provisions, asphalt base undercoating on the exterior bottom, interior lights, space heater in each vertical section, ground-fault circuit interrupter receptacle, light switch, and space heater switch. Provide walk-in enclosure to include 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 operation crank <hinged rear doors with lockable T-handle and three point latch>. Front doors shall be provided at each end of the walk-in enclosure. The aisle access door at one end shall be the width of two adjacent sections to allow easy installation or removal of power circuit breakers from the enclosure. This “double wide” opening shall have two doors that are hinged on opposite sides. One of the doors shall be equipped with a panic latch mechanism. All front doors shall be capable of being padlocked. Provide <wire mesh over louvers and rodent guards> <thermostat> <humidistat> <[3/5/7.5/10] kVA control power transformer>.

Bus bars

Main bus and riser bus will be fully isolated from the breaker, instrument and auxiliary compartments. The bus bar material shall be copper, fully [tin-plated/ silver plated] after fabrication, bolted at the connections between the vertical bus and horizontal bus, and 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-plated/ silver plated] copper. The bus arrangement shall be designed to permit future additions.

The vertical bus shall be held rigid in a support structure of non-hygroscopic and flame retardant molded glass reinforced polyester.

<An insulated / isolated bus system, which fully insulates the horizontal main bus with a fluidized epoxy coating and isolates each phase of the vertical riser bus with molded polyester glass barriers, shall be provided. Main bus joints shall be accessible through removable / replaceable covers. No live connections shall be accessible from the rear except the breaker load side terminals.>

(Note — Vertical bus in 4000A breaker sections is either furnished as bare bus or with bus compartment barriers.)

<Vertical and horizontal buses shall be isolated from the cable compartment by glass reinforced polyester barriers. No live connections shall be accessible from the rear except the breaker load side termination.>

Continuous current rating will be determined by temperature rise and limited by ANSI standards and will be demonstrated by design tests. If a main circuit breaker, bus tie circuit breaker, or an incoming bus duct or cable is provided, the continuous rating of the bus shall be equivalent to the frame size rating of the main breaker, bus tie breaker or incoming bus duct or cable. All line and load side bussing shall be rated to carry the full frame size continuous current rating of the breaker to which they are connected. In addition, breaker load side bars shall be insulated.

Breaker primary connections shall be silver-plated copper-to-copper. The bus bars of the main bus are to be braced to withstand mechanical forces exerted during a short circuit of [65kA/100kA/150kA/200kA] RMS symmetrical. Other buswork shall 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 side 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 compartment with grounded metal barriers at the top, bottom, front and sides and with flame retardant, track resistant glass reinforced polyester base barrier at the rear. Each compartment shall be equipped with drawout rails, stationary breaker contacts, mechanical interlocks, and necessary control and indicating devices. A guiderail system shall be used to ensure accurate alignment of the breaker primary and secondary disconnects during drawout operation. The drawout 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 disconnects. Positive mechanical interlocks shall prevent the breaker from being racked in or out unless the breaker is open, 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 or test positions.

The drawout mechanism shall provide for four distinct positions of the circuit breaker: CONNECT, TEST, DISCONNECT, and WITHDRAWN. The drawout mechanism shall be capable of being operated without opening the cubicle door and an indicator shall be provided on the front of the breaker to show the position of the circuit breaker. Breaker doors shall be provided without ventilation slots and shall be able to be closed when the breaker is in any of the above mentioned positions.

Grounding of the breaker frame to the switchgear shall be maintained throughout the travel of the drawout mechanism. Padlocking provisions shall permit locking of the breaker in either the test or disconnected position. The drawout rails shall accept up to three padlocks to preclude the unauthorized installation of a circuit breaker into an empty cubicle.

<Compartment doors shall be capable of being padlocked.> <Position switch with [2NO-2NC / 6NO-6NC] contacts shall be provided.> <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> breaker compartments of double ended substations <and all feeder breakers>>. (Note that a 1600A frame fused breaker with 2500A current limiting fuses does not allow the use of a shutter)Each breaker compartment shall be equipped with a steel auxiliary panel that shall be used for mounting breaker control circuit fuses, pilot lights and breaker control test switches. Direct access to these control circuit devices shall be provided to facilitate routine maintenance and quick and safe replacement of fuses and lamps without opening the breaker cubicle door or panel. The auxiliary panel shall contain an engraved breaker circuit nameplate, <pilot lights for breaker open/closed indication> <fuses for breaker close and trip circuits> <toggle switches for testing the breaker close and trip circuits when the breaker is in the test position>.

Each breaker cubicle shall contain a rugged, positive rejection system so that only the breaker frame for which the cubicle was designed can be inserted.

When specified for future breaker, the compartment shall be completely equipped for the future addition of a power circuit breaker element including all specified electrical connections. A re-usable metal barrier shall be provided for the opening in the breaker compartment door. <Field convertible blank or space compartments for [800/ 1600/ 2000] amp breakers shall be supplied as specified or as shown on the drawings. The space compartment shall have line-side bus connections only. Load-side bus, drawout rails, secondary disconnects and cubicle door with the breaker cutout shall be available for field installation at a later date.>

Circuit breakers

Circuit breakers shall be individually mounted, drawout, low voltage power circuit breakers. They shall meet the requirements of ANSI C37.13, C37.16, C37.17, C37.50, and shall be listed and labeled to UL-1066 <and CSA C22.2.>

Circuit breakers shall be manually or electrically operated, with features and accessories described in this specification. Breakers shall have a maximum voltage rating of 635 Vac (600 Vac for integrally fused breakers) and shall be rated to carry 100% of the current rating of the breaker continuously. Breakers shall have minimum interrupting ratings as shown on the drawings.

Circuit breakers shall be metal frame construction. The interrupting mechanism shall contain arc chutes constructed to suppress arcs and cool vented gases. Interphase barriers of insulating material shall be provided to isolate each pole of the breaker.

Circuit breakers shall have true 30 cycle withstand capability equal to its short time interrupting rating to help assure selectivity with downstream devices and minimize nuisance tripping when closing into high inrush loads. The breaker shall not use a hidden instantaneous or making current release to achieve its short time withstand ratings.

Breakers shall contain a true two-step stored energy mechanism providing quick-make, quick-break operation capable of charging-after-close operation. It shall be possible to discharge the closing springs without closing the main contacts. Maximum closing time shall be 5 cycles at nominal control voltage.

Each breaker shall include a flush-mounted, retractable charging handle and close / open push buttons. The manual charging handle shall be able to be used to complete charging of an electrically operated breaker in the event control power is lost during the charging operation. All manual control operators (charge / close / open) for the breaker shall be accessible from the front of the breaker when it is installed in a cubicle, with the cubicle door closed. Complete breaker operating status shall be available at the front of the breaker. Indicators in the breaker escutcheon shall provide closing spring status (charged / discharged), breaker main contact status (open / closed) and breaker drawout position (connect / test / disconnect). Each breaker shall have standard padlocking provisions, on the front of the breaker, to lock the breaker open and mechanically trip-free. The padlock provision shall accept up to three padlocks with 1/4 to 3/8" diameter shank.

The breaker trip unit shall be front mounted and shall allow full access to all trip unit information including trip status, pickup and delay settings, trip targets, and metering (where applicable) without opening the breaker cubicle door. A removable, sealable cover shall be provided over the trip unit to limit access to the trip unit. Trip settings, metering information and trip target information shall be accessible with the sealable cover installed. Trip unit settings cannot be changed unless the sealable cover is removed.

Each drawout breaker shall have provisions for up to 72 dedicated secondary disconnect points. All breaker control circuits as well as inputs and outputs for the trip unit shall be wired through the secondary disconnects. Secondary disconnect points shall be self-aligning and automatically couple with mating points in the breaker cubicle when the breaker is in the “test” or “connect” position.
Circuit breakers shall employ a rejection system that will only allow breakers of the correct ampere rating to be installed in the cubicle. A breaker with a higher short circuit interrupting rating shall be allowed to be mounted in the cubicle provided it has the same frame rating. Integrally fused breakers shall not be allowed to be mounted in a cubicle intended for an unfused breaker. Breakers shall be

equipped with a rugged guide bar that will ensure alignment of the primary and secondary disconnects as the breaker is being racked into the test and connect positions. Drawout breakers shall be equipped with wheels that will allow the breaker to be rolled into cubicle once it is installed on the drawout rails.

Standard mechanical interlocks shall be provided to prevent moving the breaker from the connect, test, or disconnect position unless the breaker main contacts are open. The breaker shall be prevented from being closed during any racking
operation and shall remain trip-free except when it is in the test or connect positions. A mechanical interlock shall discharge any energy stored in the closing springs before the breaker can be withdrawn from its cubicle. A test position shall be provided to permit operating the breaker while it is disconnected from power circuit.

Detailed specifications

This specification covers GE WavePro™ low voltage power circuit breakers, types WPS, WPH, WPX, WPF.

The continuous current frame ratings shall be 800, 1600, 2000, 3200, 4000, 5000 amperes.

Circuit breakers shall be manually or electrically operated as shown on the drawings.

Control voltage for electrically operated breakers shall be ___________volts <ac> <dc>

System voltage ______volts ac <50> <60> Hz
3Ph <3W> <4W>

Circuit breaker RMS symmetrical interrupting rating __kA at ___volts

Circuit breakers shall be equipped with the following accessories:

- Auxiliary switch <3NO/3NC>, <6NO/6NC> contacts.
- Shunt trip, voltage ________.
- 2nd shunt trip, voltage _______. (800-4000A frames only)
- Undervoltage release, voltage ________. <with time delay>
- Electric lockout device to disable manual closing, voltage _________.
- Bell alarm <with> <without> lockout, two-SPDT contacts and mechanical target, resettable from the front of the breaker.
- Non-resettable operations counter.
- Remote charge indicator contact (1-NO) for electrically operated breakers only .
- "Hidden-on" (limited access) close button.
- Remote close accessory for manually operated breakers, voltage _________.
- Circuit breakers equipped with non-communicating trip units (Power+™ or MicroVersaTrip Plus™) shall be "power management ready" to accept easy upgrade to MicroVersaTrip PM™ trip unit without modifications to the circuit breaker.
- A maintenance video tape shall be available for use as a supplement to the breaker installation and maintenance manuals. The video shall cover acceptance, installation and operation of the breakers, safety features, accessory removal and replacement, arc chute removal/replacement and contact inspection and maintenance.

Trip devices

Power+™ trip unit

1. Each circuit breaker shall be equipped with a protective trip unit system to open the breaker for overloads, short circuits <and ground faults> as specified in the following subparagraphs. The protective trip unit system shall consist of a solid-state, microprocessor-based trip unit, current sensors, trip actuator and interchangeable rating plugs.

2. As a minimum, the trip unit shall have the following features and functions:
   a. The housing shall be a metallic enclosure to protect against magnetic interference, dust and other contaminants.
   b. The protective system shall have reliable programmable controls with repetitive accuracy and precise unit settings. Overcurrent characteristics (pickup and delay) shall be selected via rotary switches with detented settings.
   c. All current sensing shall employ true rms technology for detecting overloads, <short time> overcurrent conditions and <ground fault conditions>.
   d. The optional Target Module shall be equipped with long-life lithium batteries - with automatic time delay shut-off feature - to provide observation of trip targets. The Target Module and batteries shall not be required for the trip unit to provide its protective functions.
   e. UL listed and CSA certified field installable, interchangeable rating plugs. It shall not be necessary to change or remove the trip unit to change the trip rating. Rating plugs shall contain rejection features to prevent installation of a plug with an incorrect current sensor rating. Rating plugs shall also be used to provide the trip unit with ground fault protection. Rating plugs shall be available with or without ground fault pickup and delay setting switches. It shall be possible to add ground fault protection to a trip unit by simply replacing the rating plug.
   f. Integral test jack for connection of a battery pack or test kit to the breaker.
   g. (When specified) the ground fault function shall contain a memory circuit to integrate low level arcing fault currents with time to sum intermittent ground fault current spikes.
   h. A cover with provisions for sealing the rating plug and trip unit to make the installation tamper-resistant. All trip unit settings, ratings, and target information shall be capable of being viewed with the cover in place.
   i. The unit shall be dual-rated for both 50Hz and 60Hz operation. Noise immunity shall meet the requirements of ANSI Standard C37.90.2
   j. The trip unit shall display trip targets for longtime, short time, instantaneous and ground fault trips (with optional Target Module)

3. The trip units for the main and tie breakers shall include the following protective functions:
   a. Adjustable long time current settings.
   b. Adjustable long time delay with four time delay bands.
   c. Long time pickup warning indicator (with optional Target Module).
   d. Trip targets for overload, short circuit <and ground fault> (with optional Target Module).
   e. Adjustable short time pickup and delay, with three delay bands, and switchable I^2t ramp.
   f. SELECT ONE OF THE FOLLOWING IF GROUND FAULT PROTECTION IS REQUIRED:
      1) <Adjustable ground fault pickup and time delay, with three delay bands, and switchable I^2t ramp.>
      2) <Defeatable ground fault function with adjustable pickup and time delay, with three delay bands, and switchable I^2t ramp.>

4. The trip units for feeder breakers shall include the following protective functions:
   a. Adjustable long time current settings.
   b. Adjustable long time delay with four time delay bands.
   c. Long time pickup warning indicator (with optional Target Module).
   d. Trip targets for overload, short circuit <and ground fault> (with optional Target Module).
   e. <Adjustable short time pickup and delay, with three delay bands, and switchable I^2t ramp> and/or <adjustable instantaneous pickup>.
   f. SELECT ONE OF THE FOLLOWING IF GROUND FAULT PROTECTION IS REQUIRED:
      1) <Adjustable ground fault pickup and time delay, with three delay bands, and switchable I^2t ramp.>
      2) <Defeatable ground fault function with adjustable pickup and time delay, with three delay bands, and switchable I^2t ramp.>

5. Current sensors shall be mounted on the breaker frame and shall use encapsulated construction to protect against damage and moisture. <For ground fault protection of a four-wire power system, a fourth - neutral current - sensor shall be mounted in the cable compartment, and shall be compatible with the phase current sensors.>

MicroVersaTrip Plus™ and MicroVersaTrip PM™

1. Each circuit breaker shall be equipped with a protective trip unit system to open the breaker for overloads, short circuits <and ground faults> as specified in the following subparagraphs. The protective trip unit system shall consist of a solid-state, microprocessor-based trip unit, current sensors, trip actuator and interchangeable rating plugs.

2. As a minimum, the trip unit shall have the following features and functions:
   a. The housing shall be a metallic enclosure to protect against magnetic interference, dust and other contaminants.
   b. The protective system shall have reliable programmable controls with repetitive accuracy and precise unit settings.
   c. All current sensing shall employ true rms technology for detecting overloads, <short time> overcurrent conditions, <and ground fault conditions>.
   d. A high contrast, liquid crystal display - LCD - unit shall display settings, trip targets, and the specified metering displays. The trip unit shall be equipped with long-life lithium batteries - with automatic time delay shut-off feature - to provide both programming and observation of trip targets or other functions when the breaker is de-energized.
   e. A multi-button keypad to provide local setup and read-out on the LCD of all trip settings, metering values, and trip targets.
   f. UL listed and CSA certified field installable, interchangeable rating plugs. It shall not be necessary to change or remove the trip unit to change the trip rating. Rating plugs shall contain rejection features to prevent installation of a plug with an incorrect current sensor rating.
   g. Integral test jack for connection of a battery pack or test kit to the breaker.
   h. (When specified) the ground fault function shall contain a memory circuit to integrate low level arcing fault currents with time to sum intermittent ground fault current spikes.
   i. A cover with provisions for sealing the rating plug, the trip unit, and the “ENTER” key on the protective trip unit to make the installation tamper-resistant. All trip unit settings, ratings, and target information shall be capable of being viewed with the cover in place.
   j. The unit shall be dual-rated for both 50Hz and 60Hz operation. Noise immunity shall meet the requirements of ANSI Standard C37.90.2.
   k. The trip unit shall have an integral, resettable trip counter to record the number of long time, short time, instantaneous and ground fault trips. Trip target information shall include fault current magnitude and phase for long time and short time trips and fault current magnitude (as a function of the sensor rating) for ground fault trips. When the trip unit is supplied with additional protective relay functions, the display shall also provide target indication for each type of protective relay trip.
   l. The trip unit shall display trip targets for longtime, short time, instantaneous and ground fault trips.
   m. All trip unit settings and trip target information shall be stored in nonvolatile memory.

3. The trip units for the main and tie breakers shall include the following protective functions:
   a. Adjustable long time current settings.
   b. Adjustable long time delay with four time delay bands.
   c. Long time pickup warning indicator.
   d. Trip targets for overload, short circuit <and ground fault>.
   e. Adjustable short time pickup and delay, with three delay bands, and switchable I^2t ramp.
   f. SELECT ONE OF THE FOLLOWING IF GROUND FAULT PROTECTION IS REQUIRED:

1) <Adjustable ground fault pickup and time delay, with three delay bands, and switchable I^2t ramp.>
2) <Defeatable ground fault function with adjustable pickup and time delay, with three delay bands, and switchable I^2t ramp.>

g. OPTIONAL: <Switchable short time / instantaneous and ground fault protection.>
h. OPTIONAL (Select one if req'd): Zone selective interlocking <for ground fault only> <for both ground fault and short time>.

4. The trip units for feeder breakers shall include the following protective functions:
   a. Adjustable long time current settings.
   b. Adjustable long time delay with four time delay bands.
   c. Long time pickup warning indicator.
   d. Trip targets for overload, short circuit <and ground fault>.
   e. <Adjustable short time pickup and delay, with three delay bands, and switchable I^2t ramp> and/or <adjustable instantaneous pickup>.
   f. SELECT ONE OF THE FOLLOWING IF GROUND FAULT PROTECTION IS REQUIRED:
      1) <Adjustable ground fault pickup and time delay, with three delay bands, and switchable I^2t ramp.>
      2) <Defeatable ground fault function with adjustable pickup and time delay, with three delay bands, and switchable I^2t ramp.>
   g. OPTIONAL: <Switchable short time / instantaneous and ground fault protection.>
   h. OPTIONAL (Select one if req'd): Zone selective interlocking <for ground fault only> <for both ground fault and short time>.

5. The trip units shall include the following metering functions, which shall be displayed on the LCD:
   a. Current, rms (A or kA), each phase 2.0% accuracy.
   b. OPTIONAL (Note - if any of the following are included, all will be included)
      1) Voltage, rms (V), line-to-line or line-to-neutral, +/- 1.5% accuracy.
      2) Energy (kWh, MWh, GWh), total, +/-3.5% accuracy, user resettable.
      3) Demand (kWh, MWh, GWh) over an adjustable time period of 5 to 60 minutes, +/- 3.5% accuracy.
      4) Peak Demand (kW, MW), +/- 3.5% accuracy, user resettable.
      5) Real power (kW, MW), line-to-line, line-to-neutral, +/- 3.5% accuracy.
      6) Total (apparent) power (kVA, MVA), line-to-line, line-to-neutral, +/-3.5% accuracy.
      7) Frequency (Hz), +/-1Hz accuracy.

6. OPTIONAL: The trip unit shall include all of the following protective functions. However, it shall be possible to disable, by user programming, any combination of unwanted protective functions.
   a. Undervoltage, adjustable pickup - 50 to 90%, adjustable delay - 1 to 15 seconds.
   b. Overvoltage, adjustable pickup - 110 to 150%, adjustable delay - 1 to 15 seconds.
   c. Voltage unbalance, adjustable pickup - 10 to 50%, adjustable delay - 1 to 15 seconds.
   d. Current unbalance, adjustable pickup - 10 to 50%, adjustable delay - 1 to 15 seconds.
   e. Reverse power, selectable direction, adjustable pickup - 10kW to 990kW, adjustable delay - 1 to 15 seconds.

7. OPTIONAL: The trip unit shall include communication capability as follows:
   a. The trip unit, through dedicated secondary terminals on the breaker, shall provide a communication port for communication with and access to a remote computer via the breaker supplier's standard communication network and protocol.
   b. All metering, setpoints, protective trip counts, and other event signaling shall be retrievable by the remote computer.

8. Current sensors shall be mounted on the breaker frame and shall use encapsulated construction to protect against damage and moisture. <For ground fault protection of a four-wire power system, a fourth - neutral current - sensor shall be mounted in the cable compartment, and shall be compatible with the phase current sensors.>

Devices

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

Wiring

Control wiring shall be #14 type SIS, enclosed in top and vertical metal wiring troughs. Necessary fuse holders within the switchgear shall be furnished when required. Terminal blocks for external connections shall be heavy duty, molded, one-piece type, rated 600volts, 50amps and shall be mounted in the rear cable compartment, easily accessible, away from the runbacks and cable terminals, and be provided with a bolted steel cover to enclose the terminal blocks. Control wires leaving the switchgear shall be terminated on terminal blocks with suitable numbering strips. <Marking sleeves shall be provided on all switchgear control wiring and shall be heat stamped with the wire origin and/or destination information.> Interconnection control wiring across shipping splits shall be accomplished by terminal blocks in the control wiring trough on the top of the equipment.

Ground bus

A copper [800A/1600A] ground bus is to be provided and secured to each vertical section structure. It shall extend the entire length of the switchgear and be equipped with a 4/0 terminal for connection to purchaser's ground system. A lug strap shall be provided for feeder ground terminals.

Handling

Switchgear shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and bolted directly to the floor.

Protection and control

Automatic throwover equipment shall be provided to transfer a load bus to an alternate source [immediately/ with a time delay] after detection of an abnormal condition on the normal source. Return to normal shall be [manual/ automatic with time delay]. The transfer scheme shall include [two main breakers and one tie breaker in a 3-breaker system/the normal main breaker and the emergency main in a 2-breaker system]. <Transfer logic shall be incorporated into a programmable logic controller mounted in the switchgear. When ac control power is derived within the switchgear, a "ride through" power supply shall be provided with the PLC so that the programs are executed without interruption during an undervoltage condition.> (Refer to "Automatic Transfer Equipment" description on page 31 for more details.)

Miscellaneous

<A portable breaker lifting device shall be provided.> <A portable static full function test set to check the time current characteristics of the trip unit shall be provided.>

<Provide infrared scanning windows in the rear covers of switchgear sections to facilitate the use of an IR camera for purposes of thermal scanning cable terminations. The IR windows shall be an IR "transparent" mesh for indoor NEMA 1 applications or an IR crystal window for outdoor NEMA 3R applications. IR windows shall have a gasketed cover plate secured with tamper-resistant hardware.>

<Provide a remote racking device to allow movement of the drawout circuit breaker between the CONNECT and DISCONNECT positions from a distance of up to 30 feet from the front of the switchgear. The remote racking device shall be powered from a 120 volt AC source and shall attached to the front of the circuit breaker or to the circuit breaker frame. Attaching the remote racking device shall not require the breaker cubicle door to be opened. Drawout operation of the circuit breaker with the remote racking device shall be accomplished with the breaker cubicle door closed and latched.>

Documentation

Standard print package shall include front view, floor plan, single-line diagram, installation diagram, elementary diagram showing 3-line power circuit, metering and control circuits, switchgear internal wiring diagrams, and equipment bill of material.

Standards and references

Underwriters' Laboratories, Inc.

UL 1558 – Metal-enclosed low voltage power circuit breaker switchgear.
Order from:
UL Publications Stock
333 Pfingsten Road
Northbrook, IL 60062

National Electrical Manufacturers Association (NEMA)

(NEMA has "approved and adopted" the parallel ANSI switchgear and breaker standards in lieu of continued support of the SG3 and SG5 standards.)
SG-5 – Power switchgear assemblies.
SG-3 – Low voltage power circuit breakers.
Order from:
NEMA Publications
155 East 44th Street
New York, NY 10017

Canadian Standards Association (CSA)

CSA-C22.2 – Switchgear Assemblies
Order from:
Canadian Standards Association
178 Rexdale Blvd.
Rexdale, Ontario, Canada M9W R3

American National Standards Institute (ANSI)

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, NY 10018

National Electrical Code (NEC)

Order from:
National Fire Protection Association
Batterymarch Park
Quincy, MA 02269

Other appropriate publications

Technical bulletins
DET-167 – WavePro™ Low Voltage Power Circuit Breaker Application Guide
DET-195 – WavePro Low Voltage Power Circuit Breaker Data Sheet
DET-169 – WavePro Low Voltage Power Circuit Breaker Catalog Number Guide
DEH-178 – MicroVersaTrip Plus™ and MicroVersaTrip PM™ Trip Unit Users Manual
DEH-179 – Power+™ Trip Unit Users Manual

General installation and maintenance
DEH-194 – AKD-10 Low-Voltage Switchgear Installation Manual
DEH-136 – WP08/16/20 Maintenance Manuals
DEH-137 – WP32/40/50 Maintenance Manuals

Installation and operating instructions
DEH-134 – WavePro Small Frame Users Manual WP08/16/20
DEH-135 – WavePro Large Frame Users Manual WP32/40/50

Renewal parts bulletins
DEF-004 – WP08/16/20
DEF-005 – WP32/40/50

Time Current Curves
DES-001 – Power+, MicroVersaTrip Plus and PM – LSI
DES-002 – Power+, MicroVersaTrip Plus and PM – GF
DES-026 – MicroVersaTrip Plus and PM – Non-std. GF

Notes

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www.geelectrical.com

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