

GE Energy

# Spectra Series® Switchboards



imagination at work

# Spectra Series® Switchboards

## Contents

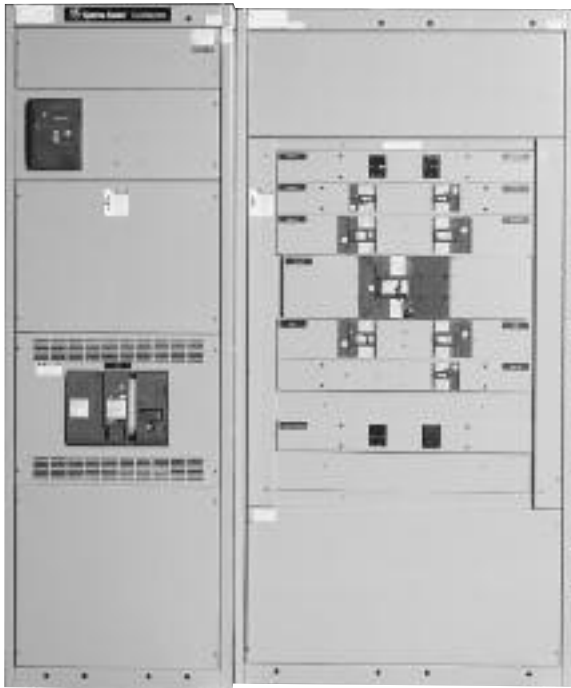
<b>Section 1 - Introduction</b> .....	2
<b>Section 2 - Features and Characteristics</b> .....	5
<b>Section 3 - Terminology</b> .....	9
<b>Section 4 - Sizing and Dimension</b>	
4.1 General .....	14
4.2 Typical Drawing .....	17
4.3 Class 1 Switchboard - Group Mounted.....	18
4.4 Class 2 Individually Mounted Main Group Mounted Feeders/ Class 5 Individually Mounted Switchboard .....	22
4.5 Utility Metering Compartments.....	24
4.6 Outdoor Enclosures.....	25
4.7 Instrument and Metering Arrangements.....	25
4.8 Busway Entrance .....	26
4.9 Low Voltage Transition Sections and Dual Voltage Switchboards .....	26
4.10 Conduit Entrance Space .....	27
4.11 Switchboard Weights .....	27
<b>Section 5 - Application Data</b>	
5.1 Standards/Codes/Ratings/Conditions .....	32
5.2 Protective Device Ratings .....	36
5.3 Power Break® II Circuit Breaker.....	38
5.4 WavePro™ Low Voltage Power Circuit Breakers .....	40
5.5 High Pressure Contact Switches.....	43
5.6 Molded Case Circuit Breakers .....	44
5.7 Fusible Switches.....	50
5.8 Surge Protective Device.....	51
5.9 Power Management Control System .....	52
5.10 Power Metering Products .....	52
5.11 Equipment Ground Fault Protection .....	54
5.12 Automatic Transfer Switches.....	57
5.13 Wire/Lug/Cable .....	63
<b>Section 6 - Additional GE Switchboard Offerings</b>	
Class 3 Switchboard.....	67
<b>Section 7 - CSI Specifications</b> .....	71
<b>Reference Publications</b> .....	80
<b>Appendix</b>	
Seismic Compliance Certification .....	81
Trip Units by Main Breaker and Functions .....	82

# Spectra Series® Switchboards

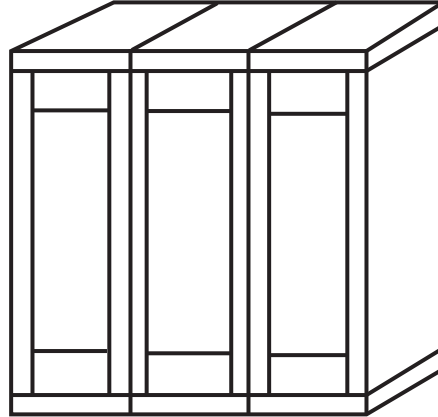
## Section 1 – Introduction

### Introduction

Spectra Series™ Switchboards offer a state-of-the-art design that provides the high quality, safety and reliability long associated with GE group-mounted switchboards. Spectra Series Switchboards are designed and manufactured to meet the stringent GE internal standards along with NEMA, NEC, UL and cUL requirements. In addition, Spectra RMS™ and Record Plus Circuit Breakers meet all NEMA, NEC, IBC Seismic, UL and cUL requirements, plus those for JIS and IEC.



### Spectra Series® Switchboards

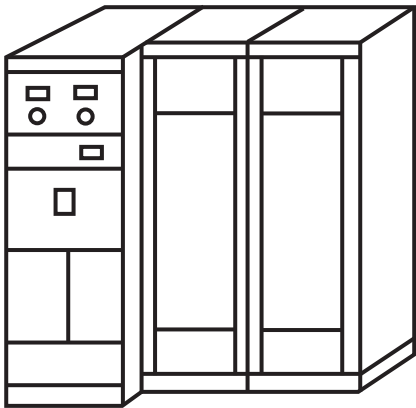


Class 1

- **Group-Mounted Main and Feeders Front-Connected**
  - 1200A Mains maximum
  - 1200A Feeders maximum
  - Rear alignment standard
  - Minimum depth 25"
  - Main lugs to 2000A
  - May be mounted against wall
- **Main and Feeder Devices Group-Mounted**
  - Molded case circuit breakers
  - Fusible switches type ADS (Spectra plug-in only)
  - Spectra RMS® molded case circuit breakers
  - Spectra RMS molded case circuit breakers with *microEntelliGuard*™ trip units
  - Record Plus molded case circuit breakers
  - Current-limiting circuit breakers
  - Integral ground fault with Power+, EntelliGuard TU and *microEntelliGuard*
  - Integral protective relay functions with EntelliGuard TU and *microEntelliGuard*
  - Integral network communications with EntelliGuard TU and *microEntelliGuard*
  - Ground fault alarm, neutral protection, ZSI and waveform capture

# Spectra Series® Switchboards

## Section 1 – Introduction



Class 2

- **Individually-Mounted Main, Group-Mounted Feeders Front Accessible or Front/Rear**

- 5000A Mains maximum (WavePro®)
- 1200A group-mounted feeders maximum
- Rear alignment standard or front and rear alignment
- Utility CT Compartments
- Main lugs to 6000A
- Depths: Mains 25" - 60" Feeders 25" minimum
- Plug-In or Bolt-On Construction for group-mounted feeders

- **Mains Individually-Mounted**

- Power Break® II insulated case circuit breakers 800-4000A with Power+ or EntelliGuard® trip units
- High pressure contact switches 800-4000A
- Integral ground fault with Spectra Series, Power Break Series and WavePro
- Integral protective relay functions with EntelliGuard TU
- Integral POWER LEADER network communications with EntelliGuard TU
- Bolted Pressure Switches 800 - 4000A
- WavePro low voltage power circuit breakers

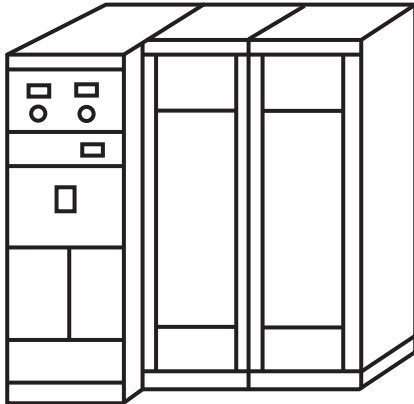
- **Feeder Devices, Group-Mounted**

- Molded case circuit breakers
- Fusible switches type ADS (Spectra plug-in only)
- Spectra RMS® molded case circuit breakers
- Spectra RMS molded case circuit breakers with *microEntelliGuard™* trip units
- Record Plus molded case circuit breakers
- Current-limiting circuit breakers
- Integral ground fault with Power+, EntelliGuard TU and *microEntelliGuard*
- Integral protective relay functions with EntelliGuard TU and *microEntelliGuard*
- Integral network communications with EntelliGuard TU and *microEntelliGuard*
- Ground fault alarm, neutral protection, ZSI and waveform capture

# Spectra Series® Switchboards

## Section 1 – Introduction

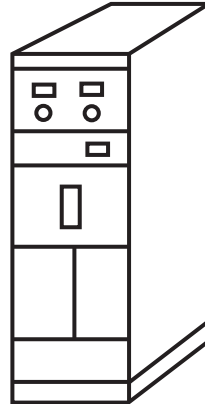
### AV3 Access Switchboards



Class 3

- **Features and Options**
  - Rear accessible
  - Front and rear alignment
  - Depths 50-60 inches
  - Molded case/insulated case/low voltage power circuit breaker mains
  - Molded case and insulated case distribution sections
  - Copper bus
  - Feeder operating handles “thru the door”
- **Main and Tie Devices - Individually Mounted**
  - Spectra molded case breaker up to 1200A
  - PowerBreak II insulated case breaker up to 4000A
  - WavePro low voltage power circuit breaker up to 5000A
- **Feeder Devices, Individually Mounted**
  - Spectra molded case circuit breaker - E (150A), F (250A), G (600A), K (1200A) frame breakers, 80 & 100% rated
  - Current limiting breakers
- **General Construction Features**
  - Tin plated copper main bus - standard, silver plating optional
  - 2000A silver plated copper vertical (riser) bus – standard in MCCB sections
  - Shutters available on ICCB and LVPCB main and tie breakers
  - 6000A main bus rating - maximum
  - Plug-in MCCB mounting with racking bolts - standard
  - Standard 30 cycle bus short circuit withstand rating up to 85ka allows LVPCB main w/o instantaneous trips
  - 200ka bus bracing available with fused main device
    - Bare bus standard
    - Optional insulated horizontal main bus with phase isolated vertical bus available in all sections
    - Bus sizing based on 1000A IN2 current density
    - 15/30/45 inch wide MCCB sections

### Spectra Series® Switchboards



Class 5

- **Individually-Mounted Mains and Feeders**
  - 800A - 4000A
    - HPC Switch
    - PowerBreak II
  - 400A - 1200A
    - Spectra Breaker
  - 800A - 4000A Bolted Pressure Switch
  - WavePro Breaker (Mains & Tie Devices only)
  - 800A - 5000A WavePro Breaker

*Note: For applications requiring insulated/isolated bus, generator control and extensive relaying refer to AV-3 or PowerBreak.*

# Spectra Series® Switchboards

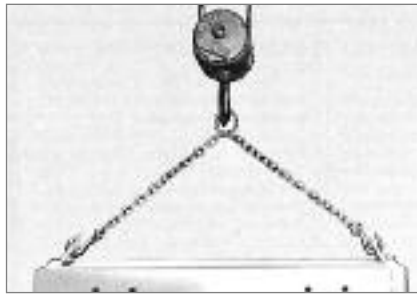
## Section 2 – Features and Characteristics

### Flexibility, Reliability, Simplicity & Safety

GE has designed a bus bar interior for use in Spectra Series™ (group-mounted) Switchboards and Spectra Series Power Panelboards.

The distribution section interior is the basic building block, designed for use with either fusible switches (plug-in only) or molded case circuit breakers, or both.

The modularity of Spectra Plug-in is possible because the interior is designed to accept device modules with spring-reinforced jaws and pressure-locked connections. The jaws and connections are an integral part of the branch modules.



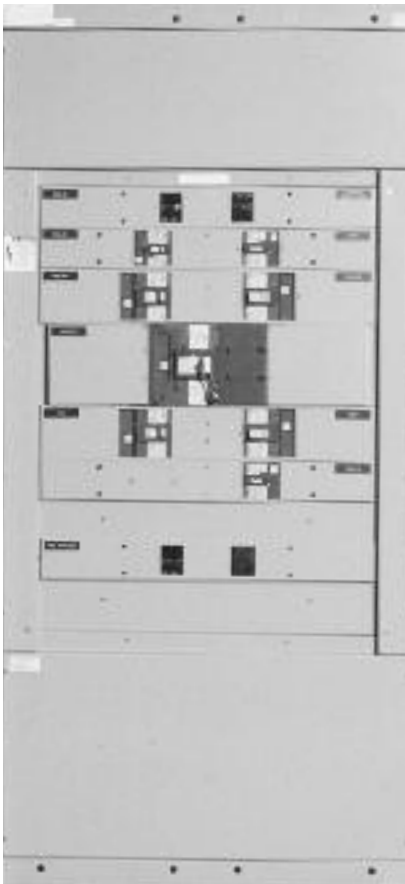
Standard lifting plates, shown, are optional (NEMA 1 only).



Spectra Series Plug-In™ circuit breaker modules accept standard off-the-shelf GE breakers and are available for single- or double-branch mounting (through 600A) without any modifications, assuring proper phase arrangement.



Spectra Series Plug-In branch fusible modules can be single- or double- (through 200A) mounted, two- or three-pole.



# Spectra Series® Switchboards

## Section 2 – Features and Characteristics

### Spectra Switchboard — Group-Mounted Interior Design

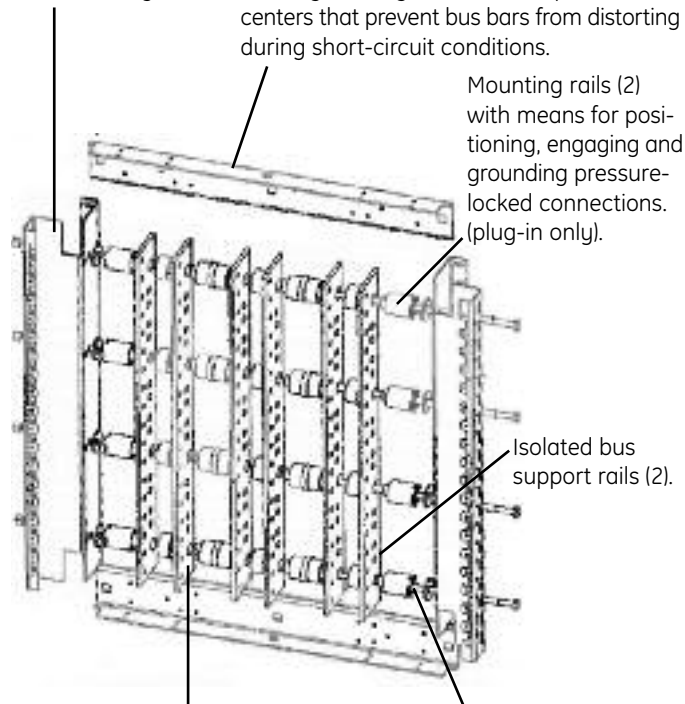
The vertical design of the bus maximizes convective heat transfer. The bus bar insulator system provides short circuit bracing to 200 kA, 600-volt spacing (without having to add baffles) and eliminates the need for any additional insulation.

### Spectra Plug-In

Mounting support brackets between bus support rails and mounting rails.

Double-insulated system consisting of bus support assemblies of molded, glass-filled polyester insulation and insulating tubes over high-strength steel bolts spaced on 7" centers that prevent bus bars from distorting during short-circuit conditions.

Mounting rails (2) with means for positioning, engaging and grounding pressure-locked connections. (plug-in only).



Standard bus is aluminum, heat rated per UL. Optional ratings include 750A psi or 600A psi aluminum and heat rated per UL, 1000A psi or 800A psi copper. All vertical bus bars are silver plated.

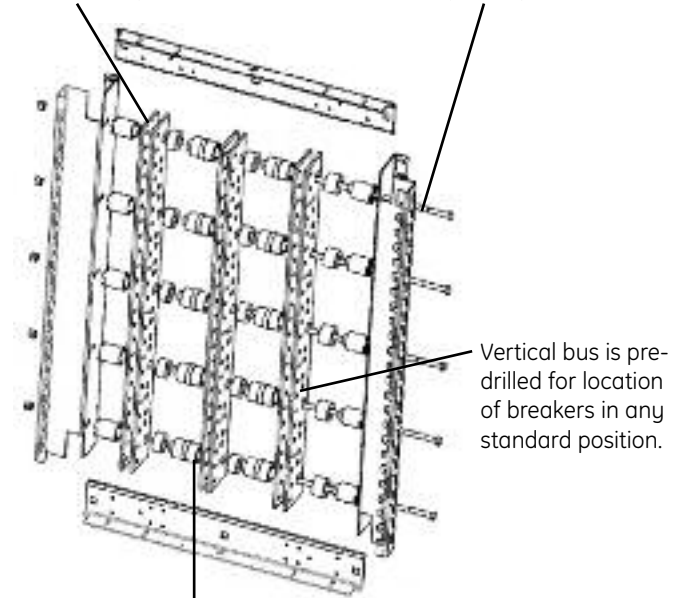
Interior cross-member supports for mounting rails and bus support rails.

Field changes are quick and easy.

### Spectra Bolt-In

Vertical bus oriented edge-wise for ease of bolted breaker strap connections.

Bolted connection between switchboard vertical bus and breaker primary connection.



Vertical bus is pre-drilled for location of breakers in any standard position.

Anti-turn device utilized at the bolted connection between the breaker strap and vertical bus.

### Spectra Plug-In™ Switchboard Construction

The universal interior has made possible a family of modular components that provide the flexibility unique to the Spectra Series™ product line. By utilizing modular assembly and pressure-locked connections to the interior, maintenance and tests are easier and faster.

This innovative design approach also facilitates field reconfiguration. Branch fusible units can be removed and circuit breaker units substituted.

Fusible switch and circuit breaker modules each consist of two assemblies: the protective device (fusible switch unit or molded case circuit breaker) and a connecting mechanism. The connecting mechanisms are the intermediate electrical/mechanical connections between the protective device and the bus structure in the interior. The fusible connecting mechanism is in the same housing as the fusible switch unit. The molded case circuit breaker connecting mechanism is separate from the breakers and is designed to accept standard GE circuit breakers.



# Spectra Series® Switchboards

## Section 2 – Features and Characteristics

The electrical connection is made utilizing spring-reinforced jaws that engage the bus bars. This type of proven design, long utilized in switchgear and busway, provides a reliable and superior electrical connection.

Mechanical connection is made with a positive, self-aligning, spring-loaded locking device bolted to each side of the mounting module. When the device module is inserted in the interior, this mechanism springs into place and positive engaging latches secure the module to the interior mounting rails.

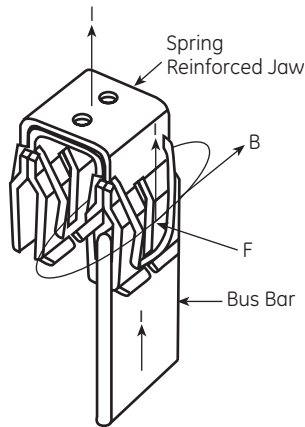
To prevent personnel from accidentally releasing the locked pressure connections, circuit breaker modules handles are bolted to each side of the module. Fusible modules are bolted directly to the interior mounting rails.



The circuit breaker mounting module has provisions for bolting various breaker ratings in place and barriers to divert ionized gases away from line terminals of opposite devices on the same module. Both types of connector-mounting modules are UL listed and CUL certified.



The fusible switch module has a self-aligning bracket screwed to the interior mounting rails.



$F = I (L \times B)$   
where  
F = Clamping Force  
I = Current  
L = Conductor Length  
B = Electromagnetic Field



The spring-reinforced jaw clamps onto the interior bus and maintains the electrical connection. At short circuit, a strong electro-magnetic field develops around the jaw. The resulting force increases the jaw pressure on the bus and maintains a secure connection. The design creates current paths and generates clamping forces as shown in the illustration.

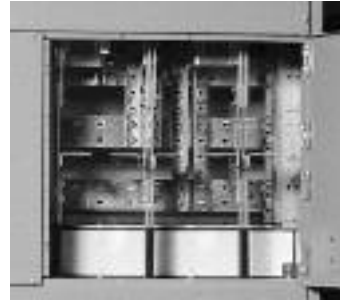


# Spectra Series® Switchboards

## Section 2 – Features and Characteristics

### Features

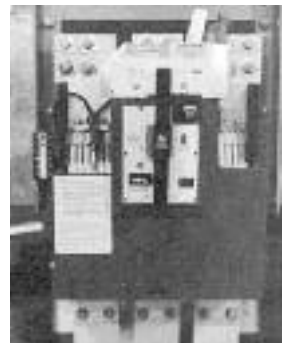
The main and utility CT compartments are designed to offer maximum flexibility. Individually-mounted main is available with Power Break II insulated case circuit breakers, 800A-4000A; high pressure contact switches, 800A-4000A; fusible switches, 400A-1200A; WavePro low voltage power circuit breakers, 800A-5000A; molded case circuit breakers, including *microEntelliGuard*, 400A-1200A; and bolted pressure switches. (800 - 4000A).



Standard utility current transformer compartments have barriers rear, top and bottom. Door has concealed hinges, three-point catch, with lockable and sealable handle. Optional side barriers are available. Current transformer compartments to meet other utility requirements are available.



A hinged door is standard on instrument and metering compartments.



Type HPC high pressure contact switches are available with ITI ground fault relay.



PCU units are available, allowing for motor starter applications up to 15hp. (plug-in only)



Power Breaker II circuit breakers with EntelliGuard TU and Power+ trip units are available as mains, submains, and ties in switchboards.

## Section 3 – Terminology

### Spectra Series Terminology

**30 cycle withstand** is the capability of the insulating and spacing materials to withstand fault currents up to 30 cycles or half of a second.

**Accessible** means not permanently closed in by the switchboard section structure, and capable of being inspected and maintained through access plates or doors without disturbing the switchboard section structure.

**Ambient Temperature** is the temperature of the surrounding medium that comes in contact with a fuse, breaker or conducting bus within a switchboard defined by UL 891 as 40°C for switchboard.

**Ampacity** is the amount of current in amps a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

**AMP Rating** is the amount of current a fuse will carry continuously without deterioration, or a circuit breaker without tripping and without exceeding temperature rise limits specified for a particular fuse or circuit breaker by NEC requirements and UL standards.

**Amp Setting**, adjustable varies the continuous current-carrying ability of a breaker through a predetermined range.

**Arcing Fault** is a high-impedance connection caused by current flowing through air between two live conductors.

**Arcing Time**, in a fuse, is the amount of time that elapses between the melting of the current-responsive element, such as a link, to the final circuit interruption. Arcing time is dependent upon such factors as circuit voltage and impedance.

**Available Short-Circuit Current** is the maximum rms (root-mean-square) symmetrical current at a given point in a power system, operating with maximum generating capacity and connected load, can deliver to any zero impedance short circuit applied at that given point.

**Blank Space Only** is specified when corresponding vertical bus device mounting and connecting straps are not furnished.

**Bolt-on** is a type of panelboard or switchboard interior where overcurrent devices require hardware to be fixed to the panel.

**Branch Circuit** is the circuit conductor between the final overcurrent device protection and the outlets or point of use.

**Bus Bar** is a solid aluminum or copper alloy bar that carries current to the branch or feeder devices in a power panelboard or switchboard. There is at least one bus bar for each phase of the incoming electrical service.

**Bus Stub** is a prefabrication provision manufactured in the switchboard for connection of incoming service or load busway.

**Class I**-Group mounted main and feeders.

**Class II**-Individually mounted main and group mounted feeders.

**Class III**-Individually mounted main and feeders with compartmentalization (not available in Spectra Switchboard.)

**Class V**-Individually mounted mains and feeders without compartmentalization.

**Compartment** is an area within a section that is so constructed as to isolate devices in that compartment from the surrounding area except for openings used for interconnections, control or ventilation.

**Compression Lug**, also called a crimp lug, is a lug that is crimped to hold cable.

**Continuous Load** is when the maximum current is expected to continue for three hours or more.

**Current Density** is rated current divided by the cross-section area of the conducting member (cable, bus bar, etc.) expressed in amps per square inch.

**Current Sensors** internally mounted current transformers (CT) used by circuit breakers to measure current. Produce lower secondary current than traditional CTs,

**Dead Front** construction is where energized parts are not exposed to a person on the operating side of the equipment.

# Spectra Series® Switchboards

## Section 3 – Terminology

**Distribution Switchboard** is any switchboard which is not UL listed for service entrance or classified as a main switchboard.

**Double-Branch** is mounting that has two fusible switch units or circuit breakers installed side by side.

**Draw-Out Mounted** device can be removed from the stationary portion of a switchboard without unbolting connections or mounting supports. Draw-out mounting is available in Power Break II and WavePro devices only.

**Electrically Operated** refers to an electrically operated mechanism to remotely open and close a circuit breaker and charge the spring. Typically used in automatic throwover schemes and automatic control schemes.

**Electrical Service or System** is the conductors and equipment which delivers energy from the electrical supply system to the wiring system of the premises served. The service or system consists of the number of phases, number of wires, voltages and amps. Type of service determines the number of poles on the main device, the number of poles valid for feeder or branch devices and the minimum voltages for 1-, 2-, or 3-pole breakers and fusible switches.

**Enclosure** is a constructed case to protect personnel against contact with the enclosed equipment and to protect the enclosed equipment against environmental conditions.

**Equipment Grounding** is the interconnection and grounding of electrical conduction material that either encloses or is adjacent to power conducting components.

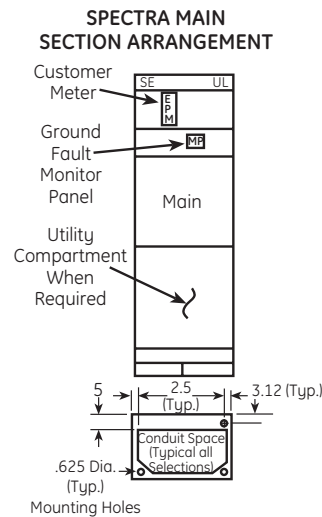
**Expansion Kit** is an assembled kit that can be installed in an empty side of a double-branch fusible switch unit to create a new fusible switch unit. It includes the handle, base plate, cover plate, load base and switch.

**Feeder Circuit** is all circuit conductors between the service equipment or the source of a separately derived system and the final branch-circuit overcurrent device.

**Filler Mounts** on side of fusible switch module, circuit breaker module, or between side trims to cover the front of the enclosure. The fillers plus trim comprise the enclosure front around the installed devices.

**Fire Pump Disconnect** serves only the code required fire pump. It must be connected ahead of any main device and sized to carry the locked rotor current of the fire pump per NFPA-20. It also must be located in an enclosure separate from other service disconnects.

**Frame Size** is the physical size of the breaker with a specific range of amp ratings. For example, an F Frame breaker is available in ratings of 70 amps to 250 amps in a 225 amp frame.



**Front Accessible** is a UL classification requiring that all bus and device connections are accessible from the front.

**Front Only Connected** is a UL classification requiring that all line & load connections can be made from the front of the switchboard.

**Front/Rear Access** is configured where rear access is required for some or all of the line and load connections.

**Front and Rear Line-Up** occurs when all sections in a switchboard lineup are the same depth and front and rear surfaces are aligned.

**Full Height Bus** refers to the maximum vertical bus length available for the group mounted panel section.

**Fully Rated Bus** refers to having the same ampacity for the horizontal bus across the whole line-up.

## Spectra Series® Switchboards

### Section 3 – Terminology

**Fuseholder or Fuse Block** is an assembly of fuse clips and insulation for mounting and connecting a fuse into the circuit.

**Fusible Switch** is a device that can switch off current flow and to which a fuse(s) is added to protect conductors.

**Ground Bus** is horizontal bus which is electrically continuous with the switchboard housing for termination of circuit ground conductor.

**Ground Fault** is a fault condition created when an energized conductor comes in contact with earth ground or metallic structure, or causes an arc current to flow to ground.

**Group (Panel)-Mounted** device is one of a closely grouped assembly of devices which is mounted on a common base or mounting surface utilizing panelboard type construction. The total assembly is then mounted in a switchboard combination or distribution section.

**Handle Lock Device** is a mechanism to insert a lock to prevent operation of a circuit protective device. Most commonly used to lock device in the open or off position for safety while performing maintenance.

**Heat Rise** is the maximum temperature a component in a switchboard can increase in temperature over a defined amount 65°C per UL 891.

**$I^2t$**  is the measure of heat energy developed within a circuit, in which  $I^2$  stands for effective let-through current squared and  $t$  is time in seconds.

**Individually Mounted** means device which is not panel-mounted and which may or may not be enclosed in its own compartment. Separated from other devices to minimize undesired influence from them. (i.e. GE Class 3 and PowerBreak Switchboard). Power Break II, HPC, WavePro and BPS devices are individually mounted in Spectra.

**Interior** refers to the side rails, bus bars and insulation system that mounts in the enclosure. It is energized through the main device (lugs, fusible switch or circuit breaker) and, in turn, energizes the installed circuit-protective devices (fusible switch or circuit breaker).

**Interrupting Rating** is the highest rms-rated current a fuse or breaker is intended to interrupt under specified conditions.

**Jaw** refers to the metal parts that grip the interior bus bar and conduct electricity to the module bus bars. The jaws are spring-reinforced to provide a highly reliable electrical connection.

**Key Interlock**, commonly called Kirk-keys, provides a mechanical method to interlock two or more devices utilizing a removable key which can only be inserted in one location at one time.

**Line** refers to the incoming (live) side of equipment or device.

**Load** is the outgoing (switched) side of equipment or device.

**Lug** is a device to terminate cables.

**Magnetic Trip** is synonymous with instantaneous trip and describes a tripping action with no intentional time delay. Current exceeding the magnetic trip level will actuate the trip mechanism and open the breaker contacts immediately.

**Main Device** is a single device that disconnects all ungrounded switchboard conductors, other than control power conductors when used, from the supply bus.

**Main Lug** is the connecting means between the incoming service cable and the bus bar.

**Mechanical Lug** is a terminal with one or more wire binding screws that are tightened to hold the conductor or cable.

**Mimic Bus** functionally displays internal buswork by applying tape or plastic strip on equipment exterior.

**NEMA Type 1 Enclosure - General Purpose Indoor** is intended primarily to prevent accidental contact of personnel with the enclosed equipment. The enclosure is intended for use indoors where it isn't exposed to unusual service conditions, dripping or splashing water, steam or conductive dusts (NEMA PB2-5.02).

## Section 3 – Terminology

**NEMA 3R Outdoor Enclosures** are intended for use in wet locations or outdoors to protect the enclosed equipment against rain. They are sleet (ice) resistant but are not dust, snow or sleet (ice) proof. If conduit connections are provided, these enclosures shall have a conduit hub or equivalent provision for watertight connections at the conduit entrance when the conduit enters at a level higher than the lowest live part. They have provisions for drainage.

**Overcurrent** is any current in excess of the rated current of equipment or the ampacity of a conductor that can result from an overload, a short circuit or a ground fault.

**Phase Failure Relay** senses a loss of voltage in any of the three phases of a power system. It is used to alarm or trip an overcurrent device.

**Plug-in** is a type of panelboard and disconnect with capability to be connected without requiring hardware to be fixed to the panel.

**Plug-in Mounted** device for line and load is one that can be plugged in to make electrical connections to a line and load bus bar. The device need not be self-supporting when withdrawn. It may be removed when switchboard is energized.

**Pole** is the number of output terminals on a fusible switch or breaker that must be insulated and separated from each other.

**Power Panelboard** is any panelboard that is not a lighting or appliance panelboard as specified by UL and NEC and is not limited as to the number and rating of branch circuits, except for available spacing and physical size. The dead-front panelboard is accessible from the front only.

**Quick-make, Quick-break** refers to the action of mechanism, where the speed of the contacts in opening and closing a breaker or fusible switch is not controlled by the operator.

**Rear-Only Connected** switchboards have all incoming and outgoing cable or bus connections accessible from the rear. Other connections may be front accessible.

**Rear Line-Up Sections** in a switchboard line-up are different depths and rear surfaces are aligned.

**Rejection Fuse and Clip** is a combination of fuses and clips that will not accept fuses of lower ratings and types. Can be used for Class R and other fuse types.

**Reverse Feed.** The following devices have been tested and are listed for reverse feeding: Fixed trip molded case circuit breakers, MET, and Spectra Circuit Breakers. Reverse feed devices may have incoming (line) bottom and load top. They simplify bottom feed connections and minimize switchboard depth. High pressure contact switches (HPC) can be specified as bottom-fed devices. Power Break II circuit breakers with EntelliGuard TU and Power+ programmers can be reverse-fed without special ordering.

**Rotor** is a mechanism in a fusible switch unit that mechanically ensures all switch blades open/close simultaneously.

**Selective Tripping** is the application of circuit breakers or fuses in series, so that, of the breakers or fuses carrying fault current, only the one nearest the fault opens and isolates the faulted circuit from the system.

**Series-Connected Rated Panel** means the UL Listed short-circuit rating of the panel is equal to the IC rating of the main protective device when properly applied with branch circuit protective device. See section 6.2 for further details.

**Service Disconnect** is a device or group of devices that disconnects all ungrounded load conductors from the service (supply) conductors. The number of service disconnects is limited to 6 per the NEC.

**Service Entrance Equipment** usually consists of circuit breakers or switches and fuses and their accessories. It is located near the point of entrance of supply conductors to a building and is intended to constitute the main control and means of cutoff for the supply to the building. Service entrance equipment have a removable link between the neutral bus and ground bus. The main device must also be barriered from feeder devices.

**Shunt Trip** opens a circuit protection device by remote control.

**Single-Branch** is A mounting module with a single device mounted in a designated vertical space. Refers to breakers or fused units.

## Spectra Series® Switchboards

### Section 3 – Terminology

**Space and Busing** for future when space and busing is only required for future inclusion of any specified devices, appropriate device supports, proper bus connections and corresponding vertical bus are furnished.

**Split Bus** refers to a division in carrying current bars of the panel interior, of 1 1/4", to isolate line or load of the panel board. Split bus arrangements allow arc fault breakers to isolate a section of the panel bus.

**Standard (80%) and 100% Ratings** Circuit breakers or fusible switches are to be applied at 80% of their ratings unless the overcurrent devices and the assemblies in which they are mounted are listed for operation at 100% of their ratings (NEC Articles 210-22(c), 220-3(a), 220-10(b), 384-16(c). Refer to listings for available 100% rated devices.

**Stationary-Mounted** device can be removed only by unbolting electrical connections and mounting supports. Should only be removed when switchboard is deenergized.

**Sub-main** is a disconnect provided for the connection of a wire or a cable to a bus bar fed by an over current protective device in the panelboard.

**Switchboard**, per the NEC, is a large single panel, frame or assembly of panels on which are mounted (on the face, back or both) switches, overcurrent and other protective devices, buses and usually instruments. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets.

**Tapered Bus** on UL 891 is the downsizing of the Busway ampacity based diversity standards.

**Thermal Trip** protects against sustained overloads. A bimetallic element reacts time-wise in inverse proportion to the current. If a circuit is overloaded, heat from excessive current flow causes the bimetal to bend, actuating the trip mechanism to open the breaker.

**Time Delay** is a term used by NEMA, ANSI and UL to denote a minimum opening time of 10 seconds on an overload current five times the amp rating of a circuit breaker or Class H, K, J and R fuses. Time delay is useful to let through momentary current inrushes, such as in motor startups, without interrupting the circuit.

**Trip Function** is that portion of the breaker that senses fault conditions, controls the associated logic functions and initiates and powers the breaker trip device.

**Trip Mechanisms** are independent of manual control handles. The breaker will trip when a fault occurs, even if the handle is held in the "ON" position.

**Under Voltage** release instantaneously trips the breaker when voltage (control or line) drops to 30%-70% of nominal rating.

**Voltage** is electrical pressure that moves electrons through a conductor and is measured in volts.

**Voltage Rating** is the rms alternating current voltage at which a fuse or circuit breaker is designed to operate.

**X Value** is an arbitrary vertical measurement of the usable mounting space on a panelboard for a fusible switch or breaker. X is equal to 1 3/8 inches (1.375"). Height of the interior is the sum of the horizontally mounted, panel-mounted components.

# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

### 4.1 General Switchboard Sizing Considerations

The following rules and arrangements must be considered when sizing and dimensioning Spectra Series switchboards.

Switchboard depth is the most variable of section dimensions, as depth varies depending on the type, size, feed direction, the combination of devices required and the circuitry involved.

Switchboard depth and section width can usually be increased in 5" increments, up to 60", to accommodate unusual arrangements, large number of conduits, or when existing footprints need to be matched.

The standard switchboard height is 90", but reduced height switchboards of 78" are available.

#### Group Mounted

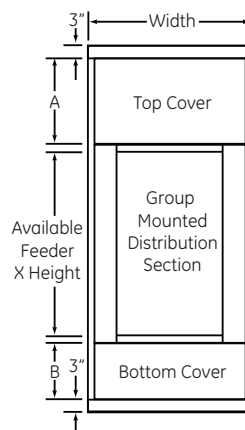
The group mounted sections utilize a panel mount arrangement similar or identical to that used in distribution panels. Group mounted breakers can be used as feeders or mains for switchboard sections 1200A and below. Group mounted breakers are typically 80%, but 100% rated group mounted breakers are available for 800A G frames and 1200A K frames for trip ratings of 60A to 1200A with fully adjustable trip ratings and 125A to 1200A for traditional trip breakers.

In addition to circuit breakers and fusible switches, additional devices that may be available to mount in the group mounted area of the switchboard include SPD, meters and motor starters.

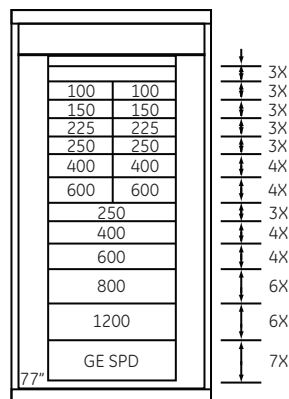
#### Sizing

Breakers are sized by X space requirements where  $X=1.375"$ . Smaller frame breakers are available twin mounted or double branch mounted in which two breakers of the same frame size are mounted adjacent to each other. Single branch mounting is the only option available for larger frame breakers, such as the 800A and 1200A K frames.

Section width is determined by the width required for the largest breaker in the section.



Panel "X" Height	A (in.)	B (in.)
18X	28	28
23X	21	28
28X	21	21
33X	14	21
38X	14	14
43X	7	14
48X	7	7
53X	7	0



See page 20 for more details

#### Bolt-on Branch Devices

Mounting	Max. Breaker Amps	Breaker Frames	"X" Height	Min. Width (in.)
Double	100	THQB, THHQB, TEY, TEB, FC, FB	3	35
	150	TED, THED, SE	3	35
	225	TQD, THQD	3	35
	250	SF, FE	3	35
	400, 600	SG, FG	4	40
Single	250	SF, FE	3	35
	400, 600	SG, FG, SGHC, SGLC, SGPC	4	35
	800, 1200	SKHA, SKLA, SKHC, SKLC SKPA, SKPC	6	40 45

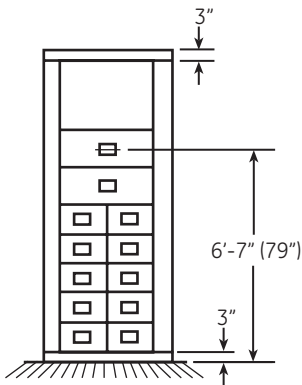
1X space adder: Note that 1X space must be added to each single or double branch mounted breaker that has internal accessories requiring side exit control wiring. These include shunt trip, auxiliary switches, bell alarms and undervoltage releases.



# Spectra Series® Switchboards

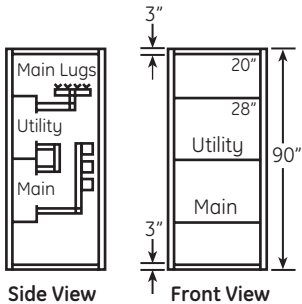
## Section 4 – Sizing and Dimensions

### 6'-7" Handle Rule



The National Electrical Code (Article 240.24) requires that switches or circuit breakers shall be installed so that the center of the grip of the operating handle of the switch or circuit breaker when in its highest position is not more than 6'-7" above the floor or working platform. Housekeeping pads that elevate the switchboard above the standing surface may violate this rule. If housekeeping pads are specified, they may have to be extended for the full working space.

### Wiring Bending Space



The National Electrical Code latest issue (Tables 312.6 (a)) specify minimum wire bending space. A 20" unit height allowance as shown in Section 5.13 will meet NEC requirements and provide wire bending space for front and rear accessibility. The 20" allowance for wire bending space may be utilized for metering, but not for devices. If there is rear accessibility, then it may be possible to reduce or eliminate the 20" allowance. Refer to factory.

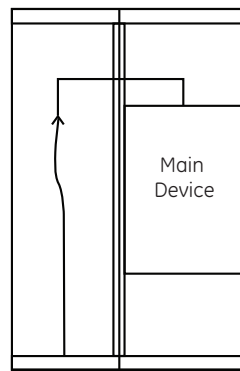
### Wiring Terminals (Lugs)

Pressure type mechanical lugs suitable for 250-600 KCMIL aluminum or copper wire are provided for short circuit ratings to 100,000A. Above 100,000A, compression type lugs may be required.

When oversize lugs are required, a lug section with minimum width shown in Section 6.17 may be furnished.

### Bussed Pull Sections

Section has cross bus that connects to adjacent main section bus.



Bussed Pull Section

### Bussed Pull Sections

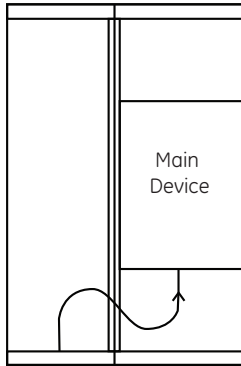
Amperage	Standard (in.)		Minimum (in.)	
	Width	Depth	Width	Depth
800	35	25	25	25
1000	35	25	25	25
1200	35	25	25	25
1600	35	25	30	25
2000	35	25	30	25
2500	35	25	35	25
3000	35	25	35	25
4000	40	30	40	30
5000	45	40	45	40

# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

### Blank Pull Sections

Pull sections are available in widths and depths from 15" to 60" in 5" increments. Depth is the same as the main section. The pull section provides space for pulling and installing cables. It is also used in bottom feed applications when reverse feed devices cannot be used. A barrier is provided for service entrance to meet NEC requirements. Busing and lugs are not provided.



Blank Pull Section

Blank Pull Sections

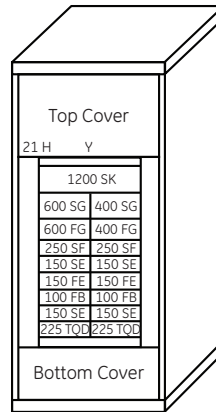
Amperage	Width	Depth
800-1200	15	25
1600-2000	20	25
2500	25	25
3000	30	25
4000	35	30

### EUSERC Pull Sections

Pull sections to EUSERC utility requirements are available in widths from 30" to 50". The minimum widths for each amperage are shown in the table below. The standard landing uses two (2) 1/2" steel studs on 1 1/4" vertical centers per 400A of rating. Multiple positions are separated by 2". These sections are designed for bottom entry, with open bottoms. A barrier is provided for service entrance to meet NEC requirements. Busing for landings is included.

Amperes	Landing Positions	Min. Width (in.)	Min. Depth (in.)
400	1	30	25
800	2	30	25
1200	3	35	25
1600	4	40	25
2000	5	40	25
2500	7	50 <sup>①</sup>	35
3000	8	50 <sup>①</sup>	40
4000	10	50 <sup>①</sup>	40

<sup>①</sup> Refer to local utility specification.



### Group Mounted Class 1

Main Lugs Only (Bolt-on and Plug-in)

Amp Rating	Top or Bottom Cable Entry Max. Feeder X-Height	Min. Depth (in.)	Min. Width (in.) <sup>②</sup>
400, 600, 800, 1000, 1200, 1600, 2000	38 <sup>①</sup>	25	35

<sup>①</sup> 38X interior for front only connection, 43X available with rear access.

<sup>②</sup> Minimum section width shown. Wider Section may be required.

Refer to branch sizing tables.

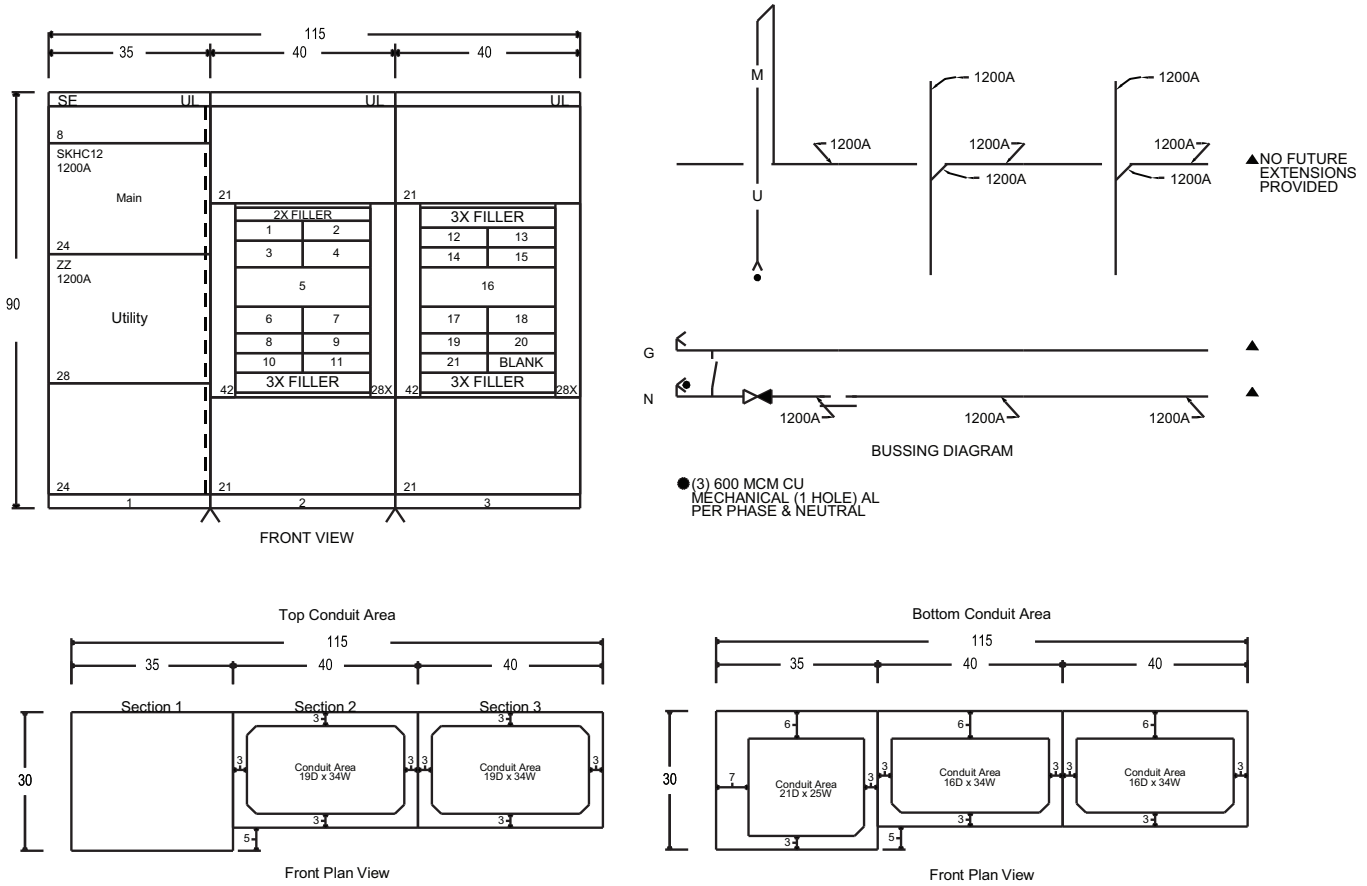
### Main Circuit Breaker (Bolt-on and Plug-in)

Type	Amp Range	Device	Main X-Height	Available Feeder X-Height	Min. Depth (in.)
Standard Circuit Breaker	400-600	FGV, FGN, FGH, FGL, FGP	4	34	25
	125-600	SGDA, SGHA, SGLA, SGPA	4	34	25
	300-1200	SKHA, SKLA, SKPA	6	32	25
MicroEntelliGuard	60-600	SGHC, SKLC, SGPC	4	34	25
	300-1200	SKHC, SKLC, SKPC	6	32	25
Record Plus	400-600	FGV, FGN, FGH, FGL, FGP	4	34	25

# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

### 4.2 Typical Drawing



	ACCESS TO: Front Only	PHASE: 3P4W	GE STANDARD UTILITY (28 INCH)
	CLASS: 2	AMPERE: 1200A	CODE ZZ
	LABEL: U/L SE	BUS MTL: Cu Heat	C/T TYPE Window
	VOLTAGE: 480/277V	PLATE: Silver Plate	P/T TYPE
	STYLE: Bolt-On	RATING: Fully Rated	PER GE DWG 75C143813 PV101.101A.101B
	BUS BRACING (RMS SYM):	65000A	PER PWR CO SPEC. 75C323045A SH. 1
DEV./MIN.INT.RATING (RMS SYM):	35000A		

#### SwitchBoard / Device Information

Circuit No.	Device	Amps	Poles	Labels	Lugs/Cable Size	Notes
Main	SKHC12	1200	3			4,5,6
1	SELA	150	3		(1) - #12 - 3/0 AWG - Mechanical AL	
2	SELA	150	3		(1) - #12 - 3/0 AWG - Mechanical AL	
3	SGHA4	400	3		(2) - 2/0 - 500 MCM - Mechanical AL	
4	SGHA4	400	3		(2) - 2/0 - 500 MCM - Mechanical AL	
5	SKHA8	800	3		(3) - 3/0 - 500 MCM - Mechanical AL	
6	SGHA6	500	3		(2) - 2/0 - 500 MCM - Mechanical AL	
7	SGHA6	500	3		(2) - 2/0 - 500 MCM - Mechanical AL	
8	SFHA	250	3		(1) - #8 - 350 MCM - Mechanical AL	
9	SFHA	250	3		(1) - #8 - 350 MCM - Mechanical AL	
10	SELA	60	3		(1) - #12 - 3/0 AWG - Mechanical AL	
11	SELA	60	3		(1) - #12 - 3/0 AWG - Mechanical AL	
12	SELA	150	3		(1) - #12 - 3/0 AWG - Mechanical AL	
13	SELA	150	3		(1) - #12 - 3/0 AWG - Mechanical AL	
14	SFHA	250	3		(1) - #8 - 350 MCM - Mechanical AL	
15	SFHA	250	3		(1) - #8 - 350 MCM - Mechanical AL	
16	SKHA8	800	3		(3) - 3/0 - 500 MCM - Mechanical AL	
17	SGHA6	500	3		(2) - 2/0 - 500 MCM - Mechanical AL	
18	SGHA4	400	3		(2) - 2/0 - 500 MCM - Mechanical AL	
19	SFHA	250	3		(1) - #8 - 350 MCM - Mechanical AL	
20	SFHA	250	3		(1) - #8 - 350 MCM - Mechanical AL	
21	SELA	60	3		(1) - #12 - 3/0 AWG - Mechanical AL	

#### NOTES:

1. Copper ground bus furnished.
2. Shipping splits between each section, ship each section separately.
3. Switchboard furnished with fully rated panel.
4. Device furnished with MET (LSIG) programmer.
5. Device is furnished with integral ground fault protection.
6. Device furnished with padlocking provisions.

# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

### 4.3 Class 1 Switchboard – Group Mounted

#### Main Lug

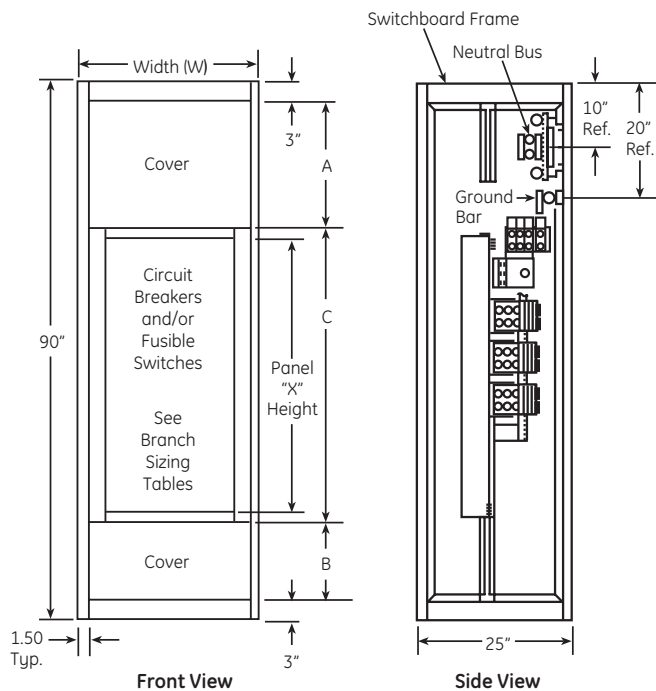
##### Standard Main Lug Termination

Ampere Rating	Quantity and Size per Ø and N	Minimum Width (W)
400 & 600	(2) 1/0-600MCM	35
800 & 1000	(3) 1/0-600MCM	35
1200	(4) 1/0-600MCM	35
1600	(5) 1/0-600MCM	35
2000	(6) 1/0-600MCM	35
Over 2000		①

① Rear access required.

Panel Rating	Panel X Height (X=1.375")	A	B	C
400-2000A	23X	21	28	35
	33X	21	14	49
	38X	21	7	56
	43X	21	0	63

Note: For bottom feed, reverse A & B dimensions.

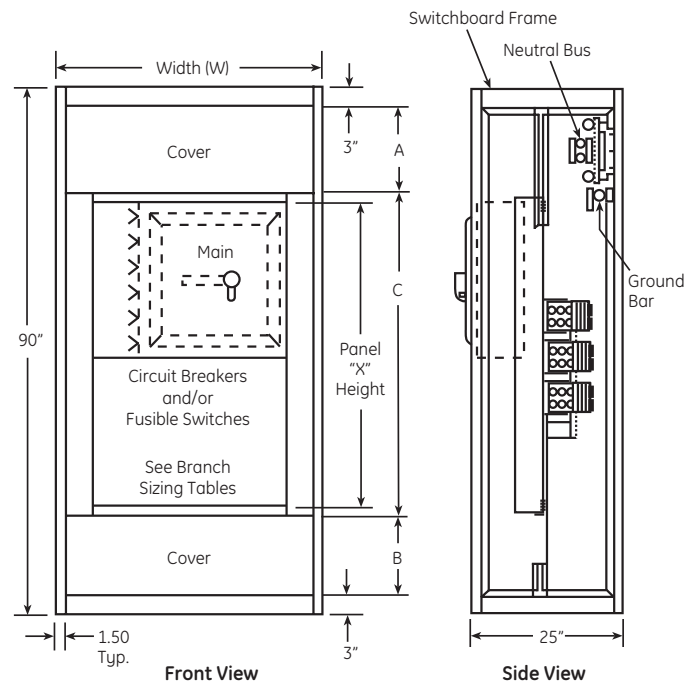


#### Main Device

Type	Device	Amp Range	Main "X" Height	Min. Width (W)	Panel "X" Height	Top Main			Bottom Main		
						A	B	C	A	B	C
Circuit Breakers	SGDA, SGHA, SGLA, SGPA	400-600	4	35	38X	14	21	49	14	21	49
						SKHA, SKLA, SKPA	800-1200	6	40 45	38X <sup>②</sup>	14
	Fusible Switch	ADS	4/600-H,K,R	10	45						38X
4/600-J,T			10	40	38X	14	7	63	0 <sup>①</sup>	21	63
800-1200			19	45	43X	14	7	63	0 <sup>①</sup>	21	63

① Rear access required.

② SKHA and SKLA available in 48X.



Cable Fed Main Devices With or Without CT's

#### Distribution Section

Panel "X" Height	A	B	C
23X	21	28	35
33X	14	21	49
38X	14	14	56
43X	7	14	63
53X	7	0 <sup>①</sup>	77

① Rear access required.

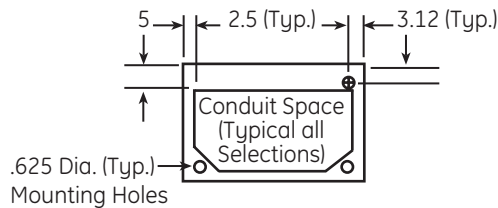
Distribution section front view same as main lug section. Distribution section side view same as main lug section side view except omit lugs.

# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

### Section Layout Notes

- These switchboard arrangements assume line cables enter top. When line cables enter from below, neutral and ground bus are mounted at bottom, and A and B cover dimensions are reversed.
- All dimensions are in inches and X values (1X = 1 3/8 inches).
- Front access to load cables requires a 7" high cover minimum.
- Front access to neutral and/or ground bus requires a 14" high cover minimum.
- Any circuit breakers with externally wired accessories (such as shunt trip, undervoltage release, auxiliary switches) will require a 1X filler between adjacent devices.
- For double branch units, only same circuit breaker type devices can be mounted across from each other.



- All single branch circuit breakers, in service entrance equipment, are mounted with load lugs staggered to allow for equal cabling in both wire gutters. Main device line lugs are located on the left side.

- After determining all applicable conditions, lay out switchboard and calculate branch circuit "x" heights, including future space. Add spaces sufficient to fill panel to standard X increment.

ADS Fusible Switch Branch Device Sizing (Spectra Plug-In Only)

Switch Rating	Branch	Volts	Poles	Fuse Class	Blank Option	Min. Width (in.)	X Height	Min. Depth (in.)
30A	Double Branch	240V 600V	2, 3P	H, K, R	Yes	40	4X	25
60A	Double Branch	240V 600V	2, 3P	H, K, R	Yes	40	4X 5X	25
100A	Double Branch	240V 600V	2, 3P	H, J, K, R T	Yes	40	5X 7X	25
200A	Single Branch	240V	2, 3P	H, K, R	No	40	7X	25
	Double Branch	240V		J, T	Yes			
	Double Branch	600V		H, K, R	Yes	45		
400A	Single Branch	240V 600V	2, 3P	J, T H, K, R	No	40 45	10X	25
600A	Single Branch	240V 600V	2, 3P	J, T H, K, R	No	40 45	10X	25
800A 1200A	Single Branch	240V 600V	2, 3P	L	No	45	19X	25

Spectra Series® Switchboards  
Section 4 – Sizing and Dimensions

Molded Case Circuit Breaker Branch Device Sizing – Plug-In

Mounting	Max. Breaker Amps	Breaker Frames	3-Pole Module <sup>②</sup> X Height	2-Pole Module <sup>②</sup> X Height	Min. Width (in.)	Min. Depth (in.)	
Double	100	THQB, THHQB, TEY, TEYF	3	—	35	25	
		SE, SF	3	3	35	25	
		SG	4	4	40	25	
		FB	3	2	35	25	
		TEB, TED, TQD, THQD	3	2	35	25	
	150	THED, SF	3	3	35	25	
		SG	4	4	40	25	
		TQD, THQD	3	2	35	25	
	225	SF, FE <sup>④</sup>	3	3	35	25	
		SG	4	4	40	25	
		TJD	6	6	45	25	
	250	SF	3	3	35	25	
		SG	4	4	40	25	
		TJD	6	6	45	25	
	400	SG	4	4	40	25	
		TJD	6	6	45	25	
		SG	4	4	40	25	
	600 <sup>①</sup>	SG, FG	4	4	40	25	
<i>micro-EntelliGuard</i> trip unit SGHC, SGLC, SGPC		4	—	40	25		
Double Adjacent to Fusible Switch	150	SEDA, SEHA, SELA, SEPA	4	4	40	25	
	250	SFHA, SFLA, SFPA	4	4	40	25	
Single	250	SF	3	3	35	25	
		SG	4	4	35	25	
	400	TJD	6	6	35	25	
		SG	4	4	35	25	
	600	SG, FG	4	4	35	25	
		<i>micro-EntelliGuard</i> trip unit SGHC, SGLC, SGPC	4	—	35	25	
	1200	SK	6	6	40	25	
		<i>micro-EntelliGuard</i> trip unit SKHC, SKLC, SKP <sup>③</sup>	6	—	40	25	
	Single Adjacent to Fusible Switch	250	SF	4	4	40	25
			SKP	6	6	45	25

① Double mounting not available in 2500A or higher main bus rating.  
 ② Add 1x to height for accessories on breakers.  
 ③ SKP requires 45" minimum width if used as a main breaker with cables.  
 ④ FE shown at 100kAIC at 3X. If 150 kAIC, then X height is 5X.

Molded Case Circuit Breaker Branch Device Sizing – Bolt-On

Mounting	Max. Breaker Amps	Breaker Frames	3-Pole Module <sup>②</sup> X Height	2-Pole Module <sup>②</sup> X Height	Min. Width (in.)	Min. Depth (in.)
Double	100	TED, FB	3	2	35	25
		TEY, TEYF	3	—	35	25
		SE, SF, THED	3	3	35	25
		SG	4	4	40	25
		TED	3	2	35	25
	150	SE, SF	3	3	35	25
		SG	4	4	40	25
		SF	3	3	35	25
	225	SG	4	4	40	25
		SF, FE <sup>④</sup>	3	3	35	25
	250	SG	4	4	40	25
		SG	4	4	40	25
	400	SG	4	4	40	25
		SG, FG	4	4	40	25
	600 <sup>①</sup>	<i>micro-EntelliGuard</i> trip unit SGHC, SGLC, SGPC	4	—	40	25
		250	SF	3	3	35
	SG		4	4	35	25
	SG		4	4	35	25
400	SG	6	6	40	25	
	SG, FG	4	4	35	25	
600	<i>micro-EntelliGuard</i> trip unit SGHC, SGLC, SGPC	4	—	35	25	
	1200	SKH, SKL	6	6	40	25
<i>micro-EntelliGuard</i> trip unit SKHC, SKLC, SKP <sup>③</sup>		6	—	40	25	

① Double branch mounting available through 3000A.  
 ② Add 2x to height for accessories on breakers.  
 ③ SKP requires 45" minimum width if used as a main breaker with cables.  
 ④ FE shown at 100kAIC at 3X. If 150 kAIC, then X height is 5X.

# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

### Branch Devices, Group Mounted, Breakers 100% Equipment Rated

Mounting	Max. Breaker Amps	Breaker Frames	3-Pole Module X Height <sup>①</sup>	2-Pole Module X Height <sup>①</sup>	Min. Width (in.)	Min. Depth (in.)
Twin	400	Spectra RMS Breaker SGHHA, SGLLA, SGPPA	4	4	40	25
Single	1000	Spectra RMS Breaker SKHHA, SKLLA, SKPPA <sup>④</sup>	8	6	40	25
Twin	400	Spectra RMS Breakers with <i>micro</i> -EntelliGuard Trip Unit SGHHC, SGLLC, SGPPC	4	-	40	25
Single	1000	Spectra RMS Breakers with <i>micro</i> -EntelliGuard Trip Unit SKHHC, SKLLC, SKPPC <sup>④</sup>	8	-	40	25
Twin	400	Spectra RMS Breakers with <i>micro</i> -EntelliGuard Trip Unit <sup>②</sup> SGHHC, SGLLC, SGPPC	6 or 5 <sup>③</sup>	-	40	25
Single	1000	Spectra RMS Breakers with <i>micro</i> -EntelliGuard Trip Unit <sup>②</sup> SKHHC, SKLLC, SKPPC <sup>④</sup>	8	-	40	25

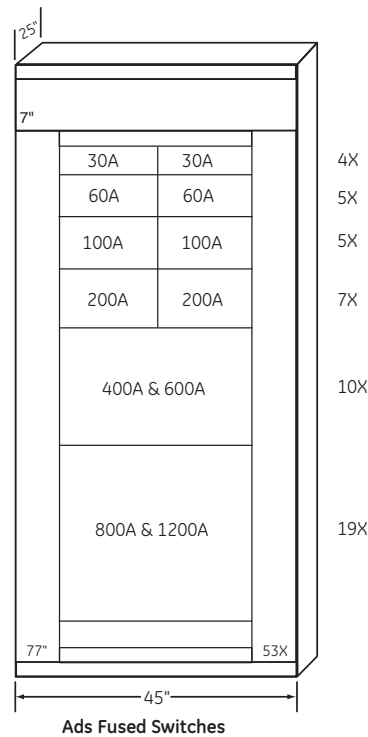
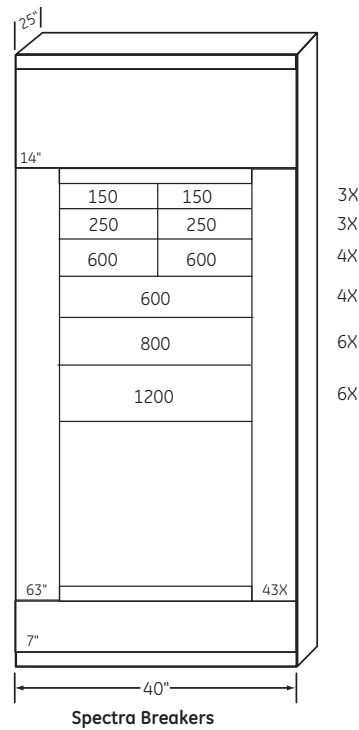
① Add 1X per double or single branch for internal accessories side control wiring space (Shunt trip, auxiliary switch, bell alarm, undervoltage release).

② A voltage module must be used with *micro*EntelliGuard trip units with metering.

③ An auxiliary switch must be installed on breakers with *micro*EntelliGuard trip units. A 1X space for side control wiring is included.

④ SKPP requires 45" minimum width.

### Sample Feeder Mounting



#### Notes

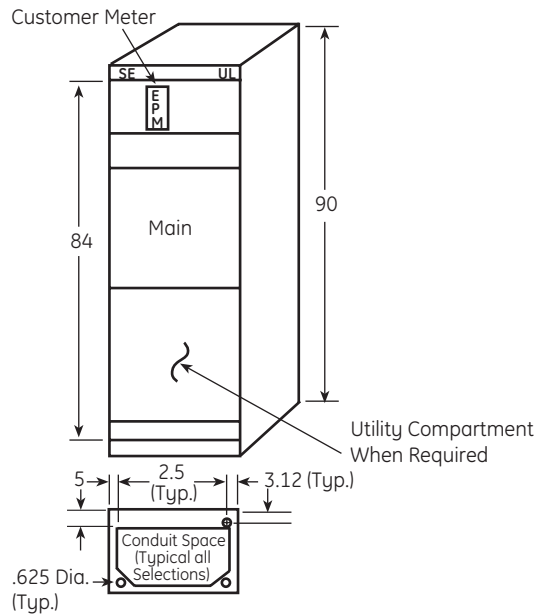
- 600A frame breakers can only twin mount on main bus under 2500A.
- 800A & 1200A breakers can mount in 40" wide section for 65kA and under. For 100kA ratings, 45" section is required, except for SKPP breakers, which always require a 45" wide section.
- X=1.375"
- Front/Rear Access 53X interior available.
- Font Only Access 43X interior available.



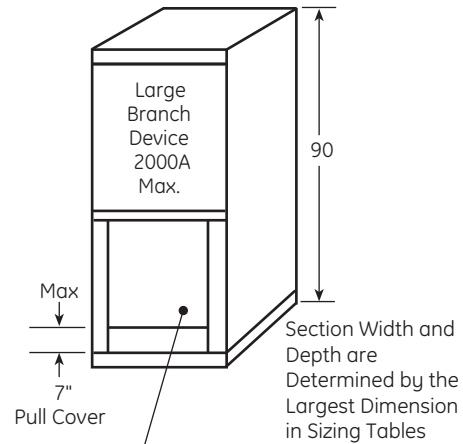
Spectra Series® Switchboards  
**Section 4 – Sizing and Dimensions**

**4.4 Class 2 Individually Mounted Main Group Mounted Feeders/Class 5 Individually Mounted Switchboard**

Single section arrangements with main device and utility cabinet are furnished through 2000A ratings when the utility does not require potential transformers. If customer metering and/or ground fault relay is required, service cables must enter from above. Otherwise, two sections are provided.



**Spectra Main Section Arrangement**



Intermix Panel Circuit Breakers or ADS Swtiches (May be Located Above or Below Large Branch)

**Intermix Design – side or rear access is required. Cable exit must be same as end panel.**

# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

The dimensions shown are minimum widths and depths of switchboard sections containing CT compartments only. If there are other devices located in the section, actual width will be based on the largest device required. Also, the entire switchboard lineup depth will be based on the largest device depth required.

The following utilities have approved the type of metering compartment shown. Compartments are available with the following features:

- CT bus bars mounted on high impact glass fiber polyester insulation and arranged in an edgewise plane.
- Door with concealed hinges, 3-point catch and lock, handle seal over CT compartment barriers rear and bottom (top). Note: The bottom barrier is furnished at top if main device is over CT compartment.
- 9" or 11" centerline is standard. For other centerlines, refer to factory.
- CT bus bars drilled for transformers with NEMA terminations.
- #10-32 and 1/4-20 screws for potential taps.
- Removable links provided if part of utility requirements.
- Cold sequence metering has CT compartment on load side of main device. Hot sequence CT compartment is on line side.

### CT Compartment Dimensions

CT Centerline	Ampere Ratings	Minimum Section Width (inches) <sup>①</sup>	Minimum Section Depth (inches) <sup>①</sup>
9" or 11"	600	35	35
	800		
	1000		
	1200		
	1600		
	2000		
	2500		
3000			
	4000	40	40

<sup>①</sup> Add 5" to depth when busway entrance is required.

### Power Break II Dimensions (Inches) Includes Incoming Lugs and Customer Meter CTs

Amp Rating		Stationary <sup>①</sup>						Draw Out <sup>①②③</sup>					
		Manual			Electrical			Manual			Electrical		
		Unit	Section	Depth	Unit	Section	Depth	Unit	Section	Depth	Unit	Section	Depth
Frame	Sensor	Height	Width	Depth	Height	Width	Depth	Height	Width	Depth	Height	Width	Depth
800 <sup>②</sup>	200, 400, 800	20"	30"	25"	20"	30"	25"	20" <sup>①</sup>	30"	40"	20" <sup>①</sup>	30"	40"
1600	800, 1000, 1600	20	30	30	20	30	30	20	30	40	20	30	40
2000 <sup>②</sup>	2000	20	30	30	20	30	30	20	30	40	20	30	40
2500	1000, 2000, 2500	40	40	35	40	40	35	32	30	40	32	30	40
3000	3000	40	40	35	40	40	35	32	40	40	32	40	40
4000	4000	40	40	40	40	40	40	44	40	45	44	40	45

<sup>①</sup> Width and depth will vary depending on neutral risers, lug arrangement and number of devices included in the section.

<sup>②</sup> Max. of 72 secondary contacts.

<sup>③</sup> Rear access may be required for 2500A through 4000A drawout.

# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

### Main Devices (Inches)

Type	Device		Stationary			Draw out		
	Designation	Ampere Rating	Min. Unit Height	Min. Section Width	Min. Section Depth <sup>②⑥</sup>	Min. Unit Height	Min. Section Width	Min. Section Depth <sup>②⑥</sup>
High Pressure Contact Switches	THPR <sup>⑦</sup>	800	28" <sup>①</sup>	30"	25"	--	--	--
		1200	32 <sup>①</sup>	30	25	--	--	--
		1600	32	30	25	--	--	--
		2000	40	30	25	--	--	--
	THPC	2500	44	35	30	--	--	--
		3000	44	40	35	--	--	--
4000 <sup>③</sup>		52	40	40	--	--	--	
Bolted Pressure Switches	QA or CBC	800	28	25	30	--	--	--
		1200	32	30	30	--	--	--
		1600	32	30	30	--	--	--
		2000	32	30	30	--	--	--
		2500	36	35	35	--	--	--
		3000	48	45	35	--	--	--
MCCB Standard & Hi-Break	SG	600	20	25 <sup>⑤</sup>	25	--	--	--
	SK	1200	24	25 <sup>⑤</sup>	25	--	--	--
WavePro	30	800	--	--	--	28	30	40 <sup>④</sup>
	50	1600	--	--	--	28	30	40 <sup>④</sup>
	T50H	2000	--	--	--	28	30	40 <sup>④</sup>
	75	3200	--	--	--	32	35	50
	100	4000	--	--	--	32	40	50 <sup>④</sup>
	125	5000	--	--	--	(refer to factory GE-Houston)		
Metering		--	--	25	25	--	--	--
Ground Fault-Ground Break		--	8	25	25	--	--	--
Automatic Throwover	800	--	28H x 35W x 35D			--	--	--
	4000	--	28H x 35W x 35D			--	--	--

① CT compartment on line side requires 4" filler.

② If metering CTs are required, add 5" to depth. For devices at extreme top or bottom, depth shown may not provide sufficient conduit entrance space. See Section 5.10 for conduit space available.

③ When integral ground fault is present, a 4" filler is required on the load side.

④ Additional depth for metering CTs not required for any stationary units or for electrical drawout units.

⑤ 30" width is recommended for 1200A devices or when more than three devices are stacked in one section.

⑥ If vertical neutral bar is required, add 5" to depth.

⑦ Not available in electrical unit.

### 4.5 Utility Metering Compartments

For current utility metering compartment information, please contact your local account manager or specification engineer.

# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

### 4.6 Outdoor Enclosures

NEMA 3R outdoor enclosures consist of standard indoor cubicles and components enclosed with a front frame and roof assembly to provide a weather resistant structure. Any number of sections may be bolted together. However, all sections must be of the same depth. Standard outdoor construction consists of:

- Flat roof
- Section height 91"
- Front and rear venting
- Galvanized end caps, front/rear louvered doors and rear covers
- Standard screen behind louvers
- Single door 15"W – 35"W
- Double door 40"W – 60"W
- Wind stop on each door
- 3-point catch with provisions for padlock
- Front extensions: non-walk in 5", 10" & 11", walk in 35" & 40"
- 110 mph wind rating
- Floor sills 1.5"

#### Options available are:

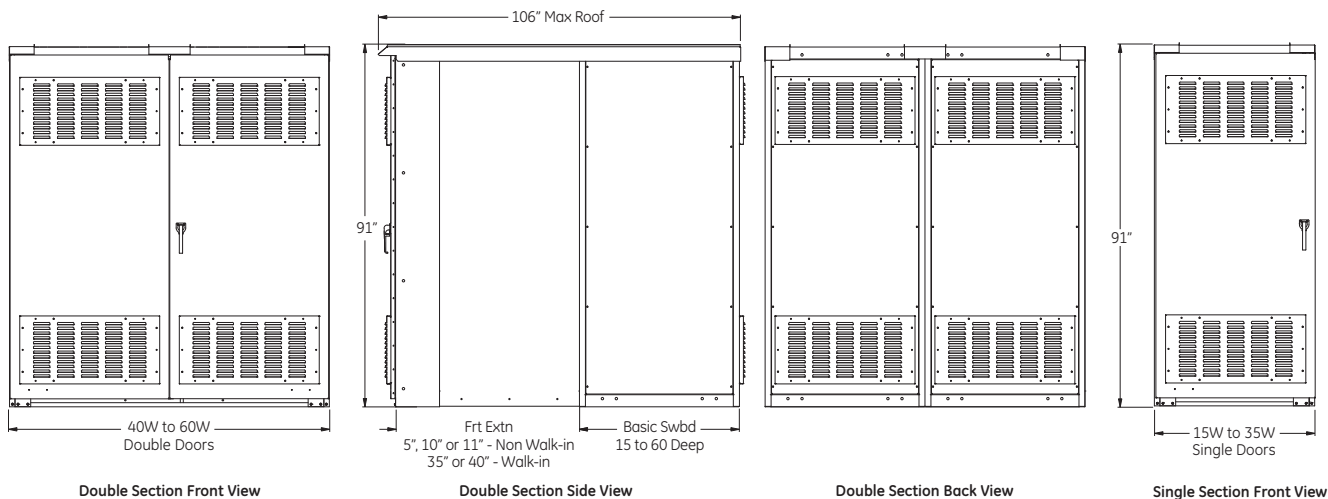
- Gasketing
- Fluorescent light, 120-volt, 15-amp and grounded convenience outlet
- Rodent guards
- Rear doors same as front with wind stops
- Lifting brackets
- Inside, movable, 4-way hoist and trolley (walk-in only)
- Busway entrance
- 130 mph wind rating (excludes walk-in)
- Filters

Typical switchboard, walk-in, double doors



### 4.7 Instrument and Metering Arrangements

Instruments and metering for mains and feeders can be provided in top compartment of switchboard. Minimum height and width for different types of switchboards are shown. The minimum height should be increased in indicated increments as necessary to accommodate required instruments and/or meters. Some preferred arrangements are shown. Hinges door is standard on all meter doors.

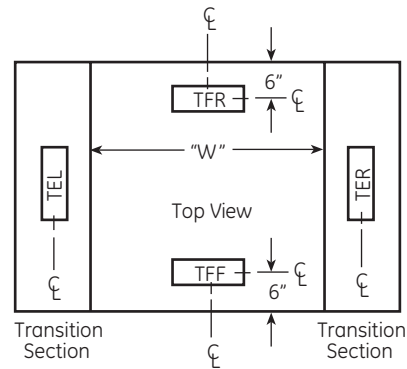


Note: For busway top exit application flat roof is used.

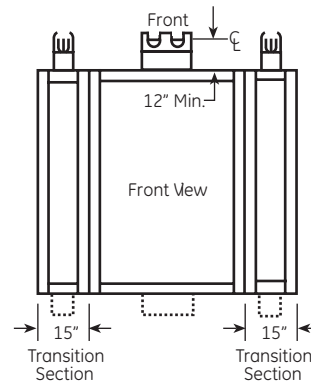
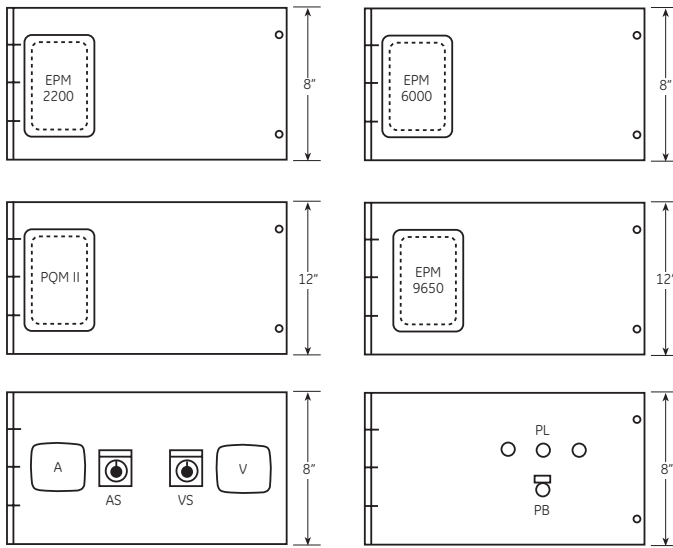
# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

Abbreviation	Description
A	Ammeter type AB40-250
V	Voltmeter type AB40, 250
EPM	EPM
PQM	PQM
AS	Ammeter Switch
VS	Voltmeter Switch
PL	Pilot Light
PB	Push Button
GFR	ITI GF Relay



① TFR requires rear access or must be preassembled into switchboard before it is set into place.



② 15" dimensions become 20" on outdoor switchboards.

### 4.8 Busway Entrance

The Spectra Series Busway switchboard stub may connect to the switchboard top main bus or the line or load terminals of a device in the switchboard section into which it enters. All dimensions shown are to centerline of busway. The above is based on individually-mounted devices in switchboards. For main lug connection to group mounted switchboards, refer to factory. When two busway runs enter a switchboard section, refer to factory. For busway entrance locations other than Spectra Series™, refer to factory.

### Switchboard Stubs

Both top and bottom entrance is available, however, TFR is the recommended standard entrance position. Dimensions for bottom entrance are the same as top entrance. Note that TEL and TER entrance positions require a separate 15-inch wide switchboard transition section adjacent to the switchboard main device for entrance. Also, note that TFRB (bottom entry) requires rear access.

### 4.9 Low Voltage Transition Sections and Dual Voltage Switchboards

#### Spectra Series Low Voltage Transition Sections

Transition sections are required for connection of low voltage Spectra Series switchboards to all liquid-filled transformers 750 to 2500 kVA. They are also required for connection of switchboards to motor control centers. Transformer and transition sections are always aligned on center of depth of both sections.

Transition section depth is determined by device and circuitry of service entrance section. Transformer depth can be deeper, the same or shallower than the transition section depth.

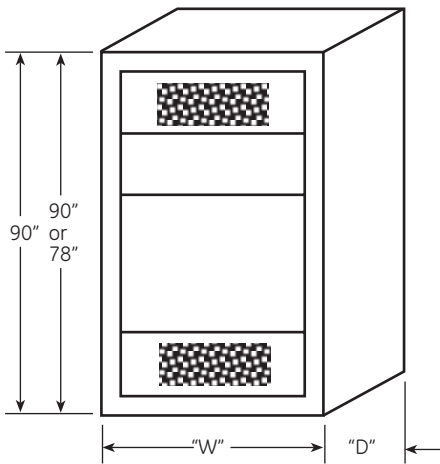
Note that the minimum allowable switchboard depth is 35" for connection to a transformer.

For the 1500 and 2000 kVA, 95 BiL transformers, a 100" high transition section is required. The switchboard remains 90" high.

# Spectra Series® Switchboards

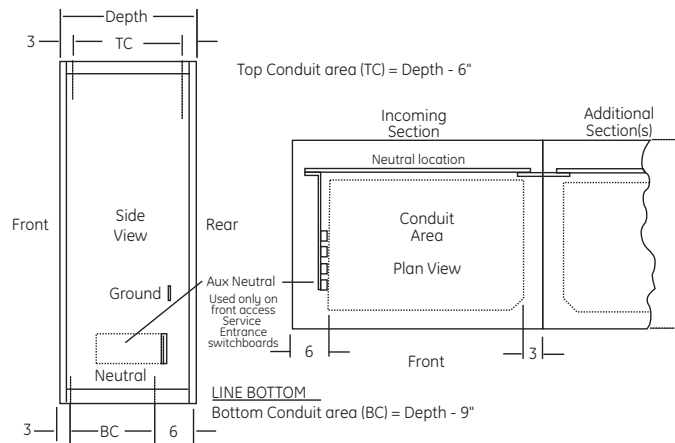
## Section 4 – Sizing and Dimensions

Transition sections are 15" wide. Consult factory for non-standard applications.



### 4.10 Conduit Entrance Space

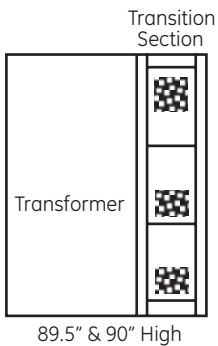
#### Incoming Line Sections



Drawing is for basic guideline purposes, refer to factory for exact dimensions.

### Spectra Series Dual Voltage Switchboards

750 and 1000 kVA transformers are provided in NEMA 1 transformer enclosures. Primary and secondary flanges to switchboard sections do not require transition sections.



Core & coil type QLC transformers provided in switchboard enclosures cable connected to primary and secondary by equipment plant.

### 4.11 Switchboard Weights

#### Estimated Switchboard Weights

Due to the variety of sections, devices and circuitry, it is not feasible to give total weights for specific combinations. However, an estimate may be made by selecting section enclosure, bussing and device weights. The resulting total weights are in a  $\pm 20\%$  range and should be used for estimating purposes only. The following tables and sections may be used to estimate the switchboard weight.

#### Switchboard Enclosure

Use the following table to determine the weight of the steel only for each switchboard section, based on the width and depth and whether indoor or outdoor.

#### NEMA 1 Indoor Switchboard Enclosure Weight (lbs)

(with shipping skid and covers on all sides)

Depths	Section Widths (inches)									
	15	20	25	30	35	40	45	50	55	60
25	270	303	336	369	402	435	470	503	536	569
30	303	336	369	402	435	470	503	536	569	602
35	336	369	402	435	470	503	536	569	602	635
40	369	402	435	470	503	536	569	602	635	668
45	402	435	470	503	536	569	602	635	668	701
50	435	470	503	536	569	602	635	668	701	734
55	470	503	536	569	602	635	668	701	734	767
60	503	536	569	602	635	668	701	734	767	800

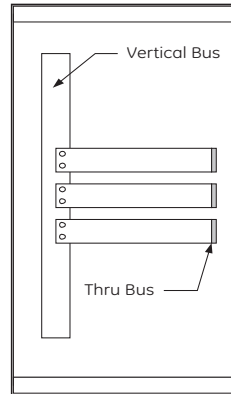
KVA	Self-Cooled	
	Width	Depth
30	30"	35"
45	30"	35"
75	35"	35"
112.5	40"	35"
150	45"	40"

# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

**NEMA 3R Outdoor (non walk-in) Switchboard Enclosure Weight (lbs)**  
(with shipping skid and covers on all sides)

Depths	Section Widths (inches)									
	15	20	25	30	35	40	45	50	55	60
25	488	549	610	671	732	793	854	915	976	1037
30	549	610	671	732	793	854	915	976	1037	1098
35	610	671	732	793	854	915	976	1037	1098	1159
40	671	732	793	854	915	976	1037	1098	1159	1220
45	732	793	854	915	976	1037	1098	1159	1220	1281
50	793	854	915	976	1037	1098	1159	1220	1281	1342
55	854	915	976	1037	1098	1159	1220	1281	1342	1403
60	915	976	1037	1098	1159	1220	1281	1342	1403	1464



### Switchboard Internal Bus Weights

The following table is used to determine the weight of the horizontal (through) bus within the switchboard section. The bus material, bus ampacity and section width determine the weight in pounds for the through bus in each section.

**Through Bus weights (lbs.) (3P4W)**

Material	Ampacity	Section Width (inches)									
		15	20	25	30	35	40	45	50	55	60
Aluminum	800	10	13	16	19	22	25	28	31	34	37
	1200	13	17	21	25	29	33	37	41	45	49
	1600	15	20	25	30	35	40	45	50	55	60
	2000	18	23	28	33	38	43	48	53	58	63
	2500	21	28	35	42	49	56	63	70	77	84
	3000	25	33	41	49	57	65	73	81	89	97
	4000	31	41	51	61	71	81	91	101	111	121
Copper	800	18	23	28	33	38	43	48	53	58	63
	1200	25	33	41	49	57	65	73	81	89	97
	1600	31	41	51	61	71	81	91	101	111	121
	2000	37	50	63	76	89	102	115	128	141	154
	2500	45	61	78	91	109	125	141	157	173	189
	3000	54	73	92	111	130	149	168	187	206	225
	4000	70	96	122	148	174	200	226	252	278	304
5000	87	120	153	186	219	252	285	318	351	384	

Use the following table to determine the weight of the vertical bussing for Group Mounted Sections. The table assumes a worst case 2000A vertical bus with the vertical height determined by the X spacing ( $x=1-3/8$ ). Connection bus between panel and through bus is included.

**Spectra Interior Weights (based on 2000A vertical bus)**

Mounting Space	With 2000A through bus		With 4000A through bus		
	Weight (lbs)		Weight (lbs)		
	Cu	Al	Cu	Al	
13X	126	68	13X	181	90
18X	142	83	18X	197	105
23X	150	98	23X	214	120
28X	175	112	28X	230	134
33X	192	127	33X	247	149
38X	209	142	38X	264	164
43X	225	157	43X	280	179
48X	242	172	48X	297	194
53X	258	187	53X	313	209

For Class 1 switchboards without thru bus, subtract 28 lbs. for Al and 82 lbs. for Cu from the 2000A through bus section of the table above.



# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

Use the following tables to determine the weight of the bus used to connect individually mounted devices to the horizontal bus and the weight of utility compartments.

### Bussing to Individually Mounted Devices

Device Amperage	Weight (lbs)	
	Cu	Al
600	48	28
800	48	28
1200	73	37
1600	91	45
2000	115	48
2500	141	63
3000	168	73
4000	226	91
5000	285	N/A

### Utility Compartment Weights (lbs)

Does not include section weight

Ampere Rating	Weight (lbs)	
	Cu	Al
1000	80	70
2000	100	80
3000	120	90
4000	150	100

Use the following table to determine the weight of the bussing necessary to connect a device within a switchboard to an external Spectra Busway. The weights below do not include the weight of the switchboard stub which is furnished with the busway.

Busway (40" Section)	Bus Riser Amperage	Cu	Al
<b>TFR, TFRB</b>	800	126	74
	1200	194	98
	1600	242	120
	2000	308	126
	2500	378	168
	3000	450	194
	4000	608	242
	5000	768	-
<b>TFF, TFFB</b>	800	174	102
	1200	267	135
	1600	333	165
	2000	423	174
	2500	519	231
	3000	618	267
	4000	834	333
	5000	1053	-

### Switchboard Overcurrent Device Weights

The weight of each individual breaker or fused switch must be added to determine the overall weight of the switchboard.

#### Overcurrent Device Weights

Device	Type	Approx Lbs.
Molded Case Circuit Breakers	THQB, TEY, TED, FB, SE, FC	5
	TQD, SF, FE	10
	SG, FG	20
	SK	50
Group Mounted Fusible Switches ADS (does not include fuses)	30-30	15
	60-60	15
	100-100	25
	200-200	65
	100	25
	200	50
	400	50
	600	50
PowerBreak II Stationary	800	75
	1200	75
	800A Manual	71
	800A Electric	80
	1600A Manual	79
	1600A Electric	88
	2000A Manual	79
	2000A Electric	88
	2500A Manual	178
	2500A Electric	187
	3000A Manual	179
	3000A Electric	188
PowerBreak II Draw-out (includes substructure)	4000A Manual	320
	4000A Electric	329
	800A Manual	140
	800A Electric	155
	1600A Manual	205
	1600A Electric	220
	2000A Manual	233
	2000A Electric	247
	2500A Manual	336
	2500A Electric	376
	3000A Manual	342
	3000A Electric	382
WavePro Draw-out (includes substructure)	4000A Manual	464
	4000A Electric	504
	800A Manual	200
	800A Electric	205
	1600A Manual	245
	1600A Electric	250
	2000A Manual	220
	2000A Electric	225
	2500A Manual	475
	2500A Electric	485
	3000A Manual	475
	3000A Electric	485
HPC Switches (does not include fuses)	4000A Manual	535
	4000A Electric	545
	5000A Manual	575
	5000A Electric	585
	800A	100
Bolted Pressure Switches (does not include fuses)	1600A	160
	2000A	190
	2500A	240
	3000A	400
	4000A	450
	800A	140
	1200A	230
	2000A	250
	2500A	330
	3000A	500
	4000A	550

# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

### Group Mounted Breakers with Hardware.

Use the following table to determine the weight of the breakers with the appropriate mounting hardware when the devices are group mounted. Weights include two breakers for twin mounted devices.

#### Group Mounted, Combined Breaker & Mounting Hardware

Breaker	Mounting	Style	
		Bolt-on	Plug-In
THQB, TEY, FC	Twin	13	18
TED, FB, SE	Twin	13	18
TQD, SF, FE	Twin	24	30
SG,FG	Single	24	38
	Twin	48	65
SK	Single	62	77

### Switchboard Component Weights

Use the following Table to determine the weight of any additional components which may be within the switchboard. This weight is added to the total for the switchboard sections.

#### Switchboard Component Weights

Type	Weight (lbs)	Type	Weight (lbs)
Ammeter-voltmeter	15	SPD	25
Metering CT Incoming	8-18	PQM II Meter	5
Metering CT ind ckt	2	EPM 2200 Meter	2
Metering VT	10	EPM 4500 Meter	35
CPT 150 VA	6	EPM 6000 Meter	2
CPT 300 VA	7	EPM 9650 Meter	13
CPT 500VA	13	Modbus Monitor	20
Meter Switch	5	Automatic Throw-over	50
Test Block	5	Kirk Lock	2
ITI GF Relay	1.5	3P Fuse Block w/fuses	3

### Special Sections

For blank or aux sections, use the enclosure weights for the width and depth of the section required.

For bussed pull sections, use the enclosure weights, add the through bus weight for the amperage and bus material and then add the weight for the lug landing straps based on the amperage of the connection.

#### Bussed Pull Sections Adder

Lug Strap Amperage	Weight (lbs)	
	Cu	Al
600	33	19
800	33	19
1200	49	25
1600	61	30
2000	76	33
2500	91	42
3000	111	49
4000	148	61
5000	186	

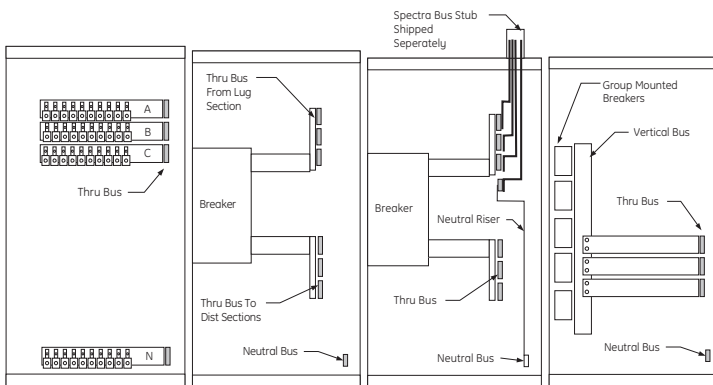
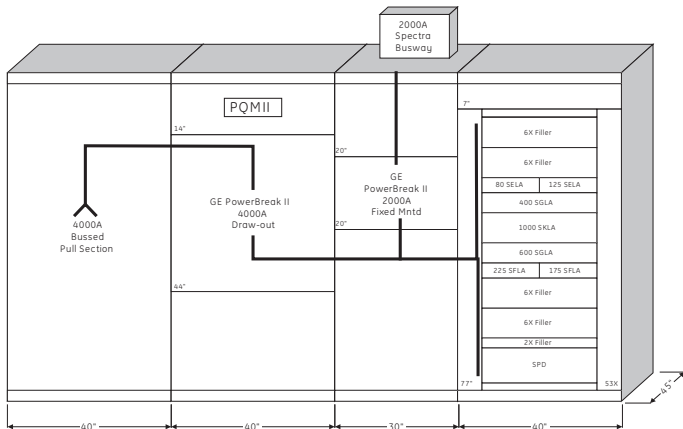
For any other special sections – which may include automatic transfer switches, transformers or any other devices – please consult the factory.

# Spectra Series® Switchboards

## Section 4 – Sizing and Dimensions

### Example Weight Calculation:

The following example utilizes copper bus, a busfed pull section, an individually mounted feeder serving a busway riser and then group mounted devices.



The various components in each individual section are added together for the total weight of the sections.

	Section 1		Section 2		Section 3		Section 4	
	Component	Weight (lbs)	Component	Weight (lbs)	Component	Weight (lbs)	Component	Weight (lbs)
	Enclosure	569	Enclosure	569	Enclosure	503	Enclosure	569
	Thru bus	200	Thru bus	200 (2)	Thru bus	148	Thru bus	200
	Lug straps	148	Ind. hardware	226	Ind. hardware	115	53X interior	313
			Breaker	464	Breaker	79	Twin SE	13
			Meter	5	Busway add	308	Twin SF	24
			CT	54			Single SG	24
			CPT	6			Single SG	24
							Single SK	62
							SPD	25
<b>Section Totals:</b>		<b>917</b>		<b>1724</b>		<b>1153</b>		<b>1254</b>

**Total Estimated Weight = 5048 lbs**

**Section 5 – Application Data**

**5.1 Standards/Codes/Ratings/Conditions**

**System Selectivity and Protection**

The design of a protective system involves two separate but interrelated steps:

1. Selection of the proper device.
2. Selection of the setting for the devices to achieve the degree of protection and selectivity desired.

A protective device is selective with another protective device if the downstream device operates first when both see the same fault current.

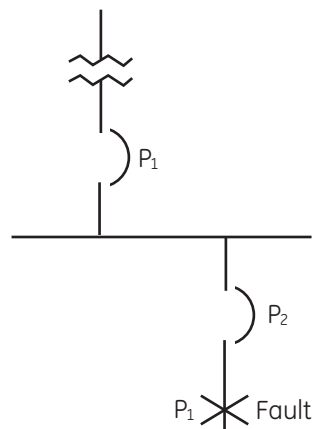
By the proper selection and setting of protective devices, the system designer can achieve a time current coordination (selectivity) among these devices that provides the maximum circuit and equipment protection consistent with the service continuity requirements. Protective device coordination is generally a compromise between maximum protection and maximum service continuity. To maintain maximum service continuity, only the devices supplying the defective element should open. This may require time delay of upstream devices. However, this prevents maximum protection that requires the upstream protective device to open instantaneously for a fault anywhere in the system. A coordination study should be performed to determine the degree of selectivity that may be achieved.

**Device Selection**

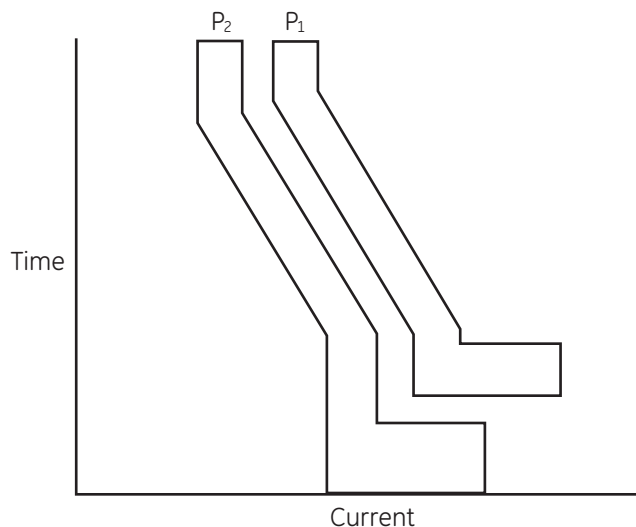
All protective devices should be applied within their ratings - voltage, frequency, current and short circuit - under usual switchboard service conditions. Additional device selection considerations may be required if the equipment is part of a system with required selectivity per the NEC. Device selections need to be made carefully to properly fulfill selectivity requirements.

**Size and Number of Services**

The use of services rated 2000 amperes or less is strongly recommended for better protection, service continuity and lower cost. Smaller transformers permit lower rated protective devices, which provide better protection and service continuity. The National Electrical Code recognized this in Section 230.2(c), which permits two or more services when the capacity requirements are in excess of 2000 amperes at 600 volts or less.



P<sub>1</sub> is Selective with P<sub>2</sub>  
 If P<sub>2</sub> Opens First for a Fault at F<sub>1</sub>, P<sub>1</sub>  
 Provide Timed Backup Protection for P<sub>2</sub>



**Service Entrance Equipment**

The National Electric Code has specific rules for the equipment that controls and protects the service or supply of electricity to a building.

The general rule is that a building is to be supplied by only one service. Exceptions include fire pumps, multiple occupancy buildings, high capacity and large areas (NEC 230.2(a)). The single service shall consist of not more than six switches or circuit breakers (NEC 230.71).

## Spectra Series® Switchboards

### Section 5 – Application Data

The service disconnecting means shall be located either inside or outside of a building at a readily accessible location nearest the point of entrance of the service conductors (NEC 230.70).

Switchboards used as service equipment shall be marked "suitable for use as service equipment" and shall provide:

1. A bonding jumper to bond the enclosure and ground bus to the neutral (NEC250.24(a)).
2. A neutral disconnect link to disconnect neutral from premises wiring (NEC 230.75).
3. A barrier to isolate service bus bars and terminals from rest of switchboard.

Ground fault protection shall be provided for solidly grounded wye services with more than 150 volts to ground but not exceeding 600 volts phase-to-phase for each service disconnecting means rated 1000 amperes or more (NEC 230.95).

#### Switchboard Enclosure

The standard switchboard enclosure is a NEMA Type 1 general purpose indoor enclosure. It is intended primarily to prevent accidental contact of personnel with live parts and to provide protection against dirt and foreign objects. NEMA 1 enclosures should be used indoors in dry locations.

Devices may require ventilation for operation at rated current. The standard switchboard enclosure should not be used in environments where ventilation is not acceptable.

Outdoor enclosures are available and should be used outdoors to protect the equipment against rain, and indoors where water may intrude, such as beneath fire sprinklers.

#### Switchboard Ratings

Switchboards are designed, tested and rated to Underwriters Standard 891 for dead-front switchboards and NEMA Standard PB2 for dead-front distribution switchboards.

System		Voltage Rating	
No. of phases	No. of wires	AC	DC
3	4	600/347 <sup>ⓐ</sup> , 480Y/277, 208Y/120	
3	4 <sup>ⓐ</sup>	240/120	
3	3	600, 480, 240, 120	
1	3	240/120	125/250
1	2	120, 240, 277	125/250

<sup>ⓐ</sup> Delta with neutral at center of one leg

<sup>ⓑ</sup> Canadian

#### Current

The continuous current ratings of switchboards are 400, 600, 800, 1000, 1200, 1600, 2000, 2500, 3000 and 5000 amperes.

Switchboard bus bars are rated on a current density basis -750A per square inch for aluminum and 1000A per square inch for copper or heat rated. (Tested per standard).

#### Frequency

AC switchboards are rated 60 Hertz and may be applied on 50 Hertz services without derating. For other ratings, refer to factory.

#### Insulation Level

Switchboards have an insulation level rating at twice the rated voltage plus 1000 volts. The dielectric test for this rating consists of applying a 60 hertz voltage for 1 minute phase-to-phase and phase-to ground with switching devices closed.

#### Working Space

The National Electrical Code (Article 110.26) requires that sufficient access and working space shall be provided and maintained about electrical equipment to permit ready and safe operation and maintenance of such equipment.

The minimum working space required by the National Electric Code for switchboards 150 volts-to-ground is three (3) feet. For voltages over 150 volts-to-ground, three feet is required from the enclosure to insulated surfaces, three and one-half (3-1/2) feet to grounded surfaces, including concrete, and four (4) feet to exposed live parts. Working space is required from all accessible surfaces (front, rear, sides).

Working space is not required in back of switchboards (Class 1, Class 2) when all connections are accessible from locations other than the back.

# Spectra Series® Switchboards

## Section 5 – Application Data

### Access and Entrance to Working Space

At least one entrance of sufficient area shall be provided to give access to the working space about switchboards. For switchboards rating 1200A or more and over six feet wide, there shall be one entrance not less than twenty-four (24) inches wide and six and one-half (6-1/2) feet high at each end (NEC 110-26(c)).

Exceptions to this are:

1. Where the equipment location permits a continuous and unobstructed way of exit travel.
2. Where work space is double the amount required.

### Phase Arrangement

The phase arrangement on three-phases buses is A, B, C, from top to bottom, front to back, or left to right as viewed from the front of the switchboard. On three-phase, four-wire delta-connected systems, the B-phase shall have the higher voltage to ground and is marked "Hi-Leg."

### Protective Device Continuous Current Ratings

The continuous load supplied by a protective device shall not exceed 80% of the device rating unless the switchboard, including the protective device, is UL listed for continuous operation at 100% of its rating. The non-continuous load may be 100% of the device rating. A continuous load is one that continues for three hours or more.

Standard group mounted MCCBs are 80% rated. 100% ratings are available with the Spectra G up to 400A and K up to 1200A.

All individually-mounted molded case circuit breakers are standard (80%) rated only.

Fusible switches 30-1200A group-mounted or individually-mounted are standard (80%) rated only.

Insulated case circuit breakers (Power Break II) can be 80% or 100% rated.

High pressure contact and bolted pressure switches are 100% rated in switchboards.

### Switchboard Short-Circuit Ratings

Switchboards shall be applied on a system having an available short-circuit current not greater than the short circuit rating of the switchboard. All switchboards

are marked with a short circuit rating. The switchboard will be fully rated or series connected rated. When fully rated, the short circuit rating of the switchboard is that of the lowest rated device in the switchboard. Series connected ratings are based on short circuit ratings given to two or more devices connected in series.

In either case, the bus bar bracing must be equal to or exceed the short circuit rating of the switchboard. Bus bar bracings available are 65,000, 100,000, 150,000 and 200,000 rms symmetrical amperes; 65,000 is the standard bracing.

### Short-Circuit Rating Tests

Switchboard buses are tested and assigned short-circuit ratings in according with UL Standard No. 891 and NEMA Standard No. PB-2. The test current duration is three cycles and the test circuit power factor is 20%.

Devices are tested and rated in accordance with the applicable standards.

If the switchboard, including devices, is applied in a circuit with a power factor less than it is tested at, derating may be required. Refer to applicable standards or the factory.

Unless otherwise noted, all GE switchboards meet the latest revision of the following standards:

- UL 50 Cabinets and Boxes, Electrical
- UL 67 Panelboards
- UL 98 Enclosed and Dead Front Switches
- UL 489 Circuit Breakers, Molded Case and Circuit Breaker Enclosures
- UL 512 Fuseholders
- UL 891 Dead Front Switchboards
- UL 969 Marking and Labeling
- Article 384 National Electrical Code
- NEMA PB1 Panelboards; NEMA KS1, Switches
- NEMA PB2 Switchboards
- CSA Certified as Distribution Switchboards
- Federal Specifications Panelboards W-P-115a  
Molded Case Circuit Breakers, WC-357B/GEN Fusible  
Switches, W-S-865C

*Note: Only switchboards containing all UL listed/recognized devices can be UL labeled.*

In addition to meeting or exceeding all applicable standards shown above, Spectra Series switchboards meet

# Spectra Series® Switchboards

## Section 5 – Application Data

GE's more stringent internal requirements, offering a greater margin of performance and safety.

The following classifications and limitations of switchboard distribution sections have been established by Underwriters Laboratories and the National Electrical Code.

*Note: An overcurrent protective device is a circuit breaker pole or single fuse.*

Device	Standard			Test Circuit Power Factor (%)
	UL	ANSI	NEMA	
Molded Case Circuit Breakers	489		AB-1	20
Power Break II Circuit Breakers	489		AB-1	20
Low Voltage Power Circuit Breakers	1066	C37.50		20
High Pressure Contact Switches	977		KS-2	20
Bolted Pressure Switches	977		KS-2	20
Fusible Switches	98			20
Fuses	198 E.B		FU-1	20

### Service Entrance Equipment

- Must be located near the point of entrance of building supply conductors.
- Switchboard distribution sections may have up to six operating handles to entirely disconnect switchboards from the source.
- Must include connector for bonding and grounding neutral conductor.
- A service entrance-type UL label must be factory installed and will be provided on the equipment (when specified).

### Service Conditions

1. Switchboards are rated for use in a 40°C room ambient per UL891. For higher ambients, the current rating of the equipment should be derated by multiplying factors in the following Table.

Room Ambient °C	Switchboard Current Derating Factor
25–40	1.00
50	.78

2. Switchboards can be applied for use in altitudes up to 6600 feet (2000 meters). Above 6600 feet, the derating factors in Table on following page apply.
3. Ambient temperature rating of installed protective devices should not be exceeded without derating. The ambient temperature ratings of the most frequently used devices are listed in Table on following page. This temperature is around the device inside the switchboard enclosure. Refer to the applicable device standard for derating factors.
4. The National Electrical Code specifies ampacity of conductors for various temperatures. Standard ratings are based on 30°C (86°F) ambient. Higher ambient temperatures will require derating as shown in NEC Table 310-16. Maximum operating temperature of conductor insulation must not exceed that shown in NEC Table 310-16.
5. All device lugs and equipment lug assemblies are UL listed and rated for use with conductors whose ampacity is based on the ampere rating of 75°C (167°F) conductors, which is in compliance with NEC 11.14. Higher temperature ratings may be used and in some cases should be used, but it must be applied at its 75°C ampacity. Lugs rated for 90°C (stamped AL9CU). However, cables terminating in our equipment can only be sized to 75°C.
6. Switchboards will resist seismic forces of 0.6G in any direction when installed with structurally certified fasteners in accordance with the installation instructions.
7. For unusual service conditions, such as corrosive atmosphere, vibration or unique equipment arrangements, refer to factory.

Altitude		Temperature Derating	Voltage Derating
Feet	Meters		
6600	2000	1.00	1.00
8500	2600	.99	.95
13000	3900	.96	.80

Short circuit ratings are not affected by altitude.

### Device Ambient Temperature Rating

Molded Case and Insulated Case Circuit Breakers	40°C
ADS Fusible Switches	40°C
Low Voltage Power Circuit Breakers	55°C
High Pressure Contact and Bolted Pressure Switches	40°C

For seismic compliance certification, see the Appendix.



## 5.2 Protective Device Ratings

### Series Connected Ratings

UL permits assigning a short circuit rating to a combination of molded case circuit breakers or fuses and molded case circuit breakers connected in series that is higher than the lowest rating protective device of the combination. This is defined as series connected ratings. The combination rating cannot exceed the rating of the protective device farthest upstream, although it will exceed the rating of the downstream protector.

The upstream protector can be a molded case breaker or fuse. Device combinations are not limited to those in the same equipment. They can be in different equipment, such as a switchboard feeder or a panelboard main versus panelboard branches. Any distance between devices in different equipment is permitted. Total fault current magnitude must flow through both protectors. Thus, fault current contribution from motors, as well as power source fault current, must flow through upstream and downstream protectors.

Molded case circuit breakers may be applied as fully rated or series connected.

In a fully rated system, (figure adjacent), the short circuit rating of all protective devices is equal to, or exceeds, the circuit short circuit requirement and, if mounted in equipment, the bus short circuit withstand rating and equipment short circuit rating exceeds the circuit available.

In a series connected system, (figure adjacent), the short circuit rating of the upstream protector is fully rated but the downstream protector is not fully rated.

UL permits assigning a short circuit rating to a combination of protective devices that is higher than the lowest rating of the downstream device. This rating of two devices in series is defined as a series rating. Series ratings can exist for a combination of molded case circuit breakers, or a combination of fuses and molded case circuit breakers. The rating of the combination cannot exceed the rating of the upstream device in the combination, but can exceed that of the downstream device.

The upstream protector can be a molded case breaker or fuse. Device combinations are not limited to those in the same equipment; They can be in different equipment, such as a switchboard feeder and a panelboard main, or a switchboard feeder and panelboard branches in a main lug panelboard. Any distance between devices is permitted. To be a valid series rating application, total fault current magnitude must flow through both protectors. Thus, fault current contribution from motors, as well as power source fault current, must flow through upstream and downstream protectors.

Molded case circuit breakers may be applied as fully rated or series rated. In a fully rated system (figure adjacent), the short circuit rating of all protective devices is equal to or exceeds the circuit short circuit requirement. If mounted in equipment, the bus short circuit withstand rating and equipment short circuit rating must also exceed the circuit available current.

In a series connected system (figure adjacent), the short circuit rating of the upstream protector is “full” (meets or exceeds the available current in the system), but the downstream protector is not fully rated (is rated less than the system available).

In series or fully rated combinations, both protectors may open on short circuits. Conversely, in selectively coordinated systems, only the device closest to the overcurrent of fault is permitted to open. In these systems, both devices must be fully rated, and the short circuit level to which they are selective must be known.

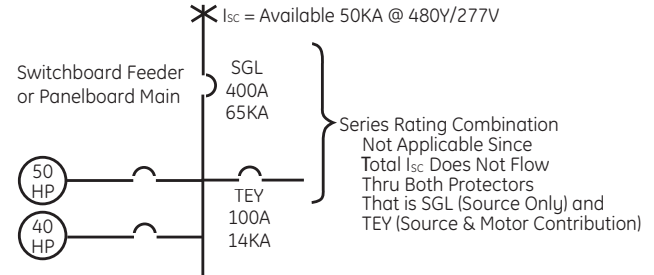
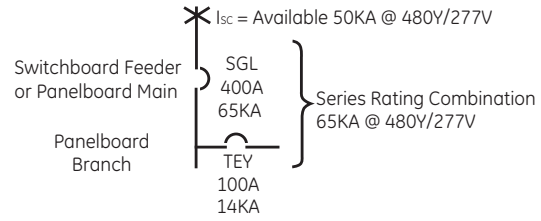
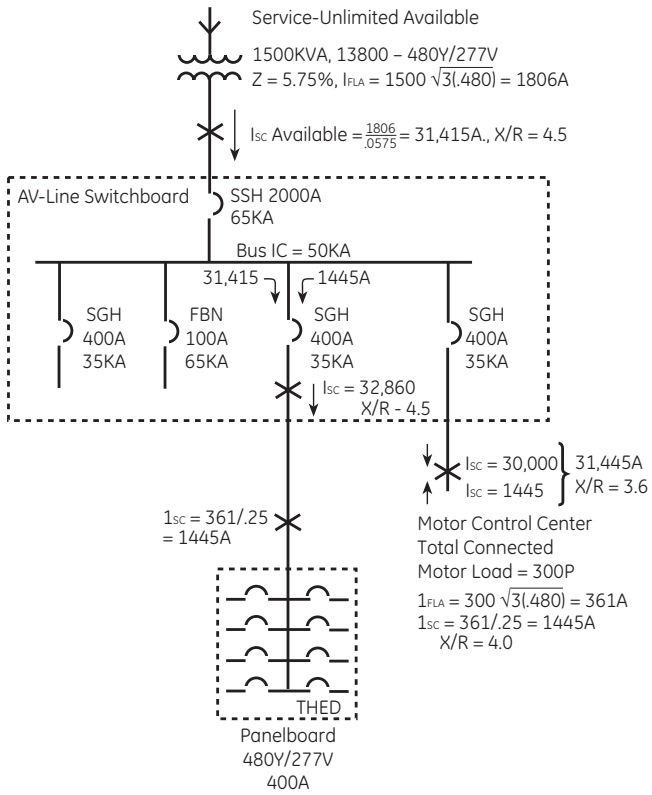
Examples where selectivity is desirable (and often required) include:

- Buildings with important loads such as: elevators, emergency lighting, critical ventilation, etc.
- Manufacturing facilities where loss of power can result in economic loss due to production downtime or damage to equipment.
- Hospitals and medical facilities where life support is critical.

Series Ratings are listed in publication DET-008.  
Selectivity Ratings are listed in publication DET-537.

# Spectra Series® Switchboards

## Section 5 – Application Data



**Section 5 – Application Data**

**5.3 Power Break® II Circuit Breaker**

**Basic Configuration**

The insulated case circuit breaker - GE pioneered the design and created the name. Power Break® II insulated case circuit breakers offer reliable, flexible and easy-to-use circuit protection.

Power Break II circuit breakers are UL Listed, CSA Certified and IEC Certified for up to 200,000 amps at 240 volts rms symmetrical interrupting capacity without fuses or current limiters. These insulated case circuit breakers can be applied on ac power systems through 600 volts. Featuring a 2000A compact design up to 40% smaller than its predecessors, Power Break II circuit breakers consist of three envelope sizes from 800 to 4000 amps.

**Greater Convenience and Operational Safety.**

The controls and status indicators you need most are readily accessible. The flush-mounted handle, ON/OFF buttons, rating plug test receptacles, bell alarm reset buttons (with or without lockout) are easily reached, and all are double-insulated from live components. For added security, a standard padlock device lets you prevent accidental or unauthorized closing of the breaker.

**Quick, Error-Free Installation of Universal Accessories**

Drop-in bell alarm, bell alarm with manual lockout, shunt trip (with or without lockout) and undervoltage release install in seconds. No special tools. No breaker disassembly. Just slide them into place. The modules are universal across all frame sizes, and each is mechanically keyed to its compartment so you make the right connection, every time. These accessories are field installable and upgradeable.

**Advanced, Solid-State Trip Units**

EntelliGuard TU trip units give you new ways to monitor and control the Power Break II breaker with unprecedented ease. A simple keypad lets you program and display a variety of functions, including tripping characteristics, remote communications, status information and protective relaying. The trip unit display also allows viewing of many standard metering parameters as well as pickup alarms, trip target indications and fault status information. For less demanding functionality, the Power+ trip unit gives you a second choice in Power Break II breaker control. Tripping characteristics are easily adjusted by a set of simple-to-use switches. The trip unit is upgradeable to ground fault by simply

inserting a ground fault rating plug. An optional target module allows for fault indication monitoring and also functions as a trip unit health indicator.

**Rating Plugs**

The same interchangeable rating plugs are used in all of the EntelliGuard TU trip units across the entire Power Break II breaker product line. Rating plugs are the key devices that establish the current rating of the breaker. They provide an essential scaling function for the unit's microprocessor and ensure maximum accuracy.

Rating plugs have rejection features that allow them to be inserted only with breakers containing the correct current sensors. Rating plugs for the EntelliGuard TU trip units are compatible with Power Break and AKR breakers with EntelliGuard TU trip units. See Table below.

**Rating Plug and Current Sensor Ratings**

Envelope Size	Frame Max. Rating (Amps)	Sensor Rating (Amps) (S)	Rating Plug Amps (X)
2000	800	200	100, 150, 200
		400	100, 150, 200, 225, 250, 300, 400
	800, 1600	800	300, 350, 400, 450, 500, 600, 700, 750, 800
		1000	400, 450, 500, 600, 700, 750, 800
	1600	1600	600, 700, 750, 800, 900, 1000, 1100, 1200, 1250, 1500, 1600
		2000	750, 800, 900, 1000, 1100, 1200, 1250, 1500, 1600, 1900, 2000
3000	2500	1000	400, 450, 500, 600, 700, 750, 800
		2000	750, 800, 900, 1000, 1100, 1200, 1250, 1500, 1600, 1900, 2000
		2500	1000, 1100, 1200, 1250, 1500, 1600, 1900, 2000, 2200, 2400, 2500
	3000	3000	1200, 1250, 1500, 1600, 1900, 2000, 2200, 2400, 2500, 3000
4000	4000	4000	1500, 1600, 1900, 2000, 2200, 2400, 2500, 3000, 3600, 3400, 4000

**Current Sensors**

Toroidally wound current sensors are furnished for all major protective functions, and for use with all Power Break II trip units. Toroidal sensors, including a second air-core winding, are provided with the high-range instantaneous function. Current sensors are factory installed and are not changeable in the field. There are 11 current ratings for the Power Break II breaker line through 4000 amps. See table above for current ratings. Rating plugs must be coordinated with the current sensor rating (S) listed on the face of the rating plug.

# Spectra Series® Switchboards

## Section 5 – Application Data

### Accessory Configuration

Activation of the bell alarm - alarm only and bell alarm with lockout are controlled by switch settings on the rear of the trip unit. To change the conditions that activate these accessories, configure the trip unit switch settings as described below.

### Accessory Switch Settings

Switch	Factory Setting	Function
1	Disable	Shunt trip activates bell alarm - alarm only
2	Disable	UVR trip activates bell alarm - alarm only
3	Enable	Protection trip activates bell alarm - alarm only
4	Disable	Shunt trip activates bell alarm/lockout
5	Disable	UVR trip activates bell alarm/lockout
6	Enable	Protection trip activates bell alarm/lockout

### Power+™ Trip Unit Characteristics

Envelope Size	Frame Max. Amp Rating	Sensor Rating (Amps) (S)	Long-Time		Short-Time	
			Current Setting (C) (Pick-Up) Multiple of Rating Plug Amps (X)	Delay <sup>①</sup> (Seconds 4 Bands)	Pick-Up (Multiple of Current Setting) (C)	Delay (Seconds 3 Bands)
2000	800	200, 400, 800	0.5, 0.6, 0.7, 0.8, 0.9, 0.95, 1.0	2.4, 4.9, 9.8, 20	1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.0, 9.0	I <sub>ct</sub> in <sup>①</sup> .10, .21, .35 I <sub>ct</sub> out <sup>②</sup> .10, .21, .35
	1600	800, 1000, 1600				
	2000	2000				
3000	2500	1000, 2000,				
	3000	2500, 3000				
4000	4000	4000				

### Trip Unit Characteristics (continued)

Envelope Size	Adjustable Instantaneous Pick-Up without ST (Multiple of Rating Plug Amps) (X)	Adjustable Instantaneous Pick-Up with ST (Multiple of Rating Plug Amps) (X)	Ground Fault	
			Pick-Up (Multiple of Sensor Amp Rating)	Delay <sup>③</sup> (Seconds 3Bands)
2000	1.5 thru 10.0	1.5 thru 15.0	0.20 thru 0.60	I <sub>ct</sub> in <sup>④</sup> .10, .21, .35 I <sub>ct</sub> out <sup>②</sup> .10, .21, .35
3000		1.5 thru 13.0	0.20 thru 0.37	
4000	1.5 thru 9.0	1.5 thru 9.0	0.20 thru 0.30	

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

② Time delay shown at lower limit of each band. All pick-up tolerances are ±10%.

③ Time delay shown at lower limit of each band. Ground fault pick-up not to exceed 1200 amps.

④ Time delay shown at 200% of pick-up at lower limit of band.

X = Rating plug amps

S = Sensor amp rating

C = Long-time current setting (pick up)

For complete information on Power Break II circuit breakers, refer to publication GET-8052.

**Section 5 – Application Data**

**5.4 WavePro™ Low Voltage Power Circuit Breakers**

**WavePro Low Voltage Power Circuit Breaker**

The GE line of WavePro Low Voltage Power Circuit Breakers is intended for use in commercial, industrial and utility applications. Built to withstand intense service conditions, these circuit breakers provide the ultimate in system selectivity because of their high withstand capabilities. These circuit breakers are UL listed and meet the ANSI standards for low-voltage power circuit breakers. The WavePro line consists of six frame sizes with current ratings of 800 to 5000 amperes and short-circuit ratings through 200,000 amperes.

**Power+ Trip Unit**

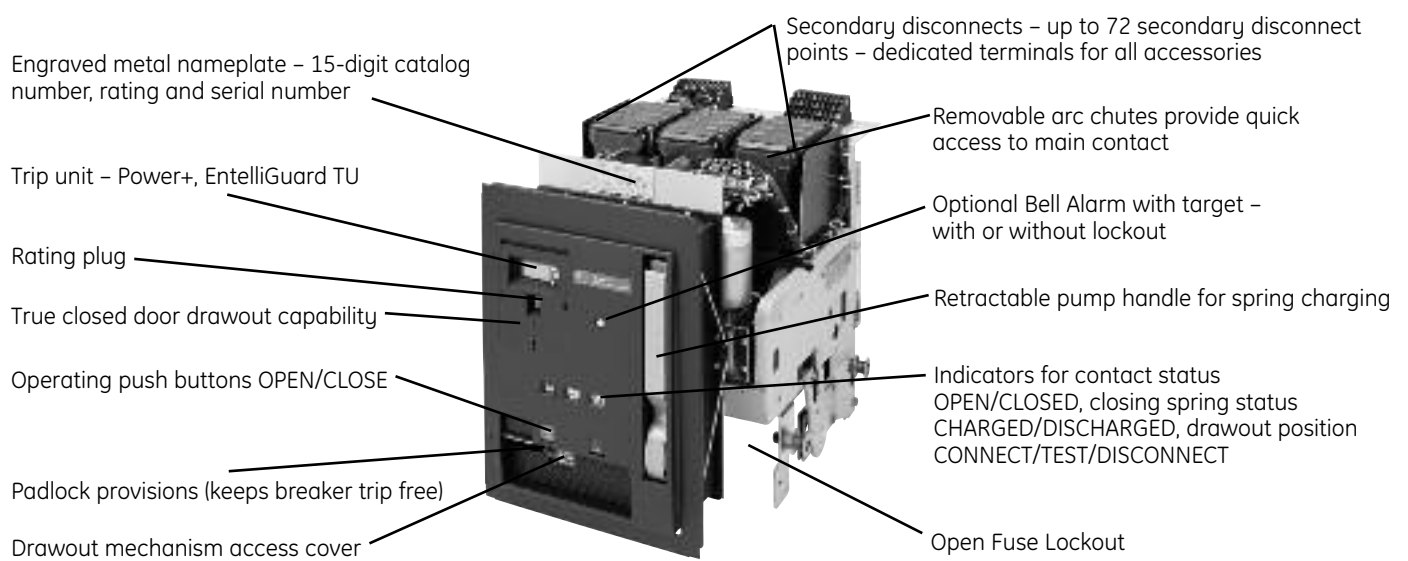
The Power+ trip unit is available on GE low voltage power circuit breakers. It provides the same true RMS sensing as the EntelliGuard TU trip units. The liquid crystal display and keypad are replaced by plug-in modules and rotary switches. The plug-in module provides optional LED targets for overload, short circuit and ground fault trips. View and reset push buttons are also provided to monitor status, including a battery check LED. 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.

**EntelliGuard TU Trip Unit**

The EntelliGuard TU trip unit offers optimum circuit protection and optimum system reliability simultaneously with little or no compromise to either of these critical functions. Reliability and arc flash protection, in one package, at the same time, all the time.

EntelliGuard TU series trip units are available as the standard controller for new production EntelliGuard G ANSI/UL 1066, UL 489 and IEC circuit breakers. EntelliGuard TU designs are also available as direct, functional replacements for GE PowerBreak II, WavePro, AKR and AK circuit breakers. EntelliGuard TU trip units are also available in kit form for many popular non-GE and older GE low voltage power circuit breakers (refer to DEH-4567).

**WPF-16 Electrically Operated Circuit Breaker Key Product Features**



# Spectra Series® Switchboards

## Section 5 – Application Data

### Breaker Features<sup>③</sup>

- Designed to meet ANSI C37.13, C37.16, C37.17 and tested to ANSI C37.50
- Listed and labeled to UL-1066 and CUL C22.2
- 100% rated (requires 90C wire sized at 75C to comply with UL), 40°C room ambient temperature
- Six frame sizes: 800, 1600, 2000, 3200, 4000, 5000
- Integral spring charging handle standard on manual and electrically operated breakers
- Improved breaker rating rejection feature
- Trip unit is mounted in the breaker escutcheon, “thru the door” access
- True closed-door drawout for maximum operator safety
- Breaker drawout position indicator in the escutcheon
- Up to 72 secondary disconnect points – accessories have dedicated wiring points
- Choice of three trip units
- Short circuit ratings through 200,000 amperes rms symmetrical
- Metal frame construction provides rigidity and endurance
- Easy access to main components to facilitate inspection and maintenance
- Optional “power management ready” for easy field upgrade

### Power+, EntelliGuard TU Trip Unit Characteristics

Frame Size	Max. Amp Rating	Sensor Rating (Amps) (CT)	Long-time		Short-time	
			Long-time (LT) (Pickup) Multiple of Rating Plug Amps (In)	Delay <sup>①</sup> [Band] (Seconds)	Pickup (Multiple of Long Time) (LT)	Delay [Band] (Seconds)
WPS-08 / WPH-08	800	150, 400, 800	Power+ 0.5 thru 1.1 in steps of 0.1	[1] [2] [3] [4] 2.4, 4.9, 9.8, 20	Power+ 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.0, 9.0	I <sup>2</sup> T in <sup>①</sup> 0.40 I <sup>2</sup> T out <sup>②</sup>
WPX-08 / WPF-08						
WPS-16 / WPH-16	1600	800, 1600	EntelliGuard TU 0.5 thru 1.1 in steps of 0.05		EntelliGuard TU 1.5 thru 9.0 in steps of 0.5	[1] [2] [3] .10, .21, .35
WPF-16						
WPS-20	2000	2000				
WPS-32 / WPH-32	3200	3200				
WPS-40	4000	4000				
WPS-50	5000	5000				

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

② Time delay shown at lower limit of each band. All pick-up tolerances are ±10%.

In or X = Rating plug amps

CT or S = Sensor amp rating

LT or C = Long-time current setting

ST = Short-time characteristic

### Power+, EntelliGuard TU Trip Unit Characteristics

Frame Size	Adjustable		Ground Fault		
	Instantaneous Pickup without ST (Multiple of Rating Plug Amps) (In)	Instantaneous Pickup with ST (Multiple of Rating Plug Amps) (In)	Pickup (Multiple of Sensor Amp Rating) (CT)	Delay with I <sup>2</sup> t <sup>①</sup> (Seconds)	Delay without I <sup>2</sup> t <sup>①</sup> [Band] (Seconds)
WPS-08 / WPH-08	Power+ 1.5, 2.0, 3.0, 5.0, 7.0, 9.0, 10.0	Power+ 1.5, 2.0, 3.0, 5.0, 7.0, 9.0, 10.0, 13.0, 15.0	Power+ .20, .25, .30, .35, .40, .45, .50, .60		
WPX-08 / WPF-08					
WPS-16 / WPH-16	EntelliGuard TU 1.5 thru 10.0 in steps of 0.5	EntelliGuard TU 1.5 thru 15.0 in steps of 0.5	EntelliGuard TU 0.20 thru 0.60 in steps of 0.01	.44 at 200% of pickup at lower limit of band	[1] [2] [3] .10, .21, .35
WPF-16					
WPS-20					
WPS-32 / WPH-32	EntelliGuard TU 1.5 thru 10.0 in steps of 0.5	Power+ 1.5, 2.0, 3.0, 5.0, 7.0, 9.0, 10.0, 13.0 EntelliGuard TU 1.5 thru 13.0 in steps of 0.5	Power+ .20, .22, .24, .26, .28, .30, .34, .37 EntelliGuard TU 0.20 thru 0.37 in steps of 0.01		
WPS-40					
WPS-50 <sup>②</sup>	EntelliGuard TU 1.5 thru 7.0 in steps of 0.5	EntelliGuard TU 1.5 thru 7.0 in steps of 0.5	EntelliGuard TU 0.20 thru 0.24 in steps of 0.01		

① Time delay shown at lower limit of band. Ground fault pick up not to exceed 1200 amps.

② Power+ not available on 5000 amp (WPS-50) circuit breaker.

In or X = Rating plug amps

CT or S = Sensor amp rating

LT or C = Long-time current setting

ST = Short time characteristic

# Spectra Series® Switchboards

## Section 5 – Application Data

### EntelliGuard TU Trip Unit Features (All Frames)®

Function	Description	Trip Unit Suffix	
		M (Metering)	PM (Metering & Relaying)
Amperes (A)	Selectable phase current, ±2.0%	X	X
Voltage (V)	L-L or L-N Volts, ±1.5%	X	X
Energy (kWh, MWh)	Total energy usage on breaker, ±3.5%	X	X
Real Power (kW)	L-L or L-N Power, ±3.5%	X	X
Frequency (Hz)	Circuit Frequency, ±1 Hz	X	X
Undervoltage Trip	Adjustable pickup: 50-90%; adjustable delay: 1-15 s, OFF		X
Overvoltage Trip	Adjustable pickup: 110-150%; adjustable delay: 1-15 s, OFF		X
Voltage Unbalance	Adjustable pickup: 10-50%; adjustable delay: 1-15 s, OFF		X
Current Unbalance	Adjustable pickup: 10-50%; adjustable delay: 1-15 s, OFF		X
Power Reversal	Adjustable pickup: 10-990 kW; adjustable delay: 1-15 s, OFF		X
Power Direction	Setup as line-to-load or load-to-line		X
Communication		X	X

① Time delay shown at lower limit of band. Ground fault pick up not to exceed 1200 amps.

② Power+ not available on 5000 amp (WPS-50) circuit breaker.

In or X = Rating plug amps  
 CT or S = Sensor amp rating  
 LT or C = Long-time current setting  
 ST = Short time characteristic

### Product Specifications®

#### Fused Breaker Ratings (Max. 600 Vac. 50/60 Hz)

Breaker Type	Frame Size (amps)	Fuse Rating, A <sup>①</sup>		Interrupting Rating RMS Symmetrical kA
		Min.	Max.	
WPF-08	800	300	1600	200
WPF-16	1600	450	2500	200
WPS-20 <sup>②</sup>	2000	2000	2500	200
WPS-32 <sup>②</sup>	3200	2000	4000	200
WPS-40 <sup>②</sup>	4000	2000	5000	200
WPS-50 <sup>②</sup>	5000	2000	5000	200

#### Shipping Weight

Draw-Out Breaker Element	Net (lbs)	
	Manual	Electrical
WPS/WPH/WPX-08	200	205
WPF-08	245	250
WPS/WPH-16	210	215
WPF-16	255	260
WPS-20	220	225
WPS/WPH-32	475	485
WPS-40	535	545
WPS-50	575	585

### WavePro Breaker Interrupting Ratings

Rated AC Voltage, Nominal (max)	Breaker Type	Frame Size (amps)	Short-Circuit 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
	WPS-40	4000	85	85	85
	WPS-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
	WPS-40	4000	85	85	85
	WPS-50	5000	85	85	85
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
	WPS-40	4000	85	130	85
	WPS-50	5000	85	130	85

① 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 on separate fuse roll-out element.

### Operating Time (Cycles on 60 Hz Base; All Frame Sizes) Closing electrically

Time from energizing closing circuit until contacts touch 5

### Open (maximum clearing time)

With instantaneous overcurrent trip 3  
 With shunt trip 3.5

For further information on WavePro Low Voltage Power Circuit Breakers, refer to DET-167

## Section 5 – Application Data

### 5.5 High Pressure Contact Switches

GE type HPC switches are UL Listed in accordance with Standard 977, Fused Power Circuit Devices.

The overcenter toggle mechanism provides stored energy, quick-make/quick-break operation. Multiple spring-loaded, high-pressure current-carrying contacts and an arcing contact arm provide excellent current carrying capability without sacrificing high interrupting fault performance. These switches can interrupt, on a make and break basis, a minimum of 12 times their nameplate ratings without fuse assistance at 600 volts ac. Complete HPC switch and Class L fuse coordination is therefore achieved for all levels of fault current up to 200,000 rms amperes symmetrical at 600 volts ac maximum. Type HPC switches used as service disconnects comply with the National Electrical Code Section 230-65 for adequate short-circuit current and ground-fault protection.

- High durability, safety of operation - High dielectric strength. Glass-reinforced insulating case.
- High interrupting capability - Arc chute of unique construction suppresses arcs and cools gases rapidly, providing quick arc interrupting and extended switch life.
- High transient voltage withstanding - Interphase partitions mesh with switch cover to completely isolate each pole.
- Extended switch life - Preloaded constant pressure pivot eliminates braid whip and fraying on high short-circuit currents and repeated operations.
- Positive "On-Off" indication - Green (Off), red (On), eliminates any question about the position of the switch contacts.
- Easy operation - Quick Make - Extra heavy duty, low torque rotary-operated closing mechanism. L-handle 800-1600 amperes; T-handle 2000 amperes and above.
- Emergency Open - Quick Break - Fingertip "Off" button instantly opens the switch contacts.
- Positive door and switch interlock - Separate fuse access door is not required.

#### Product Forms

- Top Feed - Line terminals at top of switch.
- Bottom Feed - Line terminals at bottom of switch; fuses are de-energized when switch is in Off position. Same size switchboard as top feed. When switchboard is bottom fed it permits shallow design. Space for running feed to top terminals is not required.

#### Options Available

Manual Operation - For manual, high-interrupting capacity, disconnects not requiring remote tripping and/or ground-fault protection.

Electric Trip - For remote tripping or for use with Ground Fault. All electric trip switches are the same size as manual devices.

Blown-fuse Protector - Provides single phase protection by tripping switch when a fuse blows or when switch is closed with a blown fuse or no fuse installed. Suitable for system voltage of 208-480 volts ac. Mounted internally. Does not provide protection of voltage loss of the power source.

Auxiliary Switch - Provides remote indication of main contact position. Switch elements are Type AB, single pole, double-throw. Switch element ratings are: 0.25A at 250Vdc; 0.5A at 125Vdc; 6.0 Amps at 240Vac.

External Ground Fault Relay – ITI Ground Fault Relays and Sensors are designed to form a system for detecting a ground fault current on a ground ac power system. When a ground fault exceeds a selected Current level and Time Delay setting, the relay initiates a trip signal for a shunt trip disconnect device to open and clear the fault. This ITI system is designed to provide protection for electrical equipment, not protection for personnel.

1. Integral test panel with Push To Test and Shunt Trip Bypass pushing for ease in proper operational testing of the system, with or without tripping the protective device
2. "Power on" LED indicator in cover
3. Positive visual trip indicator, manual reset
4. Infinitely adjustable Time Delay
5. Discrete current threshold adjustment
6. Panel or door mounting
7. Rear terminal kit and clear plastic cover standard with door mounting
8. Electromechanical relay output, positive "ON" and "OFF"
9. Operates with molded case and power circuit breakers, bolted pressure switches or fusible disconnect switches
10. Meets NEC service entrance equipment standards



# Spectra Series® Switchboards

## Section 5 – Application Data

### GE HPC Switch Interrupting Ratings

Type	Available Ratings		Contact Interrupting Rating Based on Ability to Operate on Overload Unassisted by the Fuse	Switch-fuse Combination at Switch-rated ac Volts with Class L Fuse
	Continuous Amperes	Maximum ac Volts		
HPC/R	800, 1200, 1600, 2000, 2500, 3000, 4000	600	"Open" - 12X amp rating; "Close-Open" - 12X amp rating	200,000

For further information on HPC switches, see GET-6205 or contact your local GE Account Manager.

### 5.6 Molded Case Circuit Breakers Features

#### Spectra® RMS Molded Case Circuit Breakers

SE150, SF250, SG600, and SK1200 circuit breaker frames have a digital, solid-state, rms sensing trip system with field installable, front-mounted rating plugs to establish or change the breaker ampere rating. Adjustable instantaneous with tracking short-time is standard on all frames including SE150. The trip system uses digital sampling to determine the rms value of sinusoidal and nonsinusoidal currents.

#### microEntelliGuard Trip Units

Spectra® SG600 and SK1200 breakers are now available with *microEntelliGuard™* trip units - the newest and most advanced trip unit available in the Spectra® line of molded case circuit breakers. Based on the EntelliGuard® TU trip unit platform, the *microEntelliGuard™* trip unit has the same HMI interface and incorporates the advanced features and protective functions for improved system protection, coordination, selectivity, performance and diagnostic capabilities. The *microEntelliGuard™* trip unit uses the same universal rating plugs and test kit offered for the EntelliGuard® TU trip unit.

A complete circuit breaker consists of a UL listed circuit breaker frame and a rating plug (UL listed interchangeable trip unit). Terminal lugs for cable connection are available if required.

- All frames use the same UL listed, field-installable internal accessories (auxiliary switch, shunt trip, undervoltage release and bell alarm).

- All frame sizes have maximum UL listed interrupting ratings of 200 kA @ 240 Vac and 100 kA @ 480 Vac with 600 Vac ratings to 65 kA depending on frame size. UL listed current limiting versions are provided through the SG600 frame for the 65 kA @ 480 Vac and the 100 kA @ 480 Vac models, with no increase in physical frame size.
- Spectra® RMS Mag-Break instantaneous-only motor circuit protectors also use the same digital, solid-state trip unit and rating plugs as the circuit breakers. The interchangeable rating plug establishes the instantaneous pickup range (with tracking short-time) but does not change the frame ampere rating.
- Spectra® RMS molded case switches have a fixed, high-set instantaneous trip (without tracking short-time function) and have short-circuit withstand ratings equal to their equivalent breaker frame size interrupting rating in most cases.
- Spectra® RMS breakers are ambient insensitive. Trip times will not vary over the range 10-50°C breaker ambient. Refer to GET-7002 for further application information.
- Spectra® RMS breakers contain no parts that would support fungus growth and are, therefore, inherently fungusproof.

#### Record Plus® Molded Case Circuit Breakers

Record Plus® represents the very latest in molded case circuit breaker design. Utilizing design features such as double-break rotary contact structures and advanced ablative materials to enhance interruption, Record Plus® is capable of interrupting ratings up to 200kA. High kAIC ratings, selective coordination, reduced arc flash energy, and current limitation embody the core design principles of Record Plus®.

FC 100 and FB 100 circuit breakers are supplied with factory installed non-user interchangeable thermal-magnetic trip units and can be supplied with or without lugs. FB breakers are available in 1-, 2- and 3-pole versions. FC is available in 2- and 3-pole versions, both in a 3-pole footprint.

FE250 and FG600 circuit breakers are supplied equipped with factory installed non-user interchangeable electronic trip units that feature the use of front accessible, user installed rating plugs to establish or change the breaker's amp rating. Rating plugs are user specified and ordered under separate product number.

## Spectra Series® Switchboards

### Section 5 – Application Data

Instantaneous pickup levels are adjustable and set via a front-mounted adjusting knob. Both are available in 2- and 3-pole versions, each in a 3-pole footprint.

All frames use common internal accessories (auxiliary switches, UV releases, shunt trips, and bell alarms) UL listed for field installation.

UL listed maximum short circuit ratings at 480VAC are 150kA for the 100A frames and 200kA for the 600A frames.

Unless noted otherwise, all circuit breakers and accessories are listed in UL file number E11592.

#### Other MCCB Features

- UL489 Listed
- Broad product line to meet virtually any application need.
- Reduced downtime. A tripped breaker is easily spotted and can be immediately reset after the fault has been corrected.
- Eliminates single phasing. A common trip bar disconnects all poles simultaneously on both overloads and short circuits.
- Offers application flexibility through the use of a wide variety of accessory devices and special attachments.
- Repetitive operation — no fuses to replace.
- Breakers can be repetitively tested. Fuses must be destroyed to confirm calibration accuracy.

For more information on these products, order publications listed in Sections 21 and 22.

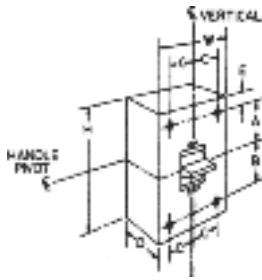
#### Quick Reference Guide

Ratings do not apply to molded case switches.

The interruption ratings and voltages shown in the tables are maximum ratings. A circuit breaker of the type given in the left-hand column may be applied at the given circuit voltage in any electrical distribution system where the available fault current at the load terminals of the breaker does not exceed the value in the table. That circuit breaker type may also be applied at intermediate values of circuit voltage provided the available fault current at the load terminals of the breaker does not exceed the value in the table for the higher value of voltage.

Spectra Series® Switchboards  
 Section 5 – Application Data

Q-Line (UL file E-11592; Fixed Thermal Magnetic Trip Unit)



THQL 32015

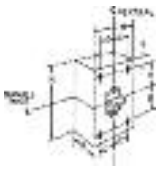
Circuit Breaker Type	Ampere Rating	No. Poles	Maximum Voltage Rating		UL Listed Interrupting Ratings—rms Symmetrical kA								Dimensions (in.)							Std. Pack	
					Vac					Vdc			H	W	D	A	B	C	E		
					ac	dc	120	120/240	240	277	480	600									125
TQL/TQB/TQC	10	1	120/240	—	—	5 <sup>2</sup>	—	—	—	—	—	—	3 9/32	1	2 3/8	—	—	—	—	50	
		2	—	—	—	5 <sup>2</sup>	—	—	—	—	—	—	2	25							
		3	240	—	—	—	—	—	—	—	—	—	3	15							
THQL <sup>1</sup> THQB <sup>1</sup> THQC <sup>1</sup>	15-70	1	120/240	—	—	10	—	—	—	—	—	—	3 9/32	1	2 3/8	—	—	—	—	50	
	15-125	2	—	—	—	10	—	—	—	—	—	—	2	25							
	15-100	3	240	—	—	—	10	—	—	—	—	—	3	15							
THHQB <sup>1</sup> THHQ <sup>1</sup>	15-70	1	120/240	—	—	22	—	—	—	—	—	—	3 9/32	1	2 3/8	—	—	—	—	50	
	15-100	2	—	—	—	22	—	—	—	—	—	—	2	25							
		3	240	—	—	—	22	—	—	—	—	—	3	15							
THHQL <sup>1</sup>	15-70	1	120/240	—	—	22	—	—	—	—	—	—	3 9/32	1	2 3/8	—	—	—	—	50	
	15-125	2	—	—	—	22	—	—	—	—	—	—	2	25							
	15-100	3	240	—	—	—	22	—	—	—	—	—	3	15							
TXQL <sup>1</sup> TXQB <sup>1</sup> TXQC <sup>1</sup>	15-30	1	120/240	—	—	65	—	—	—	—	—	—	3 9/32	1	2 3/8	—	—	—	—	50	
		2	—	—	—	65	—	—	—	—	—	—	2	25							
		3	240	—	—	—	—	—	—	—	—	—	3	15							
TQDL	125-200	2	120/240	—	—	10	—	—	—	—	—	—	6 1/16	2	2 3/8	—	—	—	—	12	
THQDL	125-200	2	120/240	—	—	22	—	—	—	—	—	—	6 1/16	2	2 3/8	—	—	—	—	12	
TQD <sup>1</sup>	100-225	2	240	—	—	10	10	—	—	—	—	—	6 9/16	2 3/4	2 5/8	2 7/16	2 7/16	—	11/16	27/32	1
	100-225	3	240	—	—	—	10	—	—	—	—	—	4 1/8	1							
THQD <sup>1</sup>	100-225	2	240	—	—	22	22	—	—	—	—	—	6 9/16	2 3/4	2 5/8	2 7/16	2 7/16	—	11/16	27/32	1
	100-225	3	240	—	—	—	22	—	—	—	—	—	4 1/8	1							
TJD	250-400	2	240	—	—	22	22	—	—	—	—	10	10 1/8	8 1/4	3 13/16	3 15/16	3 13/16	1 3/8	1 3/16	1	
		3	240	—	—	—	22	—	—	—	—	—								1	
<b>CB3 Ground Fault, Equipment Ground Fault and Arc Fault (UL File E-51075; Fixed Thermal Magnetic Trip Unit)</b>																					
THQB THQC THQL ...GF, GFEP, AF	15-30	1	120	—	—	10	—	—	—	—	—	—	3 9/32	1	2 3/8	—	—	—	—	—	10
		2	120/240	—	—	—	1	—	—	—	—	—	—	2							10
THHQL ...GF THHQB ...GF AF	15-30	1	120	—	—	22	—	—	—	—	—	—	3 9/32	1	2 3/8	—	—	—	—	—	10

<sup>1</sup> UL listed as HACR (heating, air conditioning and refrigeration).  
<sup>2</sup> Not UL listed.

# Spectra Series® Switchboards

## Section 5 – Application Data

### 10-1200A Circuit Breakers Thermal Magnetic Trip



TJJ, TJK, THJK



TFJ, TFK, THFK

TEY and TEYF (UL File E-11592; Fixed Thermal Magnetic Trip Unit; CUL LR 57114)

Circuit Breaker Type	Ampere Rating	No. Poles	Maximum Voltage Rating		UL Listed Interrupting Ratings— kA									Dimensions (In.)					Approx. Ship Wt./Std. Pack		
			ac	dc	Vac					Vdc			H	W	D	A	B	C		E	
					120/240	240	277	480	600	125	250	500 <sup>1</sup>									
TEY <sup>2</sup>	15-100	1	277	125	65	—	14	14	—	—	10	—	—	5 1/4	1	3 1/16	—	—	—	—	—
		2	480/277	250	—	—	65	14	14 <sup>5</sup>	—	—	10	—		2						
		3	—	—	—	—	—	—	—	—	—	—	3								
TEYF <sup>2</sup>	15-100	1	277	125	65	—	14	14	—	—	10	—	—	5 1/4	1	3 1/16	—	—	—	—	—
		2	480/277	250	—	—	65	14	14 <sup>5</sup>	—	—	10	—		2						
		3	—	—	—	—	—	—	—	—	—	—	3								

E150 (UL File E-11592; Fixed Thermal Magnetic Trip Unit; CUL LR 57114)

TEB <sup>2</sup>	10-100 <sup>3</sup>	1	120	125	10	—	—	—	—	—	5	—	—	6 5/16	1 3/8	3 3/8	2 41/64	2 15/64	—	23/32	26 lb/24
		2	240	250	—	—	10	—	—	—	—	5	—		2 3/4				24 lb/12		
		3	—	—	—	—	—	—	—	—	—	—	—		4 1/8				28 lb/8		
TED <sup>2</sup>	10-100 <sup>3</sup>	1	277,347 <sup>4</sup>	125	—	—	—	14	10	—	10	—	—	6 5/16	1 3/8	3 3/8	2 41/64	2 15/64	—	23/32	26 lb/24
		2	480	250	—	—	18	—	18	—	—	10	—		2 3/4				24 lb/12		
	3	480, 600	500	—	—	—	—	—	—	—	—	10	—		4 1/8				28 lb/8		
THED <sup>2</sup>	15-30	1	277,347 <sup>4</sup>	125	—	—	—	65	—	—	20 <sup>6</sup>	—	—	6 5/16	1 3/8	3 3/8	2 41/64	2 15/64	—	23/32	26 lb/24
	15-100	2	480	250	—	—	—	—	—	—	20 <sup>6</sup>	—	—		24 lb/12						
	15-150	3	600	500	—	—	—	—	25	—	—	10	—		4 1/8				28 lb/8		

K1200 (UL File E-11592; Interchangeable Thermal Magnetic Trip Unit; CUL LR 40350)

TKM8	300-800	2	600	250	—	—	42	—	30	22	—	10	—	15 1/2	8 1/4	5 1/2	8 9/16	5 11/16	1 3/8	5/8	33 lb/1
		3		500								—	—								20
TKM12	600-1200	2	600	—	—	—	42	—	30	22	—	—	—	15 1/2	8 1/4	5 1/2	8 9/16	5 11/16	1 3/8	5/8	38 lb/1
		3		—																	—
THKM8	300-800	2	600	250	—	—	65	—	35	25	—	40	—	15 1/2	8 1/4	5 1/2	8 9/16	5 11/16	1 3/8	5/8	33 lb/1
		3		—								—	—								40
THKM12	600-1200	2	600	—	—	—	65	—	35	25	—	—	—	15 1/2	8 1/4	5 1/2	8 9/16	5 11/16	1 3/8	5/8	38 lb/1
		3		—																	—

<sup>1</sup> UL listed with poles in series for 500 Vdc ungrounded battery applications.

<sup>2</sup> UL listed as HACR (heating, air conditioning, and refrigeration).

<sup>3</sup> 10 amp not UL listed.

<sup>4</sup> UL listed/CUL Certified for 10kA @ 347 Vac (TED) and 18kA @ 347V (THED). Also rated 10kA @ 480V but not UL listed.

<sup>5</sup> 480Y/277 Vac.

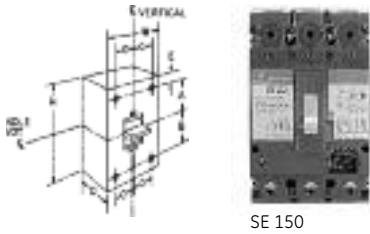
<sup>6</sup> UL listed at 10,000 amps

# Spectra Series® Switchboards

## Section 5 – Application Data

### 15-1200A Circuit Breakers

#### Electric Trip Spectra® RMS Breakers



SE 150

#### Spectra® RMS Circuit Breakers UL/CUL Ratings

Solid-State with Interchangeable Trip Unit (Rating Plug)														
Circuit Breaker Type	Ampere Rating	No. Poles	Maximum Vac	UL Listed Interrupting Rating—kA			Dimensions Inches (mm)							Approx. Ship Wt./Std. Pack
				240 Vac	480 Vac	600 Vac	H	W	D	A	B	C	E	
<b>SE150 Current Limiting (UL File No. E-11592; CUL LR 40350)<sup>1</sup></b>														
SED <sup>2,3</sup>	15-150	2	480	18	18	—	6.31 (160)	4.12 (105)	3.38 (86)	2.41 (61)	2.47 (63)	.69 (18)	.72 (18)	5.65 lb/1
		3	600			14								
SEH <sup>2</sup>	3	2	480	65	25	—								
		3	600			18								
SEL	15-150	2	480	100	65	—								
		3	600			25								
SEP	3	2	480	200	100	—								
		3	600			25								
<b>SF-250 Current Limiting (UL File No. E-11592; CUL LR 40350)<sup>1</sup></b>														
SFH <sup>2</sup>	70-250	2	480	65	35	—	10.12 (257)	4.12 (105)	3.81 (97)	3.87 (98)	3.87 (98)	.69 (18)	1.19 (30)	9.15 lb/1
	3	600	22											
SFL	70-250	2	480	100	65	—								
		3	600			25								
SFP	3	2	480	200	100	—								
		3	600			25								
<b>SG600 Current Limiting (UL File No. E-11592; CUL LR 40350)<sup>1,4</sup></b>														
SGH1 <sup>2,5</sup>	60-150	3	600	65	35	25	10.09 (256) 6	5.50 (140)	3.81 (97)	4.45 (113)	3.30 (84)	.91 (23)	1.18 (30) 6	15.85 lb/1
SGD <sup>2</sup>	125-400	2	240	65	—	—								
		3	600	—	—									
SGH4 <sup>2</sup>	3	2	600	65	35	25								
		3	600											
SGH6 <sup>2</sup>	250-600	2	600	65	35	25								
		3	600											
SGL1 <sup>5</sup>	60-150	3	600	100	65	65								
SGP1 <sup>5</sup>		3	600	200	100	65								
SGL4	125-400	2	600	100	65	65								
		3	600											
SGP4	3	2	600	200	100	65								
		3	600											
SGL6	250-600	2	600	100	65	65								
		3	600											
SGP6	3	2	600	200	100	65								
		3	600											
<b>SK1200 (UL File No. E-11592; CUL LR 40350)<sup>1,4</sup></b>														
SKH8	300-800	2	600	65	50	25	15.50 (394) 7	8.25 (210)	5.50 (140)	8.56 (217)	5.69 (145)	1.38 (35)	.62 (16) 7	47.6 lb/1
		3	600	—	—									
SKL8	3	2	600	100	65	42								
		3	600											
SKP8	3	2	600	200	100	65								
		3	600											
SKH12	600-1200	2	600	65	50	25								
		3	600											
SKL12	3	2	600	100	65	42								
		3	600											
SKP12	3	2	600	200	100	65								
		3	600											

<sup>1</sup> UL listed as HACR (heating, air conditioning and refrigeration).

<sup>2</sup> Not current-limiting circuit breaker.

<sup>3</sup> UL List as HID (high intensity discharge).

<sup>4</sup> Includes *microEntelliGuard*™, *MicroVersaTrip*® Plus and *MicroVersaTrip* PM® Trip Units.

<sup>5</sup> *microEntelliGuard*™, *MicroVersaTrip*® Plus and *MicroVersaTrip* PM® Trip Units only.

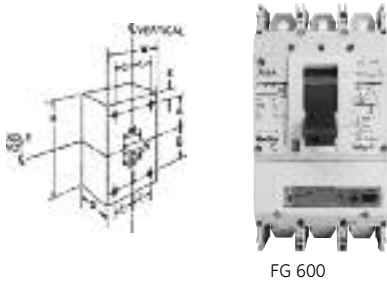
<sup>6</sup> Add 1.76 inches (45 mm) to each end with lugs and lug cover installed.

<sup>7</sup> Add 4.00 inches (101 mm) to upper end for SKP (100 kAIC-480V) lug cover.

# Spectra Series® Switchboards

## Section 5 – Application Data

### 15-600A Record Plus® Circuit Breakers



FG 600

FC 100 Amp Frame; Current Limiting (UL File No. E-11592)																		
Circuit Breaker Type	Ampere Rating	No. Poles	Maximum Voltage Rating		UL Listed Interrupting Ratings - rms Symmetrical Amperes (in Thousands)					IEC Listed Interrupting Ratings, Icu, Amperes (in Thousands)					Dimensions in. (mm.)			Approx. Ship Wt./Std. Pack
					Vac		Vdc			Vac		Vdc						
			AC	DC	240	480	600/347	250 (2p)	500 (3p)	220-240	400-415	500	250 (2p)	500 (3p)	H	W	D	
FCS	15-100	2, 3	600	500	42	25	18	22	30	36	22	14	22	30	6.4 (162.6)	3.0 (76.2)	3.2 (81.3)	2.5 lb/1
FCV	15-100	2, 3	600	500	65	35	22	25	35	50	30	18	25	35	6.4 (162.6)	3.0 (76.2)	3.2 (81.3)	2.5 lb/1
FCN	15-100	2, 3	600	500	150	65	25	30	42	85	50	22	30	42	6.4 (162.6)	3.0 (76.2)	3.2 (81.3)	2.5 lb/1
FCH	15-100	2, 3	600	500	200	100	35	42	65	100	80	36	42	65	6.4 (162.6)	3.0 (76.2)	3.2 (81.3)	2.5 lb/1
FCL	15-100	2, 3	600	500	200	150	42	65	80	200	150	50	65	80	6.4 (162.6)	3.0 (76.2)	3.2 (81.3)	2.5 lb/1

FB 100 Amp Frame; Current Limiting (UL File No. E-11592)																	
Circuit Breaker Type	Ampere Rating	No. Poles	Maximum Voltage Rating		UL Listed Interrupting Ratings - rms Symmetrical Amperes (in Thousands)					Dimensions in. (mm.)			Approx. Ship Wt./Std. Pack				
					Vac												
			AC	DC	240	277	347	480	600/347	H	W	D					
FBV	15-100	1	600/347	—	35	—	—	—	—	—	6.45 (163.8)	1.36 (34.5)	3.28 (83.3)	1.1 lb/1			
		2	600/347	—	65	—	—	—	35	22	6.45 (163.8)	2.74 (69.6)	3.28 (83.3)	2.6 lb/1			
		3	600/347	—	65	—	—	—	35	22	6.45 (163.8)	4.11 (104.4)	3.28 (83.3)	3.3 lb/1			
FBN	15-100	1	600/347	—	65	—	—	—	—	—	6.45 (163.8)	1.36 (34.5)	3.28 (83.3)	1.1 lb/1			
		2	600/347	—	150	—	—	—	65	25	6.45 (163.8)	2.74 (69.6)	3.28 (83.3)	2.6 lb/1			
		3	600/347	—	150	—	—	—	65	25	6.45 (163.8)	4.11 (104.4)	3.28 (83.3)	3.3 lb/1			
FBH	15-100	1	600/347	—	100	—	—	—	—	—	6.45 (163.8)	1.36 (34.5)	3.28 (83.3)	1.1 lb/1			
		2	600/347	—	200	—	—	—	100	35	6.45 (163.8)	2.74 (69.6)	3.28 (83.3)	2.6 lb/1			
		3	600/347	—	200	—	—	—	100	35	6.45 (163.8)	4.11 (104.4)	3.28 (83.3)	3.3 lb/1			
FBL	15-100	1	600/347	—	100	—	—	—	—	—	6.45 (163.8)	1.36 (34.5)	3.28 (83.3)	1.1 lb/1			
		2	600/347	—	200	—	—	—	150	42	6.45 (163.8)	2.74 (69.6)	3.28 (83.3)	2.6 lb/1			
		3	600/347	—	200	—	—	—	150	42	6.45 (163.8)	4.11 (104.4)	3.28 (83.3)	3.3 lb/1			

FE 250 Amp Frame; Current Limiting (UL File No. E-11592)																	
Circuit Breaker Type	Ampere Rating	No. Poles	Maximum Voltage Rating		UL Listed Interrupting Ratings - rms Symmetrical Amperes (in Thousands)			Dimensions in. (mm.)			Approx. Ship Wt./Std. Pack						
					Vac												
			AC	DC	240	480	600	H	W	D							
FEN	250	2	480	-	150	—	65	—	—	6.70 (170.1)	4.11 (104.4)	3.52 (89.5)	4.5 lb/1				
FEN	250	3	480	-	150	—	65	—	—	6.70 (170.1)	4.11 (104.4)	3.52 (89.5)	4.5 lb/1				
FEH	250	2	480	-	200	—	100	—	—	6.70 (170.1)	4.11 (104.4)	3.52 (89.5)	4.5 lb/1				
FEH	250	3	480	-	200	—	100	—	—	6.70 (170.1)	4.11 (104.4)	3.52 (89.5)	4.5 lb/1				

FG 600 Amp Frame; Current Limiting (UL File No. E-11592)																	
Circuit Breaker Type	Ampere Rating	No. Poles	Maximum Voltage Rating		UL Listed Interrupting Ratings - rms Symmetrical Amperes (in Thousands)			EN 60947-2 Interrupting Ratings, Icu, Amperes (in Thousands)			Dimensions (in.)			Approx. Ship Wt./Std. Pack			
					Vac			Vac									
			AC	DC	240	480	600	240	400-415	690	H	W	D				
FGN	250-600	2	600	—	150	65	25	—	—	—	10.31 (262.0)	5.46 (138.7)	4.53 (115.0)	22 lb/1			
		3	600	—	150	65	25	85	50	10	10.31 (262.0)	5.46 (138.7)	4.53 (115.0)	22 lb/1			
FGH	250-600	2	600	—	200	100	35	—	—	—	10.31 (262.0)	5.46 (138.7)	4.53 (115.0)	22 lb/1			
		3	600	—	200	100	35	100	80	22	10.31 (262.0)	5.46 (138.7)	4.53 (115.0)	22 lb/1			
FGL	250-600	2	600	—	200	150	42	—	—	—	10.31 (262.0)	5.46 (138.7)	4.53 (115.0)	22 lb/1			
		3	600	—	200	150	42	200	150	40	10.31 (262.0)	5.46 (138.7)	4.53 (115.0)	22 lb/1			
FGP	250-600	2	600	—	200	200	65	—	—	—	10.31 (262.0)	5.46 (138.7)	4.53 (115.0)	22 lb/1			
		3	600	—	200	200	65	—	—	—	10.31 (262.0)	5.46 (138.7)	4.53 (115.0)	22 lb/1			

Spectra Series® Switchboards  
**Section 5 – Application Data**

**5.7 Fusible Switches**  
**Spectra Plug-In**

**Module Features**  
**Fusible ADS Switches**

All Spectra Series fusible switch units are quick-make, quick-break. The powerful mechanisms are over-center types. When operated, stored energy opens the blades quickly, interrupting the circuit. Contacts and blades are self-aligning and spring-reinforced. The design of the switch takes advantage of the magnetic forces during short-circuit to prevent popping of the contacts while the fuse clears the circuit.

The 30 amp through 200 amp switches are double-break designs that allow internal and external visible proof of contact separation. The blades of the switch are mounted in a single rotor to ensure simultaneous multiple operation. The 100 amp through 200 amp designs have two blades per pole, a feature of the GE heavy-duty safety switch. The bright red handgrip is highly visible. Fuse pullers are a standard feature.

The 400 amp through 1200 amp designs are modular with heavy copper blades. The contact separation is visible. The long, rotary handle makes these high-amp switches easy to throw. All fuse types available in these switches are bolted in place and easily removable.

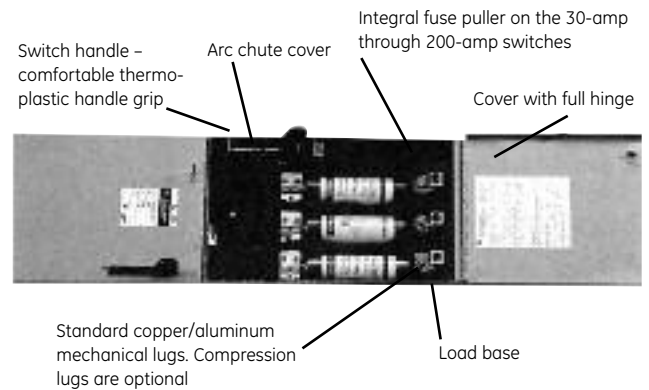
All current-carrying parts are tin or silver-plated. Wiping action ensures clean, cool-running contact surfaces. The 30 amp through 200 amp switches have double-branch capability for all fuse types.

Single-branch 30 amp through 100 amp (and 200 amp T and J fuse only as an option) modules have a fusible switch unit on one side and a blank space on the other. Larger units are single-branched switches.

A narrow T-fused 200 amp double-branch module is available in the same width as the 30 amp module, saving panel space.

Class R fuse clips are standard on 30 through 600 amp and class L are standard on 800 and 1200 amp design. Optional fuse clips include H, J, K and T through 600 amp design. U/L prohibits converting class R clips to another type in the field.

**Available in Spectra Plug-In Construction Only**



**Short-Circuit Ratings**  
**Fusible Switch Units**

The short-circuit or interrupting rating of the fusible switch is the lower of the fuse or the switch rating. Spectra Series® switches have a 200,000 amp short-circuit rating.

**Fuse Classification**

UL Class	Available Amp Rating	Maximum Short-Circuit Rating in Sym. RMS Amps	Max Voltage	Application
H	15-600	10,000	250/600	One-time general purpose
J	15-600	200,000	600	
RK1	15-600	50,000	250/600	Fast-acting rejection sizing mains & feeders, current limiting
		100,000		
		200,000		
L	800-1200	200,000	600	Rejection means available in two forms: Fast-acting mains & feeders; Time-delay motor starting current limiting
R	30-600	100,000	250/600	Duel element rejection means, motor starting current limiting
		200,000		
T	100-800	200,000	250/600	Fast-acting small physical mains & feeders, current limiting

① Ratings are based on latest revision of the National Electric Code Article 430. Horsepower ratings for switches with Standard Class H fuses are based on one-time fuses having minimum time delay. When time delay fuses are used, the horsepower ratings are maximum for the switches.

# Spectra Series® Switchboards

## Section 5 – Application Data

### Maximum Horsepower<sup>①</sup> Fusible Switch

Rating in Amps <sup>①</sup>	Volts, ac						Volts, dc		
	2-Pole			3-Pole			2-Pole	3-Pole	
	120	240	480	600	240	480	600	125	250
<b>With Standard Fuses</b>									
30	1/2	1 1/2	3	3	3	5	7 1/2	2	5
60	1 1/2	3	5	10	7 1/2	15	15	5	10
100	-	7 1/2	10	15	15	25	30	-	20
200	-	15	25	30	25	50	60	-	40
400	-	-	-	-	50	100	125	-	50
600	-	-	-	-	75	150	200	-	50
<b>With "Time-delay" Fuses</b>									
30	2	3	7 1/2	10	7 1/2	15	20	3	-
60	3	10	20	25	15	30	50	-	-
100	-	15	30	40	30	60	75	-	-
200	-	15	50	50	60	125	150	-	-
400	-	-	-	-	125	250	350	-	-
600	-	-	-	-	200	400	500	-	-

① Ratings are based on latest revision of the National Electric Code Article 430. Horsepower ratings for switches with Standard Class H fuses are based on one-time fuses having minimum time delay. When time delay fuses are used, the horsepower ratings are maximum for the switches.

For information on Process Control Units (PCUs), refer to publication DET-104.

### 5.8 Surge Protective Device SPD in Spectra Switchboards

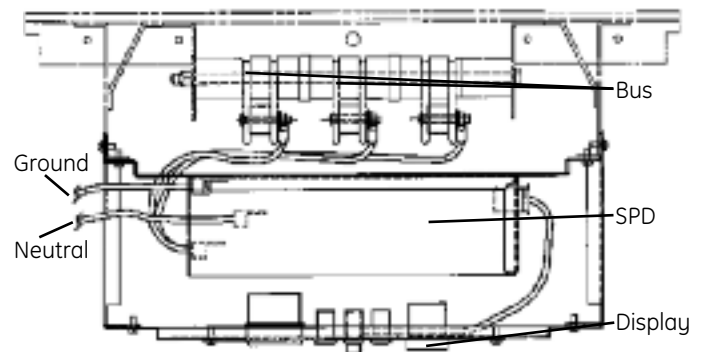
GE Tranquell™ Surge Protective Devices (SPD) are the standard SPD offering in GE Spectra Series Switchboards. The entire Tranquell HE and ME line-up has been engineered to the highest standards and is designed for rigorous duty and long life, as evidenced in our outstanding minimum repetitive surge current capacity test results. Third-party tested per IEEE C62.62 and NEMA LS-1 for the rated 8x20 s surge current, per mode with fusing included.



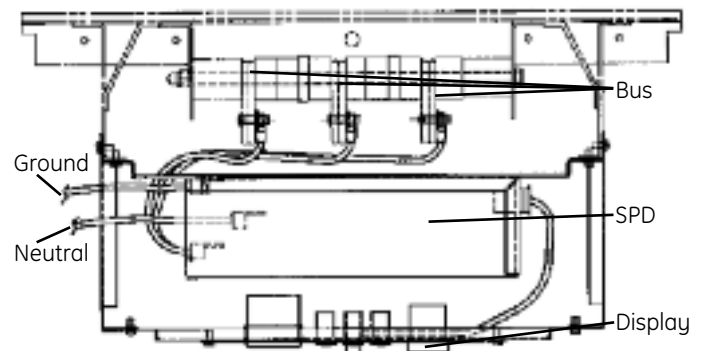
### Features and Benefits

- Mounted on load side on main device
- UL 1449 3rd Edition, Type 1 and Type 2
- cUL, CSA C22.2
- 0% to 95% non-condensing humidity
- -40° F to 149° F (-40° C to +65° C) operating temperature
- UL 96A, for use in lightning protection systems
- UL 1283, EMI/RFI noise filter
- Tranquell ME
  - 65/130kA to 100/200kA per mode/phase ratings
  - device tested to a minimum of 5,000 category C3 impulses per mode
- Tranquell HE
  - 125/250kA to 300/600kA per mode/phase ratings
  - device tested to a minimum of 20,000 category C3 impulses per mode
- Thermally protected MOVs eliminate the need for additional upstream over current protection
- NO/NC Form C dry type contacts for remote monitoring
- Green status indicating lights, red alarm light
- Audible alarm with test/disable feature
- Standard LCD surge counter

Assembly End View – Plug-in



Assembly End View – Bolt-on





# Spectra Series® Switchboards

## Section 5 – Application Data

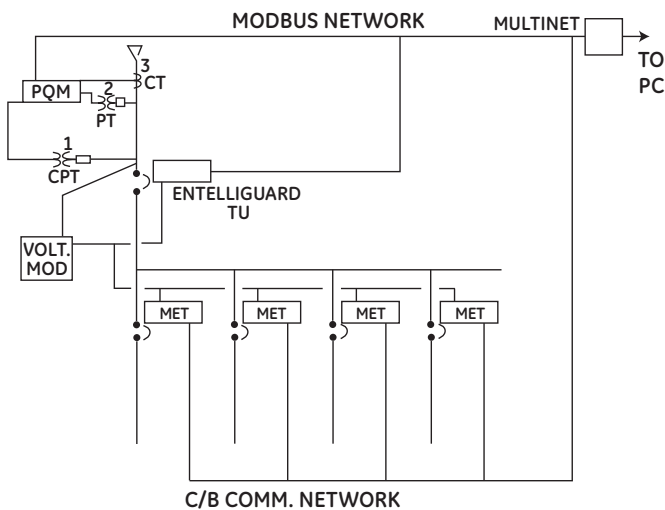
### 5.9 Power Management Control System

The GE POWER LEADER Power Management System offers a complete selection of components and software. Components include electronic meters, protective relays, digital circuit breakers and Modbus Monitors. The communication protocol is Modbus® RTU or Ethernet TCP/IP which is open and non-proprietary.

Electronic meters offered are the PQM II, EPM 2200, EPM 6000 and EPM 9650. The circuit breaker trip units are the *micro*EntelliGuard. The Modbus Concentrator transfers data to the Modbus network and meter. The Modbus Monitor is a display device that allows the user to view data at one location on the switchboard. Voltage modules provide voltage inputs and components control power to the circuit breaker trip units. Standard drivers are available for GE/FANUC PLC's, and other GE and 3rd party devices.

The *micro*EntelliGuard™ trip unit communicates via Modbus RTU. It is not necessary to use a Modbus Concentrator.

#### Typical Spectra Switchboard with Power Management



For more information and a free demonstration contact your local GE sales office.

### 5.10 Power Metering

#### EPM 2200 Digital Power Meter



The EPM 2200 meter measures more than 40 electrical power parameters providing a low-cost, multifunction monitoring solution for industrial and power generation applications. EPM 2200 can easily be mounted in a panel for generator monitoring, substation automation and more. This meter supports an optional RS485 Modbus interface with baud rates ranging from 9600 to 57.6K

#### Features and Benefits

- Economical meter for circuit monitoring of panels, main feeds, branch circuits, and gensets
- True RMS measurement
- Universal operation - 50 / 60 Hz, user programmable for medium or low voltage circuits
- Mounts in 92mm DIN and ANSI C39.1 round cut-outs

#### Applications

- Monitoring of electrical loads such as generator panels, feeders, switchgear, etc.
- Low and medium voltage applications

#### Monitoring and Metering

- Measurements of 3-phase real time amps, volts, power, energy, power factor and frequency
- 0.5% Accuracy
- Optional RS-485 Modbus and KYZ pulse outputs

#### User Interface

- Brilliant 3 line LED Display
- Easy-to-use faceplate programming

### Section 5 – Application Data

#### EPM 6000 Power Meter



EPM 6000 is the industry's highest performance revenue grade panel meter. Based on the latest technology and an all new platform, EPM 6000 has a superior cost to performance ratio and significantly outperforms other metering products many times its price.

EPM 6000 can easily be mounted in a panel for generator monitoring, substation automation and more. The unique combined ANSI and DIN mounting structure allows easy installation making it perfect for new metering applications as well as retrofit for existing analog meters.

Through a built-in infra-red (IRDA) port, the meter can be programmed through a laptop computer without a physical wire connection to the meter, making programming or data download convenient and safe. Using standard high speed Modbus communications, the meter can also provide data to RTUs, PLCs and other control devices. When used with the GE Communicator Software (integrated with EnerVista Launchpad), the meter can be remotely monitored.

The EPM 6000 excels in metering energy accurately exceeding ANSI C12.20 (0.2%) and IEC 687 (0.2%) energy measurement standards. The unit utilizes high speed DSP technology with high resolution A/D conversion to provide revenue certifiable accuracy for utility billing, substation metering, sub-metering and critical metering applications.

#### **Features and Benefits**

- High accuracy Multifunction Power meter
- Superior performance at competitive pricing
- Ultra compact, easy to install, program and use
- 0.2% Class Revenue Certifiable energy and demand metering
- Fits both ANSI and DIN cut-out
- Large 3 line .56" bright LED display for better visibility and longer life
- User programmable for different system voltages and current measurements

#### **Applications**

- Continuous metering of electrical loads such as generator panels, feeders, switchgear, etc.
- Provides remote status when used with EnerVista suite of software
- Low and Medium voltage applications
- Replaces multiple analog meters saving space and installation costs

#### **Monitoring and Metering**

- True RMS multifunction measurements including Voltage, Current, Power, Frequency, Energy, etc.
- Meets ANSI C12.20 (0.2%) and IEC 687 (0.2%) Accuracy Classes
- Future field upgradeable for added functionality without removing installed meter
- Load percentage graphical bar for instant load visualization

#### **User Interface**

- RS485 Modbus Protocol up to 57.6K Baud
- 3 Line .56" Bright Red LED Display
- Front IRDA Port laptop communication

#### EPM 9650 Power Quality Meter



The EPM 9650 is GE's most advanced 9000 meter with advanced power quality capability and waveform recording functions. The unit utilizes ACCU-Measure® Technology to provide highly accurate revenue grade readings coupled with advanced data analysis. The unit measures over 15,000 electrical parameters including real time harmonics to the 127th order, voltage surges and sags, waveform recordings, transients and a large assortment of advanced monitoring functionality. The unit also provides advanced expandable I/O with up to 256 points for control, data acquisition and alarms functions. This meter is ideally suited for critical power applications, common couplings with Utilities, load or process control and most other power monitoring applications.

#### **Features and Benefits**

- Power/Energy accuracy better than 0.04% provide highest grade revenue accuracy

## Spectra Series® Switchboards

### Section 5 – Application Data

- Harmonics measurements to the 127th order including %THD and K-Factor in real time
- Waveform Scope Mode on all channels
- Multiple Historical, Alarm and Power Quality Logs
- Advanced Waveform Recording and Analysis
- Up to 512 Samples per Cycle Resolution
- Four digital communication ports with standard Modbus Protocol
- Advanced Alarms and Control Set-Point Functions
- Up to 256 points of expandable I/O
- 3 Line LED or Touch-Screen LCD displays
- Ideal for critical loads, site-wide monitoring, power transformers, transmission lines, feeders, and generators

#### PQMII Power Quality Meter



The PQM II is an ideal choice when continuous monitoring of a three phase system is required. It provides metering for current, voltage, real and reactive power, energy use, cost of power, power factor and frequency. Programmable setpoints and 4 assignable output relays allow control functions to be added for specific applications. This includes basic alarm on over/under current or voltage, unbalance, demand based load shedding, and capacitor power factor correction control. More complex control is possible using the 4 switch inputs which also can be used for status such as breaker open/closed, flow information etc.

#### **New In Version 2.10:**

- Voltage Disturbance Recorder (VDR) to monitor voltage dips (voltage sags) and voltage spikes (voltage swells) with capacity for 500 sag/swell events.
- DNP 3.0 Communications Protocol standard feature.

#### **Features and Benefits**

- Mounting Versatility
- Keypad with large illuminated 40-character display
- Any assignable output may be used to trigger an alarm
- May be connected to DCA or SCADA systems
- Flash upgradable
- Compatible with MultiNet Serial to Ethernet Converter

#### **Applications**

- Metering of distribution feeders, transformers, generators, capacitor banks and motors

- Medium and low voltage systems
- Commercial, industrial, utility
- Flexible control for demand load shedding, power factor, etc.
- Power Quality analysis tool

#### **Protection and Control**

- A V W var VA varh Wh PF Hz unbalance
- A W var VA demand
- Load shedding
- Power factor control
- Pulse input totalizing

#### **Monitoring and Metering**

- Ia Ib Ic In
- Va Vb Vc Vab Vbc Vca
- V I unbalance
- True PF crest and K factor
- Hz W var VA
- Wh varh VAh W cost
- Demand: A W var VA
- Harmonic analysis through 63rd with THD and TIF
- Event recorder - 150 events
- Waveform capture
- Data logger - 98,000 events
- Voltage Disturbance Recorder (VDR)

#### **User Interface**

- Front RS232 serial port (1,200 to 19,200 bps)
- Two Rear RS485 serial ports
- Ethernet connectivity provided by MultiNet
- EnerVista software is provided for setup and monitoring functions
- Dial-in modem capabilities

### 5.11 Equipment Ground Fault Protection

The National Electrical Code Section 230-95 requires ground fault protection of equipment for solidly grounded wye electrical service of more than 150 volts to ground, but not exceeding 600 volts, phase-to-phase, for each service disconnecting means rated 1000 amperes or more. The maximum setting of the ground fault protection shall be 1200A and the maximum time delay shall be one second for ground fault currents equal to or greater than 3000A. The following discussion applies only to solidly grounded wye systems. Ungrounded and resistance grounded systems require special considerations and should be referred to your local GE representative.

The NEC requirement is for ground fault protection only on the main protective device. This is satisfactory

## Section 5 – Application Data

only if loss of power to the entire system is acceptable under ground fault conditions. If not acceptable, then ground fault protection should be applied on successive downstream protectors until an acceptable level of system outage is obtained. The NEC recognizes this lack of selectivity and requires health care facilities which have ground fault protection to have two levels with selectivity between the main and feeder devices.

### Detection of Ground Fault Current

Ground fault current may be monitored as it flows out from the source or as it returns to the source. In either case, care must be exercised to ensure that there is not ground connection on the neutral downstream from the ground fault sensors, and that systems with neutral interties and multiple grounds have ground fault sensors properly placed and connected so that all returning ground fault current is detected. Spot networks, secondary selective arrangements (main-tie-main) and systems with emergency generators are the most frequently encountered examples of multiple ground and neutral interties which require special consideration. Fortunately, the most commonly encountered system, the radial, lends itself to straightforward designs.

### Ground Fault Equipment

Ground fault protection may be supplied as an integral part of the trip unit used with molded case, insulated case and WavePro low voltage power circuit breakers.

NEC230-95(c) reads as follows: the ground fault protection system shall be performance tested when first installed. The test shall be conducted in accordance with approved instructions which shall be provided with the equipment. A written record of this test shall be made and shall be available to the authority having jurisdiction.

### Testing by qualified personnel

Performance testing of the ground fault protection system should be undertaken only by qualified personnel. Particularly in the tests requiring the use of a high-current test set, it is usually necessary to obtain the services of a qualified testing organization. General Electric's Installation and Service Engineering organization, the Apparatus Service Shops, and GE's extensive FAS (Factory Authorized Service) Teams are qualified and equipped to provide this testing service.

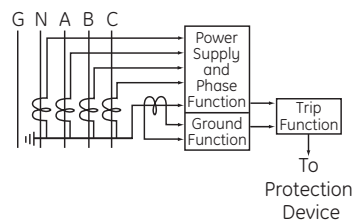
### EntelliGuard TU Trip Units

EntelliGuard TU and Power Plus units used on Power

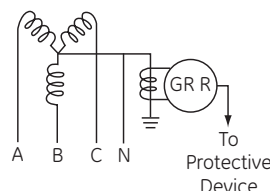
Break insulated case circuit breakers, WavePro low voltage power circuit breakers and molded case circuit breakers are self-powered. They consist of three components, a programmer, current sensors and flux shifter, which are integral parts of the circuit breaker.

The EntelliGuard TU and Power Plus trip units can be used to detect ground fault current as it flows out from the source, or as it returns to the source. A neutral sensor (current transformer) is available for systems with neutral loading.

When monitoring the outgoing ground fault current, the currents in each phase and neutral, if used, are summed up vectorially. In the absence of ground fault currents, the vector sum of the phase and neutral currents,  $I_G$  is zero. When a ground fault occurs, the vector sum,  $I_G$  corresponds to the ground fault current. When ordering the EntelliGuard TU unit, suffix G provides integral ground fault protection.



When monitoring the returning ground fault current, the EntelliGuard TU unit with suffix GR is ordered. The neutral CT is placed in the ground return circuit, not the neutral circuit. The trip unit responds to the current which the CT sees. Extreme care must be taken to insure that the CT is placed to detect all of the returning ground fault currents.



### Ground Fault Relays

ITI ground fault relays and sensors are designed to form a system for detecting a ground fault current on a ground ac power system. When a ground fault

# Spectra Series® Switchboards

## Section 5 – Application Data

exceeds a selected Current level and Time Delay setting, the relay initiates a trip signal for a shunt trip disconnect device to open and clear the fault. This ITI system is designed to provide protection for electrical equipment, not protection for personnel.

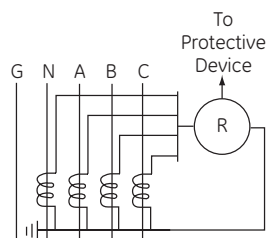
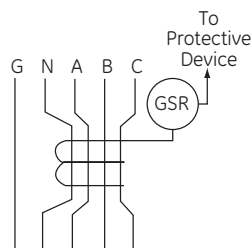
### Ground Sensor (Zero Sequence) Ground Fault Protection

In this frequently used application, the CT surrounds all phase conductors and neutral, if existing. The magnetic fluxes produced by current flowing in the power conductors cancel if there is no ground fault current and the output to the relay is zero. This is often referred to as the "zero sequence" method of detecting ground faults.

### Residual Ground Fault Protection

Ground Break can also be used in a residual arrangement. A relay, residually connected, monitors the outgoing ground fault current using three current transformers in a 3-phase, 3-wire system, or four current transformers in a 3-phase, 4-wire system.

The phase and neutral currents, if existing, add vectorially to zero if there is no ground fault current and there is no output to the relay.



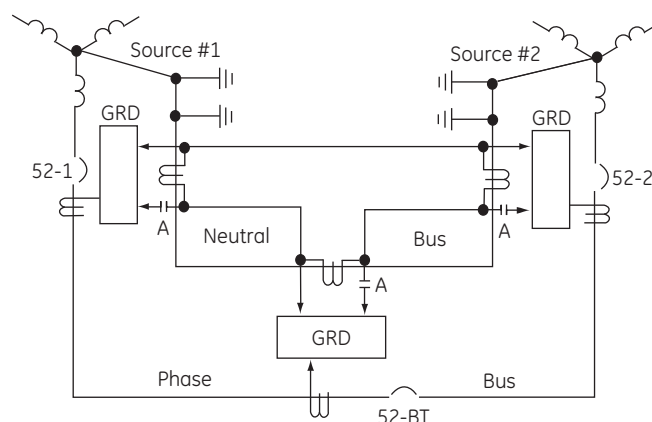
### Multi-Source Systems

Multi-Source systems with ground neutral interties, such as secondary selective and spot networks, require special ground fault circuitry. There are many circuits and types of electrical equipment that can be used to provide proper ground fault protection.

Circuits which use MicroVersaTrip® integral ground fault protection follow:

#### Extension of Integral

In the circuit shown in the Figure below, the neutral sensor secondary windings, in addition to being connected to their respective breaker, are interconnected with each other in a loop circuit. With this arrangement, the circuit is responsive to ground fault current only, regardless of its return path to the source supplying ground fault current. Each breaker must have an auxiliary contact connected as shown. The auxiliary contact "a" is open when the breaker is open. When the breaker is closed "a" is closed. One breaker must always be open so its neutral sensor will be disconnected from its associated breaker to provide the driving force to assure that the current flows around the sensor loop circuit.



### Circuit Breaker Trip Units

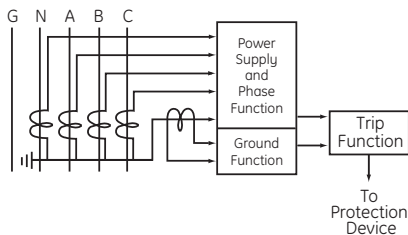
Power Plus, EntelliGuard TU and *micro*EntelliGuard units used on Power Break insulated case circuit breakers, WavePro low voltage power circuit breakers and molded case circuit breakers are self-powered. They consist of three components – a programmer, current sensors and flux shifter – which are integral parts of the circuit breakers.

The MicroVersaTrip and Power Plus trip units can be used to detect ground fault current as it flows out from the source or returns to the source. A neutral sensor (current transformer) is available for systems with neutral loading.

## Spectra Series® Switchboards

### Section 5 – Application Data

When monitoring the outgoing ground fault current, the currents in each phase and neutral, if used, are summed up vectorially. In the absence of ground fault currents, the vector sum of the phase and neutral currents, IG, is zero. When a ground fault occurs, the vector sum, IG, corresponds to the ground fault current. When ordering the MicroVersaTrip unit, suffix G provided integral ground fault protection.



- Panel or door mounting.
- Rear terminal kit and clear plastic cover standard with door mounting.
- Electromechanical relay output, positive “ON” and “OFF.”
- Operates with molded case and power circuit breakers, bolted pressure switches, fusible disconnect switches.

Operating Range: Trip currents of 5-60, 30-360, or 100-1200A. Time delay from 0.10 to 1 second. (Adjustable)

Input Power: 2 VA plus shunt coil requirements. Rated @ 120 Vac.

Input Withstand: 200,000 Amperes RMS for 3 cycles, 50/60 Hz.

Nominal Input Voltage: 120 Volts ac, 125 Volts dc, 24 Volts dc, 48 Volts dc.

Frequency: 50/60 Hz.

Ambient Temperature Range: -30°C to +60°C

Only for use with GFL sensors.

Approximate weight 1.5 lbs.

### ITI Ground Fault Current Detection Systems



These Class 1 Model ITI Ground Fault Relays and Sensors are designed to form a system for detecting a ground fault current on a ground ac power system. When a ground fault exceeds a pre-selected Current level and Time Delay setting, the relay initiates a trip signal for a shunt trip disconnect device to open and clear the fault. This ITI system is designed to provide protection for electrical equipment, not protection for personnel.

- Meets NEC service entrance equipment standards.
- Available in three basic styles, “Standard,” “Form C” or “Zone Interlocking” for coordination of single or multiple ground fault devices in system.
- Integral test panel with Push To Test and Shunt Trip Bypass pushing for ease in proper operational testing of the system, with or without tripping the protective device.
- “Power On” LED indicator in cover.
- Positive visual trip indicator, manual reset.
- Infinitely adjustable Time Delay.
- Discrete current threshold adjustment.

#### Contact Rating

Device Input Power	Inrush	Cont.
120 Volts ac	10 A	3 A
125 Volts dc	1 A	1 A
48 Volts dc	4 A	4 A
24 Volts dc	8 A	8 A

### 5.12 Automatic Transfer Switches

#### ZTE Series Transfer Switches

GE Zenith ZTE Series transfer switches deliver:

- Reliability
- Ease of operation
- Troubleshooting & diagnostics
- Flexibility to adapt to site changes
- Scalability to grow with a facility
- Simple & low-cost facility integration

Momentary loss of electric power to critical loads can endanger life, cause severe financial losses, or both. Today’s 7x24 service centers, critical healthcare facilities and data centers demand more than just continuity of power. The *quality of power* delivered to the load, the *effectiveness of periodic system testing* and the *ability to diagnose outages and disturbances* in the electrical system are issues that have serious implications for critical facilities.

**Section 5 – Application Data**

Poor power quality damages equipment and increases maintenance costs. Inherent power problems stay hidden when testing is ineffective or incomplete. Going beyond source switching and addressing the issues of complete power quality requires a whole new level of ATS capability.

**GE: Your Power Quality Partner**

Since 1930, GE has designed and manufactured Automatic Transfer Switches (ATS) – products specifically designed to keep critical loads energized and protect personnel, facilities and businesses against losses. The technological advances of the Zenith ZTE firmly establishes GE as not only a worldwide leader in the design and manufacture of ATS, but a trusted Power Quality Partner.

**New Technology Solutions**

GE’s Zenith ZTE Series of transfer switches goes beyond just source switching. Integral metering and communications, high level diagnostics and unsurpassed flexibility make the Zenith ZTE a perfect solution for today’s critical source switching.

**Global Service Capability**

The Zenith ZTE is backed by the global service capabilities and resources of one of the world’s largest corporations, capable of providing solutions to all of your power quality needs.

**Features of ATOs with 2 circuit breakers**

**Description**

Standard automatic thrower (ATO) units have the functions and features described here. Every effort should be made to apply the standard instead of specifying special features and functions.

**Two ATO units**

The 2-breaker unit is for use with a single bus power circuit where source 1 is the normal source and source 2 is the alternate source. See Fig. 1.

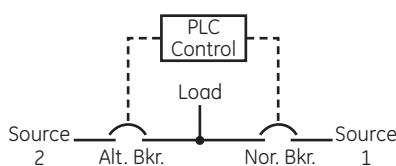


FIG. 1

**Control panel**

Control switches and indicating lights are mounted on the ATO cover. These devices include the breaker control switches, test switch, manual-automatic selector switch, and lights to indicate breaker status (open, closed, tripped on overcurrent), source power available and manual mode of operation, along with UPS indication and control.

**Programmable logic control**

GE Fanuc 90-30 with EPROM memory backup.

**Circuit breakers**

Power Break II

**Standard and optional features**

- Normal sources are monitored by adjustable voltage-sensing relays. They will detect a drop in voltage below a predetermined level. Standard setting is 75% dropout, 98% pickup. Other calibrations are available in a range of 76% to 100% for dropout and 85% to 99% for pickup.
- 5 second time delay (PLO adjustable) prevents automatic throwover from transferring to alternate source during momentary outages.
- Engine-start contact closes after 5 second time delay upon loss of normal source. The 5 second delay is PLC adjustable. Prevents engine cranking caused by momentary power outages.
- 5 minute engine cool-down (PLC adjustable) provides unloaded running time for engine before shutdown.
- Voltage-frequency relay for the alternate power source prevents transfer to that source until voltage and frequency are more than 98%.
- 15 minute retransfer delay (PLC adjustable) before automatic retransfer from alternate to normal source after normal source is restored. Should normal power be restored and the alternate power source lost during the retransfer timing period, transfer of the load back to normal source will occur instantaneously.
- “Manual-Auto” keyed selector switch provides choice of manual or automatic mode of operation:
  - Manual position – disconnects automatic control and enables manual control of breakers.
  - Auto position – enables fully automatic operation and disconnects manual control of breakers.
- Breaker control switch permits closing and tripping of breakers when the manual/auto selector switch is in manual position.



**Section 5 – Application Data**

- “Test-Norm” keyed test switch. This maintained contact selector switch functions as follows (when the manual-auto selector switch is set for automatic operations):
  - Test position – simulates loss of phase and causes the throwover to alternate source. As long as they keyed test switch is left in the “Test” position, the load will be supplied from the alternate source.
  - Normal position – enables normal operation

- Indicating light shows the following:

ATO:

- Green – Breakers open
- Red – Breakers closed
- Amber – Breaker trip by overcurrent
- White – Source power available
- Blue – Manual mode of operation

UPS:

- White – UPS on
- Green – PLC control power available
- Breakers are electrically interlocked to prevent the sources from being paralleled.
- Bypass switches on drawout breakers disconnect automatic closing and tripping control from a fully withdrawn breaker.
- Manual retransfer to normal instead of automatic retransfer can be accomplished by turning the “Manual-Auto” keyed selector switch to “Manual” any time after an automatic transfer from normal to alternate source, but before the end of the retransfer timing period. Then the load may be transferred back to the normal source by using the breaker control switches to trip the alternate breaker and close the normal breaker.

**Optional features**

A plant exerciser timer keyed switch offers the same function as the keyed test switch except on an automatic basis. It can be set for daily or weekly operation. It can also be set to operate without transferring the load.

UPS ON 	MAIN #1 CLOSED 	GEN CLOSED 		Exerciser Timer XFER NO-XFER 
	MAIN #1 TRIPPED 	GEN TRIPPED 	SOURCE #1 AVAIL 	* Key Operator
PLC CONTROL POWER 	MAIN #1 OPEN 	GEN OPEN 	SOURCE #2 AVAIL 	MANUAL MODE 
UPS ENABLE 	UPS BYPASS 	OPEN CLOSE 	OPEN CLOSE 	NORMAL TEST 
				MANUAL AUTO 

**NOTE: Ship in UPS Bypass!**

\*Key operated switch with key removal in both positions

**Operating instructions**

*Two-breaker automatic throwover*

Automatic operation – keyed selector switch on auto

1. When normal source fails, engine starts and load is transferred to the alternate source.
2. When normal source is restored, retransfer takes place automatically after delay (adj. 1-30 min.)
3. If manual retransfer is preferred, turn the keyed selector switch to manual after transfer to alternate source.
4. Engine shutdown after cool-off (adj. 5-10 min.)
5. Testing – use the keyed test switch to simulate loss of normal source.

Manual operation – keyed selector switch on manual

1. Use breaker control switches to transfer loads.
2. To start engine, turn keyed test switch to test.
3. To shut down engine, turn keyed test switch to normal.

**UPS operating instructions**

*Typical operation – selector switch on UPS enable*

1. Upon start-up, UPS will be on and charging without output. The UPS will be bypassed if UPS switch is in UPS enabled or UPS bypass position. PLC control power light should be on.
2. To enable output, press the test button on the UPS until a short beep is heard. The UPS on light will turn on.



## Spectra Series® Switchboards

### Section 5 – Application Data

3. The switch should now be in the UPS enable position. If not, turn switch to this position.
4. If UPS fails and power is still available, the UPS will be bypassed to allow power to PLC.
5. If replacing the UPS, turn selector to UPS bypass. This will allow the UPS to be shut down without disturbing the PLC. Caution: Wiring to UPS circuit is still alive!
6. If for some reason the power is lost while the selector switch is in UPS bypass position, the UPS will not supply power to the PLC. Turn selector switch to UPS enable position to allow the UPS to power the PLC.

#### **Automatic control**

##### *Normal control*

1. When normal source is available at rated voltage and the keyed selector switch is on auto, the normal main breaker will be closed and the load will be served by the normal power source.

##### *Automatic transfer*

2. When normal source voltage drops below the dropout setting of the 3-phase undervoltage relay:
  - After 5 second delay (adj.) the engine start contact will close.
  - When alternate source is present at more than 98% voltage, the normal breaker will open and the alternate breaker will close, transferring the load to the alternate source

##### *Automatic retransfer*

3. When normal service is restored, automatic retransfer will take place after a timing period (PLC adjustable). Should normal power be restored and the alternate power source lost during the retransfer period, the load will be instantaneously transferred back to the normal source. For manual retransfer after automatic transfer, see step 8.

##### *Engine shutdown*

4. Following retransfer, the engine will shut down after a 5 minute cool-off period.

##### *Testing*

5. Loss of normal source may be simulated by turning the keyed test switch to “Test.” This will initiate transfer as described in step 2. This load will be supplied from the alternate source as long as the keyed test switch is left in the “Test” position. Return the keyed test switch to “Normal” and retransfer will proceed as described in steps 3 and 4.

#### **Manual control**

##### *Manual transfer*

6. To manually transfer load from normal to alternate source (when normal source is still available):
  - Turn the keyed selector switch to “Manual.”
  - Turn the keyed test switch to “Test.” Engine starts if normal source fails, engine will start automatically.
  - Alternate source available light indicates when voltage and frequency are more than 98%.
  - Use breaker control switches to trip normal breaker and close alternate breaker.

##### *Manual retransfer*

7. To manually retransfer load from alternate to normal source:
  - Turn the keyed selector switch to “Manual.”
  - Turn the keyed test switch to “Normal.” The normal source light will indicate if the source is available
  - Use breaker control switches to open alternate breaker and close normal breaker.
  - Engine will shut down after cool-off period.

##### *Manual retransfer after automatic transfer*

8. After an automatic transfer from normal to alternate source, if it is desired to manually retransfer the load to normal, do the following:
  - Turn the keyed selector switch to “Manual” any time after the transfer to alternate source but before the end of the retransfer timing period.
  - After normal source is restored (as indicated by the light), use breaker control switches to transfer the load by opening alternate breaker and closing normal breaker.
  - Turn the keyed selector switch to “Auto” if automatic mode of operation is then desired.
  - If the keyed selector switch is left in “Manual,” the manual mode light (blue) will remain on as a reminder that the system is not set to automatic control.

##### *Overcurrent lockout and reset*

9. When a breaker trips on overcurrent, it will be locked out mechanically to prevent reclose until hand reset. This is indicated by its amber indicating light. To reset, push the yellow bell alarm button on the breaker.

##### *Interlocking*

10. Interlocking provisions prevent interconnections of normal and alternate sources. Both breakers may be in the open position, but both cannot be in the closed position simultaneously.

## Section 5 – Application Data

### Time delay settings

11. All time delay settings are internal to the PLC program. They may be adjusted by the following methods (requires optional equipment):

- Portable PC computer loaded with GE Fanuc Logicmaster software
- GE Fanuc hand-held programmer.

### Features of ATOs with 3 circuit breakers

#### Description

Standard automatic thrower (ATO) units have the functions and features described here. Every effort should be made to apply the standard instead of specifying special features and functions.

#### Three-breaker ATO units

The 3-breaker ATO unit is for use with a sectionalized bus power circuit where source 1 and 2 are normal sources, usually separate utility services. A normally open bus tie breaker connects the two sections of the main bus. See Fig. 1.

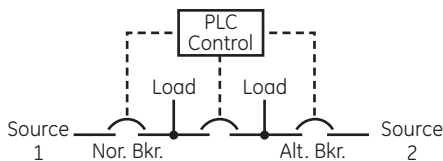


FIG. 1

#### Control panel

Control switches and indicating lights are mounted on the ATO cover. These devices include the breaker control switches, test switch, manual-automatic selector switch, and lights to indicate breaker status (open, closed, tripped on overcurrent), source power available and manual mode of operation.

#### Programmable logic control

GE Fanuc 90-93 with EPROM memory backup.  
PLC logic written in Versapro

#### Circuit breakers

Power Break II

### Standard and optional features

- Normal sources are monitored by adjustable voltage-sensing relays. They will detect a drop in voltage below a predetermined level. Standard setting is 75% dropout, 98% pickup. Other calibrations are available in a range of 75% to 100% for dropout and 85% to 99% for pickup.
- Adjustable time delay (factory set at 5 seconds) before automatic throwover from normal to alternate source is provided to override momentary outages.
- Adjustable timing (1 to 30 minutes, factory set at 15 minutes) provides delay before automatic retransfer from alternate to normal source after normal source is restored. Should normal power be restored and the alternate power source lost during the retransfer timing period, transfer of the load back to normal source will occur instantaneously.
- “Manual-Auto” keyed selector switch provides choice of manual or automatic mode of operation:
  - Manual position – disconnects automatic control and enables manual control of breakers.
  - Auto position – enables fully automatic operation and disconnects manual control of breakers.
- Breaker control switch permits closing and tripping of breakers when the manual/auto selector switch is in manual position.
- “Test #1-Norm-Test#2” test switch. This maintained keyed selector switch functions as follows (when the manual-auto selector switch is set for automatic operations):
  - Phase failure relay protection. Designed to protect against phase loss and phase unbalance in a power system. The output contacts change their normal state only when a phase loss or unbalance occurs for longer than the preset trip delay. The PFR relay operates in conjunction with the UV relay to initiate the throwover process.
  - Test position simulates loss of phase and causes throwover to alternate source, as long as the test switch is left in the “Test” position. The load will be supplied from the alternate source. Returning the test switch to the “Norm” position will retransfer the load to the normal power source.

# Spectra Series® Switchboards

## Section 5 – Application Data

- Indicating light show the following:  
ATO:  
 Green – Breakers open  
 Red – Breakers closed  
 Amber – Breaker trip by overcurrent  
 White – Source power available  
 Blue – Manual mode of operation  
UPS (if used):  
 White – UPS on  
 Green – PLC control power available
- Breakers are electrically interlocked to prevent the sources from being paralleled.
- Bypass switches on drawout breakers disconnect automatic closing and tripping control from a fully withdrawn breaker.
- Manual retransfer to normal instead of automatic retransfer is readily accomplished by using the standard controls. This is done by turning the selector switch to manual any time after an automatic transfer from normal to alternate source, but before the end of the retransfer timing period. Then the load may be transferred back to the normal source by using the breaker control switches to trip the alternate (or bus tie) breaker and close the normal breaker.

4. Testing – use the keyed test switch to simulate loss of normal or alternate source.

Manual operation – selector switch on manual  
 1. Use breaker control switches to transfer loads.

Interlock prevents closing all three breakers.

Overcurrent trip lockout – to reset, push breaker trip button.

### UPS operating instructions

*Typical operation – selector switch on UPS enable*

1. Upon start-up, UPS will be on and charging without output. The UPS will be bypassed if UPS switch is in UPS enable or UPS bypass position. PLC control power light should be on.
2. To enable output, press the test button on the UPS until a short beep is heard. The UPS on light will turn on.
3. The switch should now be in the UPS enable position. If not, turn switch to this position.
4. If UPS fails and power is still available, the UPS will be bypassed to allow power to PLC.
5. If replacing the UPS, turn selector to UPS bypass. This will allow the UPS to be shut down without disturbing the PLC. Caution: Wiring to UPS circuit is still alive!
6. If for some reason the power is lost while the selector switch is in UPS bypass position, the UPS will not supply power to the PLC. Turn selector switch to UPS enable position to allow the UPS to power the PLC.

UPS ON 	MAIN #1 CLOSED 	TIE CLOSED 	MAIN #2 CLOSED 		
	MAIN #1 TRIPPED 	TIE TRIPPED 	MAIN #2 TRIPPED 	SOURCE #1 AVAIL 	
PLC CONTROL POWER 	MAIN #1 OPEN 	TIE OPEN 	MAIN #2 OPEN 	SOURCE #2 AVAIL 	MANUAL MODE 
UPS ENABLE 	UPS BYPASS 	OPEN CLOSE 	OPEN CLOSE 	Normal TEST 1 TEST 2 	MANUAL AUTO 

NOTE: Ship in UPS Bypass!

\*Key operated switch with key removal in all (3) positions  
 #Key operated switch with key removal in both positions

### Operating instructions

*Three-breaker automatic throwover*

Automatic operation – keyed selector switch on auto

1. When normal source fails, its load is transferred to the alternate source.
2. When normal source is restored, retransfer takes place automatically after delay.
3. If manual retransfer is preferred, turn the keyed selector switch to manual after transfer to alternate source.

### Automatic control

*Normal control*

1. When both normal sources are available at rated voltage and the selector switch is on auto, the bus tie breaker will be open and both main breakers will be closed, serving their respective loads.

*Automatic transfer*

2. When source voltage on one of the normal sources drops below the dropout setting of the 3-phase undervoltage relay:
  - After 5 second time delay (PLC adj.), the main breaker will open and the bus tie breaker will close, transferring the load to the alternate source

*Automatic retransfer*

3. When normal service is restored, automatic retransfer will take place after a timing period of 15 min. (PLC adjustable). Should normal power be restored and the alternate power source lost during the retransfer

## Spectra Series® Switchboards

### Section 5 – Application Data

timing period, the load will be instantaneously transferred back to the normal source. For manual retransfer after automatic transfer, see step 7.

#### Testing

4. Loss of either normal source may be simulated by turning the keyed test switch to “Test.” This will initiate transfer as described in step 2. The load will be supplied from the alternate source as long as the test switch is left in the “Test” position. Return the keyed test switch to “Normal” and retransfer will proceed as described in steps 3 and 4.

#### Manual control

##### Manual transfer

5. To manually transfer load from one normal source to the alternate normal source:
  - Turn the selector switch to “Manual.”
  - Source available light should indicate power available on the source to which transfer is to be made.
  - Use breaker control switches to trip normal breaker and close bus tie breaker.

##### Manual retransfer

6. To manually retransfer load from alternate to normal source:
  - Turn the selector switch to “Manual.”
  - Source available light should indicate power available on the source to which transfer is to be made.
  - Use breaker control switches to trip bus tie breaker and close normal breaker.

##### Manual retransfer after automatic transfer

7. After an automatic transfer from one of the normal sources to the alternate source, if it is desired to manually retransfer the load back to the normal source, do the following:
  - Turn the selector switch to “Manual” any time after the transfer to alternate source but before the end of the retransfer timing period.
  - After the missing normal source has been restored (as indicated by its light), use the breaker control switches to transfer the load by tripping the bus tie breaker and closing the main breaker.
  - Turn the selector switch to “Auto” if automatic mode of operation is then desired.
  - If the selector switch is left in “Manual,” the manual mode light (blue) will remain on as a reminder that the system is not set to automatic control.

#### Overcurrent lockout and reset

8. When a breaker trips on overcurrent, it will be locked out electrically and mechanically to prevent reclose until hand reset. This is indicated by its amber indicating light. To reset, push the yellow bell alarm button on the breaker.

#### Interlocking

9. Interlocking provisions prevent interconnections of normal and alternate sources. All breakers may be in the open position, but only two can be in the closed position simultaneously.

#### Time delay settings

10. All time delay settings are internal to the PLC program. They may be adjusted by the following methods (requires optional equipment):
  - Portable PC computer loaded with GE Fanuc Logicmaster software
  - GE Fanuc hand-held programmer.

#### Phase failure relay

11. The phase failure relay has adjustable time delay settings of 1 to 10 seconds. The relay will automatically reset upon restoration of normal power. Factory setting will be on minimum.

### 5.13 Wire/Lug/Cable

#### Wiring Terminals (Lugs) Main Lug Connection

Pressure type mechanical lugs suitable for 250–600MCM aluminum or copper wire, are provided for short circuit ratings to 100,000A. Above 100,000A, compression type lugs are provided for all amperages.

When oversized lugs are required, a lug section with minimum width may be furnished.

# Spectra Series® Switchboards

## Section 5 – Application Data

Lug sizes and quantity also apply to main devices

Standard Main Lug Terminations	
Ampere Rating	Quantity and Size
	Per Ø and Ñ
800	(3) 250-600 MCM
1000	(4) 250-600 MCM
1200	(4) 250-600 MCM
1600	(6) 250-600 MCM
2000	(7) 250-600 MCM
2500	(9) 250-600 MCM
3000	(10) 250-600 MCM
4000	(13) 250-600 MCM
5000	(15) 250-600 MCM
6000	(18) 150-600 MCM

**Note:** Lug sizes do not apply to Class I group mounted MCCB mains. Quantity will vary. Chart based on 500 MCM AL cable rated at 310 amps per cable.

Standard Lug sizes unless otherwise noted

Lugs	Cable Range	Cable Material	Qty. Holes
Aluminum Mechanical	#14 - 1/0	CU/AL	1
	#6 - 2/0	CU/AL	1
	#6 - 350MCM	CU/AL	1
	1/0 - 600MCM	CU/AL	1
	3/0 - 800MCM	CU/AL	1
	500 - 1000MCM	CU/AL	2
Copper Mechanical	#14 - 2/0	CU	1
	#6 - 350MCM	CU	1
	300 - 800MCM	CU	1
Aluminum Compression	#8 - 1/0	CU/AL	1
	2/0 - 4/0	CU/AL	1
	#4 - 300MCM	CU/AL	1
	250 - 350MCM	CU/AL	1
	2/0 - 500MCM	CU/AL	1 or 2
	400 - 600MCM	AL	1 or 2
Copper Compression	500 - 750MCM	AL	1 or 2
	750 - 1000MCM	AL	2
	#6 - 1/0	CU	1
Copper Compression	2/0 - 300MCM	CU	1
	250 - 500MCM	CU	1 or 2
	500 - 750MCM	CU	1

Minimum Cable Bending Space Reference Tabulation (75°C Cable Ampacity Rating Applies)

Amps	Lug Qty	Conductor		MCM Size		Cable Bending Space
		Al	Cu	500	750	
800①	3		x	x		12
	2		x		x	16
	3	x		x		12
	3	x			x	19
1000①	3		x	x		12
	3		x		x	19
	4	x		x		13
	3	x			x	19
1200①	4		x	x		13
	3		x		x	19
	4	x		x		13
	4	x			x	21
1600	5		x	x		13
	4		x		x	21
	6	x		x		13
	5	x			x	21
2000	6		x	x		13
	5		x		x	21
	7	x		x		13
	6	x			x	21
2500	7		x	x		13
	6		x		x	21
	9	x		x		13
	7	x			x	21
3000	8		x	x		13
	7		x		x	21
	10	x		x		13
	8	x			x	21
4000	11		x	x		13
	9		x		x	21
	13	x		x		13
	11	x			x	21
5000	14		x	x		13
	11		x		x	21
	17	x		x		13
	13	x			x	21

① Compression lugs are provided at 100 KA

Standard Fusible Switch Module Terminations (Cu/Al Mechanical)

Amp Rating	Voltage	Wire Size (Cu/Al)	# Wires Per Pole
30	240/600	#14-#2	1
60	240	#14-#2	1
60	600	#14-1/0	1
100	240/600	#14-1/0	1
200	240/600	#6-250 MCM	1
400	240/600	1/0-250 MCM or #2-600 MCM	2 or 1
600	240/600	1/0-250 MCM or #2-600 MCM	4 or 2
800	600	1/0-250 MCM or #2-600 MCM	6 or 3
1200	600	1/0-250 MCM or #2-600 MCM	8 or 4

# Spectra Series® Switchboards

## Section 5 – Application Data

### Optional Fusible Switch Module Terminations

	Max # Wires Per Pole								
	30A	60A 240V	60A 600V	100A	200A	400A	600A	800A	1200A
Cu/Al Mechanical									
#6 - 350 MCM					1	2	2	4	4
3/0 - 800 MCM Cu									
250 - 800 MCM Al									
Cu Mechanical									
#4 - #14	1	1							
#6 - #14			1						
#6 - 1/0			1	1					
#6 - 250 MCM					1				
1/0 - 600 MCM						2	2	4	
1/0 - 4/0						4	4	8	4
Cu/Al Compression									
#8 - 1/0	1	1	1	1					
#4 - 300 MCM					1				
2/0 - 500 MCM						2	2	4	4
400 - 500 MCM Cu						2	2	4	4
400 - 600 MCM Al						2	2	4	4
750 - MCM Cu						2	2	4	4
500 - 750 MCM Al						2	2	4	4
Cu Compression									
#6 - 1/0	1	1	1	1					
2/0 - 300 MCM					1				
250 - 500 MCM						2	2	4	4
400 - 750 MCM						2	2	4	4

### Molded Case Circuit Breaker Lugs, Line Shields, Covers and Bus Connectors

Accessory	Wire Size	For Use With	Catalog Number
Copper-Aluminum Lugs	#14-6 Cu, #12-2 Al	TQC (15-60A)	TQAL 3
	#4-1/0 Cu-Al	TQC (70-100A)	TQAL 4
	#1-300 MCM	TQD	TCAL 25
	#14-8	E150, THLC1, TB1 (15-30A)	TCAL 14
	#14-3 Cu, #12-1 Al	E150, THLC1, TB1 (15-60A)	TCAL 12
	#6-2/0 Cu, #4-2/0 Al	E150, THLC1, TB1 (70-90A)	TCAL 12A
	#3-3/0 Cu, #1-3/0 Al	E150, THLC1, TB1 (100-150A)	TCAL 15
	#4-300 MCM	F225 Load end	TCAL 24
		Line end	TCAL 26
		J400, J600 (thru 400A)	
	(1) 6-600 MCM or (2) 2/0-250 MCM	TJD	TCAL 43
	(2) 4/0-350 MCM Cu or (2) 300-500 MCM Al	J600 (45-600A)	TCAL 63
	(1) 750 MCM Cu-Al	J400, TJD	TCAL 47
	(2) 3/0-250 MCM Cu-Al		
	(2) 1/0-250 MCM or (1) #4-600 MCM	K1200	TCAL 41
	(2) 2/0-500 MCM	K1200	TCAL 61
	(3) 3/0-500 MCM	K1200	TCAL 81①②
(4) 250-350 MCM or (4) 250-500 MCM Al	K1200 (1000-1200A)	TCAL 121④	
(4) 250-350 MCM	TK4V - Load end	TCAL 131④	
Copper Only Lugs with Follower and Extra Plating	#14-2/0	E150, TB1 (thru 150A)	TCO 12
	#1-300 MCM	TQD (100 -225A)	TCT 25
		F225 Load end	TCO 24
	#14-300 MCM	Line end	TCO 26
	(1) 6-600 MCM or (2) 2/0-250 MCM	J400	TCO 43
	(2) 250-350 MCM	J600	TCO 63
	(1) 1/0-600 MCM or (2) 1/0-250 MCM	K1200	TCO 41②
	(2) 2/0-500 MCM	K1200	TCO 61
(3) 250-500 MCM	K1200 (700-1000A)	TCO 81A	
(4) 250-400 MCM	K1200 (1200A)	TCO 121	
Line Shield		TEB, TEC, TED, THED	TEDLS
		TFH and TFK	TFKLS
		TJJ and TJK	TJKLS
Lug Cover, TKM Breaker (two per breaker)		TCO41, TCAL41 Lugs	789A448G3③
		TCO61, TCAL61,	
		TCAL81 Lugs, TCO81A	789A448G1
Connector (back strap)		TCO121; TCAL 121 Lugs	789A448G2
		TKM	TKMC1

① Not suitable for 1000-amp aluminum conductor.

② Not UL listed.

③ End cover supplied with 800A frame is used as lug cover.

④ Suitable for 500 MCM copper for voltage drop considerations.

# Spectra Series® Switchboards

## Section 5 – Application Data

### Spectra® RMS Lugs, Lug Covers, and Bus Lugs

Accessory	For Use With	Wire Range (Qty.)		Product Number	Description	Ampacity Range <sup>1</sup>	
		Copper	Aluminum				
Plated extruded aluminum lugs for terminating copper or aluminum cables	SE150	(1) #12-3/0	(1) #12-3/0	TCAL18	Single lug	15-150	
	SF250	(1) #8-350 kcmil	(1) #8-350 kcmil	TCAL29	Single lug	70-250	
	SG600	(2) 2/0-500 kcmil or	(2) 2/0-500 kcmil or	TCLK265 <sup>2</sup>	2-pole lug kit <sup>2</sup>	125-600	
		(1) #8-600 kcmil	(1) #8-600 kcmil	TCLK365 <sup>2</sup>	3-pole lug kit <sup>2</sup>	125-600	
	SK1200	(3) 350-750 kcmil	(3) 350-750 kcmil	TCAL124	Single lug	Cu 275-1200 Al 225-1100	
		(3) 3/0-500 kcmil	(3) 3/0-500 kcmil	TCAL81	Single lug	300-800	
		(4) 250-500 kcmil	(4) 250-500 kcmil	TCAL125	Single lug	600-1200	
	Replacement Lug Covers and End Covers	SE150	-	-	SE3LCK	Three lug covers for upper (line) end	-
		SF250	-	-	SF3LCK	Three lug covers for upper (line) end	-
		SG600	-	-	SG1LCK	3-pole lug cover for upper (line) or lower (load) end	-
-			-	SG1BCK <sup>4</sup>	3-pole lug cover for upper (line) or lower (load) end <sup>4</sup>	-	
SK1200		-	-	SK1LCK <sup>3</sup>	Lug cover for upper (line) or lower (load) end <sup>3</sup>	-	
Plated Copper Lugs	SE150	(1) #12-3/0	-	TCO18	Single lug	15-150	
	SF250	(1) #8-350 kcmil	-	TCO19	Single lug	70-250	
	SG600	(2) 2/0-500 kcmil or	-	TCOK265	2-pole lug kit	125-600	
		(1) #8-600 kcmil	-	TCOK365	3-pole lug kit	125-600	
	SK1200	(3) 250-500 kcmil	-	TCO81A	Single lug	300-800	
		(4) 250-400 kcmil	-	TCO121	Single lug	600-1200	
		(3) 350-750 kcmil	-	TCO124	Single lug	600-1200	
		(4) 250-500 kcmil	-	TCO125	Single lug	600-1200	
Line voltage control wire kit for terminating control wire at breaker lugs	SE150	(1) #12-3/0	(1) #12-3/0	TCAL18LV	Single lug with .25 Quick Connect for Control Voltage	15-150 70-250	
	SF250	(1) #8-350 kcmil	(1) #8-350 kcmil	TCAL29LV			
	SG600	-	-	SGLVK	Single .25 Quick Connect	-	
	SK1200	-	-	SKLVK	Single .25 Quick Connect	-	
Clear rating plug cover with provision for wire seal	SG600 / SK1200	-	-		for MicroVersaTrip® Plus and PM trip units Replacement cover	-	
				SPCOV1	Cover with access to instantaneous set point	-	
				SPCOV2	Cover with no access to instantaneous set point	-	
				SPCOV3	for microEntelliGuard™ trip units Replacement cover	-	
				SPCOV1C	Cover with no access	-	
				SPCOV3C		-	

<sup>1</sup>Both copper and aluminum cables may not cover full ampacity range.

<sup>2</sup>With lug cover for line or load end.

<sup>3</sup>100kA, 480 Vac (SKPA) uses longer lug cover/arc shield on upper end. Use Product Number SKPSHLD for replacement. May be used on other SK1200 devices.

<sup>4</sup>Required for line end bus connection.

### Record Plus Lugs and Lug Kits

For Use With	Wire Range (Qty.)		Product Number	Description	Ampacity Range	
	Copper	Aluminum				
FB100 /FC100	#14-10		FCAL12	Single lug	15-20	
			FCALK12	3-pole lug kit		
	#10-4		FCAL13	Single lug	25-60	
			FCALK13	3-pole lug kit		
	#4-1/0		FCAL14	Single lug	70-100	
FCALK14			3-pole lug kit			
FE250	#14-3/0		FCAL15	Single lug	150	
			FCALK15	3-pole lug kit		
	#8-250 kcmil	#8-350 kcmil	FCAL16	Single lug	250	
			FCALK16	3-pole lug kit		
	FG600	Top	#8-400 kcmil	#6-500 kcmil	FCALK218H	3-pole lug kit
Bottom		#2/0-600 kcmil				
Top		#8-400 kcmil	#6-500 kcmil	FCALK318H	2-pole lug kit	100-600
Bottom		#2/0-600 kcmil				

## Section 6 – Additional GE Switchboard Offerings

### Class 3 Switchboard

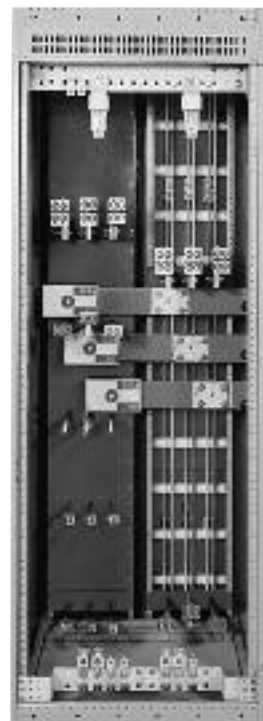
#### AV3 Access™ Switchboard

The reliability and flexibility of AV3 Access Switchboards are now available with all the advantages of Power Break II Insulated Case Circuit Breakers.

- Meets UL 891 and NEMA PB2 standards for switchboard construction.
- Standard rugged plug-on molded case circuit breaker design for interchangeability with same compartment heights.
- Indoor and outdoor (walk-in and non-walk-in) enclosure available (5000A offering indoor only).
- Optional POWER LEADER™ Power Management System capability (AKR, Power Break II, SG, SK).
- 100% rated Spectra Molded Case Circuit Breaker combines ease of use and state-of-the-art performance in 150A, 250A, 600A and 1200A frame sizes.
- Convenient “thru-the-door” access to breaker controls, trip units and rating plugs.
- Fully equipped solid state *micro*EntelliGuard™ trip units on SG/SK breakers and EntelliGuard® TU trip units on Power Break II/AKE breakers provide additional savings.
- Individual breakers isolated (top, bottom and rear) from adjacent breaker compartments and main bus/rear cable compartment.
- Padlocking capability for additional safety (optional).

Standard full height 2000A silver-plated copper riser bus allows for easy breaker add-ins to future spaces.

- Riser bus bracing (RMS symmetrical).
  - 65kA
  - 100kA
- Main bus bracing (RMS symmetrical).
  - 65kA
  - 100kA
  - 150kA
  - 200kA
  - 5000A maximum main bus rating
- Industry-exclusive 30 cycle short circuit withstand bus rating up to 85kA eliminates need for instantaneous tripping function.
- Optional double- or triple-wide rear compartment permits easy accessibility for cable terminations and maintenance.





# Spectra Series® Switchboards

## Section 6 – Additional GE Switchboard Offerings

### Standards and Interrupting Ratings

#### Standards

##### Equipment

AV3 Access Switchboard

- UL 891
- NEMA PB-2

##### Insulated Case Circuit Breaker

Power Break II

- UL 489
- CUL C22.2 No. 5.1
- NEMA AB-1
- IEC (pending)

##### Molded Case Circuit Breaker

Spectra

- UL 489
- NEMA AB-1

##### Low Voltage Circuit Breaker

WavePro

- ANSI C37.13; C37.16; C37.17; C37.50; C37.51
- UL-1066

### Interrupting Rating, RMS symmetrical (kA)

Molded Case Circuit Breakers

Spectra														
Frame Size	150A				250A			600A				1200A		
	SEDA	SEHA	SELA	SEPA	SFHA	SFLA	SFPA	SGDA	SGHA	SGLA	SGPA	SKHA	SKLA	SKPA
240Vac	18	65	100	200	65	100	200	65	65	100	200	65	100	200
480Vac	14	25	65	100	25	65	100	—	35	65	100	50	65	100
600Vac	10	18	25	25	18	25	25	—	25	65	65	25	42	65

Record Plus											
Frame Size	100A				250A			600A			
	FBV/FCV	FBN/FCN	FBH/FCH	FBL/FCL	FCS	FEN	FEH	FGN	FGH	FGL	FGP
240Vac	65	150	200	200	42	150	200	150	200	200	200
480Vac	35	65	100	150	25	65	100	65	100	150	200
600Vac	22	25	35	42	18	—	—	25	35	42	65

# Spectra Series® Switchboards

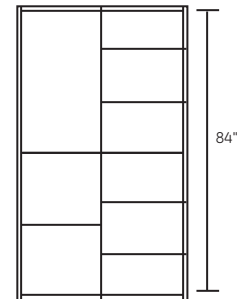
## Section 6 – Additional GE Switchboard Offerings

### Insulated Case Circuit Breakers – Main Devices

Power Break II						
Frame Size	800A	1600A	2000A	2500A	3000A	4000A
<b>Standard</b>						
240Vac	65	85	85	100	100	100
480Vac	65	65	65	100	100	100
600Vac	50	50	50	85	85	85
<b>High-Break</b>						
240Vac	100	125	125	200	200	200
480Vac	100	100	100	150	150	150
600Vac	65	65	65	100	100	100
<b>Short-time</b>						
(0.5 sec)	25	30	30	42	42	42

### Low Voltage Circuit Breakers – Main Devices

AKR									
Frame Size	800A		1600A		2000A	3200A		4000A	5000A
Breaker Type	AKR-30	AKR-30H	AKR-50	AKR-50H	AKRT-50H	AKR-75	AKR-75H	AKR-100	AKR-125
<b>Instantaneous</b>									
240Vac	18	65	100	200	65	100	200	65	65
480Vac	14	25	65	100	25	65	100	—	50
600Vac	10	18	25	25	18	25	25	—	25
<b>Short-time</b>									
240Vac	18	65	100	200	65	100	200	65	65
480Vac	14	25	65	100	25	65	100	—	50
600Vac	10	18	25	25	18	25	25	—	25



Available compartment height is 84"

### Main and Feeder Devices

Type	Device Rating	Structure	Main & Tie Devices			Feeder Devices <sup>①</sup>															
			Manual & Electrical Operations			Manual & Electrical Operations															
			Unit Height	Section Width	Section Depth	Unit Height	Section Width	Section Depth													
<b>Molded Case Circuit Breakers</b>																					
Spectra	150	80%	15"	45", 50", 60"	15"	45", 50", 60"	14" <sup>②</sup>	15"	45", 50", 60"												
		100%					14" <sup>②</sup>														
	250	80%					15"			45", 50", 60"	15"	45", 50", 60"	14"	15"	45", 50", 60"						
		100%											14"								
	600	80%											15"			45", 50", 60"	15"	45", 50", 60"	21"	15"	45", 50", 60"
		100%																	21"		
1200	80% <sup>③</sup>	15"	45", 50", 60"	15"	45", 50", 60"	21", 28"		15"	45", 50", 60"												
	100% <sup>④</sup>					35"															

# Spectra Series® Switchboards

## Section 6 – Additional GE Switchboard Offerings

### Main Devices<sup>⑤</sup>

Insulated Case Circuit Breakers		Height	Width	Depth	
Power Break II	800	Stationary			
		Drawout	14"		
	1600	Stationary		22" Std	
		Drawout		30" Opt	
	2000	Stationary			50", 60"
		Drawout	21"		
	2500	Stationary			
		Drawout	35"	22" Std	
	3000	Stationary		30" Opt	
		Drawout			
	4000 <sup>⑥</sup>	Drawout	42"	22" Std	60"
				30" Opt	

- ① Feeder devices can be located in the same section with mains rated 3000A and lower.
- ② Requires 7" blank at top to meet 6'6" rule.
- ③ Maximum 3 per stack with 21" blank.
- ④ Maximum 2 per stack with 14" blank.
- ⑤ A 2" transition is needed when using a Power Break II or AKR main device.
- ⑥ Selections adjacent to a 4000A device or AKR breaker must be a minimum of 30" wide. Add 2" for non walk-in outdoor construction.

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

- 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.

# Spectra Series® Switchboards

## Section 7 – CSI Specifications

SECTION 16402: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

SECTION 26 24 13: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Low Voltage, Front-Accessible and Front/Rear-Accessible switchboards with circuit breaker for mains and feeders and/or fusible switches for mains and feeders as specified below and shown on the contract drawings.

#### 1.02 RELATED SECTIONS

- A. [16415] [26 36 23] Automatic Transfer Switches.
- B. [16479] [26 43 13] Surge Protective Devices

#### 1.03 REFERENCES

- A. The low voltage switchboards and protection devices in this specification are designed and manufactured according to latest revision of the following standards (unless otherwise noted).
  1. ANSI 61
  2. ANSI/NEMA PB 2, Deadfront Distribution Switchboards
  3. ANSI/NEMA PB 2.1, General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less
  4. ANSI/NFPA 70, National Electrical Code
  5. NEMA AB 1, Molded Case Circuit Breakers and Molded Case Switches
  6. NEMA KS 1, Fused and Non - fused Switches
  7. UL 489, Molded Case Circuit Breakers
  8. UL 891, Dead Front Switchboards
  9. UL 98, Enclosed and Dead Front Switches
  10. UL 977, Fused Power Circuit Devices
  11. [UL 1066, Low Voltage Power Circuit Breakers]

#### 1.04 DEFINITIONS

- A. Front-Connected only shall be as defined by UL 891 standard which requires that all line and load connections for phase, neutral, and ground conductors can be made and maintained from the front of the switchboard without access to the rear.
- B. Front-Accessible shall be as defined by UL 891 standard which is an enclosure in which all bus and device connections are accessible from the front. If necessary, a limited number of devices shall be permitted to be removed to achieve this accessibility.

#### 1.05 SYSTEM DESCRIPTION

- A. The power system feeding Switchboard (insert designation) is [208] [480] [575] volts, [50] [60] Hertz, 3 phase, [3-] [4-] wire, [solidly grounded wye] [ungrounded delta] [corner grounded delta] [mid - phase grounded delta] [low resistance grounded wye] [high resistance grounded wye].
- B. Switchboard(s) shall have [front connected and rear aligned for mounting against a wall] [front and rear access]. [Switchboards shall be front and rear aligned.]

#### 1.06 SUBMITTALS

- A. Manufacturer shall provide [3] copies of the following documents to owner for review and evaluation in accordance with general requirements of Division [1] [01] and Division [16] [26]:
  1. Product Data on specified product;
  2. Shop Drawings on specified product;

#### 1.07 INSTALLATION, OPERATION AND MAINTENANCE DATA

- A. Manufacturer shall provide [3] copies of installation, operation and maintenance procedures to owner in accordance with general requirements of Division [1] [01] and Division [16] [26].

#### 1.08 QUALITY ASSURANCE (QUALIFICATIONS)

- A. Manufacturer shall have specialized in the manufacture and assembly of low voltage switchboards for [25] years.
- B. Low voltage switchboards shall be listed and/or classified by Underwriters Laboratories in accordance with standards listed in Article 1.03 of this specification.
- C. Equipment shall be qualified for use in seismic areas as follows:
  1. High seismic loading as defined in IEEE Std 693-1997, with 1.33 amplification factor.
  2. IBC-2009, Sds = 1.05g, Ss = 158%, Ip = 1.5, for all z/h greater than 0 and Sds = 1.67g, Ss = 250%, Ip = 1.5, for z/h equal to 0 in accordance with ICC-ES-AC156.
  3. Seismic compliance shall be qualified only through shake table testing. Compliance by calculation is not acceptable.

#### 1.09 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall store, protect, and handle products in accordance with recommended practices listed in manufacturer's Installation and Maintenance Manuals.
- B. Ship each switchboard section in individual shipping splits for ease of handling. Each section shall be mounted on shipping skids and wrapped for protection.
- C. Contractor shall inspect and report concealed damage to carrier within 48 hours.
- D. Contractor shall store in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation.
- E. Contractor shall handle in accordance with manufacturer's recommendations to avoid damaging equipment, installed devices, and finish. Lift only by manufacturers recommended procedures.

#### 1.10 PROJECT CONDITIONS (SITE ENVIRONMENTAL CONDITIONS)

- A. Follow (standards) service conditions before, during and after switchboard installation.
- B. Low voltage switchboards shall be located in well-ventilated areas, free from excess humidity, dust and dirt and away from hazardous materials. Ambient temperature of area will be between minus 30 and plus 40 degrees C. Indoor locations shall be protected to prevent moisture from entering enclosure.

#### 1.11 WARRANTY

- A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of purchase, whichever occurs first.

#### 1.12 FIELD MEASUREMENTS

- A. Contractor shall make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in National Electrical Code.

# Spectra Series® Switchboards

## Section 7 – CSI Specifications

SECTION 16402: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

SECTION 26 24 13: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

### PART 2 PRODUCTS

#### 2.01 MANUFACTURER

- A. General Electric Company products have been used as the basis for design. Other manufacturers' products of equivalent quality, dimensions and operating features may be acceptable, at the Engineer's discretion, if they comply with all requirements specified or indicated in these Contract documents.

#### 2.02 EQUIPMENT

- A. Furnish GE Type Spectra Switchboards (or approved equal).

#### 2.03 COMPONENTS

- A. Refer to Contract Drawings for actual layout and location of equipment and components; current ratings of devices, bus bars, and components; voltage ratings of devices, components and assemblies; interrupting and withstand ratings of devices, buses, and components; and other required details.

#### B. Standard Features

1. Switchboards shall be fully self-supporting structures with 90 inch tall vertical sections (excluding lifting eyes and pull boxes) bolted together to form required arrangement.
2. Switchboard frame shall be die formed, 12 gauge steel with reinforced corner gussets. Frame shall be rigidly bolted to support cover plates (code gauge steel), bus bars and installed devices during shipment and installation.
3. All sections may be rolled, moved or lifted into position. Switchboards shall be capable of being bolted directly to the floor without the use of floor sills.
4. All switchboard sections shall have open bottoms and removable top plate(s) to install conduit.
5. Front-Connected switchboard sections shall be [rear aligned] [front and rear aligned] for placement against a wall. Front/Rear-Access switchboards shall be front and rear aligned.
6. Switchboards shall be UL listed.
7. Switchboards that are series rated to short circuit requirements shall be appropriately labeled. Tested UL listed combination ratings shall be included in UL recognized Component Directory (DKSY2).
8. All covers shall be fastened by hex head bolts.
9. Provide hinged doors over metering compartments and individually mounted device compartments. All doors shall have concealed hinges and be fastened by hex head bolts.
10. Switchboard protective devices shall be furnished as listed on drawings and specified herein, including interconnections, instrumentation and control wiring. Switchboards and devices shall be rated for the voltage and frequency listed on the drawings.
11. Switchboard current ratings, including all devices, shall be based on a maximum ambient temperature of 40 degree C per UL Standard 891. With no derating required, temperature rise of switchboards and devices shall not exceed 65 degrees C in a 40 degree C ambient environment.

12. Switchboard Service Entrance sections shall comply with UL Service Entrance requirements including a UL service entrance label, incoming line isolation barriers, and a removable neutral bond to switchboard ground for solidly grounded wye systems.

13. The group mounted feeder breaker and/or main devices within switchboards shall be circuit breakers or fusible switches as indicated on the drawings. Mounting for [plug-in] connections. Mounting for fusible switches shall be Spectra Plug-In construction.

#### C. Incoming Section

1. Incoming section shall be (pick one)  
[utility pull section]  
[bussed pull section]  
[blank pull section]  
[direct cable connection to main breaker]  
[busway stub-in entering {the top}{the bottom}]  
[the side] [as shown on drawings]
2. Furnish switchboard(s) arranged for [bottom entry of incoming cable.] [top entry of incoming cable.]
3. Provide [mechanical] [crimp compression type] lugs in the quantity and size required per the contract drawings. All lugs shall be tin-plated aluminum and UL listed for use with [copper cable.] [aluminum cable.] Lugs shall be rated for 75 degree C. Cable.
4. [Furnish switchboard(s) [List each by designation] [where indicated on the drawings] with a transition for close - coupled connection to a transformer.]

#### D. Bus Bars

1. Bus bars shall be [tin-plated aluminum] [silver-plated copper][tin-plated copper]. The bus bars shall have sufficient cross sectional area to meet UL 891 temperature rise requirements. Phase and neutral bus ampacity shall be as shown on the plans. The neutral bus shall have the same ampacity as the phase bus.
2. Bus bars shall be mounted on high impact, non-tracking insulated supports. Joints in the vertical bus are not permitted.
3. Bus bars shall be braced to withstand mechanical forces exerted during short circuit conditions as indicated in drawings, but in no case less than 65KA RMS SYM.
4. Bus joints shall be bolted with high tensile steel Grade 5 bolts. Belleville type washers shall be provided with aluminum bus.
5. Ground Bus shall be sized to meet UL 891. Ground bus shall extend full length of switchboard. {Ground bus shall be copper}
6. A-B-C bus arrangement (left to right, top to bottom, front to rear) shall be used throughout to assure convenient and safe testing and maintenance. Where special circuitry precludes this arrangement, bus bars shall be labeled.
7. All feeder device line and load connection straps shall be rated to carry current rating of device frame (not trip rating).
8. The main incoming bus bars shall be rated for the main protection device frame size or main incoming conductors, if there is no main device.

# Spectra Series® Switchboards

## Section 7 – CSI Specifications

SECTION 16402: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

SECTION 26 24 13: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

9. Main horizontal bus bars shall be [standard tapered per UL] [fully rated and arranged for future extensions].
- E. Enclosure
  1. Switchboard(s) shall be [NEMA 1] [NEMA 3R non walk-in] [NEMA 3R walk-in] deadfront construction or as indicated on drawings.
  2. NEMA 3R construction shall be as listed below.
    - a. Consist of standard indoor cubicles with a front frame and roof assembly to provide a weather resistant structure. Filtered front and rear roof vents. Space heaters [fed from control power transformer in switchboard.] [fed from separate source as indicated on drawings.]
    - b. Front hinged doors with 3 point catch with padlocking provision and wind stop. Bolted rear covers.
    - c. Walk-in construction shall have a minimum 30 inch wide clear walk through space
    - d. [Front to rear full depth lifting beams.]
    - e. Include the following options
      - (1) Thermostatic control for space heaters.
      - (2) Gasketing.
      - (3) [Fluorescent lighting and convenience outlets.]
      - (4) [Rear hinged doors with 3 point catch with padlocking provision and wind stop.]
- F. Utility Metering Section
  1. Provide utility metering section where indicated on drawings. Pull section and metering compartment shall comply with [EUSERC and] [utility name] requirements.
  2. Compartment shall be barriered from the rest of the section, have a hinged lockable front cover, removable bus links with provisions for mounting current transformers, and when required, provisions for mounting voltage transformers. Current and voltage transformers shall be supplied and installed by the utility company.
- G. User Metering
  1. Provide a UL listed and digital multifunction power monitor. The monitor case shall be fully enclosed and shielded
  2. The monitor shall accept a voltage monitoring range of up to 600 volts, phase to phase.
    - a. The Monitor shall withstand 200% rated current continuously. It shall withstand 10X rated current for at least 3 seconds. Isolation shall be no less than 2500V AC.
    - b. Surge withstand shall conform to IEEE C37.90.1,62.41 and IEEE 1000-4
    - c. Shall have a standard ANSI C39.1 case mount.
  3. The Monitor shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral; real power, reactive power, apparent power, power factor and frequency.
    - a. The Monitor must be capable of providing readings for both instantaneous and average readings.
    - b. The Monitor must also be capable of providing all single phase real, apparent, reactive power and power factor values.
    - c. The Monitor shall record and store total bi-directional energy. It shall include separate registers for positive

- and negative energy.
- d. The Monitor shall record and store total bi-directional accumulated energy and total accumulated apparent energy.
- e. The Monitor shall monitor max/min average demand values for all current and power readings. The demand interval shall be user programmable. [Maximum and minimum values shall be stored with a date/time stamp.]

### **NOTE TO SPECIFIER: THE FOLLOWING REFLECTS CAPABILITIES OF THE EPM6000:**

4. The Monitor shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power functions, and shall meet IEC687 (0.2%)
5. The monitor shall include a three line, integrated, light-emitting diode (LED) display.
  - a. The Monitor must be capable of displaying one leg of volts, amps and total power simultaneously.
  - b. The display shall provide user access to all phase voltages (phase to neutral and phase to phase), currents (phase and neutral) , watts, VARs, VA, power factor, frequency and kwh
  - c. The display must provide user access to max/min values for all displayed quantities.
  - d. The display shall have a % load bar display for ease of full load viewing
6. The monitor shall be microprocessor based and shall be fully user programmable.
7. [The monitor shall be provided with an RS485 digital communications port. The Monitor shall communicate using a MODBUS RTU protocol and shall have a communication baud rate of at least 57k.]
8. [The monitor shall be provided with one KYZ pulse outputs]

### **NOTE TO SPECIFIER: THE FOLLOWING REFLECTS CAPABILITIES OF THE GE PQMII METER**

9. The Monitor shall have an accuracy of +/- 0.2% or better for volts and amps, and 0.4% for watts.
10. Voltages and currents shall be sampled at 64 samples per cycle.
11. The Monitor shall have up to 1MB of non-volatile RAM for data trending and waveform capture.
  - a. The monitor shall be capable of retaining historical data in a non-volatile memory with a programmable number for a single parameter. The user can select any combination of values to be stored.
  - b. Interval of snapshots shall be triggerable on programmable changes of state of voltage and current.
  - c. The Monitor shall store waveform events for all 6 channels of voltage and current for a minimum of 100 events. Each event will consist of readings of 60 cycles, 10 cycles prior to the event, and 50 cycles past the event.
  - d. Event recording shall be triggered when the RMS of voltage or current exceeds user programmable high-speed set points.

# Spectra Series® Switchboards

## Section 7 – CSI Specifications

### SECTION 16402: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

### SECTION 26 24 13: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

- e. The Monitor must be able to record each of the channels of voltage or current per event if the event continues past the initial 60 cycles. Recording duration set-point shall be programmable.]
- 12. The Monitor shall have three serial communication port; 1 RS232C and 2 RS485. Ports must be capable of communicating simultaneously to different devices.
- 13. The Monitor shall communicate using a MODBUS RTU or DNP open protocol and support communications baud rates of up to 19.2K
- 14. The Monitor shall calculate the harmonic signature, %THD and K-Factor for all voltage and current inputs with valid data for harmonic spectrum capability to the 32nd harmonic.
- 15. The Monitor must be capable of capturing a graphic image of the waveform for each of the 6 channels of Voltage and Current and make it available in a RAM buffer for retrieval through the digital communication port.

**NOTE TO SPECIFIER: THE FOLLOWING CAPABILITIES ARE FURNISHED ON THE GE EPM9650Q METER.**

- 16. The monitor shall have the following minimum accuracy requirements.
  - a. Voltage accuracy shall be within less than 0.01% for the 1 second readings and less than 0.1% for the 100 millisecond readings.
  - b. Current accuracy shall be within less than 0.025% for the 1 second readings and less than 0.1% for the 100 millisecond readings.
  - c. Power and energy accuracy shall be within less than 0.04% at unity PF and within 0.06% at 0.50 PF.
  - d. Frequency accuracy shall be within less than 0.001 Hz.
  - e. Power meter shall meet ANSI C12.20 and IEC 687 accuracy requirements.
- 17. Power meter shall provide multiple digital communication ports and support multiple open protocols.
  - a. Meter shall include four (4) independent, digital communication ports. Each port shall be RS-485 architecture. Port 1 shall be user selectable as either RS-232 or RS-485 architecture.
  - b. Each port shall be user configurable with regard to speed, protocol, address, and other communications parameters. All ports shall support a maximum communication speed of 115k baud simultaneously.
  - c. One communication port shall be configurable as either a Master or a Slave port. The Master configuration shall enable the unit to act as an RTU and interface with other Modbus devices and EI I/O Modules communicating using Modbus RTU protocol.
  - d. Meter shall offer both Modbus and DNP 3.0 open protocols as standard configurations. All instantaneous data, logged data, event data, power quality analysis and waveform information shall be available using these open protocols.
- 18. Meter shall have at least eight high-speed status inputs for capturing external events. All high-speed status inputs shall be monitored at a user set rate from 1 to

- 8 samples per millisecond. All changes in status shall be time stamped to the nearest millisecond and placed in an event log with time and event label information.
- 19. Power meter shall provide a separate IRIG-B input for time synchronizing to GPS time signal. IRIG-B input shall accept un-modulated time signal input from a standard GPS satellite clock.
- 20. Power meter shall be equipped with 4MB of non-volatile RAM for recording logs and programming information.
  - a. Meter shall store historical trending data, power quality data, and waveform recordings in memory.
  - b. In the event of loss of control power, data stored in memory shall be retained for at least 10 years.
  - c. Memory shall be allocated to the various logging functions required. All logging features required shall be simultaneously available at the specified levels. Exercising any one feature at the specified level shall not limit exercising of any or all other features to their full, specified level.
  - d. Meter shall store all programming and set-up parameters in non-volatile memory. In the event of loss of control power, meter programming data stored in memory shall be retained for at least 10 years.
- 21. Power meter shall measure and record the magnitude and phase angle of all harmonics through the 127th for all voltages and currents. Meter shall provide %THD and K-Factor for all channels. All harmonic values shall be available through the digital communications ports in real time.
- 22. Power meter shall capture and record all CBEMA quality events. CBEMA events shall be date/time stamped to the millisecond. Entries to CBEMA log shall include date/time stamp, duration, and magnitude information. The CBEMA log shall be downloadable through the digital communications ports.
- 23. Power meter shall capture and record out-of-limit conditions in a log. Entries to Limits log shall be made anytime a monitored quantity exceeds the user set limit assigned to that quantity. Entries to the Limits log shall be time stamped to the millisecond and include the measured quantity value and label.
- 24. Power meter shall provide waveform recording to capture and record transients and quality problems on current and voltage waveforms. Meter shall sample waveform at a user configurable rate of 16 to 512 samples per cycle (60Hz cycle).
  - a. Meter shall hold at least 96 records of waveform recording in non-volatile memory. Each record shall be a minimum of 8 cycles in duration at the highest sample rate or 64 cycles in duration at the lowest sample rate. Each waveform record shall include pre-event and post-event data.
  - b. A waveform record shall be taken whenever the RMS value of voltage or current exceeds user-set limits or a status change occurs on any one of the eight high-speed status inputs.

# Spectra Series® Switchboards

## Section 7 – CSI Specifications

### SECTION 16402: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

### SECTION 26 24 13: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

#### H. METERING TRANSFORMERS

1. All instrument transformers shall be UL listed and classified as indicated in drawings.
2. Current Transformers shall be as shown on drawings with burden and accuracy to support connected meters and relays as required by [ANSI/IEEE C57.13].
3. Potential transformers shall be provided where indicated on drawings with burden and accuracy to support connected meters and relays as required by [ANSI/IEEE C57.13].

#### I. Main Devices

1. Main device shall be [individually mounted, insulated case circuit breaker] [individually mounted high pressure contact fusible switch] [individually mounted molded case circuit breaker][group mounted molded case circuit breaker]. Provide device as specified in appropriate article below.
2. Tie device(s), if included, shall be the same as the main device.
3. Where indicated provide the following with the main device:
  - a. [Phase failure relay]
  - b. [shunt trip]
  - c. [undervoltage release]
  - d. [auxiliary contacts]
  - e. [bell alarm]

#### J. Transfer Switch

1. Where indicated on the drawings, provide a transfer switch between the main device and feeder devices. Transfer switch shall be a GE Zenith type ZTS or approved equal. Refer to Section [16415] [26 36 23], Automatic Transfer Switches.
2. Transfer switch shall be [3-pole] [4-pole], [manual transfer] [delayed transition] [closed transition].
3. Transfer switch shall transfer load from [utility to generator] [utility to utility].

#### K. Feeder Devices

1. [Feeder devices 1200 amps and smaller shall be group mount molded case circuit breakers with bolted connections] [Feeder devices 1200 amps and smaller shall be group mounted with plug-in construction] [Feeder devices 1200A and smaller shall be ADS fusible switches in Spectra Plug-In construction] Intermixing of fusible switches and circuit breakers within the group mounted section shall not require any special hardware or construction] Provide devices as specified in appropriate article below.
2. Feeder devices larger than 1200 amps shall be individually mounted [Insulated Case circuit breaker] [HPC fusible switches] as indicated on the drawings.
3. All circuit protective devices shall have the following minimum symmetrical current interrupting capacity: [18kA] [25kA] [35kA] [50kA] [65kA] [100kA] [or as listed on the contract drawings].
4. Where indicated provide the following with the feeder device(s):
  - a. [shunt trip]
  - b. [undervoltage release]

c. [auxiliary contacts]

d. [bell alarm]

#### L. Molded Case Circuit Breakers

1. Furnish GE Spectra RMS $\delta$  or Record Plus Molded Case Circuit Breakers.
2. Group mounted breakers shall be connected to the vertical bus by [bolted connections] [modular plug-in construction].
3. Individually mounted molded case circuit breakers shall be stationary mounted.
4. Circuit breaker frames shall be constructed of a high-strength, molded, glass-reinforced polyester case and cover. Breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.
5. Breakers shall have ON and OFF position clearly marked on escutcheon. Breakers shall include a trip-to-test means on the escutcheon for manually tripping the breaker and exercising the mechanism and trip latch.
6. Breakers shall include factory installed mechanical lugs. Lugs shall be UL listed and rated 75 or 60/75 degrees C as appropriate. Breakers shall be standard, or 80 percent rated.
7. Breakers [larger than 150 amps] shall use digital true RMS sensing trip units and a rating plug to determine the breaker trip rating.
8. [Each main, feeder, and tie breaker with a frame size 400 amps and larger shall have digital electronic trip units] as described in Article 2.03.N.]
9. [Circuit breakers with trip ratings greater than 250 amperes to 1200 amperes shall be UL listed as 100 percent continuous duty rated [where indicated on the drawings].]
10. Breaker digital electronic trip units shall be as described in Article 2.03.N.

#### M. Insulated Case Circuit Breakers

1. Insulated case circuit breakers shall be individually mounted.
2. Main and tie breakers shall be [manually] [electrically] operated, [stationary] [drawout] mounted. Feeder breakers (larger than 1200 amps) shall be [manually] [electrically] operated, [stationary] [drawout] mounted.
3. Breakers shall be constructed of a high dielectric strength, glass reinforced insulating case. The interrupting mechanism shall be arc chutes. Steel vent grids shall be used to suppress arcs and cool vented gases. Interphase barriers shall to isolate completely each pole.
4. Breakers shall contain a true two-step stored energy operating mechanism which shall provide quick make, quick break operation with a maximum five cycle closing time. Breakers shall be trip free at all times. Common tripping of all poles shall be standard.
5. Insulated Case circuit breakers shall be rated to carry 100 percent of their frame ampacity continuously.



# Spectra Series® Switchboards

## Section 7 – CSI Specifications

### SECTION 16402: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION SECTION 26 24 13: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

6. A charging handle, close push-button, open push-button, and Off/On/Charge indicator shall be located on the breaker escutcheon and shall be visible with the breaker compartment door closed.
  7. Where drawout breakers are specified, the drawout design shall permit the breaker to be withdrawn from an engaged position, to a test position, and to a disengaged position.
  8. Breaker digital electronic trip units shall be as described in Article 2.03.O.
- N. Digital Electronic Trip Unit for Molded Case Circuit Breakers
1. Each main, feeder[, and tie circuit breaker shall be equipped with a digital electronic trip unit. The trip unit shall provide protection from overloads, [and] short circuits [and ground faults]. The protective trip unit shall consist of a solid state, microprocessor based programmer; tripping means; current sensors; power supply and other devices as required for proper operation.
  2. Furnish GE microEntelliGuard digital electronic trip units or equal that complies with all of the following.
  3. The protective trip unit shall consist of a solid state, microprocessor based programmer; tripping means; current sensors; power supply and other devices as required for proper operation.
  4. Long time and short time protective functions shall have true RMS sensing technology for harmonic rich currents including up to the 19th harmonic.
  5. High contrast liquid crystal display (LCD) unit shall display settings, trip targets, and the specified metering displays.
  6. A multi-button keypad shall provide local setup and readout of all trip settings on the LCD.
  7. UL Listed interchangeable rating plug. It shall not be necessary to remove the trip unit to change the rating plug. Rating plugs shall be available in sizes from 40% to 100% of the breaker sensor rating
  8. The trip unit shall have an integral test jack for testing via a portable test set and connection to a battery source.
  9. Noise immunity shall meet the requirements of IEEE C37.90.
  10. The trip unit shall display trip targets for long time, short time, and ground fault, if included.
  11. Provide visual illuminated indication of the trip unit (normal, pickup, trip, error).
  12. The trip unit shall be provided with a ten event trip history log. Each trip event shall be recorded with type, phase and magnitude of fault that caused the trip
  13. As a minimum, the trip unit shall have the following protective functions:
    - a. Current setting or long time pickup, adjustable from 50% to 100% of the rating plug value.
    - b. Adjustable long time delay with typical inverse time characteristics (minimum of 10 bands). In addition, a set of straight line fuse shaped long time delay bands shall be provided to facilitate selectivity with downstream fuses (minimum 7 bands).
    - c. Instantaneous pickup, adjustable from 2.0 to 10 times the rating plug in 0.5 increments
    - d. Short time pickup and delay. Short time pickup shall be adjustable from 1.5 to 9 times the long time pickup setting in 0.5 increments with an OFF option. Provide minimum of 12 short time delay bands with three selectable I<sup>2</sup>t bands.
    - e. [Adjustable ground fault pickup and delay. Ground fault pickup shall be adjustable from 0.4 to 1.0 times the breaker sensor rating in 0.05 increments. Provide a minimum of 15 ground fault delay bands with three selectable I<sup>2</sup>t bands.] [Where indicated on the drawings provide GF alarm only function which shall operate an output control contact]
    - f. [Neutral Protection: Trip shall provide ability to protect against neutral conductor overload. Protection shall be the same as that for the phase conductors with settings at 50%, 100% or 150% of phase conductor protection settings for long time and short time pickups and delays. Sensing shall be provided via a neutral current sensor or from a summation calculation using phase current sensor signals.]
- SPECIFIER NOTE: NEUTRAL PROTECTION MAY BE ADVISABLE IN 120/208V APPLICATION OR OTHER APPLICATIONS WHERE EXCESSIVE TRIPLEN HARMONICS MAY BE ENCOUNTERED. TRIPLE HARMONICS CAN CAUSE NEUTRAL CURRENTS TO EXCEED 150% OF THE PHASE CURRENT. IF THE NEUTRAL CONDUCTORS, INCLUDE EQUIPMENT BUS AND TERMINATIONS ARE NOT SUITABLY SIZED THIS COULD RESULT IN OVERLOADED CONDUCTORS OR EQUIPMENT.**
- SPECIFIER NOTE: ZSI IMPLEMENTATION REQUIRES AT LEAST TWO LEVELS OF CIRCUIT BREAKERS THAT HAVE ZSI CAPABILITY. THE DOWNSTREAM BREAKER THAT SENDS THE SIGNAL AND THE UPSTREAM BREAKER THAT RECEIVES IT AND ADJUSTS ITS PROTECTION TIMING ACCORDINGLY. GE SPECTRA MICROENTELIGUARD G AND K FRAME CBS ARE ABLE TO PROVIDE ZSI FOR THE INSTANTANEOUS FUNCTION. INSTANTANEOUS ZSI ENABLES SELECTIVITY BETWEEN THESE MOLDED CASE CIRCUIT BREAKERS AND SIMILARLY EQUIPPED ENTELLIGUARD G, OR WAVEPRO CIRCUIT BREAKERS UP TO THE FULL SHORT CIRCUIT RATING OR WITHSTAND RATING OF THE LINE SIDE DEVICE.**
- g. [Zone Selective Interlocking for Short Time and Ground Fault protection.] [Zone Selective Interlocking for Short Time, Ground Fault and Instantaneous protection.]
- SPECIFIER NOTE: ALSO KNOWN AS A MAINTENANCE SWITCH OR ALTERNATE SETTING GROUP. CALLED A RELT SETTING IN GE LITERATURE. IN GE SWITCHBOARDS IT WILL BE PROVIDED ON INDIVIDUALLY MOUNTED BREAKERS ONLY, NOT ON GROUP MOUNTED BREAKERS. A 3-POSITION SWITCH WILL BE PROVIDED THAT ALLOWS TESTING OF CONTROL POWER AND INDICATES TRIP PROTECTIVE STATUS VIA A CONTACT CLOSURE PROVIDED BY THE TRIP UNIT.**
- h. [Reduced Energy Let-Through (RELT) Instantaneous trip. When specified this feature shall be provided on individually mounted breakers to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled

# Spectra Series® Switchboards

## Section 7 – CSI Specifications

SECTION 16402: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

SECTION 26 24 13: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

through a switch mounted on front of the switchboard. The switch shall be combined with an indicating light that positively indicates that the RELT is enabled or disabled.]

14. The trip unit shall display rms current, each phase, on the LCD.

### **SPECIFIER NOTE: INCLUDE THE FOLLOWING FOR ADVANCED METERING OPTIONS:**

15. [The following monitored values shall also be displayed on the trip unit LCD:
  - a. Voltage, rms, line-to-line, or line-to-neutral;
  - b. Energy, KWH, total;
  - c. Demand KWH, over an adjustable time period of 5 to 60 minutes;
  - d. Peak demand, KW, user resettable;
  - e. Real power, KW, line-to-line, line-to-neutral;
  - f. Total (apparent) power, KVA, line-to-line, line-to-neutral.
  - g. Reactive Power, KVAR, line-to-line, line-to-neutral.
  - h. Power Factor (%)
  - i. Frequency (Hz)
16. Trip shall be provided with serial communications using Modbus RTU protocol. Manufacturer's literature shall provide full register map.
17. Trip unit shall provide waveform capture capability for fault events. Capture data shall include 4 cycles before and 4 cycles after the event or can be initiated through a Modbus command. Data shall be provided in a Comtrade file format for use by power management system.
18. If a manufacturer's trip unit can not incorporate the above specified metering functions, separate device(s) with equal function shall be provided for each breaker

### **SPECIFIER NOTE: INCLUDE THE FOLLOWING FOR PROTECTIVE RELAY OPTION:**

19. [The following protective relay functions shall be provided. User shall be able to enable or disable each option as required by the coordination study. If the manufacturer's trip unit cannot incorporate the specified functions, separate device(s) with equal function shall be provided for each breaker.
  - a. Undervoltage, adj. pickup, 50 to 90 percent; adj. delay, 1 to 15 seconds.
  - b. Overvoltage, adj. pickup, 110 to 150 percent; adj. delay, 1 to 15 seconds.
  - c. Voltage unbalance, adj. pickup, 10 to 50 percent; adj. delay, 1 to 15 seconds.
  - d. Current unbalance, adj. pickup, 10 to 50 percent; adj. delay, 1 to 15 seconds.
  - e. Reverse power, adj. pickup, 10 KW to 990 KW; adj. delay, 1 to 15 seconds.
  - f. Load alarm, adj. ON, 0.55 to 1.0 x Longtime pickup; adj. OFF, 0.5 to 0.95 x Longtime pickup.]
- O. Digital Electronic Trip Unit for Insulated Case Circuit Breakers
  1. Each insulated case PowerBreak II breaker shall be equipped with a digital electronic trip unit. The trip unit shall provide protection from overloads, [and] short circuits [and ground faults]. The protective trip

unit shall consist of a solid state, microprocessor based programmer; tripping means; current sensors; power supply and other devices as required for proper operation. Furnish GE Entelliguard TU digital electronic trip units as specified below.

2. As a minimum, the trip unit shall have the following protective functions unless otherwise indicated on the drawings:
  - a. adjustable current setting or long time pickup;
  - b. adjustable long time delay (22 bands);
  - c. switchable, adjustable short time pickup and delay (11 bands) with 3 I<sup>2</sup>t selectable slopes;
  - d. adjustable instantaneous pickup;
  - e. [adjustable ground fault pickup and delay] [Where indicated on the drawings provide GF alarm only function]
  - f. [Reduced Energy Let-Through (RELT) Instantaneous trip. When specified this feature shall be provided to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard.]

### **SPECIFIER NOTE: ZSI IMPLEMENTATION REQUIRES AT LEAST TWO LEVELS OF CIRCUIT BREAKERS THAT HAVE ZSI CAPABILITY. THE DOWNSTREAM BREAKER THAT SENDS THE SIGNAL AND THE UPSTREAM BREAKER THAT RECEIVES IT AND ADJUSTS ITS PROTECTION TIMING ACCORDINGLY. GE POWERBREAK II CBS ARE ABLE TO PROVIDE ZSI FOR THE INSTANTANEOUS FUNCTION. INSTANTANEOUS ZSI ENABLES SELECTIVITY BETWEEN THESE CIRCUIT BREAKERS AND SIMILARLY EQUIPPED ANSI RATED ENTELLIGUARD G OR WAVEPRO CIRCUIT BREAKERS UP TO THE FULL SHORT CIRCUIT RATING OR WITHSTAND RATING OF THE LINE SIDE DEVICE.**

- g. [Zone Selective Interlocking for Short Time and Ground Fault protection.] [Zone Selective Interlocking for Short Time, Ground Fault and Instantaneous protection.]
3. As a minimum, the trip unit shall include the following features:
  - a. Long time and short time protective functions, if provided, shall have true RMS sensing technology and thermal long time memory.
  - b. Ground fault protective function, if provided, shall contain a memory circuit to integrate low level arcing fault currents with time, to sum the intermittent ground fault spikes.
  - c. High contrast liquid crystal display (LCD) unit shall display settings, trip targets, and the specified metering displays.
  - d. Multi-button keypad to provide local setup and readout of all trip settings on the LCD.
  - e. UL Listed interchangeable rating plug. It shall not be necessary to remove the trip unit to change the rating plug.
  - f. An integral test jack for testing via a portable test set and connection to a battery source.
  - g. A mechanism for sealing the rating plug and the trip unit.

# Spectra Series® Switchboards

## Section 7 – CSI Specifications

### SECTION 16402: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

### SECTION 26 24 13: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

- h. Noise immunity shall meet the requirements of IEEE C37.90.2.
- i. Display trip targets for long time, short time, and ground fault, if included.
- j. The trip unit shall keep a log of the last ten events including overcurrent trips, protective relay trips. The log shall store rms currents, phase, type of trip, trip counter, time and date for each event.
- k. Instantaneous trip shall utilize filtering which permits fully selective operation with downstream current limiting devices up to the short time rating of the circuit breaker, when the instantaneous pickup is set above the current limiting threshold.

**SPECIFIER NOTE: INCLUDE THE FOLLOWING FOR COMMUNICATION OPTION:**

- l. [The trip unit shall include Modbus RTU communication capability. The trip unit, through dedicated secondary terminals on the breaker, shall provide a communication port for communication with and access to a remote computer. All metering, setpoints, protective trip counts, and other event signaling shall be retrievable by the remote computer.]
- 4. The trip unit shall include the following metering functions, which shall be displayed on the LCD (if the manufacturers trip unit can not incorporate the specified functions, separate device(s) with equal function shall be provided for each breaker):
  - a. Current, RMS, each phase;

**SPECIFIER NOTE: INCLUDE THE FOLLOWING FOR METERING OPTION:**

- b. [Voltage, RMS (V), line-to-line or line-to-neutral.
- c. Energy (kWh, MWh, GWh), each phase and total, user resettable.
- d. Peak Power Demand (KW, MW), user resettable.
- e. Real power (KW, MW), each phase and total.
- f. Reactive power (KVAR, MVAR), each phase and total.
- g. Apparent power (KVA, MVA) , each phase and total
- h. Frequency (Hz).
- i. Power factor.
- j. Waveform capture capability. Upon triggering, a total of eight cycles of voltage (each phase) and current (each phase) shall be recorded. The eight cycles shall include four pre-trigger and four post-trigger cycles. The waveform capture shall be configurable to trigger by manually over communications (when specified), by an overcurrent trip, by a protective relay trip (when specified), or by a current alarm. Waveform data shall be available in "Comtrade" file format via serial communications or at a front port at the trip unit.]

**SPECIFIER NOTE: INCLUDE THE FOLLOWING FOR PROTECTIVE RELAY OPTION:**

- 5. [The trip unit shall include all of the following protective functions. It shall be possible to disable, by user programming, any combination of unwanted protective functions. Except for reverse power, relay settings shall be in 1 percent steps over indicated range. Each function shall have a time delay, adjustable in 1-second incre-

ments (1 to 15 seconds) and shall be able to be switched OFF. If the manufacturers trip unit can not incorporate the specified functions, separate device(s) with equal function shall be provided for each breaker.

- a. Undervoltage, adj. pickup, 50 to 90 percent; 1% increment adj. delay, 1 to 15 seconds.
  - b. Overvoltage, adj. pickup, 110 to 150 percent; 1% increment adj. delay, 1 to 15 seconds.
  - c. Voltage unbalance, adj. pickup, 10 to 50 percent; adj. delay, 1 to 15 seconds.
  - d. Current unbalance, adj. pickup, 10 to 50 percent; 1% increment adj. delay, 1 to 15 seconds.
  - e. Reverse power, selectable direction, adj. pickup, 10 KW to 990 KW; 10kW increment adj. delay, 1 to 15 seconds.]
- P. Individually Mounted Fusible Switches
- 1. Furnish GE type HPC high pressure contact fusible switches.
  - 2. High pressure contact fusible switches shall be butt type contact construction with multiple, spring loaded main arms and an arcing arm per pole. An over-center toggle mechanism shall provide quick make, quick break operation.
  - 3. Switches shall have a molded insulating case and cover with integrally molded interphase partitions. All current carrying parts shall be silver plated copper.
  - 4. Fusible switches shall be equipped with mounting provisions for UL class L fuses. Switches shall have an interrupting rating of 200 kAIC RMS SYM at 600V when used with class L fuses. Provide a complete set of UL class L fuses for each switch.
  - 5. Switches shall be rated for making and breaking 12 times nameplate rating current at 600 VAC. Switches shall be rated to carry 100 percent of their frame ampacity continuously.
  - 6. Switches shall be manually operated and stationary mounted. Switches shall have a front mounted operating handle for charging the closing springs and closing the switch and a push-button for opening the switch. Switches shall include a visible external ON - OFF indicator.
  - 7. Switches shall have defeatable, front access, coin proof interlocks. Interlocks shall prevent opening switch door when switch is ON and prevent turning switch ON when door is open. Switches shall include provisions for padlocking the switch in the open position.
  - 8. Provide the following UL listed accessories:
    - a. [120] [240] [480] VAC Electric trip [and control power transformer].
    - b. [Blown- fuse Protector.]
    - c. [Provision for Key Interlock.]
    - d. [Auxiliary Switches with [1] [2] [3] [4] single-pole, double-throw elements.]
    - e. Ground fault protection} relay with mechanical ground fault indicator, test function, adjustable current pick-up and time delay, and current sensors as required. Ground fault relay shall have an internal memory circuit that integrates intermittent arcing ground faults with time.]

# Spectra Series® Switchboards

## SECTION 16402: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION SECTION 26 24 13: LOW VOLTAGE SWITCHBOARDS GROUP MOUNTED DISTRIBUTION

- Q. Group Mounted Fusible Switches
  - 1. Furnish GE type ADS group mounted fusible switches.
  - 2. Fusible switches shall be quick make, quick break type with over center mechanism. Contacts and blades shall be self-aligning and spring reinforced.
  - 3. Fusible switches rated 600 amps or less shall be equipped with UL class J fuse clips and fuses. Fusible switches rated above 600 amps shall be equipped with UL class L fuse clips and fuses. Provide a complete set of fuses for each switch.
  - 4. External handle shall be padlockable in OFF position. Handle shall be interlocked with switch cover to prevent access to switch interior when switch is ON. Interlock shall have an override release.
  - 5. Switches shall include factory installed mechanical lugs. Lugs shall be UL listed and rated 75 or 60/75 degrees C as appropriate. Switches shall be standard, or 80 percent rated.
  - 6. Switch and fuse assembly shall have an interrupting rating as indicated on the contract drawings.
- 2.04 FINISH
  - A. All steel surfaces shall be chemically cleaned prior to painting.
  - B. Exterior paint color shall be ANSI 61 Light Gray over phosphate-type rust inhibitor.
- 2.05 ACCESSORIES
  - A. Fuses
    - 1. Manufacturer: Ferraz Shawmut (or equal).
    - 2. Interrupting Rating of all fuses shall be [200,000] RMS amperes.
  - B. [Furnish adhesive plastic strip mimic bus for switchboards.]
  - C. [Furnish nameplates for each device] as indicated in drawings. Color schemes shall be as indicated on drawings.]
  - D. [Provide Surge Protective Device system as specified in Section [16479] [26 43 13].]
- 2.06 TESTING

### PART 3 EXECUTION

- 3.01 EXAMINATION
  - A. The following procedures shall be performed by the Contractor.
    - 1. Examine installation area to assure there is enough clearance to install switchboard.
    - 2. Check concrete pads for uniformity and level surface.
    - 3. Verify that Spectra Series switchboards are ready to install.
    - 4. Verify field measurements are as [shown on Drawings] [instructed by manufacture].
    - 5. Verify that required utilities are available, in proper location and ready for use.
    - 6. Beginning of installation means installer accepts conditions.
- 3.02 LOCATION
- 3.03 INSTALLATION
  - Additional provisions and editing may be required for this part.
  - A. Installation shall be performed by the Contractor.
    - 1. Install per manufacturer's instructions.
    - 2. Install required safety labels.
- 3.04 FIELD QUALITY CONTROL N/A
- 3.05 ADJUSTING N/A
- 3.06 CLEANING

# Spectra Series® Switchboards

## **Reference Publications**

### **Integrated Switchboards**

- DEA-373A

### **Commercial Metering Switchboards**

- DEA-340

### **Jiffy II Switchboards**

- DEA-344

### **Busway**

- DE-307

### **ZTS**

- Standard: PB-5066
- Delay: PB-5067
- Bypass: PB-5068

### **DC**

- GIZ-2691

### **Process Control Unit (PCU)**

- DET-104

### **PowerBreak II**

- GET-8052

### **Powerpanel**

- GET-7006

### **AV3 Access Switchboard**

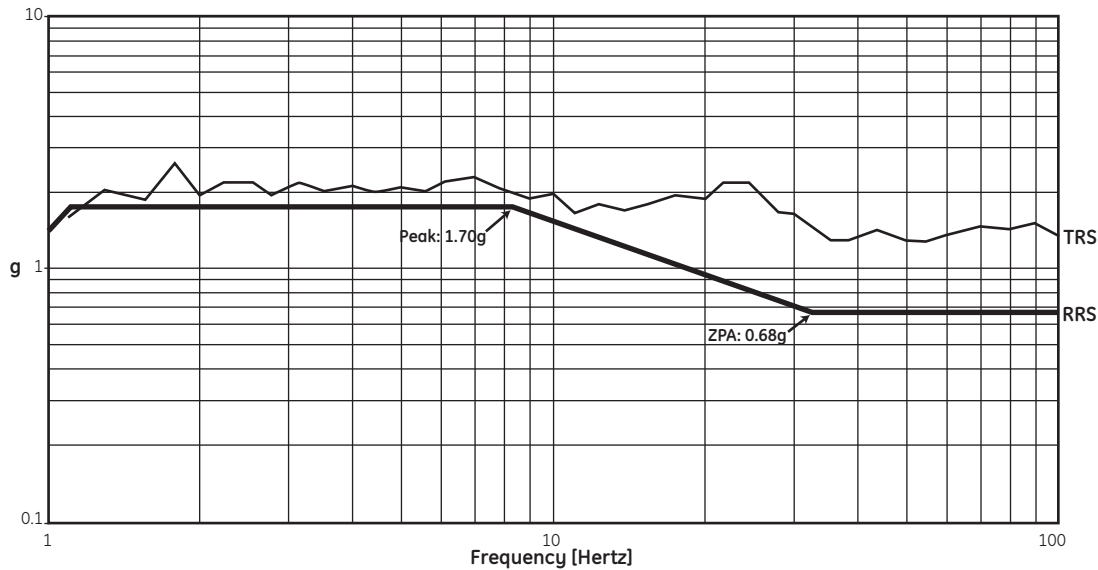
- DET-138

**Appendix  
Seismic Compliance Certification**

**For Spectra & Jiffy Series Switchboards**

Qualified to IEEE-693-1997      HIGH Level with 1.33 Amplification Factor.

Qualified to IBC-2009       $S_{ds} = 1.05g, S_s = 158\%, I_p = 1.5$ , for  $z/h > 0$   
 $S_{ds} = 1.67g, S_s = 250\%, I_p = 1.5$ , for  $z/h = 0$   
 in accordance with ICC-ES-AC156.



Lowest equipment natural frequency: 4.5 Hz      Qualified by shake-table testing, Wyle Laboratories, May, 1998,  
 July, 1998, March, 2001

**THIS IS TO CERTIFY THAT THE ABOVE NAMED EQUIPMENT MEETS OR EXCEEDS  
 ALL OF THE ABOVE REQUIREMENTS ACCORDING TO IEEE-693-1997 AND IBC-2003.**

Certification Report Prepared by

**W. E. Gundy & Associates, Inc.**  
 P.O.Box 2900, Hailey, ID, 83333

See GE document 10095999P1 for Certification Report, interpretation of test data and P.E. stamp.

**Appendix**  
**Trip Units by Main Breaker and Functions**

		Trip Units				
		MicroVersaTrip® Plus	MicroVersaTrip® PM	Power +	EntelliGuard® TU	microEntelliGuard™
<b>Main Breaker</b>	Power® Break II	●	●	●	●	
	Spectra®	●	●			●
<b>Functions</b>	Long	●	●	●	●	●
	Short	●	●	●	●	●
	Instantaneous	●	●	●	●	●
	Ground	●	●	●	●	●
	Ground Fault Alarm				●	●
	Neutral Protection				●	●
	ZSI		●		●	●
	RELT		●		●	●
	Waveform Capture		●		●	●
	Metering		●		●	●
	Communications		●		●	●
Protective Relays				●	●	

Note: MicroVersaTrip® is in legacy status and is for replacement only.

Information provided is subject to change without notice. Please verify all details with GE. All values are design or typical values when measured under laboratory conditions, and GE makes no warranty or guarantee, express or implied, that such performance will be obtained under end-use conditions.

**GE Energy**  
41 Woodford Avenue, Plainville, CT 06062  
[www.geindustrial.com](http://www.geindustrial.com)  
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