POWER GUARDIAN™ USER GUIDE

GENERAL PRODUCT OVERVIEW

Smart Wires Guardian technology increases transmission line reactance by injecting magnetizing reactance in series with the line. The first generation of the GuardianTM product line was the PowerLine Guardian® which is a conductor-mounted device. The Power Guardian 390 operates using the same electrical configuration as the PowerLine Guardian but provide 20-60 times more reactance for a given current rating than the PowerLine Guardian. By leveraging the technology development and lessons learned from the PowerLine Guardian, Smart Wires solutions with the Power Guardian 390 can significantly reduce unit requirements to achieve the same overall reactance, and push power to underutilized circuits. The Power Guardian 390 is installed on a single-phase basis, meaning that for most transmission and distribution deployments, there will be an equal number of units per phase.

FIGURE 1. POWER GUARDIAN WITH MOUNTING BRACKET (WITHOUT CORONA RINGS)

ELECTRICAL OPERATION OF A SINGLE MODULE

The Power Guardian 390 device injects magnetizing reactance to increase the line impedance and "push" power onto parallel lines. The Power Guardian 390 device is connected in series with the power circuit, operated at line potential and has no connection to ground. This technology is particularly effective in highly meshed electric grids where spare system capacity can be utilized to resolve overload situations. Figure 2 illustrates the basic electrical configuration of the Power Guardian 390.

Current Transformers

Each Power Guardian 390 is equipped with two Current Transformers (CTs). The first current transformer (CT_1), is used to harvest a small amount of power from the transmission line to power the control and communications circuits in the devices. There is another separate CT (not shown) that senses the line current and feeds into the control circuitry.

Injection Reactor

The Reactor is used to inject magnetizing reactance (X_M) in series with the line. The size of the reactor is similar across the product rated current range, but the number of windings in the path of the power line varies from Model to Model.

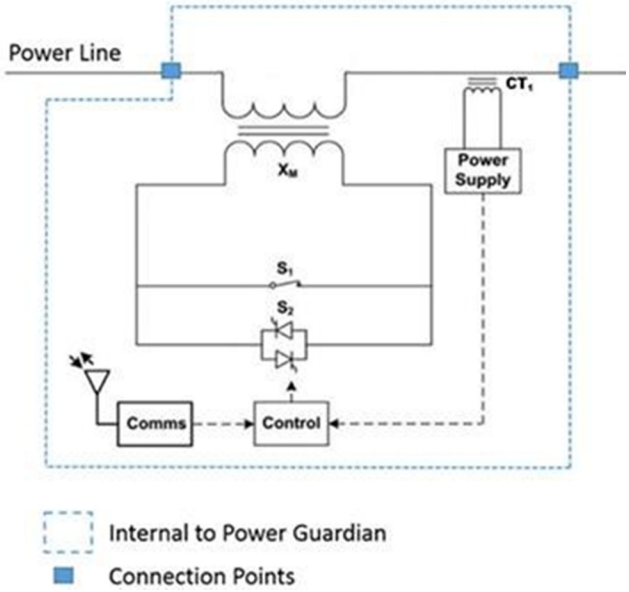

FIGURE 2. POWER GUARDIAN 390 SYSTEM DIAGRAM

POWER GUARDIAN CONTROL

The Power Guardian 390 has two distinct modes of operation, with granular performance at each device described as below.

1. Injection Mode - the normally-open contactor S_1 remains open, and magnetizing reactance (X_M) is injected onto the line. The magnitude of this magnetizing reactance is defined by the device rating. The Power Guardian 390 is capable of transmitting telemetry data in this mode.
2. Monitoring Mode - no reactance is injected as S_1 is closed and the reactance coupling transformer is shorted. The Power Guardian 390 is capable of transmitting telemetry data in this mode. When the Power Guardian 390 senses a line current which exceeds its rated tolerance, it automatically shorts the secondary with fast-acting antiparallel silicon-controlled rectifier (SCR) switches (S_2), entering monitoring mode within 1 millisecond.

Whenever the device switches from one mode to another, the antiparallel SCR switches (S_2) are engaged during the short time of contactor state change. This prevents arcing and prolongs the contactor service life.

See the Power Guardian Product Specification sheet for more details on performance.

CONTROL METHODS

There are three Control methods for the Power Guardian 390, defined by their levels of automation and communication requirements. A deployment of Power Guardian 390 devices only functions in a single manner at any given time.

1. Static – This is the simplest control method. The deployment of Power Guardian 390 devices continuously delivers the desired level of reactance (the system is static) and does not require backhaul communications. The level of injected reactance can be adjusted by using local communications and is typically adjusted on a seasonal basis to accommodate various reliability needs.
2. Manual – This method is similar to static control, however backhaul communications are enabled. This functionality allows for manual remote-control of the Power Guardian 390 deployment by the system operator. Operators can change the Operating Mode (Injection vs. Monitoring) of individual and/or groups of Power Guardian 390 devices. This enables real-time flexibility of power flow control.
3. Set-point– With this method, no manual control is required, but backhaul communications are necessary. The deployment of Power Guardian 390 devices operate autonomously, switching from monitoring to injection mode (and vice-versa) based on the real-time line current or conductor temperature. These set-points are user-defined and configurable. Any number of set-point configurations can be created by operators within the Smart Wires software platform.

PRODUCT COMPONENTS

The major components of the Power Guardian 390 are shown below in Figure 3.

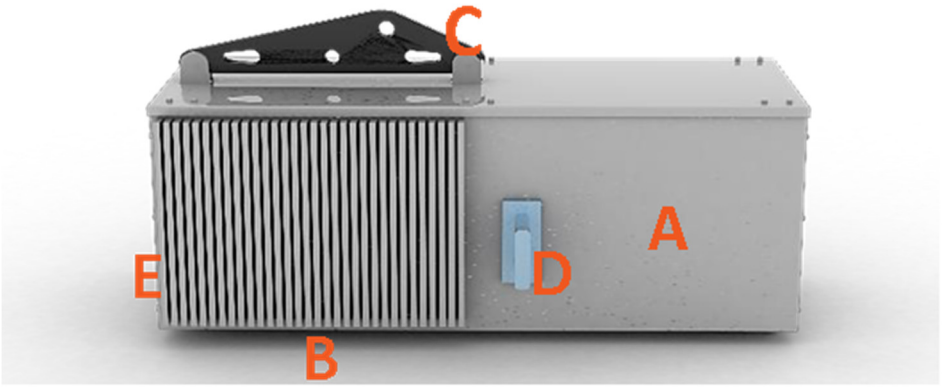

FIGURE 3. POWER GUARDIAN 390 COMPONENTS

- A – Communications and Control – this side of the unit contains all the communication and control circuitry.
- B – Power Guardian 390 Reactor– this side of the unit contains the reactor.
- C – Yoke Plate – this plate is the fixture point for insulators supporting the unit from above.

- D – NEMA Pad – this is the electrical connection point for the unit, one on each side.
- E – Cooling Fins – these draw heat from the internal unit components and dissipate the heat externally.

Regulatory Compliance User Notice:

FCC:
[illegible]

IC:
This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada’s licence-exempt RSS(s). Operation is subject to the following two conditions:

1. *This device may not cause interference.*
2. *This device must accept any interference, including interference that may cause undesired operation of the device.*

Innovation, Science and Economic Development Canada ICES-003 Compliance Label: CAN ICES-3(A)/NMB-3(A)

L’émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d’Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L’exploitation est autorisée aux deux conditions suivantes :

1. *L’appareil ne doit pas produire de brouillage;*
2. *L’appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d’en compromettre le fonctionnement.*

Étiquette de conformité à la NMB-003 d’Innovation, Sciences et Développement économique Canada : CAN ICES-3 (A)/ NMB-3 (A)

To comply with RF exposure limits established in the ANSI C95.1 standard, the distance between the antenna or antennas and the user should not be less than 20 cm for USA and Canada

This product does not contain any user serviceable components. Any unauthorized product changes or modifications will invalidate warranty and all applicable regulatory certifications and approvals, including authority to operate this device.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Canada – Industry Canada (IC)
This device complies with Industry Canada RSS-247 and license-exempt RSS standard(s).
Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Ce dispositif est conforme à lanorme CNR-247 d'Industrie Canada applicable aux appareils radio exempts de licence. Son fonctionnement est sujet aux deux conditions suivantes: (1) le dispositif ne doit pas produire de brouillage préjudiciable, et (2) ce dispositif doit acceptertout brouillage reçu, y compris un brouillag
e susceptible de provoquer un fonctionnement indésirable.