Generator Power Control™ (GPC)

Utility Power Control™ (UPC)

Meter Monitor Control™ (MMC)

Highlights

Multifunction Integrated Generator Control

Standard Communications Protocols

Flexible Development Environment

Protective Relay Modules

ATS Module

Synchronizer Module

System Control Module for Multiple Genset Applications

Data Sheet Contents

Introduction

The Encorp Power™ family of controls are analog/digital microprocessor-based devices designed to fully control single and multiple generator sets, act as master control nodes and serve meter/monitoring functions. These industrial-grade devices are protected by their distinctive Gold Box covers.

The Encorp Power family of controls provide real and reactive power control, load sharing, generator and utility metering, automatic transfer switching, synchronizing, and protective relay functions. All Encorp Power control products use the LONWORKS® open field bus protocol for configuration and control. Encorp Intelligence™ software products can be used to configure, control, and display data from Encorp Power controls.

Single Genset Version (PTC)

The GPC is available in a Single Genset Version (PTC), designed to control an Automatic Transfer Switch in multiple modes.

Multiple Genset Version (KWS)

The GPC is also available in a Multiple Genset Version (KWS) designed to control Automatic Paralleling Switches capable of load sharing in multiple modes.

Utility Power Control (UPC)

The Utility Power Control (UPC) is designed to act as a master control node for multiple gensets while controlling utility and utility-tie circuit breakers.

Meter Monitor Control (MMC)

The Meter Monitor Control (MMC) is used primarily as an multifunction power meter and can also perform miscellaneous tasks as required by custom designs.

Remote Access

The Generator Power Control allows application developers easy access through Encorp Intelligence Network Services Tool™ and Virtual Maintenance Monitor™ software interfaces for design and configuration level changes. Standard and non-standard binding sets can be developed for simple and complex switchgear applications. Once deployed, the GPC enables energy system managers to remotely monitor and control distributed energy resources from a single location. The ease at which Encorp Intelligence VMM and VPP software integrates into GPC Single and Multi-Genset systems allows developers wide latitude in designing innovative distributed systems.

Technology Neutral

The flexible development environment of the GPC allows developers to design control scenarios for virtually any type of prime mover technology. The GPC is adaptable to established as well as emerging power generating sources.

Industry Standard Communications Protocols

Embedded PLC software module, IEC 1131 Programming Language

IEC 1131 is the only major standard for industrial control programming. It harmonizes the way people design and operate industrial controls by standardizing the programming interface. A standard programming interface allows for an easy software development lifecycle. All pieces adhere to a common structure and work together harmoniously. The standard includes the definition of the Sequential Function Chart (SFC) language, used to structure the internal organization of a program, and four inter-operable languages: Instruction List (IL), Ladder Diagram (LD), Function Block Diagram (FBD) and Structured Text (ST). This powerful PLC kernel is embedded into each GPC and is fully integrated into the overall design architecture of the unit.

Communications through LONWORKS®

The LONWORKS system is a leading, open, networked automation and control solution for the building, industrial, transportation, and home markets. Thousands of application developers and millions of devices have been installed worldwide. In a LONWORKS network, intelligent control devices, called nodes, communicate with each other using a common protocol. Each node in the network contains embedded intelligence that implements the protocol and performs control functions. The central functioning within each GPC is accomplished through highly sophisticated LONWORKS objects developed for their specific function by Encorp engineers.

Communications through MODBUS®

Touch-pad devices used for on-site control of GPC equipped products communicate using the MODBUS protocol. The MODBUS protocol is a messaging structure, widely used to establish master-slave communication between intelligent devices. RS232, RS422, and RS485 hardware communication layers are supported..

A Word About Bindings

(or - Why Our Control is So Unique)

Encorp's controls replace the myriad of external, electrical devices found in traditional switchgear cabinets with a single control that implements the same functions in software. Encorp controls retain the familiar distinction between devices by replacing each physical device with a corresponding software object. Each device (object) is then wired together in software using a process called binding.

Bindings—the software equivalent of the wires—connect the internal objects together. All of the bindings within a control are referred to collectively as a binding set. The NST Binding software, available from Encorp, is a Windows 32 bit program used to create and modify binding sets.

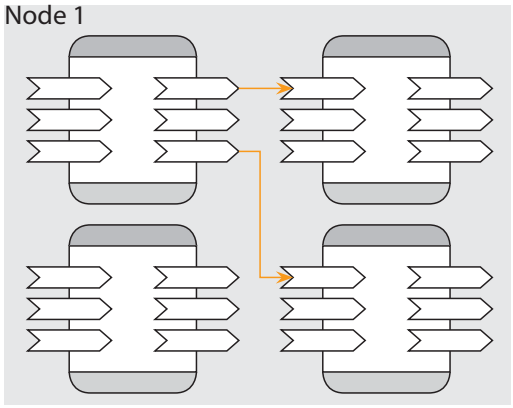

Figure 2 Internal Bindings

• Bindings that connect two or more objects within the same control are called internal bindings (Figure 2). An internal binding connects an output variable from one object to the input variable on another object. Both objects reside within the same control.

• Bindings that connect two or more objects on different controls are called external bindings (Figure 1). Bindings are a function of the Echelon LONWORKS standard used by all Encorp controls. Using the NST, you can create bindings between any nodes on the LONWORKS network. Encorp produces a standard binding set as an off-the-shelf product for each control type. In addition, Encorp can produce custom binding sets for virtually any application. Standard binding sets may be modified or developers may create their own binding sets using the NST and documentation from Encorp.

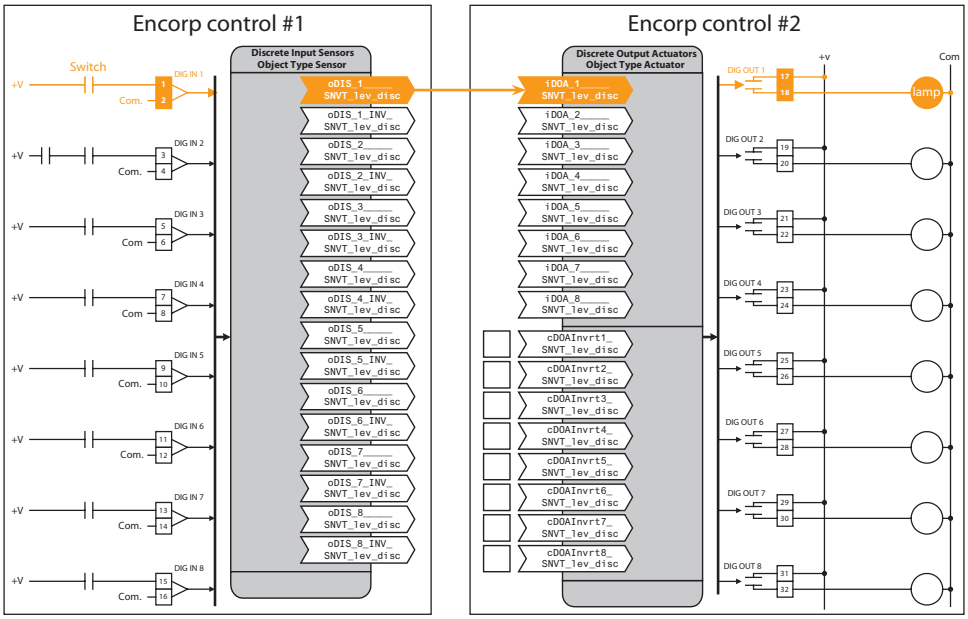

Figure 1 External Bindings

GPC - Single Genset Version (PTC)

The Single Generator version of the control is designed for use as a generator control in single-unit applications. The GPC/PTC is intended to control a stand-alone genset as well as enabling it to parallel with the utility. The GPC/PTC is most commonly used in single-unit Automatic Transfer Switch (ATS) applications.

Software Control Features

Unless otherwise noted, the following control features are found in all models of the Encorp Power Control.

Programmable Logic Controller

Using the embedded Programmable Logic Controller, application engineers can write custom code which interacts with other embedded objects.

Synchronizer (PTC, UPC, & KWS)

This fully configurable object allows developers to configure phase, voltage and slip accept windows, phase offset, slip frequency set point, circuit breaker controllers, dead bus delay time, proportional gain (frequency and voltage), integral gain, and voltage ramp rate. Since not all features are needed in every application, developers use only those features they need for a particular application.

Import/Export Control (PTC) & Baseload Control (PTC & KWS)

For GPC/PTC installations equipped with an Automatic Parallel Switch, the PTC Real Power Control object has Import/Export and Baseload Control capability. The PTC Real Power Control object allows for two separate Import/Export and Baseload set points and allows developers to configure minimum and maximum generator and utility loads, set the rated generator and utility kW, set the generator and utility disconnect levels, and set kW droop for use in droop mode. Other configurable parameters include: raise and lower ramp rates; proportional, integral, and derivative gain; and dead band settings.

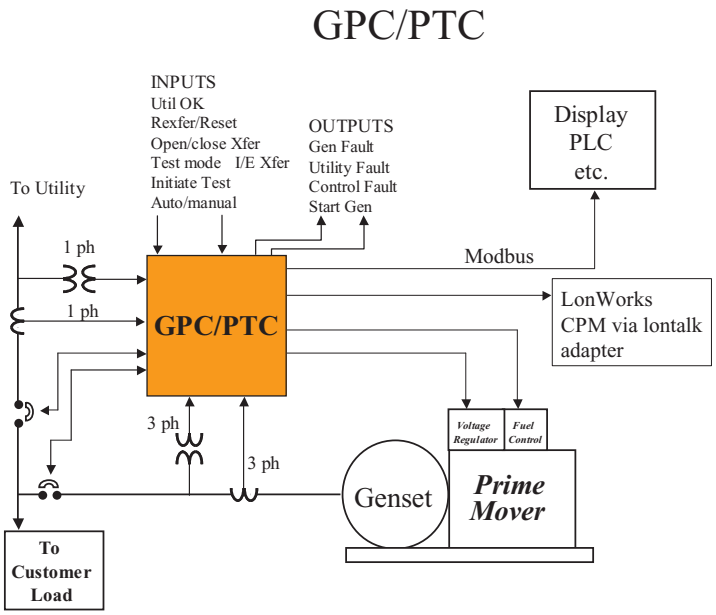

Figure 3 Single Genset GPC - Inputs & Outputs

Automatic Transfer Switch (PTC & UPC)

For GPC/PTC installations equipped with an Automatic Transfer Switch, the PTC Automatic Transfer Switch object has fully configurable capabilities for both open and closed transfer operations.

Configurable time delays (in seconds) include:

- Generator Start Delay (TDES)
- Engine Start (TDCL)
- Stable Delay (TDNE)
- Open Transfer (TDN)
- Retransfer Delay (TDEN)
- Cooldown (TDEC)

VAR/PF Control (PTC & KWS)

The Reactive Power Control can be configured to control VARs (volt-amp reactive) or PF (power factor). The configurable parameters include: set point (percent leading or lagging for PF), proportional and integral gain, ramp rate, and dead band.

Digital Power Monitor

The Encorp Power control includes numerous digital power monitors and tracks the following:

- kW
- kVAR
- kVA
- PF
- Frequency
- Harmonics

Protective Relay Modules

The following IEEE standard protective relays are embedded in each Encorp Power control:

- Over/under voltage for gen and util tie(27/59)
- Over/under frequency for gen and util tie (81 O/U)

- Directional power relay (32)
- Directional reactive power relay (32VAR)
- Reverse-phase current relay (46)
- Phase-sequence voltage relay (47)
- Voltage-restrained overcurrent relay (51)

Digital/Analog Interfaces

Discrete Inputs

The Encorp Power control contains 8 discrete inputs for collecting and processing data, typically from critical circuit breakers annunciators and equipment status annunciators.

Discrete Outputs

The Encorp Power control contains 8 discrete outputs for actuating certain devices typically for opening and closing critical circuit breakers.

Single and Three Phase PTs (potential transformers) Inputs

PTs are used to monitor generator and utility voltage.
60 to 150 Vac; 50/60 Hz; delta, open delta or wye configurations

Single and Three Phase CTs (current transformers) Inputs

CTs are used to monitor generator and utility current.
0 to 5 amps; 50/60 Hz

Frequency and Voltage Bias Outputs

Bias outputs used to regulate generator voltage and frequency.
+/- 3 Vdc and 4-20 Ma

Monitoring Features

Demand Meters

Demand is the average power delivered over a fixed time interval, typically 15 minutes. The Encorp Power control employs two utility grade methods for calculating demand:

Sliding Window - divides the demand interval into a number of sub-intervals. This results in a better response time than the thermal computation as a new value is available at each sub-interval.

Thermal - is the equivalent to the response to heating of a thermal demand meter. The time characteristic of the thermal demand meter is continuous and independent of the selected discrete time interval

Digital Meters

The Encorp Power control uses various metering objects for displaying power output and usage:

Energy Meters - Tracks total energy usage

Power Meters - Displays power in kVA, kVAR, and PF for individual phases

Three Phase Measurements - Displays system equivalent three phase power in kW, kVA, kVAR, and PF

Harmonics - Harmonics are continuous, integral multiples of the fundamental frequency. When present in

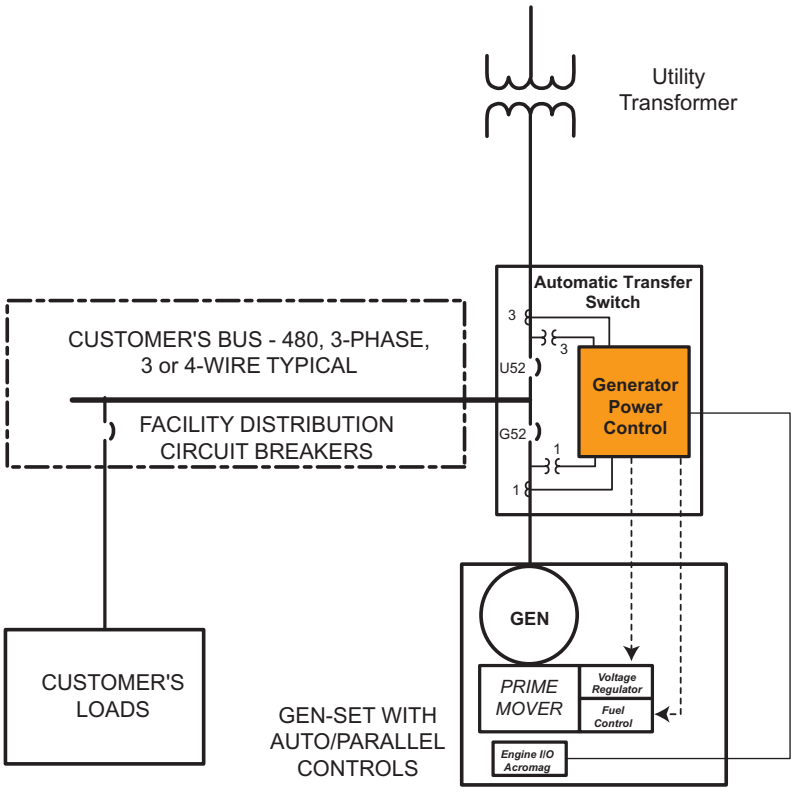

Figure 4 Single Genset ATS Oneline diagram

sufficient quantities, they can cause a system to become thermally overloaded, contributing to system downtime and operating costs.

GPC - Multi-Genset Version (KWS)

The multi-genset version of the Encorp Power control allows multiple gensets to loadshare, passing data across a digital network. Each Multi-Genset (KWS) GPC is intended to control an individual genset and loadshare with other gensets. The KWS control can also be configured to baseload while operating in parallel to the utility. While in baseload, set point signals for real and reactive power are sent from the Master Control (UPC) to the Slave controls (KWS units).

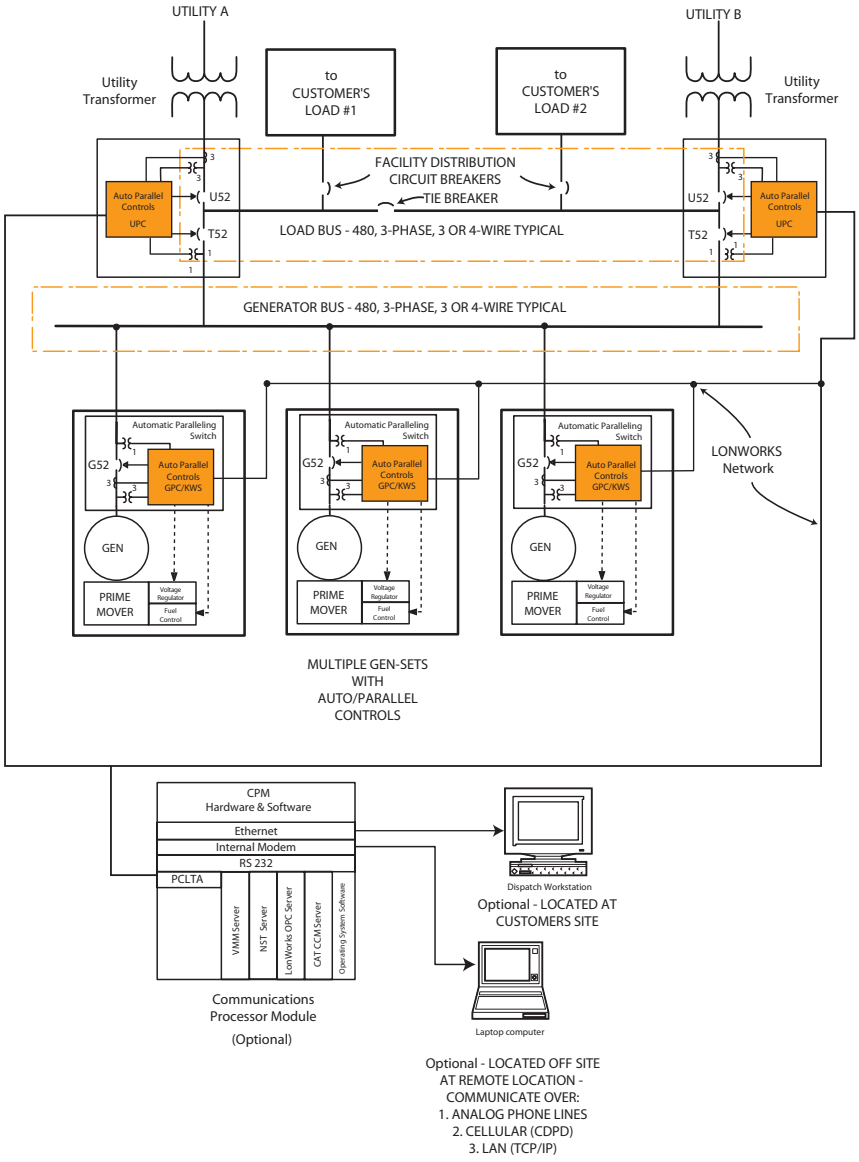

Figure 5 Multiple Units in Peak Shaving and/or Standby Mode

UPC - Utility Power Control

The UPC (Utility Power Control) acts as a master control for multiple GPC's; providing safe, reliable synchronization and paralleling of multiple generators to the utility grid. This integrated control solution allows for easier and faster installation, increased reliability and the latest cutting-edge technology. Unique control design permits baseload and loadshare control schemes across simple and complex electrical bus architectures.

MMC - Meter Monitor Control

The MMC (Meter Monitor Control) is a full-featured, configurable metering and monitoring control. The MMC employs current and voltage sensors, discrete and analog input and output actuators, as well as circuit breaker controllers.

Multi-Genset Sequence of Operations:

1. Using more than one genset, the facility loads can parallel with the utility for peak shaving, export power to the utility, or be used in standby mode.

2. The controls will start each generator and wait for proper voltage and frequency.

3. The first genset to reach proper voltage and frequency is closed to the dead bus. The remaining gensets are paralleled and synchronized to the gen-bus by the controls (close each genset breaker, G52).

4. When all generators or a predetermined number of generators are available, either or both ATS's will parallel and synchronize the generator bus to the load-bus (close the gen-tie breaker T52).

5. The controls will ramp up and softload the generators to the load.

6. If the utility is lost, the ATS will open the utility breaker U52.

7. The gensets will pick up the load, however, the gensets must be properly sized to handle the load or load shedding must occur to prevent the gensets from tripping offline.

8. When the utility is again available, the ATS will parallel and synchronize the utility back online (closed-transition or open transition) to carry facility loads (close the utility breaker U52). The generator bus tie breaker, T52, can remain closed during the process (closed transition).

9. The genset controls will soft unload (ramp) the gensets back to a predetermined set point in peak shaving mode or completely unload the gensets, open the genset breakers, run the gensets in cooldown mode, and then shut each genset down in standby mode.

System Control Object (UPC & KWS)

All Multi-Genset GPC and UPC Versions include the System Control Object which gives capabilities not found in any other embedded controller.

The SCO detects disconnected or non-responsive nodes.

The SCO allows application engineers to design systems that contain up to four separate generator and utility buses. The key to this is the SCOs ability to dynamically alter communication links depending on breaker positions. This feature allows independent load sharing (VAR sharing and PF control) on up to four separate busses with the ability to seamlessly integrate load sharing as tie breakers close using dynamic bus addressing.

The SCO uses the LONWORKS protocol for custom communications between controls.

The SCO allows for safe dead bus closing as gensets come online after a utility failure. Since an SCO object is in each KWS and UPC control, as the gensets come up to speed, sophisticated algorithms within each control evaluate each other and logically decide which genset should close to the dead bus first. This feature ensures reliable back up generation while avoiding multiple simultaneous breaker closings.

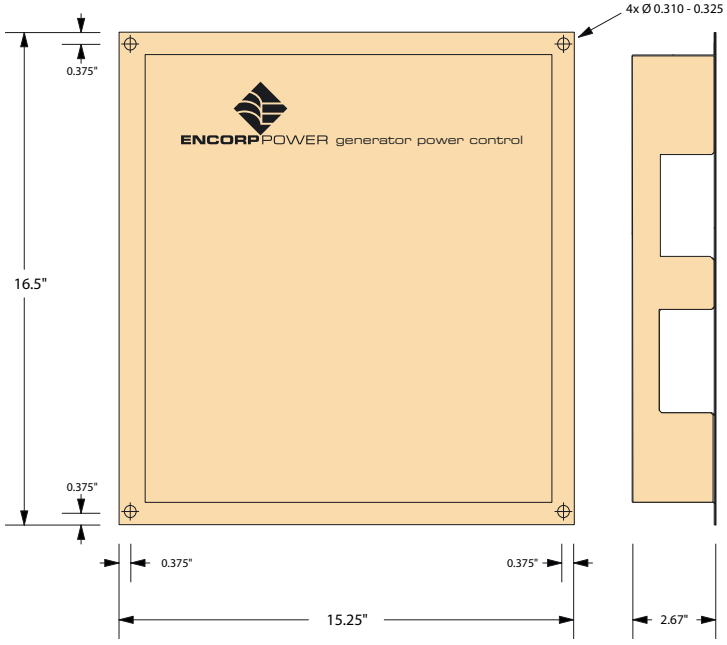

Figure 6 GPC Dimensions

The System Control Object was designed to satisfy the following requirements:

Power Control and Data Acquisition Functionality

- Enable load sharing over the digital LONWORKS network for up to 16 units
- Enable VAR sharing over the digital LONWORKS network for up to 16 units
- Enable multiple bus support for systems with multiple generating resources tied together with a complex bus/breaker structure
- Enable safe dead bus closing between multiple units
- Detect disconnected, or non-responsive nodes
- Assist with data acquisition / communication by including packed state variables so that greater quantities of discrete information can be gathered together at a single node (limited to 8 discretes per node). This also allows addressed communications between PLC kernels on different nodes (limited to 9 bits of information).

General Specifications

Environmental:

Humidity:95%at 38° C
Temperature:-25°C to 70°C

Mechanical Vibration:

24 to 2000 Hz:2.5 g

Power Requirements:

10 to 18 Vdc (<10W)
18 to 75 Vdc (<10W)
85 to 265 Vac (<25W)

Single Phase Potential Input:

60 to 150 Vac; 50/60 Hz; delta, open delta or wye configurations

Single Phase Current Input:

0 to 5 amps; 50/60 Hz

3-Phase Current Inputs:

0 to 5 amps; 50/60 Hz

Digital Inputs:

20 to 40 Vac/Vdc; 85 to 150 Vac/Vdc

Digital Outputs:

1 to 120 Vac/Vdc; 0.15 amps max

Frequency and Voltage Bias Outputs:

+/- 3 Vdc and 4-20 ma

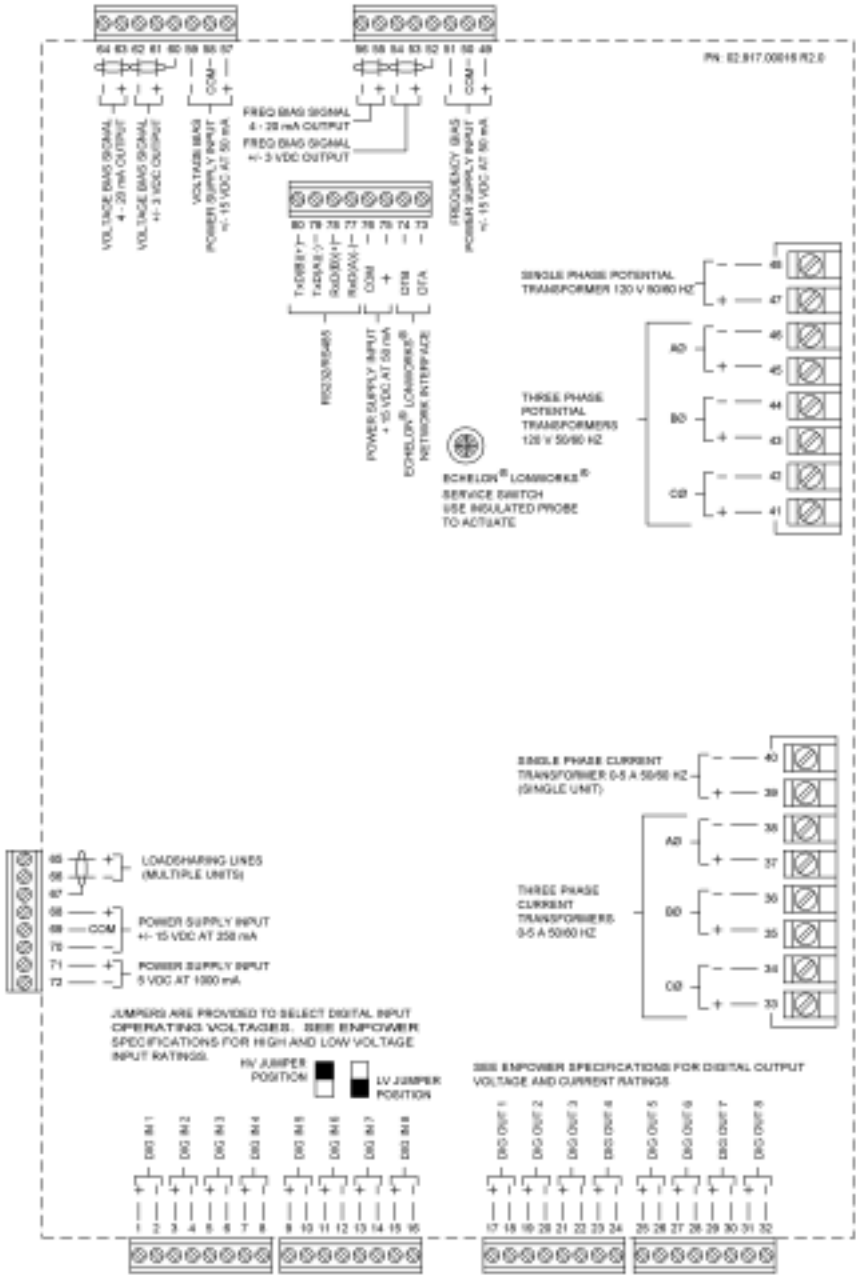

Figure 7 GPC Input and Output Terminals

Designed to meet or exceed ANSI/IEEE C37.90-1989, IEEE Standards for Relays and Relay Systems associated with Electrical Power Apparatus (5000 Volt Surge Withstand)
Designed to comply with:
IEC 1000-4-2 Electrostatic Discharge
IEC 1000-4-3 Radiated Immunity
IEC 1000-4-4 Fast Transient
IEC 1000-4-5 Surge Withstand
IEC 1000-4-6 Conducted Immunity
ANSI/IEEE C37.90.1 Surge Withstand/Fast Transient
ANSI/IEEE C37.90.1 Radiated Immunity
Designed for LONMARK Compatibility
Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories Inc.

Detailed Technical Specifications

Encorp Power controls have been designed to conform to UL and CSA standards. All isolation and interface parts are UL, CSA, and CE approved, with the exception of the on-board Potential Transformers. The PTs are designed to conform to these standards and certification is pending.

Characteristics	Min	Typical	Max
Conducted immunity			
• IEC 1000-4-6			
• Class 3, 150 kHz to 80 MHz			10 V
Control boot time			
• Revision 2.0		12 s	18 s
• Revision 3.0		21 s	30 s
Current inputs			
• Current TB 33-40		5 A	7 A
• Transient current			
• One second			200 A
• Continuous			15 A
• Accuracy			0.5 percent
• Resistive dc impedance		0.0007 ohms	
• Burden at 5 Amps			0.2 VA
Discrete Input Voltage			
• Jumper = HV	90 Vac or Vdc	120 Vac or Vdc	150 Vac or Vdc
• Turn-on voltage		50 Vac, 67 Vdc	
• Turn-off voltage		50 Vac, 39 Vdc	
• Current draw @ 120 Vac		2.00 mA	
• Jumper = LV (24V)	20 Vac or Vdc	24 Vac or Vdc	40 Vac or Vdc
• Turn-on voltage		17Vdc, 12Vac	
• Turn-off voltage		10Vdc, 12Vac	
• Current draw @ 24Vdc		1.15 mA	
• Jumper = LV (12Vdc)	10 Vdc	12 Vdc	18 Vdc
• Turn-on voltage		9.7 Vdc	
• Turn-off voltage		6.0 Vdc	
• Current draw @ 12 Vdc		1.50 mA	
Discrete Outputs			
• Voltage			120 Vac or Vdc
• Current			0.15 A
• Output Impedance (on)		0.5 ohms	
• Discrete output impedance (off)	10 Mohms		

Characteristics	Min	Typical	Max
Electrostatic discharge			
• IEC 1000-4-2			
• Level 4			
• Contact discharge		8 kV	
• Air discharge		15 kV	
Frequency Sensing			
• Tolerance at 0.05 Hz	10 Hz	60 Hz	70 Hz
GPC Power Supply			
• 24 Vdc model TB 81–88			
• Input voltage	20 Vdc	24 Vdc	40 Vdc
• Input current @24Vdc		160 mA	300 mA
• 12 Vdc model TB 81–88			
• Input voltage	9 Vdc	12 Vdc	18 Vdc
• Input current @12Vdc		550 mA	800 mA
• 120 Vac or Vdc model TB 89–90			
• Input voltage (Vac)	100 Vac	120 Vac	240 Vac
• Input voltage (Vdc)	90 Vdc	100 Vdc	200 Vdc
• Input current @120 Vac		110 mA	800 mA
GPC Internal Power Supply Outputs			
• 12 and 24 Vdc model			
• Main 5Vdc TB 71–72	4.85 Vdc	5.00 Vdc	5.15 Vdc
• Main ±15Vdc TB 68–70 or	14.55 Vdc	15.00 Vdc	15.45 Vdc
• Main ±12Vdc TB 68–70	11.55 Vdc	12.00 Vdc	12.45 Vdc
• Frequency bias ±15Vdc TB 49–51 or	14.55 Vdc	15.00 Vdc	15.45 Vdc
• Frequency bias ±12Vdc TB 49–51	11.55 Vdc	12.00 Vdc	12.45 Vdc
• Voltage bias ±15Vdc TB 57–59 or	14.55 Vdc	15.00 Vdc	15.55 Vdc
• Voltage bias ±12Vdc TB 57–59	11.55 Vdc	12.00 Vdc	15.55 Vdc
• 120 Vac or Vdc model			
• Main 5Vdc TB 71–72	4.85 Vdc	5.00 Vdc	5.15 Vdc
• Main ±15Vdc TB 68–70	14.55 Vdc	15.00 Vdc	15.45 Vdc
• Frequency bias ±15Vdc TB 49–51	14.55 Vdc	15.00 Vdc	15.45 Vdc
• Voltage bias ±15Vdc TB 57–59	14.55 Vdc	15.00 Vdc	15.45 Vdc

Characteristics	Min	Typical	Max
Isolation			
• Analog outputs			
• Speed and voltage outputs			3000 Vac
• Discrete inputs and outputs			2500 Vac
• Load sharing lines, from power input			1500 Vac
• Power supplies			
• AC supplies			3000 Vac
• DC supplies			1500 Vac
• Transformers:			
• current			2500 Vac
• voltage			2500 Vac
Load sharing line voltage		±3 Vdc	±5 Vdc
LonWorks network			
• Maximum network length			1500 meters
• Maximum stub length			3 meters
NVRam (real time clock, runtime, watthours, etc.)			
• Charge time (to 95%) at 25° C		3 hours	5 hours
• Discharge time at 25° C	30 days	44 days	50 days
PT			
• Voltage TB 41-48	40 Vac	120 Vac	150 Vac
• Accuracy	–1 percent		+1 percent
• Resistive dc impedance		1900 ohms	
• Burden at 120 V			0.2 VA
Radiated immunity			
• IEC 1000-4-3			
• Level 3			
• 80 to 1000 MHz			10 V/m
• ANSI/IEEE C37.90.2			
• 25 to 1000 MHz	10 V/m		20 V/m
Serial port			
• Power supply (TB3–4)	7 Vdc	12 Vdc	18 Vdc
• Baud rate		9600 baud	
• Number of Data bits		8 bits	
• Parity		No parity	
• Stop bits		1 bit	

Characteristics	Min	Typical	Max
Frequency bias			
• ±3Vdc output (TB53–54)			
• Voltage		±3 Vdc	±4.95 Vdc
• Impedance	10K ohms		100M ohms
• 0-1 mA output (TB55–56)			
• Current	0 mA	1 mA	
• Impedance	0 ohms		10K ohms
• 4-20 mA output (TB55–56)			
• Current	0 mA		22 mA
• Impedance	0 ohms		500 ohms
• PWM output (TB53–54)			
• Amplitude	–3 Vdc		+3 Vdc
• Frequency	498 Hz	500 Hz	502 Hz
• Duty Cycle	20 percent		80 percent
• Impedance	10K ohms		100M ohms
Voltage bias			
• ±3Vdc output (TB61–62)			
• Voltage		±3 Vdc	±4.95 Vdc
• Impedance	10K ohms		100M ohms
• 0-1 mA output (TB63–64)			
• Current	0 mA	1 mA	
• Impedance	0 ohms		10K ohms
• 4-20 mA output (TB63–64)			
• Current	0 mA		22 mA
• Impedance	0 ohms		500 ohms
Surge withstand / Fast transient			
• IEC 1000-4-4			
• Level 4			
• 2.5 kHz on power supply			4.0 kV
• 5 kHz on I/O, data and control ports			2.0 kV
• IEC 1000-4-5			
• Power inputs, level 4			4.0 kV
• Data and control ports, level 2			1.0 kV
• ANSI/IEEE C37.90.1			
• Oscillatory 1.0 MHz			3.0 kV
• 50 ps burst			5.0 kV