RFL
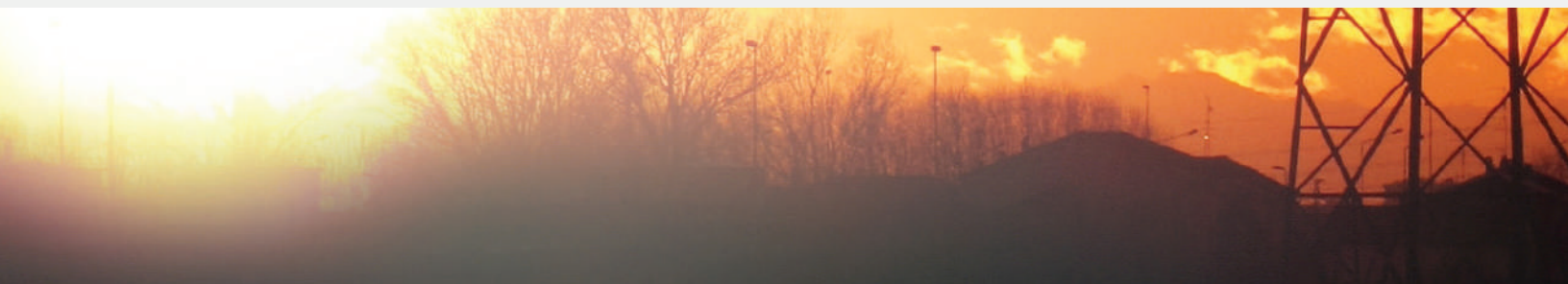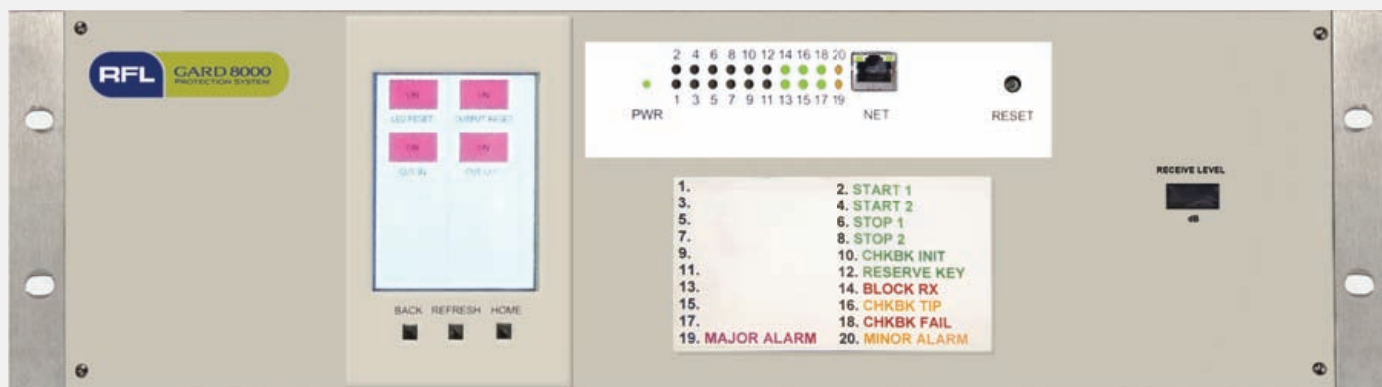
SOLUTIONS FOR AN EVOLVING WORLD

RFL GARD 8000

Programmable
Single Function PLC

Your world is changing and so are we.

At RFL, we know your needs change much faster than your infrastructure. Our comprehensive line of solutions meets you wherever you are to help you bridge the gap from yesterday to tomorrow.

We aren't just engineering products. We are continuously innovating to give legacy equipment the advantage of today's technologies. Our highly adaptable solutions offer more features for more flexibility and a custom fit for your specific needs.

When we deliver, we also deliver our reputation. So when you open that box, you're opening a custom-engineered solution, factory-tested and ready for deployment.

And as long as you own that equipment, you own the attention of RFL. We see you as our partner and we want to ensure that our solution is working for you – now and over the long haul. RFL – delivering solutions that work. Period.

GARD 8000

Programmable Single Function PLC

System Features

Remote access via Ethernet, RS485, RS232

Easy to program via integrated HTML Web Pages

Optional integrated 4-zone distance protective relay

Supports IEC 61850

User defined logic and alarms for your specific applications

Straight forward web browser user interface for setting and diagnostics; no proprietary application program required

Optional built-in GPS receiver provides accurate time tags

DNP3, Level 2 compliant

Full system redundancy option available

Additional plug-in protection modules such as audio-tone teleprotection and distance relay modules can be used with the GARD 8000 Single Function PLC System

Supports NERC/FERC security standards

Single Function PLC Features

Single or dual PLC systems in one chassis available

One product for all ON/OFF and FSK PLC applications

Up to four ON/OFF or FSK can be supplied in one chassis

Internal CLI meter available

One filter

Built-in skewed hybrid

Automatic setup for commissioning

Integrated Reflected Power Meter

Full system redundancy option

10W, 50W, and 100W Power Options

Built-in Check-back with remote initiate capabilities standard

Complies to latest ANSI C93.5-1997 Single Function PLC Standard

Complete address and Check-back testing

10 Year Warranty

GARD 8000 SFPLC

System Description

The GARD 8000 Single Function PLC channel is a product that can be programmed as Frequency-Shift Keyed (FSK) power line carrier system or as an amplitude-modulated ON/OFF powerline carrier transmitter/receiver terminal.

The unit is designed for pilot protection relaying applications, requiring high-speed reliable communications. The GARD 8000 PLC can be programmed for On/Off type directional comparison blocking (DCB), or Frequency Shift, type direct transfer trip, (DTT) Unblocking (DCU), or either single, or dual phase comparison applications.

The extensive sequence of events and diagnostic features provide information for the GARD 8000 and integrated PLC modules.The chassis is available in both a 3U version which can support one PLC system, or a 6U version which can support up to four PLC systems.

In the smaller 3U version, a PLC system and a plug-in 4-Zone distance relay module is supported eliminating the need for a conventional PLC and distance relay. The 6U version can support two PLC systems and two distance relays with full redundancy to simplify applications even further.

The unit is available with front panel direct reading (in dB) digital meter to indicate signal strength. Each unit also comes with an external carrier level indicator output for use with external measuring devices such as a panel meter or an analog RTU input.

Other GARD 8000 function modules such as an analog teleprotection module and current differential relay module can also be used in the chassis if desired. Redundant controller and power supplies are available as options.

On/Off Carrier Operation

Description

On/Off Powerline Carrier is normally used in a "Blocking" type protection application. In this application the transmitter is normally off, and is turned on by a protective device. The blocking signal is sent to a remote station, via the transmission line, to prevent undesirable tripping for circuits that are not affected by the system fault. The Blocking signal needs to be sent, and received with a minimum of delay to prevent tripping out healthy circuits, and causing unnecessary system disturbances. On/Off Powerline Carrier applications, are almost always bi-directional, and send, and receive the same RF frequency at both terminals.

Transmitter

Frequency programmable: Frequency programmable from 30 to 392 kHz in 125 Hz increments, without hardware changes. Frequencies from 392 to 500 KHz utilize a high frequency output filter.

Output Power: Programmable for 1 watt, 3 watt, or 10 watt levels. Output power is displayed on optional front PDA and is remotely accessible. The unit is available with 50W and 100W options in external 3RU chassis.

Output Impedance: 50 Ohms standard
                                              75 Ohms available

Frequency Stability: +/- 10 Hz

External Keying Inputs: (4) Carrier Start, Stop, Reserve Signal Key, and Check Back Test Initiate. All inputs programmable active high or low to operate at the following nominal voltage levels: 24 Vdc, 48 Vdc, 125 Vdc, 250 Vdc. Active inputs are recorded in SOE files and their status displayed on the optional front PDA.

Receiver

Frequency programmable: Programmable from 30 to 500 kHz in 125 Hz increments, without hardware changes.

Receiver Level: On command, the receiver sensitivity will self adjust to the incoming signal strength. The receiver gain will then be fixed.

Receiver Input Impedance: Terminated mode, 50 or 75 Ohm Unterminated mode, > 30 K-Ohm.

Dynamic Range: >40dB

Receiver Bandwidth, Channel Spacing and Channel Delay Times: Receiver bandwidth is user selectable from the following table, without hardware changes. The channel times are inclusive of GARD 8000 System.

Nominal Bandwidth	Total Channel Delay Time	Channel Spacing
500 Hz	5 ms	1 kHz
1000 Hz	3 ms	2 kHz
1500 Hz	1.5 ms	3 kHz

Receiver Outputs: The receiver can be provided with the following standard outputs; or programmed for specific applications:

        (4) Block received
        (1) Transmitter Fail / Hardware Alarm
        (1) Checkback fail alarm
        (1) Checkback test in progress
        Guard output status
        Checkback initiate status
        High percent reflected power alarm
        Logic alarm

Automatic Checkback Operation: The PLC system is supplied with an internal automatic carrier checkback program. The checkback code structure, and programming is compatible with the existing RFL 9785, and previous Model 6785P series checkback systems. The checkback can also be manually initiated from either end.

This system consists of two modes, normal and hard carrier. In normal mode, a code is on-off modulated onto the powerline and a response code is returned at full or reduced power by the receiving station. In hard carrier, instead of a response code, the receiving station responds by turning on its carrier at full or reduced power for a programmed period of time.

FSK Carrier Operation

Description

Frequency shift power line carrier is normally used in a "Unblocking" or "Permissive" type protection application. In this application the transmitter is continuously sending a "Guard" signal, via the transmission line to the remote terminal. Reception of the guard signal provides both continuous channel, and equipment monitoring. The receipt of a valid guard signal prevents high speed tripping at the remote terminal. The transmitter is keyed to the Unblock or Trip frequency by a protective device. The trip signal is sent to a remote station, via the transmission line, to enable tripping for circuits that are affected by the system fault. The tripping signal needs to be sent, and received with a minimum of delay to "permit" high speed tripping of transmission line circuit breakers to limit equipment damage, and minimize any system disturbances. These permissive trip type applications are usually bi-directional, and send, and receive different guard, and trip frequencies between terminals.

Transmitter

Frequency programmable: Frequency programmable for either 2F, or 3F operation, from 30 to 352 kHz in 125 Hz increments, without hardware changes frequency from 392 to 500 KHz utilize a high frequency output filter. Output frequency settings will be available on optional front mounted PDA.

Frequency Shift : Standard frequency shifts of +/- 100 Hz +/- 250 Hz, and +/- 500 Hz are available. Three – frequency operations are capable of providing 250 Hz shift from the center (Guard) frequency for permissive relaying protection channels, and 100 Hz shift from the center frequency (Guard) for direct transfer trip (breaker failure) applications.

Output Power: User programmable for the following power output levels:

      1W guard /1W trip
      1W guard /10W trip
      3W guard /10W trip
      10W guard /10W trip
      Optional 50W guard /50W trip available
      Optional 100W guard /100W trip available

Output Impedance: 50 Ohms standard
                        75 Ohms available

Frequency Stability: +/- 10 Hz

Receiver

Frequency programmable: Programmable from 30 to 500 kHz. in 125 Hz increments, without hardware changes.

Receiver Level: The receiver sensitivity self adjusts to the incoming signal strength. The actual signal level is available for display on the optional front mounted PDA, remotely via TCP/IP or RS-232 interface or on a local laptop, The level can be selectively displayed in either dBm, (+/- 20 dB range), or mv.

Receiver Sensitivity: Minimum = 5 mVrms,
                          Maximum = >25 Vrms

Receiver Input Impedance: Terminated mode, 50 or 75 Ohm Unterminated mode, > 30 K-Ohm.

Dynamic Range: >40dB

Receiver Bandwidth, Channel Spacing and Channel Delay Times: Receiver bandwidth is user selectable from the following table, without hardware changes. The channel times are inclusive of GARD 8000 System

Nominal Bandwidth	Frequency Shift	Total Channel Delay Time	Unidirectional Channel Spacing	Bidirectional Channel Spacing
200 Hz	+/- 100 Hz	13 ms	500 Hz	1000 Hz
500 Hz	+/- 250 Hz	8 ms	1250 Hz	2500 Hz
1000 Hz	+/- 500 Hz	6 ms	2500 Hz	5000 Hz

No Test Equipment Needed

Transmit and Receive Levels Measured

The Transmit and Receive Levels are measured and can be accessed remotely. If the receive level drops below a preset value an alarm will activate.

Reflected Power Measured

The power reflected due to mismatch of the power line coupling equipment is measured every second and available when requested. A threshold can be entered by the user, beyond which an alarm condition is generated.

Trans Hybrid Loss Measured

The trans-hybrid attenuation value is also available to the system. The amount of the transmitter leaking back into the receiver will be measured. This attenuation includes the affect of any receive filter. This feature eliminates the need for frequency selective voltmeters to perform routine carrier maintenance testing.
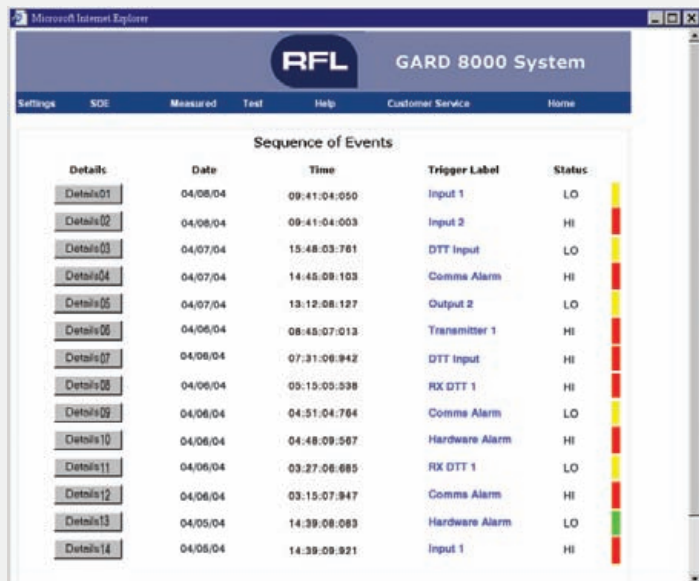
Diagnostics and Testing

Diagnostic information is available and easily accessible with the GARD 8000 Single Function PLC unit. RFL's diagnostic package takes the guesswork out of power system fault analysis and evaluating communications system performance during the fault-clearing process. The GARD 8000 Single Function PLC provides the following standard features:

Two ethernet TCP/IP ports and two RS-232 ports for local and remote access
600 Sequence-of-events records
Remote access to transmit/receive and reflected power levels
Internal real-time system clock
Optional built-in GPS receiver
IRIG-B Clock sync input
Current status of all system parameters
Diagnostic information about the remote end
Checkback testing either locally or remotely initiated
Automatic checkback

Sequence of Events

Figure 1 shows the Sequence of Events directory, listing the record number, date, time, trigger label, status and color indicator.

Figure 1. Sequence of Events Log

Programmability

Logic functions can be changed or fine-tuned remotely through the GARD 8000 Single Function PLC unit's TCPIP or RS-232 ports.

User Programmable Logic Functions

Change timer values, logic states and logic functions without ever removing a module or opening the chassis.

User Programmable Inputs and Outputs

The smaller 3U version of the GARD 8000 when configured with the single Function PLC module has two I/O slots available. Each I/O can accept communications or up to two discrete input / output modules. All logic mapping to the inputs, outputs and communications is fully programmable to meet specific customer requirements.

Create your own alarm conditions

The GARD 8000 Single Function PLC unit can be programmed to any alarm configuration desired using the outputs on the I/O modules.

Programming

The GARD 8000 Single Function PLC unit is programmed to use a standard web browser (e.g. MicroSoft Internet Explorer™ on a PC. All programming levels available over the RS-232 or TCP/IP interface are password-protected.

Every GARD 8000 Single Function PLC unit is supplied pre-programmed with either default operating logic or custom logic. It should be noted that it is standard practice for RFL to provide system programming with every unit at no charge.

Real Time Clock

IRIG-B

The GARD 8000 Single Function PLC unit accepts the IRIG-B Standard Time Code on a 1kHz modulated or unmodulated carrier. Nominal signal levels are 3.3 volts peak-to-peak (± 0.5v) for a logic "1" and 1 volt peak-to-peak (± 0.2v) for a logic "0". The IRIG-B input presents a 3.7k ohm impedance and is transformer isolated. An optional integrated GPS receiver is available.

Resolution 1 ms

Accuracy
Free Running: Within 1 minute per month
Under IRIG-B Control ±1msecs

Reset
Manual or by IRIG-B code

Carrier Level Indicator

Display Front panel 3 1/2 direct reading (in dB)

Range ±10 dB

External Meter Output 0-5 V, 0-1 mA, 0-100 mA

Technical Specifications

Real Time Clock

IRIG-B
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Resolution 1 ms

Accuracy
Free Running: Within 1 minute per month
Under IRIG-B Control ±1msecs

Reset
Manual or by IRIG-B code

Remote Access

Events Storage
The Sequence of Events Recorder on the main controller module can store up to 600 events. After this limit is reached, older events are overwritten. The Events Log keeps a running tally of the number of times each function, input, output and alarm is active along with the time and date the event occurred. Up to 1,000,000 counts can be stored for each item.

Ethernet TCP/IP Port
Two ethernet TCP/IP ports, located on the front and rear of the chassis, for remote interrogation.

Isolation
The GARD 8000 Single Function PLC unit's RS-232 port is isolated from circuit common and chassis ground to a surge withstand level of 500 Vdc.

RS-232 Interrogation Ports
The GARD 8000 Single Function PLC unit provides one RS-232 Port located on the rear of the chassis. The RS-232 port is configured as a DTE interface.

Data Rates
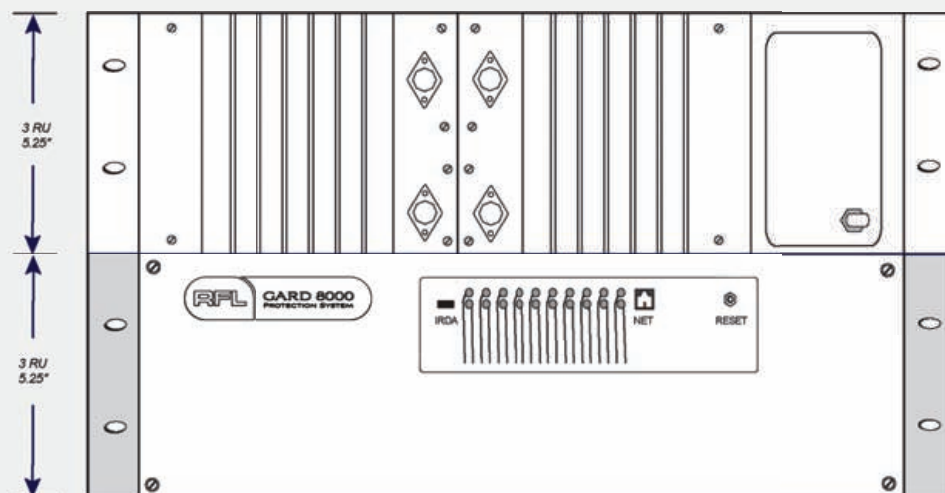300 bps, 1200 bps, 2400 bps, 9600 bps or 19.2 Kbps.
Communication Parameters:
Number of Data Bits: Eight
Number of Stop Bits: One
Parity: None
Flow Control: XON/XOFF

Figure 2. GARD 8000 50 Watt Configuration

The GARD 8000 Single Function PLC can be configured for either 50 or 100 Watt RF power outputs. The RFL model 9508 RF power amplifier is rated for 50 Watt PEP and is the standard amplifier used for single sideband applications. Two amplifiers are required for 100 Watt applications. A 6U GARD 8000 can also be configured with 50 and 100 Watt applications.

General Specifications

Displayed Level Accuracy
The levels displayed on the front panel and through remote access will be within 1 dB of the actual values.

Pre-Trip Timer
Adjustable in 0.5 ms steps

Trip Hold Timer
Adjustable in 0.5 ms steps

Command Extend Timer
Adjustable in 0.5 ms steps

Non-Volatile Storage
All parameters relating to system operation are stored in electric erasable non-volatile RAM.

Specifications are subject to change without notice

General Specifications Continued

RFI Susceptibility
ANSI C37.90.2 (35 Volts/Meter)
EN 60255-22-3 (RFI Class III)

Interface Dielectric Strength
All contact inputs, solid-state outputs, power supply inputs and relay outputs meet the following specifications:

ANSI C37.90-1989 (Dielectric)
ANSI C37.90.1-2002 (SWC and Fast Transient)
EN 60255-5 (1500 Vrms Breakdown
Voltage and Impulse Withstand)
EN 60255-22-1 (SWC Class III)
EN 60255-22-2 (ESD Class III)
EN 60255-22-4 (Fast-Transient Class III)
EN 60834-1

Input Power Requirements (EN 60834-1)

24V	Rated	Vdc
	Range	19-29 Vdc
	Burden	<100W
48/125V	Rated	48/125 Vdc or 120 Vac
	Range	38-150 Vdc or 96-132 Vac
	Burden	<100W
250V	Rated	250 Vdc or 220 Vac
	Range	200-300 Vdc or 200-240 Vac
	Burden	<100W

Power Supply
A single or redundant power supply can be provided depending on the reliability of the application. For example a DTT application for a higher voltage level line may demand the dependability of a redundant power supply. When a redundant supply is used, only one supply carries the load. The GARD 8000 Power Supply is provided with Form C alarm contacts for power supply failure and system failure alarm.

Temperature
Operating: -20° C to +75° C (-4° F to + 167° F)
Storage: -40° C to +85° C (-40° F to +185° F)

Relative Humidity
Up to 95 percent at +40° C (+104° F), non-condensing

Warranty Statement
RFL's standard warranty for the Single Function PLC unit is 10 years from date of delivery for replacement or repair of any part which fails during normal operation or service.

Ordering Information
Contact RFL or use GARD 8000 configurator available on RFL website (www.rflelect.com).

Front Panel LEDs

Two rows of ten multi-colored LEDs provide basic event information. The LED operation is fully configurable and labels can be changed to suit the application. Custom configuration and labeling can be factory-made by RFL without extra charge. Any field modifications required are simply made by use of the browser interface.

Front Panel Display

An optional touch screen display (TSD) is available for metering, targets and settings. The TSD provides a color screen that will automatically orientate itself for horizontal or verticle mounting. User programmable buttons are provided for unique customer requirements. For things such as breaker control or cut-in/cut-out switches.
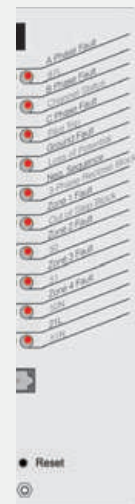

Figure 3. GARD 8000 Front Panel LEDs (6U)

The GARD 8000 front panel has two infrared ports when the PDA is supplied permanently mounted on the front. One communicates with the front PDA and the other is available for any external PDA the user may carry. Communication may be established with any Palm OS PDA via its browser application.

Figure 4. GARD 8000 3U Front Panel

Specifications are subject to change without notice

Web Browser User Interface

Web Browser UI

Protection system reliability may be compromised by increased complexity of protection devices. While these protection devices offer added flexibility they also increase the risk for errors. Complicated settings, configurations and interconnections all combine to having an undesirable effect on protection system security and dependability. The GARD 8000 System is designed with ease-of-use in mind. While high functionality and great detail is provided, it is not necessary to make field configurations, if not desired. The Web Browser User Interface makes interaction with the device highly intuitive and handling greatly simplified.

All interaction with the GARD 8000 System is made by the use of a standard web browser. The web pages reside in the device; no special application software is required on the PC.

A PC is connected to the front Ethernet TCP/IP port with a standard connector. Alternatively, the front (or rear) RS-232 port can be used but will not provide the same "lightning-fast" response, as the ethernet port.

Web browser technology provides a much higher level of ease-of-use as compared to the conventional "menu-driven" operation. It is fast and simple to view device status, access diagnostic and test functions and to change settings. Emulating the operations of a standard web site, navigation is intuitive and eliminates the need to study written instructions. If needed, the instruction manual, that also resides in the device, is simply accessed by the HELP function.

For off-line preparation of settings and configuration files, a small application program "emulating" a GARD 8000 System can reside on the PC or local server. Archiving and documentation of settings and configuration is made simple as these are stored in standard text files.

Up to 8 setting groups are available. A group does not only contain settings but all configuration, output and input mapping and labels as well. Input contacts and/or HMI commands can be used for group switching.
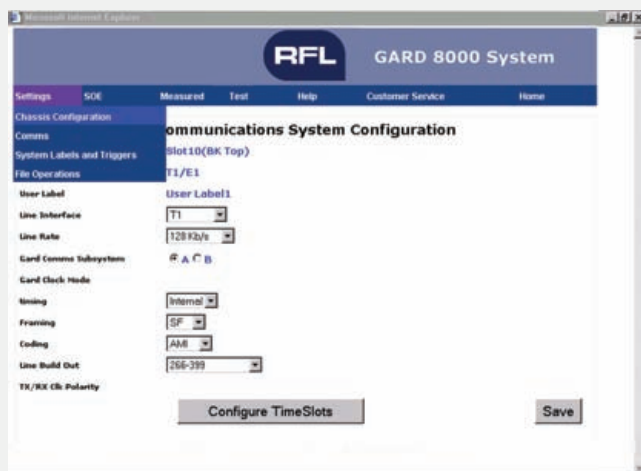

Figure 6. Web Browser User Interface

Input and Output Modules

The GARD 8000 System is configured with a selectable number of input and output modules on the rear part of the chassis. Each communication interface contains 1 input module with 6 opto-isolated inputs or 1 output module.

Solid-state outputs, relay outputs and additional inputs are mounted in sets of 6, with 2 sets on each board occupying 1 slot. The following combinations are available. Ten rear slots are available in the 6U version and 4 rear slots are available in the 3U version:
1 communication interface/6 inputs
1 communication interface/6 outputs
6 inputs/6 inputs
6 inputs/6 relay outputs
6 inputs/6 solid state outputs
6 solid state outputs/6 solid state outputs
6 solid state outputs/6 relay outputs
6 relay outputs/6 relay outputs
4 latching relay outputs/4 Form-C contacts

All output contacts are Form A (NO) or Form B (NC) jumper selectable. A simple setting for an inverter logic gate will provide inversion for each input and output. Each input and output has a timer associated with it that has settings for both pick-up delay (input debounce, output security) and drop-out delay (pulse-stretch).

* With the exception of the latching relay module which is Form-C only.

Figure 7. Ethernet Connector

Optically Isolated Inputs
Quantity: 6 per module

Input Voltage Jumper Selectable: 24/48/125/250 Vdc
Operation Range:

24 Volts:	19 to 36 Vdc, Nominal Input
48 Volts:	37 to 68 Vdc
125 Volts:	94 to 150 Vdc
250 Volts:	189 to 300 Vdc

Input Current: 1.5 mA minimum

Minimum Pulse Width:
0.03 ms, additional debounce time set in the logic

Solid-State Outputs
Quantity: 6 per module
Output Current:
Maximum 1 A continuous, 2 A for
1 minute, or 10 A for 100 msec
Open-Circuit Voltage: 300 Vdc maximum
Pick-up Time: 0 msec

Relay Output
Quantity: 6 per module
Relay Pick-up Time: 4 msec
Output Current Rating: 6 A continuous
Surge: 30 A for 200 msec

Alarm Relays
Quantity: 2
Contacts: SPDT (Form C)
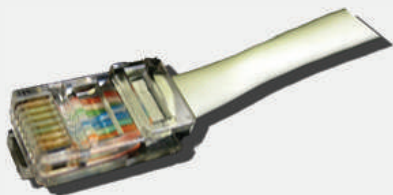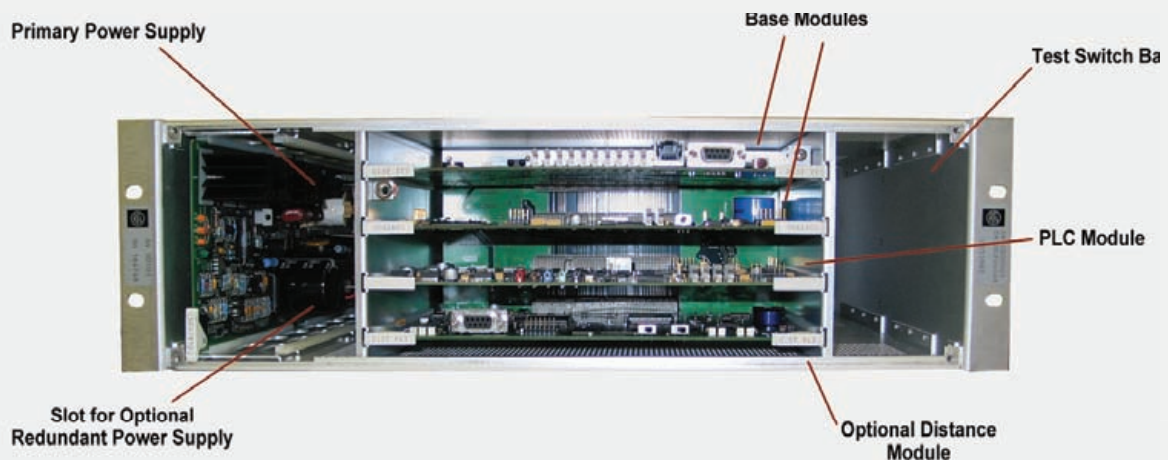Output Current: 100 mA 300 Vdc resistive load

Figure 8. Front View 3U GARD 8000 with panel removed
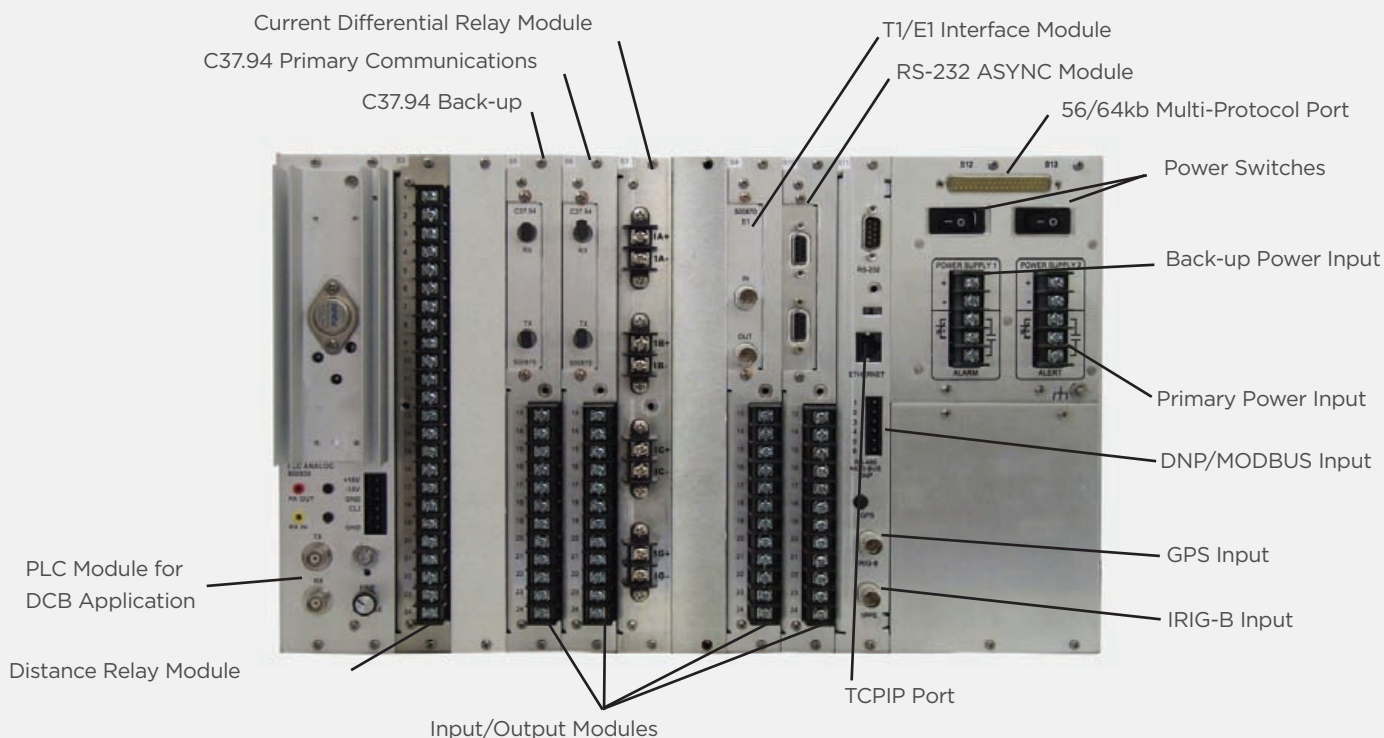
Examples of GARD 8000 System Configurations

Current Differential Relay Module
C37.94 Primary Communications
C37.94 Back-up

T1/E1 Interface Module
RS-232 ASYNC Module
56/64kb Multi-Protocol Port
Power Switches
Back-up Power Input
Primary Power Input
DNP/MODBUS Input
GPS Input
IRIG-B Input

PLC Module for
DCB Application

Distance Relay Module

Input/Output Modules

TCPIP Port

Figure 9. Rear View 6U GARD 8000 with Distance Module with Powerline Carrier
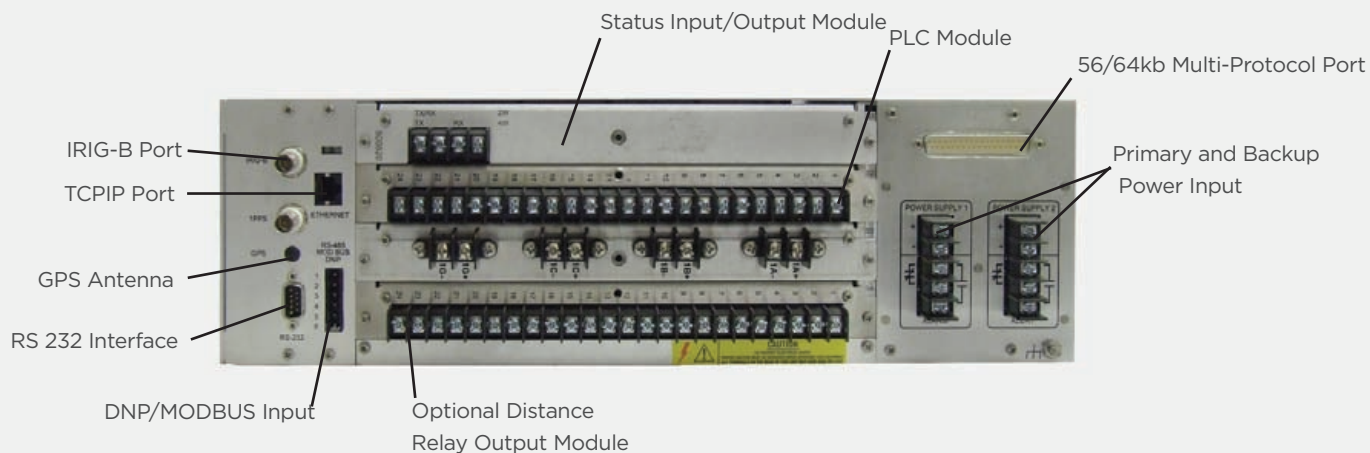Interface and Current Differential Relay with Primary and Back-Up Communications

Status Input/Output Module
PLC Module
56/64kb Multi-Protocol Port
Primary and Backup
Power Input

IRIG-B Port
TCPIP Port

GPS Antenna
RS 232 Interface

DNP/MODBUS Input
Optional Distance
Relay Output Module

Figure 10. Rear View 3U GARD 8000 with PLC Module, Distance Relay,
and Input/Output Module

Dimensions

GARD 8000
Single Function PLC
3U System Dimensions
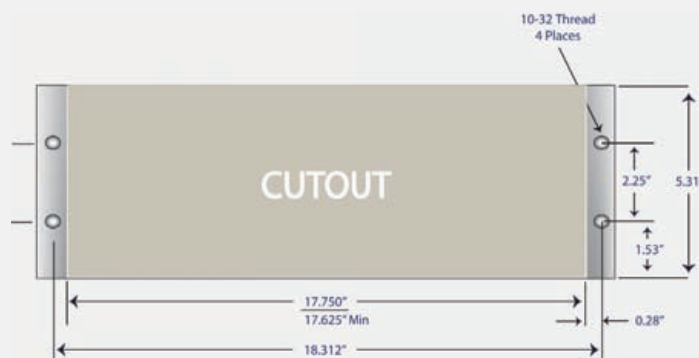

Figure 11. Rack or Cabinet Mounting (3U)

Figure 12. Panel Mounting (3U)

6U System Dimensions

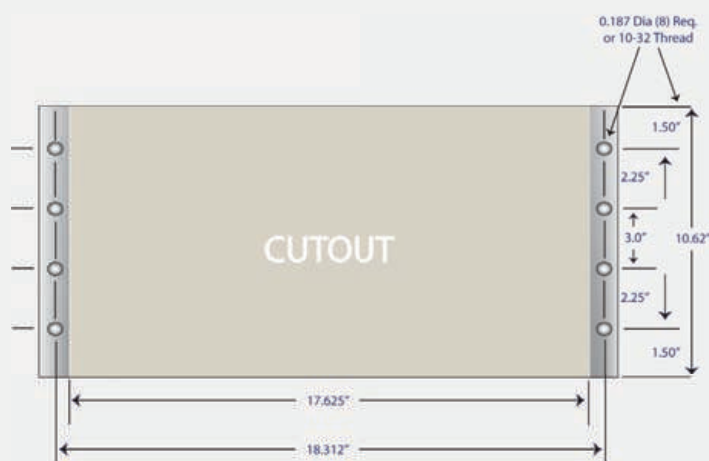Figure 13. Rack or cabinet Mounting (6U)

Figure 14. Panel Mounting (6U)

Notes

Notes

Notes