Relion® Protection and Control

Advanced Recloser Protection and Control RER620
PG&E 2179 Communication Protocol Manual

Power and productivity
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620 series
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Table of contents

Section 1 Introduction

1.1 This manual

The communication protocol manual describes a communication protocol supported by the IED. The manual concentrates on vendor-specific implementations.

1.2 Intended audience

This manual addresses the communication system engineer or system integrator responsible for pre-engineering and engineering for communication setup in a substation from an IED perspective.

The system engineer or system integrator must have a basic knowledge of communication in protection and control systems and thorough knowledge of the specific communication protocol.

1.3 Product documentation

1.3.1 Product documentation set

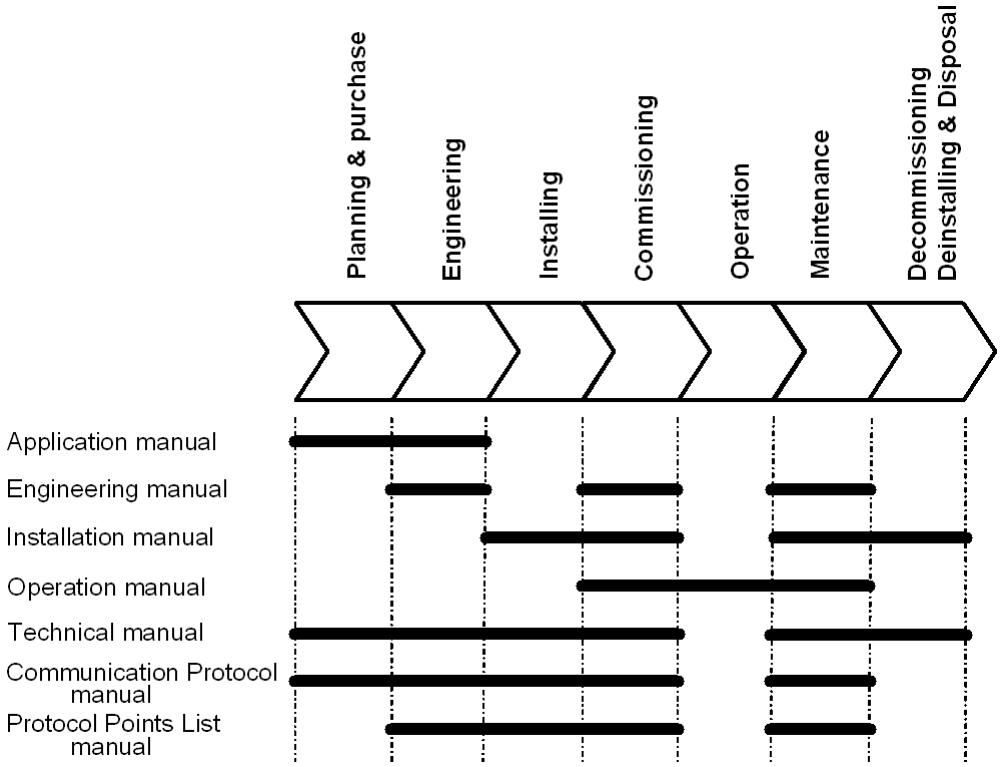

Figure 1: The intended use of manuals in different lifecycles

The engineering manual contains instructions on how to engineer the IED using the different tools in PCM600. The manual provides instructions on how to set up a PCM600 project and insert IEDs in the project structure. The manual also recommends a sequence for engineering of protection and control functions, LHMI functions and communication engineering for IEC 61850.

The installation manual contains instructions on how to install the IED. The manual provides procedures for mechanical and electrical installation. The chapters are organized in chronological order in which the IED should be installed.

The operation manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for monitoring, controlling and setting the IED. The manual also describes how to identify disturbances and how to view calculated and measured power grid data to determine the cause of a fault.

The application manual contains application descriptions and setting guidelines sorted per function. The manual can be used to find out when and for what purpose a typical protection function can be used. The manual can also be used when calculating settings.

The technical manual contains application and functionality descriptions and lists function blocks, logic diagrams, input and output signals, setting parameters and technical data

sorted per function. The manual can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

The communication protocol manual describes a communication protocol supported by the IED. The manual concentrates on vendor-specific implementations. The point list manual describes the outlook and properties of the data points specific to the IED. The manual should be used in conjunction with the corresponding communication protocol manual.

1.3.2 Document revision history

Document revision/date	Product series version	History
A/31/10/2011	1.1	First release

Download the latest documents from the ABB web site http://www.abb.com/substationautomation.

1.3.3 Related documentation

Product-specific point list manuals and other product series- and product-specific manuals can be downloaded from the ABB web site http://www.abb.com/substationautomation.

1.4 Symbols and conventions

1.4.1 Safety indication symbols

The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.

The information icon alerts the reader to important facts and conditions.

The tip icon indicates advice on, for example, how to design your project or how to use a certain function.

Although warning hazards are related to personal injury, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

1.4.2 Manual conventions

The manual follows a few conventions, symbols, acronyms, fonts etc. and are summarized below. A particular convention, symbol, acronym etc. while listed, may not necessarily be used in this manual.

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push button navigation in the LHMI menu structure is presented by using the push button icons, for example:

  To navigate between the options, use  and  .
- HMI menu paths are presented in bold, for example:

  Select **Main menu > Settings**.
- LHMI messages are shown in Courier font, for example:

  To save the changes in non-volatile memory, select `Yes` and press  .
- Parameter names are shown in italics, for example:

  The function can be enabled and disabled with the *Operation* setting.
- Parameter values are indicated with quotation marks, for example:

  The corresponding parameter values are “Enabled” and “Disabled”.
- IED input/output messages and monitored data names are shown in Courier font, for example:

  When the function picks up, the `PICKUP` output is set to TRUE.
- Dimensions are provided both in inches and mm. If it is not specifically mentioned then the dimension is in mm.

Section 2 PG&E 2179 Protocol overview

2.1 PG&E 2179 Protocol standard

PG&E 2179 Protocol is a communication protocol developed by PG&E. It is designed as a universal platform by PG&E to provide Supervisory Control and Data Acquisition (SCADA) for use in real-time environment with rapid response and reliability.

The serial communication as implemented in RER620 IED follows the specifications maintained by PG&E.

PG&E 2179 Protocol communication reference details are available with PG&E

2.1.1 Protocol Overview

PG&E 2179 Protocol has been designed by PG&E with the intent to provide a universal platform for performing Supervisory Control and Data Acquisition (SCADA), with a high level of flexibility to suit various applications. It can be implemented in part such as in a simple metering application. It can also be applied for total control and monitoring of a grid substation at the other end of the spectrum. The protocol has necessary functionality and flexibility for use in real-time environments with highest reliability with minimum delay and rapid response, required for modern supervisory systems.

PG&E 2179 is a master-slave protocol and is defined for serial communication networks. This IED implements the slave side of the protocol. Depending on the chosen physical serial interface it is possible to build multidrop networks or point-to-point communication connections. Presently serial asynchronous mode has been defined in the specification which has been implemented in this product.

The protocol allows collection of both analog and digital data, status change, sequence of events (SOE), load profile, report by exception etc. Supervisory control using Select Before Operate (SB0) as well as Direct Operate are possible, though the latter is not recommended. Proportional control and analog outputs are also possible through the protocol.

PG&E comprises physical message format with multiple ‘Octet’s, each octet comprising of 8 bits. Start and Stop bits are used to frame each Octet, resulting in a 10-bit asynchronous format. No parity is considered in each frame format. However a 2 octet, (16bit) Cyclic Redundancy Check (CRC-16) is attached at the end of each message to verify the integrity of all octets in a message. A message typically comprises of Master address, Slave address, function, command, status, other information and CRCas appropriate depending on the requirement.

There can only be one PG&E 2179 Protocol master unit on a PG&E 2179 Protocol serial network. The Master unit communicates with the Slave unit, through an assigned port, at a time. Usually the master reads, or scans, data from the slaves cyclically. The master can also write data /configure the slave or give commands to the slave units. Each slave unit has a unique unit address. Thus, the master can identify the slave with which it communicates. In situations when there could be requirement of multiple master units, such as local SCADA Master as well as Remote SCADA Master accessing the same slave unit, the RTU or the slave unit is configured to have multiple ports with multiple databases, which will all share the same memory which are tied to external physical digital or analog in and out connections. It is thus possible to configure each database uniquely for a particular Master Station requirement.

The PG&E 2179 Protocol standard also defines the possibility for Master broadcast transmissions.

The RTU / IED configuration may be hard coded or down-loadable from the Master station. Using configuration, it is possible to create, customize, define and map data points for communication with the Master. Hard coding is done in the field device and cannot be changed by any connected Master station. The unit defaults to this configuration when powered up or reset.

Dynamic configuration, typically done in the volatile memory part, downloaded from the Master Station, enables to tailor supervisory control, data acquisition and apply special applications for specific requirements.

The protocol defines “Sequence Number Assignments” for various data types to be accessed from the remote Master unit. Typically, for 2bit status with change for Binary Inputs, it is in the range 00(Hex) to 1F(Hex). Format as defined in the protocol standard for such data is two octet, which defines the status of 8 status inputs with change. This limits the number of binary ‘status with change’ inputs to 256.

Similarly, the number of wired analog inputs for each device is limited to 128, including two reference channels.

In order to cater to physical devices with more status inputs and outputs, the Protocol allows two modes of operation: Normal and Virtual.

Normal Mode configuration is used for relatively small RTUs / IEDs that are physically single piece of equipment and have point counts of less than 128 analogs and 256 status points.

Virtual Mode is used when point requirements of a single RTU / IED exceed the capacity of the Normal Mode sequence numbering system. As many as 256 times more points than normal mode are possible in this mode. This is possible by defining multiple “Logical Units” (LU) within a physical RTU / IED. The Sequence Number Assignments for each LU is the same as the assignments for a single Normal Mode RTU. The Logical Unit Number (LUN) is used to define a Logical Unit within an RTU data base. When in Virtual Mode, a combination of Logical Unit Number and Sequence Number (LUN/SEQ) is used to identify the physical active inputs and outputs.

2.2 Documentation

The ANSI PG&E 2179 Protocol point list manual covers RER620 IED.

A newer SW version of the same RER620 IED configuration may contain additional PG&E 2179 Protocol points.

Section 3 Vendor-specific implementation

3.1 PG&E 2179 Protocol link alternatives

PG&E 2179 Protocol communication is possible over the serial communication interface, either in RS232 or RS485

3.1.1 Serial link

PG&E 2179 Protocol serial communication requires that the IED variant is equipped with a serial interface card Module ID Comb23A at the slot X000. This card has two serial interfaces.

Though PG&E 2179 Protocol design allows configuring of multiple data bases and assigning each data base to one of the serial port, effectively making the IED appear as multiple RTU, the actual implementation in the IED has only one data base configured, which can be assigned to either of the serial ports, as determined in the setting parameters.

Documentation concerning the PG&E 2179 Protocol serial link messages and the PG&E 2179 Protocol standard can be obtained from PG&E

3.1.1.1 PG&E 2179 Protocol serial link parameters

Serial link setting parameters can be accessed with PST or via the LHMI path **Configuration > Communication > PGNE2179**

In the LHMI parameter names end either with number 1 or with number 2. The numbers refer to two separate serial ports, that is the instances 1 and 2.

Serial port

It is possible to define which serial port is used for separate PG&E 2179 Protocol serial instances: COM1 or COM2. The serial communication instance is not active if this parameter is set to “Not in use.”

If this protocol does not operate as expected, make sure that other serial protocols are not using the COM port as well.

Baud rate is defined on the serial driver side and are therefore located via the LHMI paths **Configuration > Communication > COM1** and **Configuration > Communication >COM2**.

3.1.1.2 PG&E 2179 Protocol serial diagnostic counters

PG&E 2179 Protocol Serial diagnostic counters can be viewed via the LHMI path **Monitoring > Communication > PGNE2179** .

Counters related to the possible PG&E 2179 Protocol serial instance 1...2 have the suffixes 1…2 (N). The counters show complete PG&E 2179 Protocol link frames and PG&E 2179 Protocol errors. The serial communication drivers (COM1, COM2) maintain their own counters for lower level serial communication diagnostics.

Table 1: Serial diagnostic counters

Counter	Description
Received frames 1	Total amount of received PG&E 2179 Protocol frames. For example, the PG&E 2179 Protocol frames that are addressed to this instance (1)
Transmitted frames 1	Total amount of transmitted PG&E 2179 Protocol responses.

3.1.1.3 Character framing

According to the PG&E 2179 Protocol standard, the character length is 10 bits. with 8bit of information, along with a start and stop bit. No parity bit is used.

Table 2: RTU characters

Coding system	8-bit binary
Bits per character	1 start bit 8 data bits, the least significant bit is sent first 1 stop bit

3.2 Supported function codes and Application data

3.2.1 PG&E 2179 Protocol data objects

The PG&E 2179 Protocol in RER620 is built on top of the internal IEC 61850 data model. Thus, the PG&E 2179 Protocol application data objects, events and MCD bits are derived from IEC 61850 data objects and data set reporting. RER620 has a predefined IEC 61850 data set configuration. In other words, it is predefined which internal data object changes the RER620 IEDs detect.

The available PG&E 2179 Protocol indications in the RER620 IEDs are generally selected from the IEC 61850 indications residing in data sets. Objects that do not reside in any data set are updated to the PG&E 2179 Protocol database slower. This concerns, for example, some measurand register values. Fast changes in these object values may not be detected or propagated to the PG&E 2179 Protocol database. However, the latest value of these objects is always found in the PG&E 2179 Protocol database.

For a list of the available data objects, see the point list manual.

3.2.2 PG&E 2179 Protocol data implementation

The IED is internally modelled according to the IEC 61850 standard. The PG&E 2179 Protocol is implemented on top of this model. However, all features of the IEC61850 data model are not available through the PG&E 2179 Protocol interface. A sub-set of PG&E 2179 Protocol is implemented in the IED as allowed by the flexibility built within the protocol specification

Control operations

Depending on the controlled object, the control operations may be of direct-operate or select-before-operate type. Control operations include automatic checking for authorization, local and remote blockings

The following control codes are supported by the IEDin Normal Mode. The unit does not support Virtual Mode

Table 3: Control Scan Operation

Function Code	Description
00	‘Basic Scan’ Operation. All data of types specified in the command octet will be returned in response message
01	‘Scan Inclusive’. All data in which sequence numbers fall within the parameters specified in the master message will be returned by the slave unit
10	‘Supervisory Control’. Perform control operation defined inthe command octet and parameters

The implementation of the protocol in the present IED does not support SOE, exception data reporting, RTU internal control including Time Setting, correction and reading of timings, special applications, retrival of load profile / event data, RTU configuration etc.

When Function code 00 is sent for Basic Scan operation, command code shall specify which type of data is to be returned. The following table highlights the supported command lists:

Table 4: Basic Scan commands with Function Code 00 *:*

Command #	Description
00	Simple Status Data (SS)
01	Status Countrers (CTR)
02	2-bit Status Data (2BS)
03	16-bit Analog Format (SBA)
06	16-bit Pulse Accumulator Data(PA)
07	Pulse Accumulator Buffer (PB)

Under Function Code 01 (Scan Inclusive), the following command bits are supported:

Table 5: Scan Inclusive commands with Function Code 01

Command #	Description
03	16-bit Analog Format (SBA)

When Function Code 10 (Supervisory Control) is selected, the following command bits are supported:

Table 6: Supervisory commands with Function Code 10

Command #	Description
01	Control Select Open
11	Control Select Close
20	Operate Select Point
21	Reset Select
22	Pulse selected Point

The unit does not support Direct Digital control, Direct Open, Direct Close, High resolution Proportional Control, Analog Output and sending Unsigned Integer Format.

The sequence numbers associated with the above commands in the remote IED / RTU are 00-FF (Hex) corresponding to 256 hardware output points. On control select open or close command input the IED sets a default 5 second timeout period for the Master to send an operate command. The master then sends an Operate or Pulse command to the RTU which will open or close the selected point.

The control operate/Pulse output will pulse the selected output point. The default pulse length is 1.5 sec.

If the Master has to abort the selected operation, it can issue a Reset Select command and the IED will immediately cancel the Select.

Application data compatibility

This IED is designed to operate with a wide range of PG&E 2179 Protocol masters spanning from industrial PLCs to substation SCADA devices. The application solutions have been chosen to achieve the highest possible level of compatibility with these systems:

- Digital data are readable as bits with simple status change in two-octet forms comprising of 16 binary status
- It is possible as well to read status and bit change in two-octet form of 8 binary status
- Status point counters of 16 status, each with a modulo 256(8bit) counters, in a 16-Octet form
- 16bit unpacked format for analogs
- Change detect data can be used as an alternative to the event record reading to catch fast indication data transitions between the master scans.
- 16bit pulse accumulator

- The addressing of the IED in the documentation and tools follow the address considering the IED in Normal mode. The IED provides slave addressing capability between 0 and 2047 with default setting of 976
- The device can support Master addresses between 0 and 31 with default set at 0.

3.2.3 Data mapping principles

PG&E 2179 Protocol data is organized sequentially, to comply with Sequential Number Assignments guidelines set in PG&E 2179 Protocol specification.

3.2.3.1 Data in monitoring direction

All data in the monitoring direction is available through sequence number assignments 00(Hex) through FF(Hex)

The PG&E 2179 Protocol data may contain empty bits or registers within the sequential data areas. These bits and registers are intended for possible future expansion. Reading this data does not result in any PG&E 2179 Protocol exception response. The value in these bits or registers is always zero.

3.2.3.2 Data in control direction

The IED configuration is hard coded and cannot be changed by any linked Master Station. In other words the IED cannot support any dynamic configuration, including change in operation mode from Normal to Virtual. It is not possible to change Scan Table configuration, Control output duration, analog deadbands etc.

All points in controlling direction are available through sequence number assignments 00(Hex) through FF(Hex.

3.2.4 Measurand registers

The PG&E 2179 Protocol measurands are located in the PG&E 2179 Protocol register area.

The values as read from the protocol are in16 bit signed format, it is necessary to apply a scale factor if necessary.

The range of the original IEC 61850 value can be seen in the PG&E 2179 Protocol memory map point list.

3.2.4.1 Primary and per-unit values

Measurands originating from CT measurements can be obtained from the IED in two ways. They can be viewed either as primary values or as per-unit values.

The primary values are represented internally as decimal numbers. The primary units are [A] for current. The internal representation of the per-unit values is always 1.0 at nominal current. A typical range for a per-unit value is 0.00...40.00, that is 0 to 40 times nominal.

If the primary value representation is selected but no CT ratio parameters are configured in the IED, the PG&E 2179 Protocol values remain as per-unit values.

3.2.4.2 Register sizes

In all cases the measurands or counters are located in single 16 bit registers.

3.2.4.3 Time of update

Some PG&E 2179 Protocol values may have a time structure attached to their values in the PG&E 2179 Protocol memory map. The time structure shows the time when the value was last updated.

3.2.5 Control operations

The control objects in this IED are either single point or double point control objects.

Control operation modes

This IED supports two control models: direct-operate and select-before-operate.

The single point control objects in this IED are of direct-operate type. The double point control objects can be configured either into the direct-operate or select-before-operate mode.

An output cannot support both direct-operate and select-before-operate modes at the same time.

The double point select-before-operate mode is usually used for the circuit breaker operations. It consists of four controllable objects:

- Select open
- Select close
- Reset Select
- Control Operate (=execute)

3.2.6 Parameter setting group selection

The active parameter setting group can be changed by writing the new setting group number into one of the binary output signals.

Section 4 PG&E 2179 Protocol parameters and diagnostics

4.1 Parameter list

The PG&E 2179 Protocol parameters can be accessed with PCM600 or via the LHMI path **Configuration > Communication > PGNE2179**.

Table 7: PG&E 2179 Protocol settings

Parameter	Values (Range)	Unit	Step	Default	Description
Serial port 1	0=Not in use 1=COM 1 2=COM 2			0=Not in use	COM port for Serial interface 1
End delay 1	0...20	char		4	End frame delay in chars on Serial interface 1
Device Address 1	1...65535		1	1	PG&E Protocol unit address on Serial interface 1
Selection Timeout	1...65	Sec	1	5	Selection Timeout for control SBO operation

4.2 Monitored data

The PG&E 2179 Protocol serial monitored data can be accessed with PST or via the LHMI path **Monitoring > Communication > PGNE2179**

Table 8: PG&E 2179 Protocol serial

Parameter	Values (range)	Description
Received frames 1	0...2147483648	Received PG&E Protocol frames by instance 1
Transmitted frames 1	0...2147483648	Transmitted PG&E Protocol frames by instance 1

Section 5 Glossary

615/620	Series of numerical IEDs for basic, inexpensive and simple protection and supervision applications of utility substations, and industrial switchgear and equipment
ACD	Start/pickup status
ACT	Application Configuration Tool in PCM600; Trip status
ANA	PG&E 2179 Protocol13-bit analog format
ANP	PG&E 2179 Protocol 12-bit Packed analog format
ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
CmdState	Command state
C	PG&E 2179 Protocol Command Octet
CHG	PG&E 2179 Protocol: Change Bits 2-bit status format (Status with change)
CPU	Central processing unit
CRC	Cyclical Redundancy Check
CT	Current transformer
DPC	Double point control
DPS	Double point status
DS	Data set
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
HMI	Human-machine interface
HW	Hardware
IEC 61850	International standard for substation communication and modelling
IED	Intelligent electronic device
INS/INC	Integer status
LED	Light-emitting diode
LHMI	Local human-machine interface

LSB	Least significant bit
LUN	PG&E 2179 Protocol: Logical Unit Number
MCD	Momentary change detect
PG&E 2179 Protocol, PGNE2179	A serial communication protocol developed by PG&E for providing universal platform for performing SCADA
PG&E 2179 Protocol memory map	Allocation of accessible protocol data
MOM	Momentary position
PCM600	Protection and Control IED Manager
PLC	Programmable logic controller
PST	Parameter Setting Tool in PCM600
RS-232	Serial link according to EIA standard RS232
RS-485	Serial link according to EIA standard RS485
RTC	Real-time clock
RTU	Remote terminal unit (Slave unit in PG&E 2179 Protocol)
SCADA	Supervision, control and data acquisition
SBA	PG&E 2179 Protocol: 16bit analog format
SEC	Security violation
SEQ	PG&E 2179 Protocol: Sequence Number
SPC	Single point status of a controllable object
SPS	Single point status
SS	PG&E 2179 Protocol: Simple status data
SW	Software
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
UDR	User-definable register
UID	Unique ID
UTC	Coordinated universal time

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