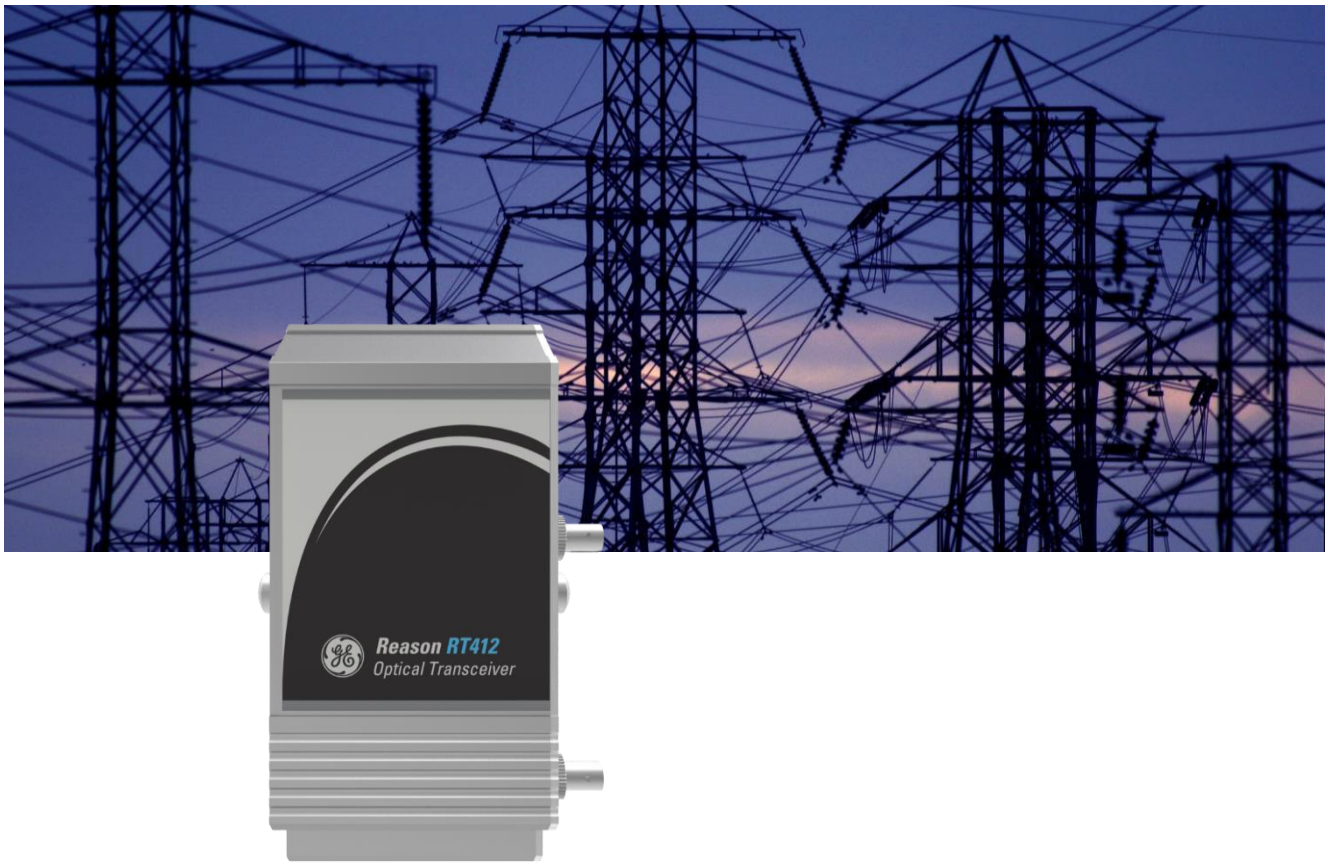
GE
Grid Solutions

Reason RT412

Optical Transceiver



Technical Manual

Platform Hardware Version: A
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Chapter 1: Introduction

This chapter provides general information about the technical manual and an introduction to RT412 Optical Transceiver.

1 Foreword

This technical manual provides a functional and technical description of GE Reason RT412 Optical Transceiver, as well as a comprehensive set of instructions for using the devices. The level at which this manual is written assumes that you are already familiar with protection engineering and have experience in this discipline. The description of principles and theory is limited to that which is necessary to understand the product.
We have attempted to make this manual as accurate, comprehensive and user-friendly as possible. However, we cannot guarantee that it is free from errors. Nor can we state that it cannot be improved. We would therefore be very pleased to hear from you if you discover any errors, or have any suggestions for improvement. Our policy is to provide the information necessary to help you safely specify, engineer, install, commission, maintain, and eventually dispose of this product. We consider that this manual provides the necessary information, but if you consider that more details are needed, please contact us.

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Target Audience

This manual is aimed towards all professionals charged with installing, commissioning, maintaining, troubleshooting, or operating any of the products within the specified product range. This includes installation and commissioning personnel as well as engineers who will be responsible for operating the product.
The level at which this manual is written assumes that installation and commissioning engineers have knowledge of handling electronic equipment. Also, system and protection engineers have a thorough knowledge of protection systems and associated equipment.

Accronyms and abbreviations

AC - Alternating Current;
ACEB NEMEA - Acronyms and Abbreviations;

ASCII - American Standard Code for Information Interchange;
BMC - Best Master Clock;
BNC - Bayonet Neil Councilman connector;
Bps - Bytes per second;
bps - Bits per second;
CAT5 - Network Cable;
PLC - Programmable Logic Controller;
CMOS - Complementary Metal-Oxide-Semiconductor;
DB9 - Connector do type D-subminiature;
DC - Direct Current;
DCF77 - Time synchronization protocol Deutschland LORAN-C (Long Range Navigation - C) Frankfurt 77 (77.5 kHz);
DMARK – Single pulse with a programmable date and time;
DNS - Domain Name System;
DST - Daylight Saving Time;
DTE - Data Terminal Equipment;
E2E - End-to-end;
ETH - Abbreviation of the term Ethernet;
FW - Abbreviation of the term Firmware;
GLONASS - GLObal NAvigation Satellite System from Russian Aerospace Defense Forces;
GND - Abbreviation of the term Ground;
GNSS - Global Navigation Satellite System;
GPS - Global Positioning System;
GPZDA - Serial Datagram format;
HTTP - Hypertext Transfer Protocol;
HTTPS - Hypertext Transfer Protocol Secure;
IEC - International Electrotechnical Commission;
IED - Intelligent Electronic Devices;
IEEE - Institute of Electric and Electronic Engineers;
HMI - Human-Machine Interface;
IP - Internet Protocol;
IP40 - Degree of protection 40;
IRIG-B - Time synchronization protocol Inter Range Instrumentation Group (Rate Designation B);
LCD - Liquid Crystal Display;
MAC - Media Access Control;
MIB - Management Information Base;
NTP - Network Time Protocol;
OUT - Abbreviation of the term Output;
P2P - Peer-to-peer;
PLC - Programmable Logic Controller;
PPM - Pulse per minute;
PRP - Parallel Redundancy Protocol;
PPS - Pulse per Segundo;
PPX - Pulse per X s;
PTP - Precision Time Protocol;
RAIM - Receiver Autonomous Integrity Monitoring;
RJ45 - Ethernet Connector with 8 conductors;
RS232/485 - Serial port levels;
RX - Receiving data;
SNMP - Simple Network Management Protocol;

SNTP - Simple Network Time Protocol;
ST - Bayonet-lock connector;
TCP - Transmission Control Protocol;
TMARK - Daily pulses with programmable time;
TTL - Transistor-to-Transistor logic;
TX - Data transmission;
UDP - User Datagram Protocol;
UTC - Universal Time Coordinate.

2 Product Scope

RT412 – Optical Transceiver may convert electrical signals into optical signals, or vice-versa. The input signal could be either electrical or optical, and the outputs are two electrical ports plus one optical. The equipment is ruggedized and specifically designed for operation and to be part of the large scale electrical fixed installations, as electrical power generation installations, electrical substations and electrical utilities control systems.
RT412 can convert IRIG-B demodulated, PPS or any signal with a voltage up to 5 Vdc, and frequencies up to 5 MHz. The equipment's time accuracy is based on the accuracy of the time reference source been used.
It also has indicators for monitoring the received time reference signal and the power supply.

3 Functional Overview

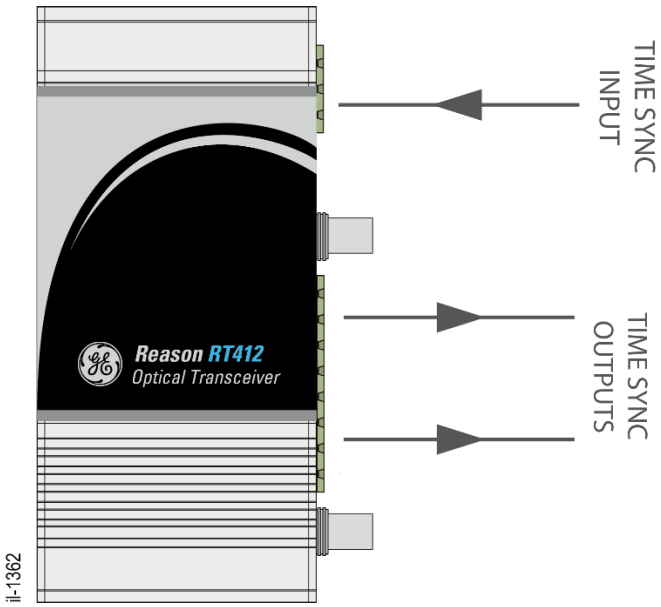
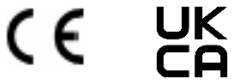


Figure 1: Functional Overview of RT412

4 Standards Compliance

The device has undergone a range of extensive testing and certification processes to ensure and prove compatibility with all target markets.

Compliance with the European Commission Directive and UK Conformity Assessed on EMC and LVD is demonstrated by self-certification against international standards.



- EMC Compliance: Compliance with IEC 60255-26:2013 was used to establish conformity.
- Product Safety: Compliance with IEC 61010-1:2010 was used to establish conformity.
- Protective Class: Protective Class I. This equipment requires a protective conductor (ground) to ensure user safety.
- Installation category: Compliance with IEC 61010-1:2010 Overvoltage Category II
- Environment: IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-30, IEC 60068-2-14, IEC 60255-21-1, IEC 60255-21-2. The equipment is intended for indoor use only. If it is required for use in an outdoor environment, it must be mounted in a specific cabinet or housing which will enable it to meet the requirements of IEC 60529 with the classification of degree of protection IP20.
- R&TTE Compliance: Radio and Telecommunications Terminal Equipment (R&TTE) directive 99/5/EC. Conformity is demonstrated by compliance to both the EMC directive and the Low Voltage directive, to zero volts.

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Chapter 2: Safety Information

This chapter provides information about the safe handling of the equipment. The equipment must be properly installed and handled in order to maintain it in a safe condition and to keep personnel safe at all times. You must be familiar with information contained in this chapter before unpacking, installing, commissioning, or servicing the equipment.

1 Health and Safety

Personnel associated with the equipment must be familiar with the contents of this Safety Information.
When electrical equipment is in operation, dangerous voltages are present in certain parts of the equipment. Improper use of the equipment and failure to observe warning notices will endanger personnel.
Only qualified personnel may work on or operate the equipment. Qualified personnel are individuals who are:

- Familiar with the installation, commissioning, and operation of the equipment and the system to which it is being connected.
- Familiar with accepted safety engineering practices and are authorized to energize and de-energize equipment in the correct manner.
- Trained in the care and use of safety apparatus in accordance with safety engineering practices
- Trained in emergency procedures (first aid).

The documentation provides instructions for installing, commissioning and operating the equipment. It cannot, however cover all conceivable circumstances. In the event of questions or problems, do not take any action without proper authorization. Please contact your local sales office and request the necessary information.

Each product is subjected to routine production testing for Dielectric Strength and Protective Bonding Continuity.

2 Symbols

Throughout this manual you will come across the following symbols. You will also see these symbols on parts of the equipment.

Caution: Refer to equipment documentation. Failure to do so could result in damage to the equipment

Risk of electric shock

Ground terminal. Note: This symbol may also be used for a protective conductor (ground) terminal if that terminal is part of a terminal block or sub-assembly.

Protective conductor (ground) terminal

Both direct and alternating current

Instructions on disposal requirements

The term 'Ground' used in this manual is the direct equivalent of the European term 'Earth'.

3 Installation, Commissioning and Servicing

Lifting Hazards

Many injuries are caused by:

- Lifting heavy objects
- Lifting incorrectly
- Pushing or pulling heavy objects
- Using the same muscles repetitively

Plan carefully, identify any possible hazards and determine how best to move the product. Look at other ways of moving the load to avoid manual handling. Use the correct lifting techniques and Personal Protective Equipment (PPE) to reduce the risk of injury.

Electrical Hazards

All personnel involved in installing, commissioning, or servicing this equipment must be familiar with the correct working procedures.

Consult the equipment documentation before installing, commissioning, or servicing the equipment.

Always use the equipment as specified. Failure to do so will jeopardize the protection provided by the equipment.

Removal of equipment panels or covers may expose hazardous live parts. Do not touch until the electrical power is removed. Take care when there is unlocked access to the rear of the equipment.

Isolate the equipment before working on the terminal strips.

Use a suitable protective barrier for areas with restricted space, where there is a risk of electric shock due to exposed terminals.

Disconnect power before disassembling. Disassembly of the equipment may expose sensitive electronic circuitry. Take suitable precautions against electrostatic voltage discharge (ESD) to avoid damage to the equipment.

NEVER look into optical fibers or optical output connections. Always use optical power meters to determine operation or signal level.

Testing may leave capacitors charged to dangerous voltage levels. Discharge capacitors by reducing test voltages to zero before disconnecting test leads.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Operate the equipment within the specified electrical and environmental limits.

Before cleaning the equipment, ensure that no connections are energized. Use a lint free cloth dampened with clean water.

Integration of the equipment into systems shall not interfere with its normal functioning.

The functioning of the device has been certified under the circumstances described by the standards mentioned. Usage of the equipment in different conditions from the specified in this manual might affect negatively its normal integrity.

The equipment shall have all their rear connectors attached even if they are not being used, in order to keep their levels of ingress protection as high as possible

Never manipulate liquid containers near the equipment even when it is powered off.

Avoid modification to the wiring of panel when the system is running.

Fusing Requirements

A high rupture capacity (HRC) fuse type with a maximum current rating of 10 Amps and a minimum dc rating of 250 V dc may be used for the auxiliary supply (for example Red Spot type NIT or TIA). Alternatively, a miniature circuit breaker (MCB) of type C, 10 A rating, compliant with IEC 60947-2 may be used.

Reason devices contain an internal fuse for the power supply, which is only accessed by opening the product. This does not remove the requirement for external fusing or use of an MCB as previously mentioned. The ratings of the internal fuses are 2 Amp, type T, 250V.

Equipment Connections

Terminals exposed during installation, commissioning and maintenance may present a hazardous voltage unless the equipment is electrically isolated.

Tighten M3 clamping screws of heavy-duty terminal block connectors to a nominal torque of 1.0Nm. Tighten captive screws of header-type (Euro) terminal blocks to 0.5 Nm minimum and 0.6 Nm maximum.

Always use insulated crimp terminations for voltage and current connections.

Always use the correct crimp terminal and tool according to the wire size.

In order to maintain the equipment's requirements for protection against electric shock, other devices connected to the equipment shall have protective class equal or superior to Class I.

Ground the equipment with the supplied PCT (Protective Conductor Terminal).

Do not remove the PCT.

The PCT is sometimes used to terminate cable screens. Always check the PCT's integrity after adding or removing such ground connections.

The user is responsible for ensuring the integrity of any protective conductor connections before carrying out any other actions.

The PCT connection must have low-inductance and be as short as possible. For best EMC performance, ground the unit using a 10 mm (0.4 inch) wide braided grounding strap.

All connections to the equipment must have a defined potential. Connections that are pre-wired, but not used, should be grounded, or connected to a common grouped potential.

Pay extra attention to diagrams before wiring the equipment. Always be sure that the connections are correct before energizing the circuits.

Pre-energization Checklist

Check voltage rating/polarity (rating label/equipment documentation).

Check protective fuse or miniature circuit breaker (MCB) rating.

Check integrity of the PCT connection.

Check voltage and current rating of external wiring, ensuring it is appropriate for the application.

Peripheral Circuitry

Where external components such as resistors or voltage dependent resistors (VDRs) are used, these may present a risk of electric shock or burns if touched.

Operation of equipment connected to RT41x under environmental conditions such as temperature and humidity that exceed the conditions specified in their respective manuals can cause malfunctioning or even irreversible damage to them or the nearby installation.

There might be situations in which the unit is operating within its environmental operational range, but the computers, equipment connected to them or nearby equipment are operating outside their operational range. That situation can cause malfunctioning and/or irreversible damage to those devices. In that occasion the communication to the Reason equipment might be compromised but its operational and safety capacities will not be affected.

Upgrading/Servicing

Do not insert or withdraw modules, PCBs or expansion boards from the equipment while energized, as this may result in damage to the equipment. Hazardous live voltages would also be exposed, endangering personnel.

Internal modules and assemblies may have sharp edges. Take care when inserting or removing modules into or out of the IED.

4 Decommissioning and Disposal

Before decommissioning, completely isolate the equipment power supply (both poles of any dc supply). The auxiliary supply input may have capacitors in parallel, which may still be charged. To avoid electric shock, discharge the capacitors using the external terminals before decommissioning.

Avoid incineration or disposal to water courses. Dispose of the equipment in a safe, responsible and environmentally friendly manner, and if applicable, in accordance with country-specific regulations.

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Chapter 3: Hardware Design

This chapter demonstrates the main hardware characteristics from RT412

1 Equipment View

With a compact design, all the equipment connections can be access by one side.

Figure 2: Front view of RT412

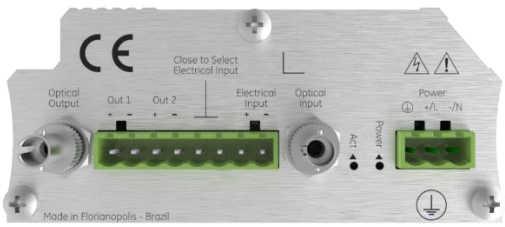

Figure 3: View from RT412 connectors

The RT412 comprises:

- One power supply, AC/DC high voltage;
- One electrical input, one optical input and one input selection connection for time reference;
- Two TTL electrical outputs for synchronization, been Euro Type connector;
- One optical output using ST connector;

The Act indicator shows if the time reference is detected, and the Power indicator simply shows if the equipment is energized or not.

2 Power Supply

The power supply has the following nominal voltages: 100-240Vac, 110-250Vdc.

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Chapter 4: Installation

The RT412 is ruggedized and specifically designed for operation and to be part of the large scale electrical fixed installations, as electrical power generation installations, electrical substations and electrical utilities control systems.

1 Unpacking

Unpack the unit carefully and make sure all the accessories and cables are put aside so they will not be lost.
Check the contents against the packing list that goes with the product. If any of the content listed is missing, please contact GE Grid Solutions (see contact information in Maintenance chapter).
Examine the unit for any shipping damage. If the unit is damaged or fails to operate, notify the shipping company without delay. Only the consignee (the person or company receiving the unity) can file a claim against the carrier for shipping damage.
We recommend you to keep the original packing materials for possible transport in the future.

Normal Use of the Equipment

In order to maintain the equipment integrity, levels of protection and assure user safety, the RT412 must be installed in an enclosed panel with recommended ingress protection rating of IP54 or above.
The enclosing panel must ensure that the equipment is unexposed and protected against impact and water, whilst maintaining adequate temperature and humidity condition for the devices. Furthermore, the equipment must have all their connectors attached, even if not being used, to keep their levels of ingress protection as high as possible.

2 Mounting

RT412 has been designed to be mounted in a standard DIN-rail.
Keep adequate clearance for all connections. In particular, the optical fiber cables should be installed in compliance with the 30 mm minimum bending radius.

Connectors

Components and connectors of RT412 are shown in figure below.

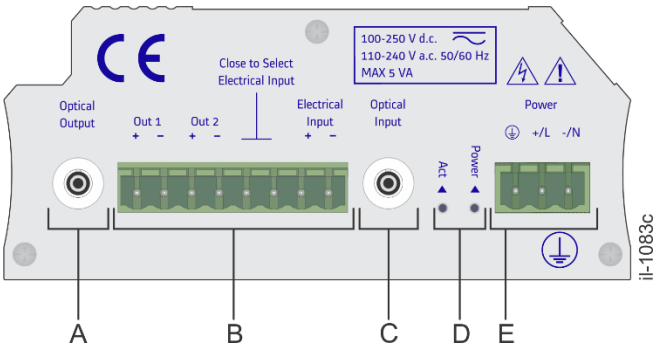

Figure 4: Connectors of RT412

Table 1: RT412 connectors

Indicator	Description
A	1 optical output, ST connectors
B	One Euro Type connector, comprising: • 2 electrical TTL outputs; • Jumper to select the type (electrical or optical) of input signal for time reference • Electrical Input for time reference
C	Optical Input for time reference, ST connector
D	The Act indicator shows if the time reference is detected; The Power indicator simply shows if the equipment is energized or not.
E	Power supply, high voltage AC/DC

Power Supply

The unit can be powered from a DC or AC power supply within the limits specified.
The power connections must use insulated flameproof flexible cable with a 1.5 mm² cross section, 70 °C thermal class, and 750 V insulation voltage.
To reduce the risk of electrical shock, pre-insulated tubular pin terminals should be used on the ends of the power connections.

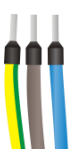

Figure 5: Pre-insulated tubular pin terminals

The pin terminals must be completely inserted into the connector supplied with the unity so that no metallic parts are exposed, according to the figure below.

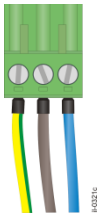

Figure 6: Supply connector assembly

A 1.5 mm² ground lead must be connected to the terminal marked with the protective ground symbol for safety.

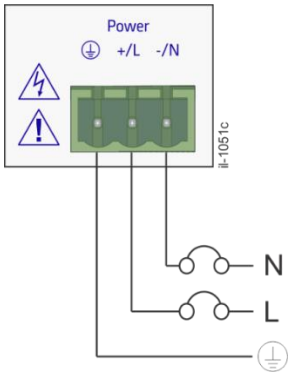

Figure 7: RT412 power connection

For AC power connection, the phase conductor must be applied to terminal (+/L), neutral conductor to terminal (-/N) in the supply terminals identified as illustrated below.
For DC power connection, the positive line should be applied to terminal (+/L), negative to terminal (-/N) in the supply terminals identified as illustrated below.

For compliance with IEC 61010, install a suitable external switch or circuit breaker in each current-carrying conductor of RT412 power supply; this device must interrupt both the hot (+/L) and neutral (-/N) power leads. An external 10 A, category C, bipolar circuit-breaker is recommended. The circuit breaker should have an interruption capacity of at least 25 kA and comply with IEC 60947-2. The switch or circuit-breaker must be suitably located and easily reachable, also it must not interrupt the protective ground conductor.

Grounding (Earthing)

To ensure proper operation of the equipment under extreme electromagnetic conditions, connect the equipment protective ground terminal to the panel using a copper strap of at least 10 mm width as M6 ring lug.

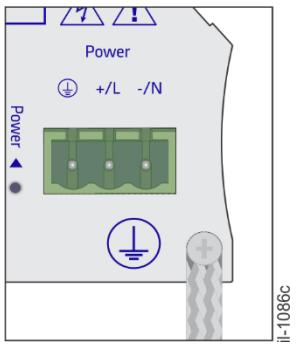

Figure 8: RT412 Grounding Strap

Electrical/Optical Time Input

The RT412 has one optical input and one electrical input for time reference. Both accepts IRIG-B00X, PPX, DCF77, or any signal with frequency up to 5 MHz. The electrical input support up to 5 Vdc signals.
Note the time accuracy of RT412 depends on the time reference source.

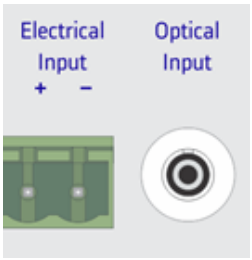

Figure 9: Electrical/Optical Time Input

To synchronize the RT412 using optical fiber, adequate optical fiber should be used, respecting a minimum bend radius of 30 mm. To synchronize the equipment using the electrical input, it is recommended the use of twisted pair.
For distances over 3 m, the use of an optical fiber cable is recommended to minimize the effects related to EMC.
The length of the optical fiber cables should not exceed 2 km.

Selecting the Type of Time Input

An electrical jumper allows selecting the input to be used as time reference. The electrical time reference port is enabled when making the jumper connection. In case the jumper is disconnected, the equipment operates using the optical time reference port insulated.

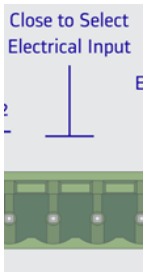

Figure 10: Input Selection

Table 2: Jumper Selection of Time Input

Closed Jumper	Electrical Input
Opened Jumper	Optical Input

The jumper connections must use insulated flameproof flexible cable with a 1.5 mm² cross section, 70 °C thermal class, and 750 V insulation voltage.

Optical Output

The RT412 has 1 output for multimode optical fiber as shown below.

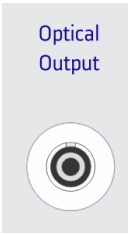

Figure 11: Optical Outputs

The optical and both electrical outputs have the same signal as the one applied in the time reference input. The length of the optical fiber cables should not exceed 2 km.

Electrical Outputs

The RT412 has 2 electrical TTL outputs, using the Euro Type connector.

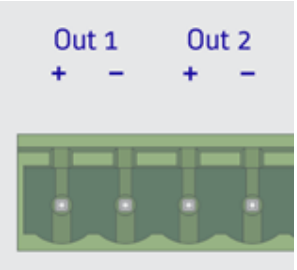

Figure 12: Electrical Outputs

The optical and both electrical outputs have the same signal as the one applied in the time reference input. The length of the optical fiber cables should not exceed 2 km.
More than one device can be connected in parallel from one TTL output. The maximum number of devices that can be connected to the TTL output depends on the current that each device's input uses. As the maximum current supplied from each TTL output is 150mA, the sum of the currents from all devices connected cannot exceed this value (cable resistance should be considered). The TTL voltage level is 5V.
Electrical cable length should not exceed 100m.
To minimize EMC effects in IRIG-B signals, the use of fiber-optic cable is recommended for distances greater than 3 m.

3 Powering Up

Before energizing the unit, familiarize yourself with all the risks and attention indicators in the equipment frame.

- Connect the power supply (including the ground lead) to the appropriate terminals, and the unit will power up;
- If the time input is connected and selected correctly, the indicator Act will light up;
- To turn off the unit, switch off the external switch or circuit breaker.

In case the unit does not behave in a way here described, carefully check all power and signal connections. See Maintenance chapter for additional suggestion for problem diagnosis.

4 Preventive Maintenance Actions

In view of the critical nature of the application, GE products should be checked at regular intervals to confirm they are operating correctly. GE products are designed for a life in excess of 20 years.
The devices are self-supervising and so require less maintenance than earlier designs of protection devices. Most problems will result in an alarm, indicating that remedial action should be taken. However, some periodic tests should be carried out to ensure that they are functioning correctly and that the external wiring is intact.
It is the responsibility of the customer to define the interval between maintenance periods. If your organization has a Preventative Maintenance Policy, the recommended product checks should be included in the regular program. Maintenance periods depend on many factors, such as:

- The operating environment;
- The accessibility of the site;
- The amount of available manpower;
- The importance of the installation in the power system;
- The consequences of failure.

Preventive Actions

For optimum performance of Reason RT412, perform the following preventive maintenance procedures and actions:
Keep temperature and humidity at adequate levels inside the panel. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) recommends

operating network equipment within the following ranges of temperature and relative humidity (see the ASSHRAE TC9.9 “2011 Thermal Guidelines for Data Processing Environments – Expanded Data Center Classes and Usage Guidance”).

- Temperature within 18° C to 27° C (64.4° F to 80.6° F)
- Relative humidity less than 60%
- Dew point within the range of 5.5° C to 15° C (41.9° F to 59.0° F)

Operating within this range supports the highest degree of equipment reliability, even though the equipment data sheets may state wider ranges of minimum and maximum temperature and humidity (for example, -40° C to 55° C and 5% to 95% RH). Continuous equipment operation at the minimum and maximum limits is not recommended.
Keep panel sealed to avoid dust and/or animals and insects.
Inspect the installation site for moisture, loose wires or cables, and excessive dust.
Make sure that airflow is unobstructed around the device and into the air intake vents.
It is recommended weekly or every two weeks to access the web interface area of the unit and check the equipment details in Status area. See Operation chapter for further details regarding the equipment status.
If any abnormal conditions are observed, refer to Maintenance chapter or contact the technical support team to obtain the suitable instructions to deal with the issue.

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Chapter 5: Maintenance

This chapter describes the information to consider for an eventual maintenance.
For any further assistance required please contact the information and call center as follows:

GE Grid Solutions:
Worldwide Contact Center
Web: www.GEGridSolutions.com/contact
Phone: +44 (0) 1785 250 070

1 Power Indicator Off

- Make sure the power supply terminal is connected properly;
- Check if there is voltage at the terminals.

2 Act Indicator Off

- Check if the time input terminal is connected properly;
- Make sure there is proper time reference in the terminals;
- Make sure the cable is in good conditions, in accordance with the technical specifications required.

3 Cleaning Instructions

Before cleaning the equipment, make sure that the primary voltage is removed. If it is necessary cleaning the exterior of the equipment, use only a dry cloth. Internally it is not required any cleaning.

4 Equipment Return

All parts and components comprising Reason devices must be repaired exclusively by GE Grid Solutions. In case of equipment malfunction the customer must get in contact with GE's Contact Centre and never attempt to repair the device by his own.
To request equipment repair service, call GE Grid Solutions to check out shipment options and receive the technical assistance order code.
The equipment must be packed in its original package or a suitable package to protect against impacts and moisture.
Send equipment to address supplied including the sender's identification and the technical assistance reference.

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Chapter 6: Technical Specification

This chapter describes the technical specifications of the product.

1 Power Supply

Table 3: Power supply specifications

Operating nominal voltage	100-250Vdc, 110-240Vac
Operating voltage range	80-300Vdc, 88-264Vac
Frequency	50/60 Hz ± 3 Hz
Power Consumption	MAX 5 VA

2 TTL Electrical Input

Table 4: TTL Electrical input specification

TTL Voltage Level	5 Vdc
High Level	> 4.8 Vdc
Low Level	< 0.2 Vdc
Impedance	220 Ω
Connector	Euro Type

3 Optical Input

Table 5: Optical input specification

Connector	ST
Wavelength	820 nm
Fiber Type	Multimode 50/125 µm, 62.5/125 µm, 100/140 µm or 200 µm HCS
Power Sensitivity	- 24.0 dBm

4 TTL Electrical Outputs

Table 6: TTL Electrical Outputs specification

Number of Outputs	2
TTL Voltage Level	5 Vdc
High Level	> 4.8 Vdc
Low Level	< 0.2 Vdc
Impedance	4.7 Ω
Maximum current	150 mA
Time Difference between Input and Outputs (mean)	73 ns
Connectors	Euro Type

5 Optical Output

Table 7: Optical Output specification

Number of Output	1
Connector	ST
Wavelength	820 nm
Fiber Type	Multimode 50/125 µm, 62.5/125 µm, 100/140 µm or 200 µm HCS
Emission power	- 17.8 dBm (50 / 125 µm) - 14.0 dBm (62,5 / 125 µm) - 8.5 dBm (100 / 140 µm) - 5.7 dBm (200 µm HCS)
Time Difference between Input and Outputs (mean)	73 ns

6 Environment

Table 8: Environment specification

Operating temperature range	-40°C … +55°C (or –40°F to +131°F)
As tested per IEC 60068-2-1	-40°C
As tested per IEC 60068-2-2	+85°C
Maximum operating altitude	2000 m (6560 ft)
Relative humidity	5 … 95%, non-condensing

Table 9: Enclosure Protection IEC 60529

Product safety protection	IP20

7 Type Test

Table 10: EMC tests were performed according to IEC 60255-26 referring to the following standards

IEC 61000-4-2:2008	6 kV contact / 8 kV air
IEC 61000-4-3:2006	10 V/m
IEC 61000-4-4:2012	2 kV @ 5 kHz
IEC 61000-4-5:2005	Differential mode: 1 kV Common mode: 2 kV
IEC 61000-4-6:2008	10 V
IEC 61000-4-8:2009	30 A/m continuous 300 A/m @ 1 s
IEC 61000-4-11:2004 **IEC 61000-4-29:2000**	• A.C. and D.C. voltage dips Test level: 0% residual voltage Duration time A.C.: 1 cycle D.C.: 16,6 ms • Test level: 40% residual voltage Duration time A.C.: 12 cycles D.C.: 200ms • Test level: 70% residual voltage Duration time A.C.: 30 cycles D.C.:500 ms • A.C. and D.C. voltage interruptions Test level: 0% residual voltage Duration time A.C.: 300 cycles

	D.C.: 5 s
IEC 61000-4-17:1999	Test level: 15% of rated DC value Test frequency: 120 Hz, sinusoidal waveform.
IEC 61000-4-18:2006	Voltage oscillation frequency: 1 MHz Differential mode: 1 kV peak voltage; Common mode: 2.5 kV peak voltage
IEC 60255-26:2008	Shut-down ramp: 60 s Power off: 5 m Start-up ramp: 60 s
CISPR11:2009	Radiated emission 30 to 230 MHz – 50 dB (µV/m) quasi peak at 3 m and 230 to 1000 MHz – 57 dB (µV/m) quasi peak at 3 m
CISPR22:2008	Radiated emission The definition of the limit frequency is based on the maximum internal frequency of the equipment. On RT412, the maximum internal frequency is 5 MHz. For this case, the levels of CISPR 11 satisfy the normative IEC 60255-26. Conducted emission 0.15 to 0.50 MHz - 79dB (µV) quasi peak; 66 dB (µV) average 0.5 to 30 MHz - 73dB (µV) quasi peak; 60 dB (µV) average

Table 11: Safety tests

IEC 61010-1 **CE Certification**	Safety Requirements
IEC 60255-5	Impulse: 5 kV Dielectric withstand: 2.8 kVdc Insulation: > 100 MΩ

Table 12: Environmental tests

IEC 60068-2-1	-40°C, 16 hours (Cold)
IEC 60068-2-2	+85°C, 16 hours (Dry heat)
IEC 60068-2-30	95% no condensation, +55°C (Damp heat)
IEC 60068-2-14	-40°C to +85ºC / 9 hours / 2 cycles (Change of temperature)
IEC 60255-21-1	Class 2 (Vibration)
IEC 60255-21-2	Class 1 (Shock)

8 Dimensions, Weight

Table 13: Dimensions and weight specification

Height	117 mm (4.6 in)
Width (body)	55 mm (2.2 in)
Depth	51 mm (2.0 in)
Weight	1 kg (2.2 lbs)

RT412 dimensions are shown below.

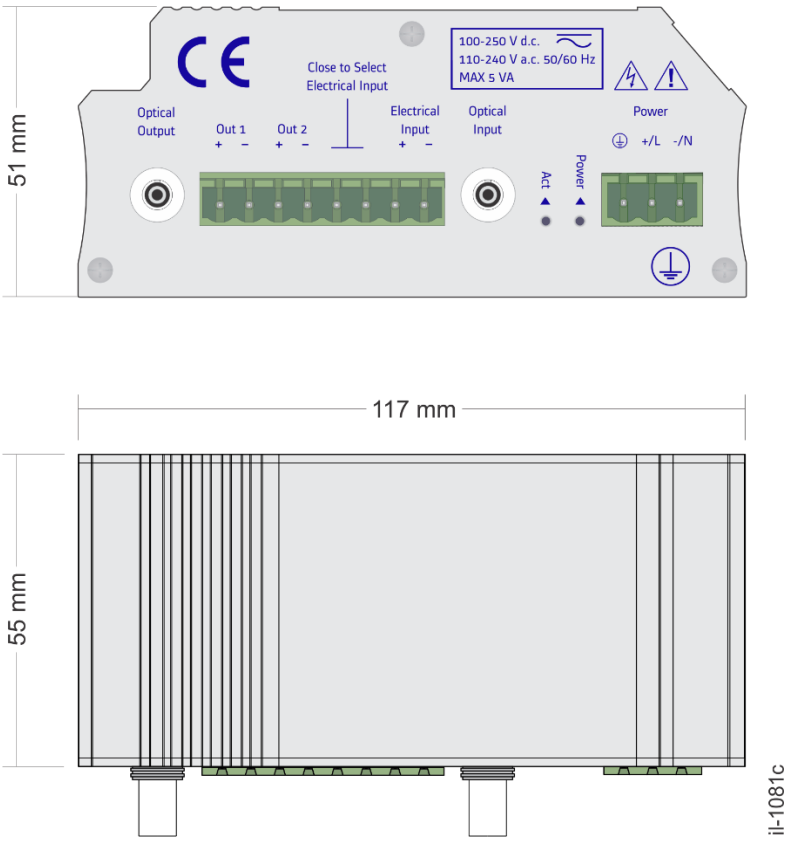

Figure 13: RT412 Dimensions

Reason RT412

Optical Transceiver

Chapter 7: Ordering Options

This chapter describes the CORTEC number formation from RT412.

1 RT412 Cortec

Variants	Order Number			
	1-5	6	7	8
Model Type RT412 Optical Transceiver	RT412			
Power Supply ~~24-48 Vdc~~		~~1~~		
100-250 Vdc / 110-240 Vac		3		
Customization / Regionalisation GE branding			C	
Hardware Design Suffix Initial version				A

Issue D

Reason RT412

Optical Transceiver

Chapter 8: Appendixes

Appendix A – IRIG-B Standard Summary

Table 14: IRIG-B standard summary

0	P_r	reference bit (P_r)	
1	P_r + 10 ms	seconds 1	seconds (0 ... 59 or 60)
2	P_r + 20 ms	seconds 2	
3	P_r + 30 ms	seconds 4	
4	P_r + 40 ms	seconds 8	
5	P_r + 50 ms	index bit (0)	
6	P_r + 60 ms	seconds 10	
7	P_r + 70 ms	seconds 20	
8	P_r + 80 ms	seconds 40	
9	P_r + 90 ms	position identifier 1 (P_1)	
10	P_r + 100 ms	minutes 1	minutes (0 ... 59)
11	P_r + 110 ms	minutes 2	
12	P_r + 120 ms	minutes 4	
13	P_r + 130 ms	minutes 8	
14	P_r + 140 ms	index bit (0)	

15	P_r + 150 ms	minutes 10	
16	P_r + 160 ms	minutes 20	
17	P_r + 170 ms	minutes 40	
18	P_r + 180 ms	index bit (0)	
19	P_r + 190 ms	position identifier 2 (P_2)	
20	P_r + 200 ms	hours 1	hours (0 ... 23)
21	P_r + 210 ms	hours 2	
22	P_r + 220 ms	hours 4	
23	P_r + 230 ms	hours 8	
24	P_r + 240 ms	index bit (0)	
25	P_r + 250 ms	hours 10	
26	P_r + 260 ms	hours 20	
27	P_r + 270 ms	index bit (0)	
28	P_r + 280 ms	index bit (0)	
29	P_r + 290 ms	position identifier 3 (P_3)	
30	P_r + 300 ms	days 1	day of the year (1 ... 365 or 366)
31	P_r + 310 ms	days 2	
32	P_r + 320 ms	days 4	
33	P_r + 330 ms	days 8	
34	P_r + 340 ms	index bit (0)	
35	P_r + 350 ms	days 10	
36	P_r + 360 ms	days 20	

37	P_r + 370 ms	days 40	
38	P_r + 380 ms	days 80	
39	P_r + 390 ms	position identifier 4 (P_4)	
40	P_r + 400 ms	days 100	
41	P_r + 410 ms	days 200	
42	P_r + 420 ms	index bit (0)	
43	P_r + 430 ms	index bit (0)	
44	P_r + 440 ms	index bit (0)	
45	P_r + 450 ms	index bit (0)	
46	P_r + 460 ms	index bit (0)	
47	P_r + 470 ms	index bit (0)	
48	P_r + 480 ms	index bit (0)	
49	P_r + 490 ms	position identifier 5 (P_5)	
50	P_r + 500 ms	year 1	The last 2 digits of the year (00 ... 99)
51	P_r + 510 ms	year 2	
52	P_r + 520 ms	year 4	
53	P_r + 530 ms	year 8	
54	P_r + 540 ms	index bit (0)	
55	P_r + 550 ms	year 10	
56	P_r + 560 ms	year 20	
57	P_r + 570 ms	year 40	
58	P_r + 580 ms	year 80	

59	P_r + 590 ms	position identifier 6 (P_6)	
60	P_r + 600 ms	index bit (0)	
61	P_r + 610 ms	index bit (0)	
62	P_r + 620 ms	Daylight Saving Pending (DSP)	1 during the minute before beginning or end of DST
63	P_r + 630 ms	Daylight Saving Time (DST)	1 during DST
64	P_r + 640 ms	Time Offset Sign (0=+, 1=-)	difference between local time and UTC (negative for West Greenwich)
65	P_r + 650 ms	Time Offset 1	difference between local time and UTC (-12 ... +12)
66	P_r + 660 ms	Time Offset 2	
67	P_r + 670 ms	Time Offset 4	
68	P_r + 680 ms	Time Offset 8	
69	P_r + 690 ms	position identifier 7 (P_7)	
70	P_r + 700 ms	Time Offset – 0.5h	0 – none 1 – Additional 0.5h time offset
71	P_r + 710 ms	Time Quality (bit 1)	4-bit code representing approx. clock time error: 0000: Clock is locked 0001, 0010, …. , 1010, 1011: Time within 10-9s, 10-8s, …. , 1s,10s of UTC 1111: Fault — time not reliable
72	P_r + 720 ms	Time Quality (bit 2)	
73	P_r + 730 ms	Time Quality (bit 3)	
74	P_r + 740 ms	Time Quality (bit 4)	
75	P_r + 750 ms	Parity (odd)	Module 2 of the sum of the data bits 0 to 74 (Bits 75-99 not included in the sum)
76	P_r + 760 ms	Continuous Time Quality (bit 1)	3-bit code representing the estimated maximum time error in the transmitted message.
77	P_r + 770 ms	Continuous Time Quality (bit 2)	
78	P_r + 780 ms	Continuous Time Quality (bit 3)	

79	P_r + 790 ms	position identifier 8 (P_8)	
80	P_r + 800 ms	time-of-day 1	seconds of the year (0 ... 86399)
81	P_r + 810 ms	time-of-day 2	
82	P_r + 820 ms	time-of-day 4	
83	P_r + 830 ms	time-of-day 8	
84	P_r + 840 ms	time-of-day 16	
85	P_r + 850 ms	time-of-day 32	
86	P_r + 860 ms	time-of-day 64	
87	P_r + 870 ms	time-of-day 128	
88	P_r + 880 ms	time-of-day 256	
89	P_r + 890 ms	position identifier 9 (P_9)	
90	P_r + 900 ms	time-of-day 512	
91	P_r + 910 ms	time-of-day 1024	
92	P_r + 920 ms	time-of-day 2048	
93	P_r + 930 ms	time-of-day 4096	
94	P_r + 940 ms	time-of-day 8192	
95	P_r + 950 ms	time-of-day 16384	
96	P_r + 960 ms	time-of-day 32768	
97	P_r + 970 ms	time-of-day 65536	
98	P_r + 980 ms	index bit (0)	
99	P_r + 990 ms	position identifier 0 (P_0)	

Appendix B – Application Examples

Application Example 1: Traditional and Modern Time Sync

The first example illustrates the traditional and modern manners to synchronize devices, using a single time source: RT430. In the left, the clock provides NTP and IRIG-B for legacy IEDs, and in the right, the PTP represents the modern protocol for time synchronization. Using Ethernet networks, the PTP is distributed through PTP-aware Ethernet switches and whenever a legacy IED needs to be included in a modern architecture, the RT431 acts as a PTP translator converting PTP to IRIG-B or PPS.

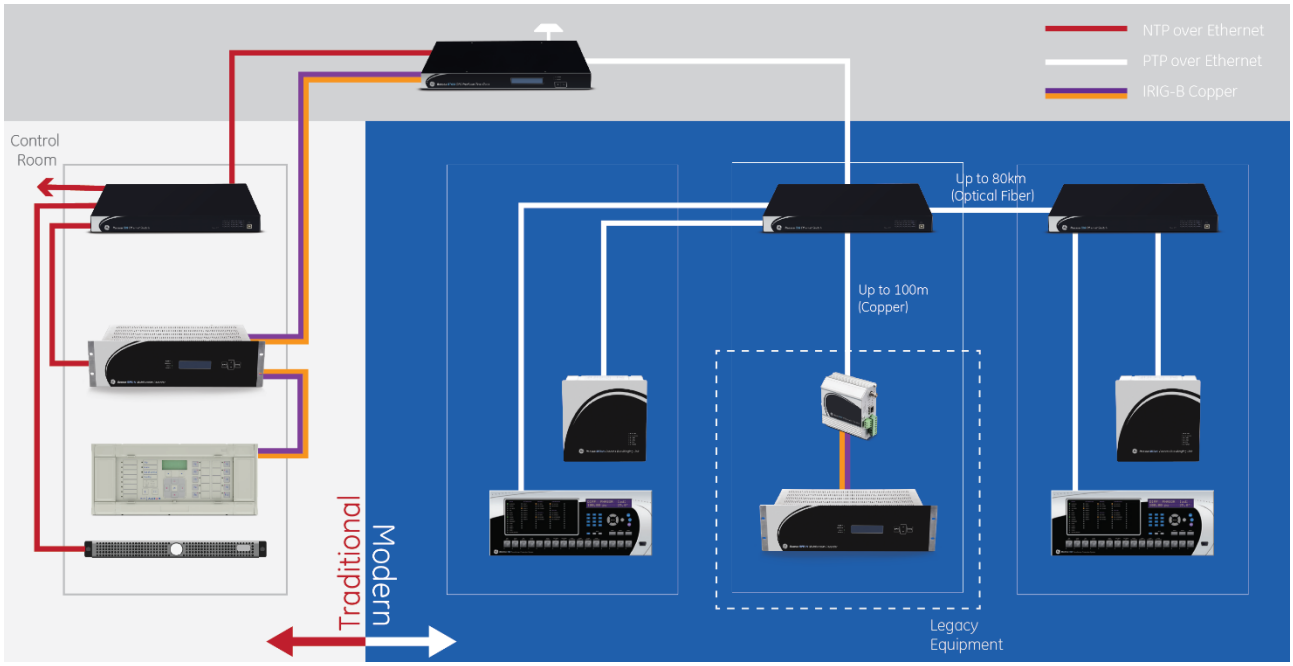

Figure 14: Traditional x Modern Time Synchronization

Application Example 2: System Wide Grandmaster Clock

Using the RT430 along with GE JunglePAX is a great way to have PTP over a wide network. The next figure exemplifies an architecture which a given application has a local PTP Grandmaster clock, which commonly will be the Best Grandmaster Clock for the local IEDs. Whenever this local clock became unavailable or does not represent the best accurate clock, the local IEDs can count with a remote PTP Grandmaster clock, which is called as System Wide Grandmaster.

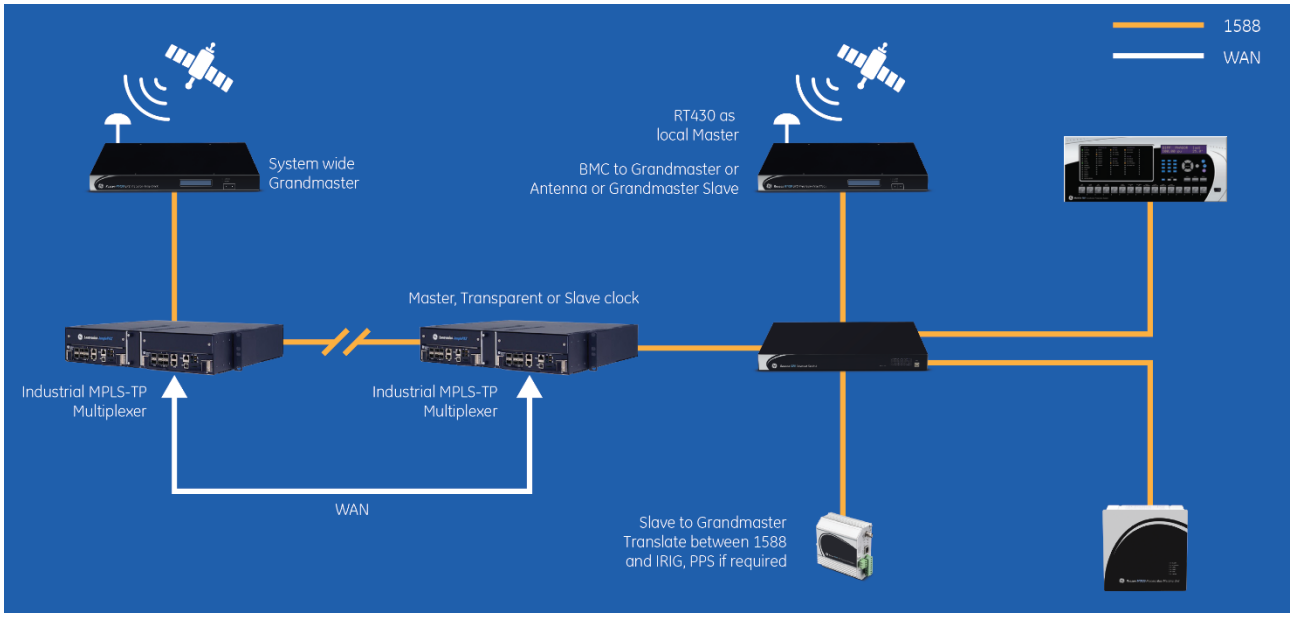

Figure 15: System Wide Grandmaster Clock

Application Example 3: Synchrophasor, TWFL and Process Bus Applications

Requiring 1 µs time accuracy, this third example demonstrate the best way to synchronize devices used for Synchrophasor (PMU), Travelling Waves Fault Locators (TWFL) and Process Bus devices.

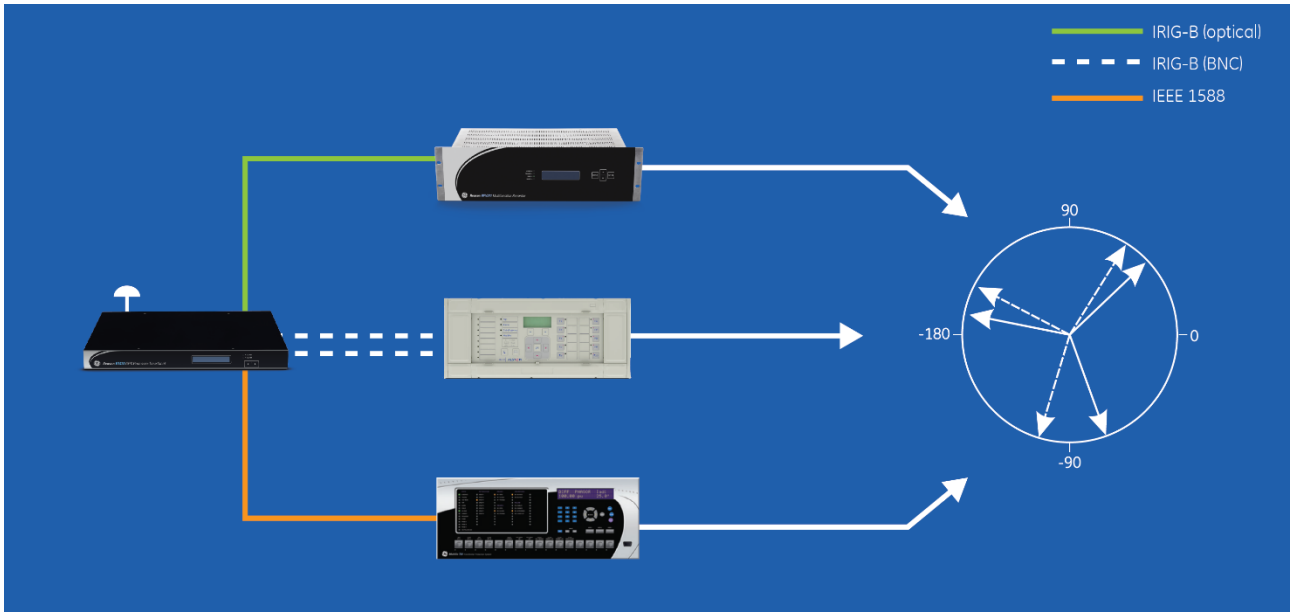

Figure 16: Synchrophasor devices synced by RT430/434

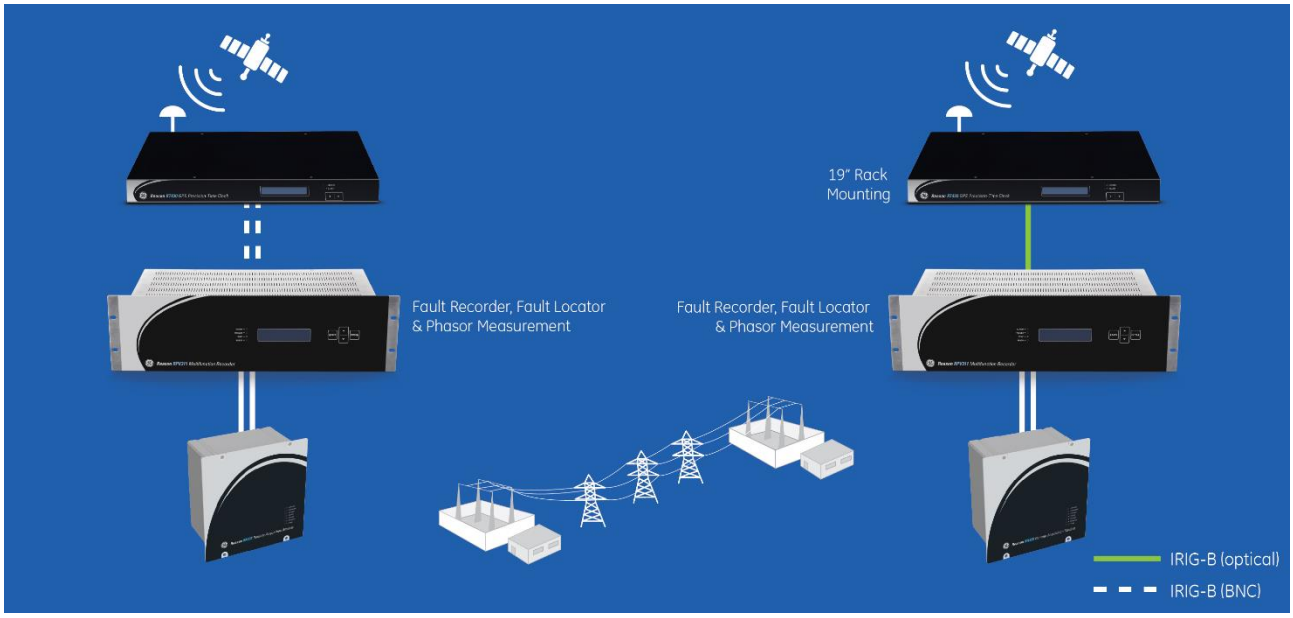

Figure 17: TWFL application using RT430/434 for Time Sync

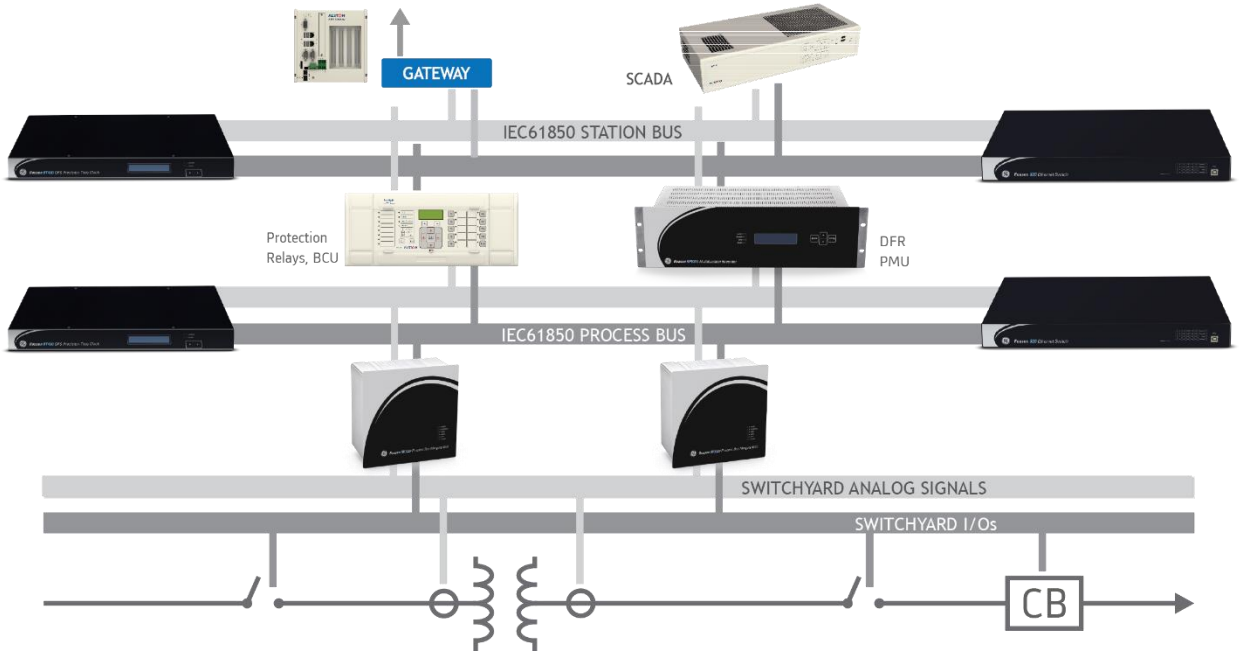

Figure 18: Process Bus application using PTP via the Station Bus network.

Application Example 4: IEEE 1588 in a PRP Network

RT430 offers the highly accurate IEEE 1588v2 Precision Time Protocol (PTP) combined with the Parallel Redundancy Protocol IEC 62439-3:2016, ensuring 100 ns accuracy and high availability in time synchronization over Ethernet networks. In case of failure in one of the redundant networks, the recovery-time for the PTP is zero. In other words, the PRP architecture overcomes any single network failure without affecting the data transmission.

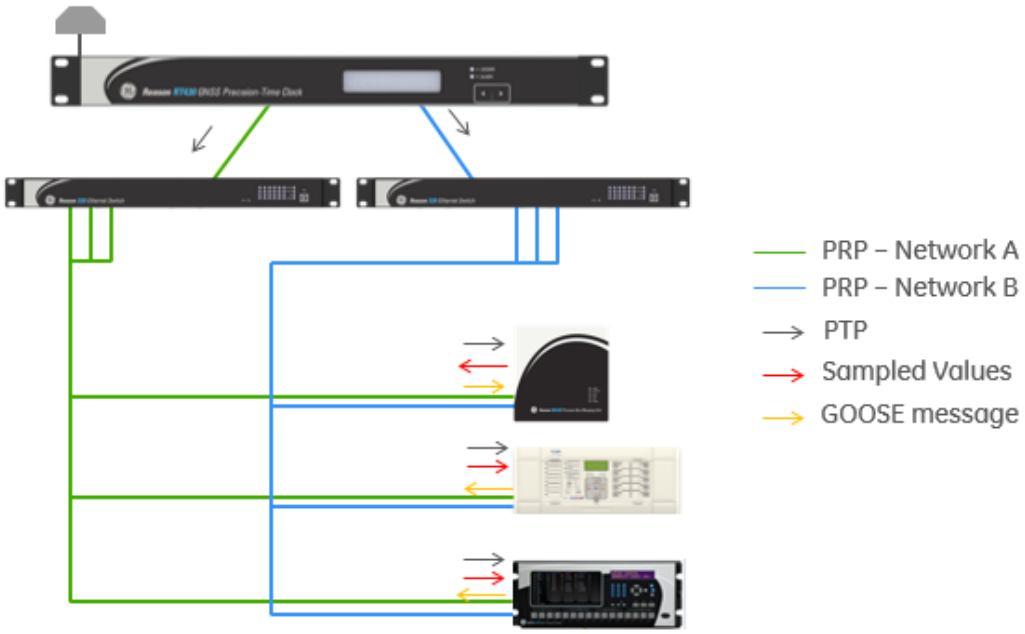

Figure 19: Process Bus application using PTP via the Station Bus network.

Application Example 5: Time Sync Expansion using RT411 and RT412

In applications where a higher number of TTL or ST outputs are required for IRIG-B/PPS, the RT411 is a cheap solution to expand the number of outputs from clocks. Furthermore, the RT412 can convert optical signals to electrical and vice versa, which is a great solution to distribute time synchronization. The next figure demonstrates an IRIG-B time distribution using only one clock plus a RT411 and many RT412, used in Automation & Control architectures.

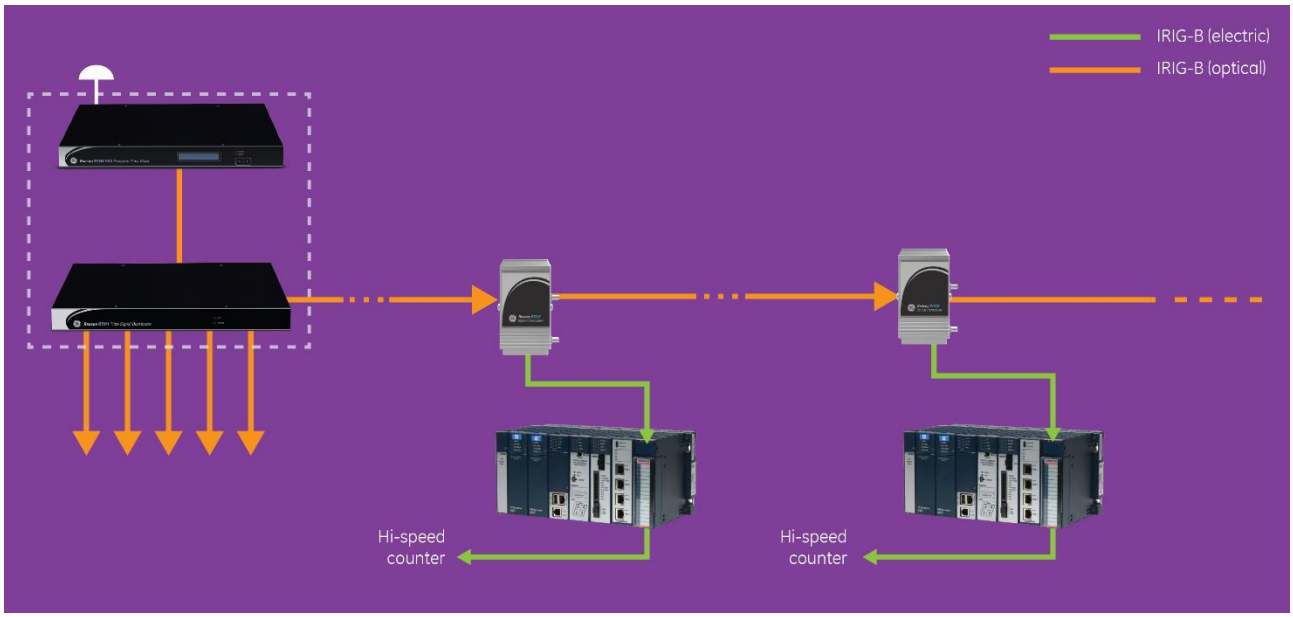

Figure 20: Time Sync expansion using RT411 and RT412