

Reason RT411

Time Signal Distributor



Technical Manual

Platform Hardware Version: A

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imagination at work

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Reason RT411

Time Signal Distributor

Chapter 1: Introduction

This chapter provides general information about the technical manual and an introduction to RT411 Time Signal Distributor.

1 Foreword

This technical manual provides a functional and technical description of GE Reason RT411 Time Signal Distributor, 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.

Acronyms 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

RT411 - Time Signal Distributor expands the number of electrical/optical signal outputs from a GPS/GNSS Clock. 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.

RT411 multiplies IRIG-B demodulated, PPS or any signal with a voltage up to 5 Vdc, and frequencies up to 5 MHz, through the electrical and optical outputs. The equipment's time accuracy is based on the accuracy of the time reference source been used.

The equipment has up to 10 electrical outputs with a 150 mA individual supply capacity and up to 10 optical outputs for multimode fiber and ST connector.

It also has indicators for monitoring the received time reference signal and the power supply.

3 Functional Overview

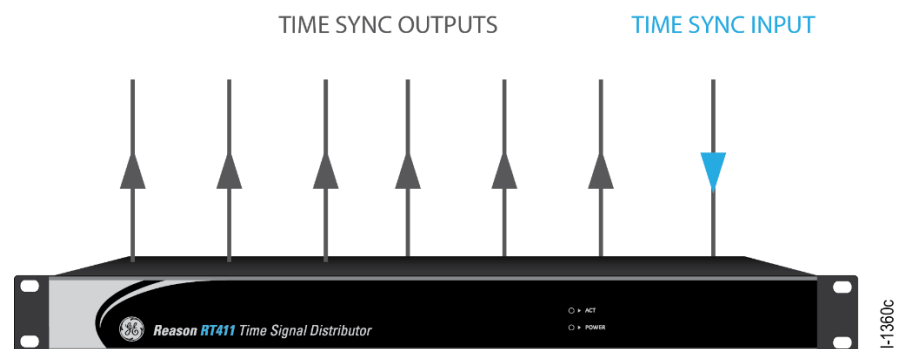


Figure 1: Functional Overview of RT411

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/Serviceing



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 RT411

1 Equipment View

The front panel of the RT411 comprises two indicators. The Act indicator shows if the time reference is detected, and the Power indicator simply shows if the equipment is energized or not.



Figure 2: Front view of RT411



Figure 3: View from RT411 connectors

The RT411 comprises:

- One power supply, AC/DC high voltage;
- One electrical input, one optical input and one input selection connection for time reference;
- Ten TTL electrical outputs for synchronization, been 8x using the Euro Type connector and 2x the BNC connectors;
- Ten optical outputs using ST connectors;

2 Power Supply

The power supply has 100-240Vac, 110-250Vdc nominal voltage ranges.

Reason RT411

Time Signal Distributor

Chapter 4: Installation

The RT411 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 RT411 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

The equipment has been designed to be mounted in a standard 19-inch rack using four M6x15 screws.

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 RT411’s rear panel are shown in figure below.

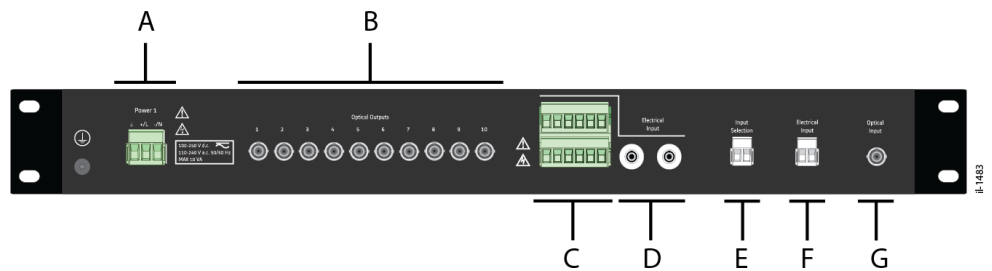


Figure 4: Connectors of RT411

Table 1: RT411 connectors

| Indicator | Description |
|-----------|------------------------------------------------------------------------------------------------------------|
| A | Power supply, high voltage AC/DC |
| B | 10 optical outputs, ST connectors |
| C | 8 electrical TTL outputs, Euro Type connectors |
| D | 2 electrical TTL outputs, BNC connectors |
| E | Jumper to select the type (electrical or optical) of input signal for time reference , Euro Type connector |
| F | Electrical Input for time reference, Euro Type connector |
| G | Optical Input for time reference, ST connector |

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.

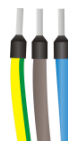


Figure 5: Pre-insulated tubular pin terminals

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.

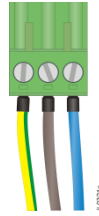


Figure 6: Supply connector assembly

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

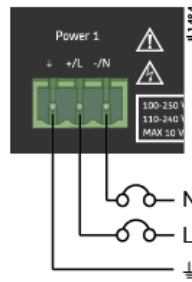


Figure 7: RT411 power connection

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 RT411 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 safety and performance, the case protective ground connection must be grounded to the panel using a 10mm width copper strap (minimum) with M6 ring lug connector.

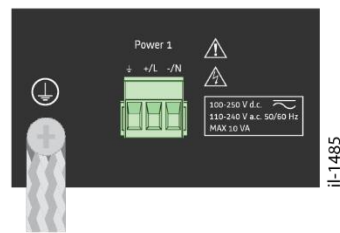


Figure 8: RT411 Grounding Strap

Electrical/Optical Time Input

The RT411 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 RT411 depends on the time reference source.

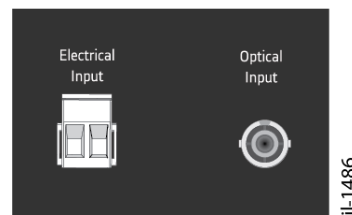


Figure 9: Electrical/Optical Time Input

To synchronize the RT411 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 connection in the INPUT SELECTION connector, as shown below. In case the jumper is disconnected, the equipment operates using the optical time reference port insulated.

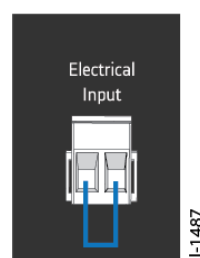


Figure 10: Input Selection

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 Outputs

The RT411 has 10 outputs for multimode optical fiber as shown below.

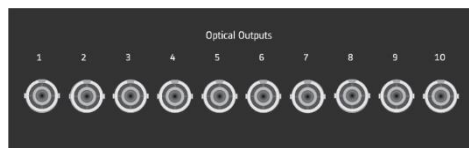


Figure 11: Optical Outputs

All optical and 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 RT411 has 10 electrical outputs, 8 using the Euro Type connectors and 2 using the BNC connectors.

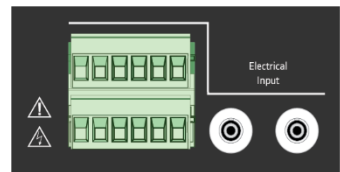


Figure 12: Electrical Outputs

All optical and electrical outputs have the same signal as the one applied in the time reference input.

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.

The following information is available in the top of the unit, but if it is already installed in the panel, it may be useful when handling the Euro Type connector for TTL outputs

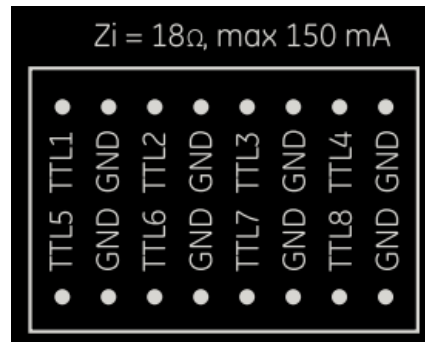


Figure 13: Euro Type label for connections

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 RT411, 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 ASHRAE 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.

Reason RT411

Time Signal Distributor

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.

Reason RT411

Time Signal Distributor

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 \pm 3 Hz |
| Power Consumption | MAX 20 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 | 10 |
| TTL Voltage Level | 5 Vdc |
| High Level | > 4.8 Vdc |
| Low Level | < 0.2 Vdc |
| Impedance | 5 Ω |
| Maximum current | 150 mA |
| Time Difference between Input and Outputs (mean) | 73 ns |
| Connectors | 8x Euro Type 2x BNC |

5 Optical Outputs

Table 7: Optical Outputs specification

| | |
|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Number of Outputs | 10 |
| Connector | ST |
| Wavelength | 820 nm |
| Fiber Type | Multimode 50/125 μm, 62.5/125 μm, 100/140 μm or 200 μm HCS |
| Power Emission | - 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

| | |
|---------------------------------------|------|
| Front flush mounted with panel | IP54 |
| Rear and sides | IP20 |

| | |
|----------------------------------|-----------------------------------------------------|
| Product safety protection | IP20 (due to live connection on the terminal block) |
|----------------------------------|-----------------------------------------------------|

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 | <ul style="list-style-type: none"> • 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 |

| | |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <p>Test level: 0% residual voltage</p> <p>Duration time</p> <p>A.C.: 300 cycles</p> <p>D.C.: 5 s</p> |
| IEC 61000-4-17:1999 | <p>Test level: 15% of rated DC value</p> <p>Test frequency: 120 Hz, sinusoidal waveform.</p> |
| IEC 61000-4-18:2006 | <p>Voltage oscillation frequency: 1 MHz</p> <p>Differential mode: 1 kV peak voltage;</p> <p>Common mode: 2.5 kV peak voltage</p> |
| IEC 60255-26:2008 | <p>Shut-down ramp: 60 s</p> <p>Power off: 5 m</p> <p>Start-up ramp: 60 s</p> |
| CISPR11:2009 | <p>Radiated emission</p> <p>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</p> |
| CISPR22:2008 | <p>Radiated emission</p> <p>The definition of the limit frequency is based on the maximum internal frequency of the equipment. On RT411, the maximum internal frequency is 5 MHz. For this case, the levels of CISPR 11 satisfy the normative IEC 60255-26.</p> <p>Conducted emission</p> <p>0.15 to 0.50 MHz - 79dB (µV) quasi peak; 66 dB (µV) average</p> <p>0.5 to 30 MHz - 73dB (µV) quasi peak; 60 dB (µV) average</p> |

Table 11: Safety tests

| | |
|----------------------------------------------------------|----------------------------|
| <p>IEC 61010-1</p> <p>CE Certification</p> | <p>Safety Requirements</p> |
|----------------------------------------------------------|----------------------------|

| | |
|--------------------|-------------------------------------------------------------------------|
| 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 +85°C / 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 | 44.3 mm (1.7 in) |
| Width (body) | 430 mm (16.9 in) |
| Depth | 180 mm (7.1 in) |
| Weight | 2.3 kg (5.0 lbs) |

RT411 dimensions are shown below.

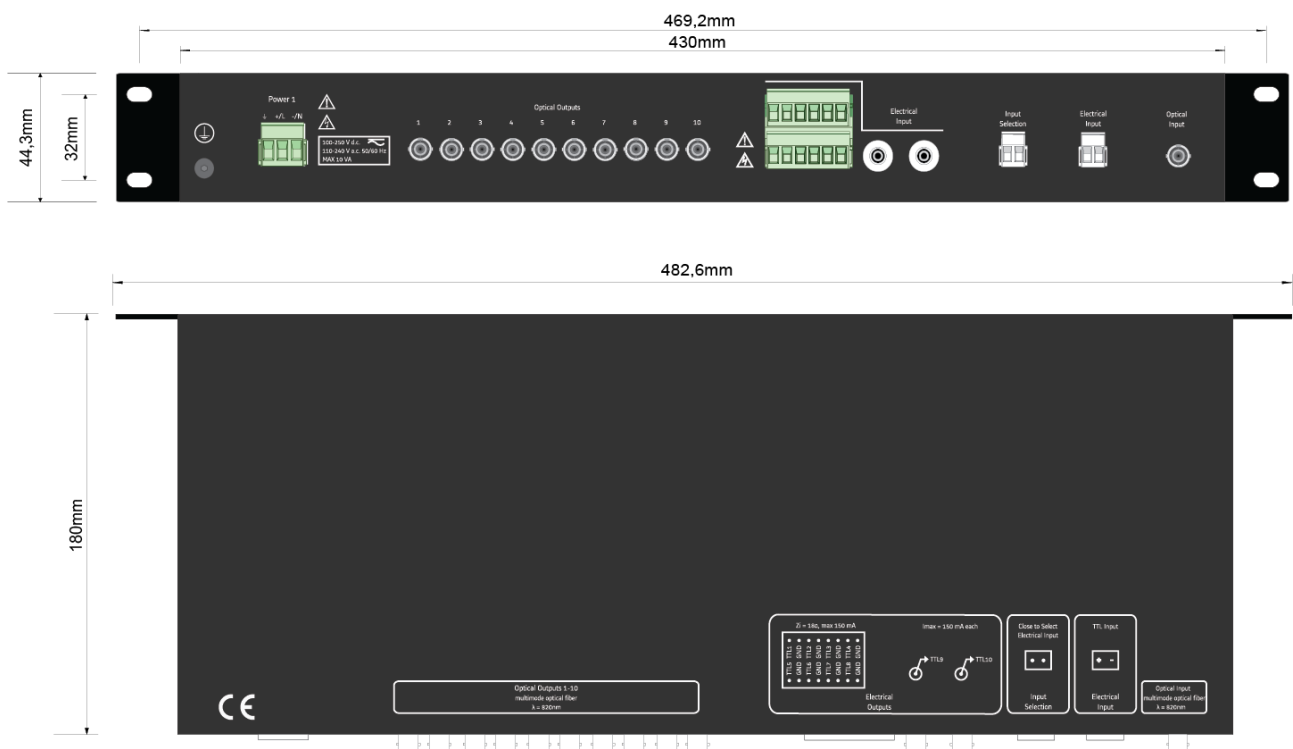


Figure 14: RT411 Dimensions

Reason RT411

Time Signal Distributor

Chapter 7: Ordering Options

This chapter describes the CORTEC number formation from RT411.

1 RT411 Cortec

| Variants | Order Number | | | |
|--------------------------------------------------------------------------|--------------|---|---|---|
| | 1-5 | 6 | 7 | 8 |
| Model Type RT411 Time Signal Distributor | RT411 | | | |
| Power Supply 24-48 Vdc 100-250 Vdc / 110-240 Vac | | 4 | 3 | |
| Customization / Regionalisation GE branding | | | C | |
| Hardware Design Suffix Initial version | | | | A |

Issue D

Reason RT411

Time Signal Distributor

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

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

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

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

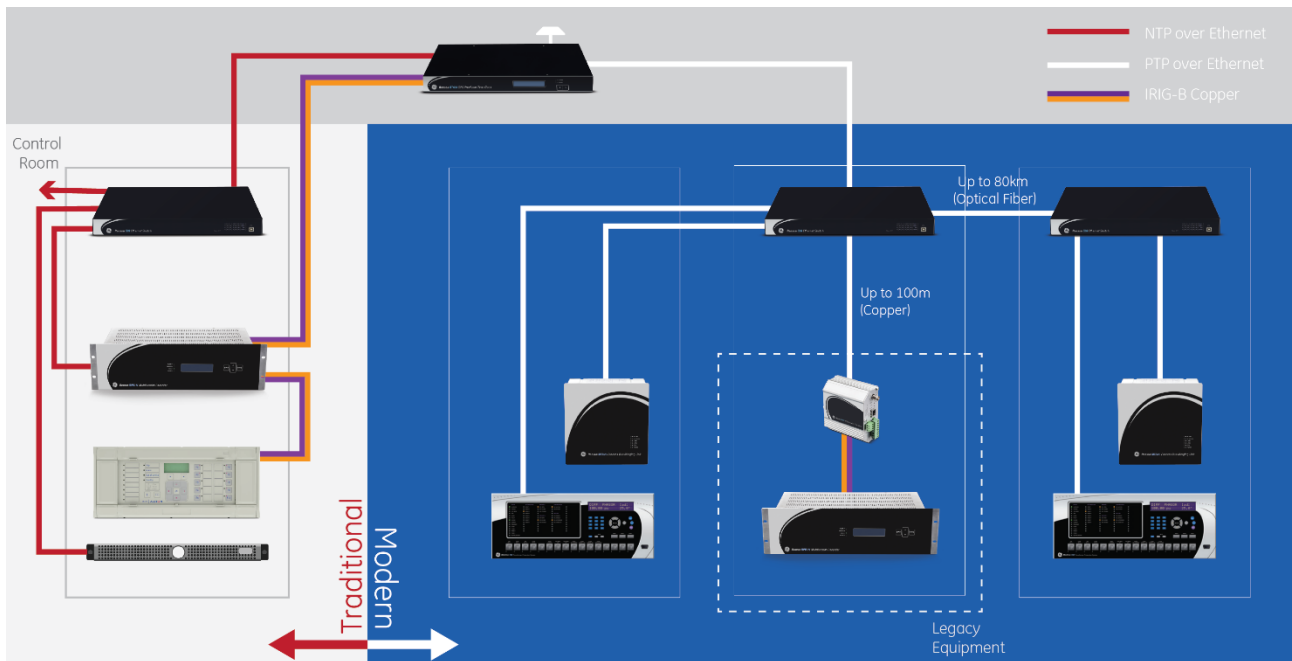


Figure 15: Traditional x Modern Time Synchronization

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.

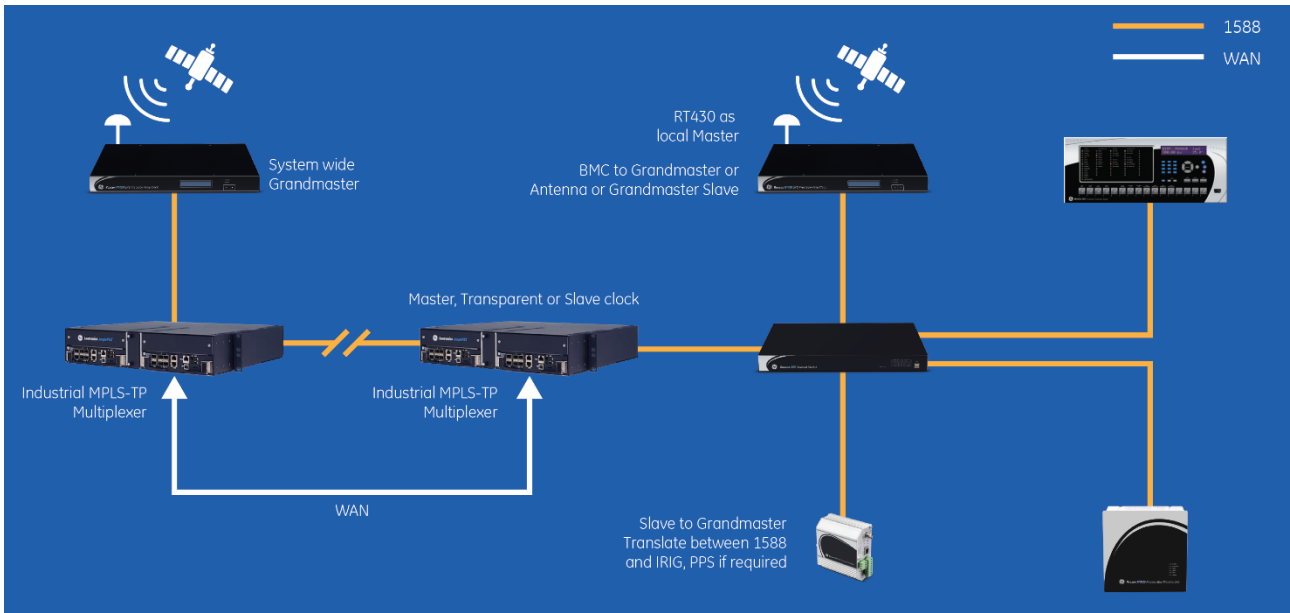


Figure 16: System Wide Grandmaster Clock

Application Example 3: Synchrophasor, TWFL and Process Bus Applications

Requiring 1 μ s 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.

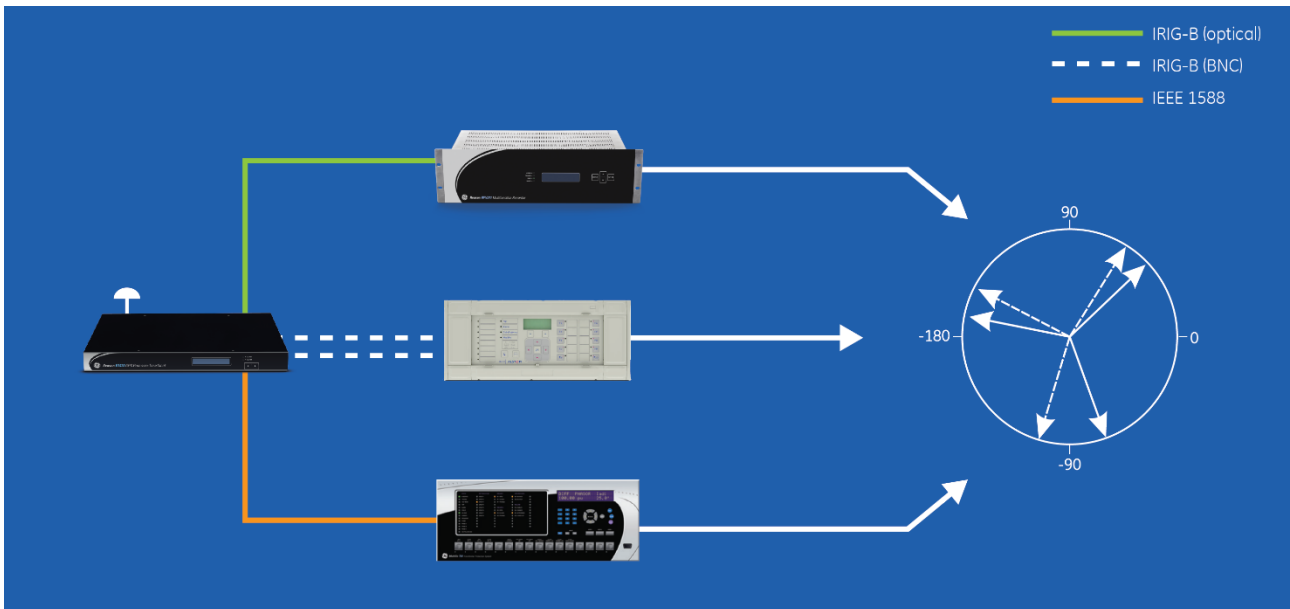


Figure 17: Synchrophasor devices synced by RT430/434



Figure 18: TWFL application using RT430/434 for Time Sync

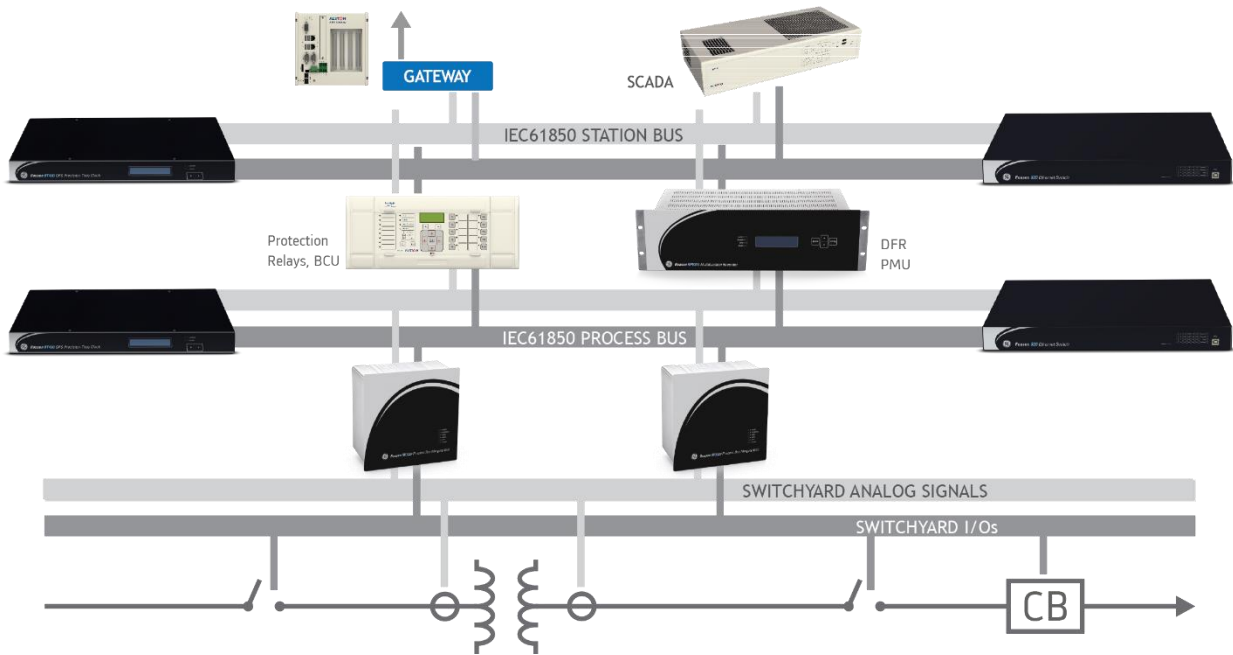


Figure 19: Process Bus application using PTP via the Station Bus network.

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.

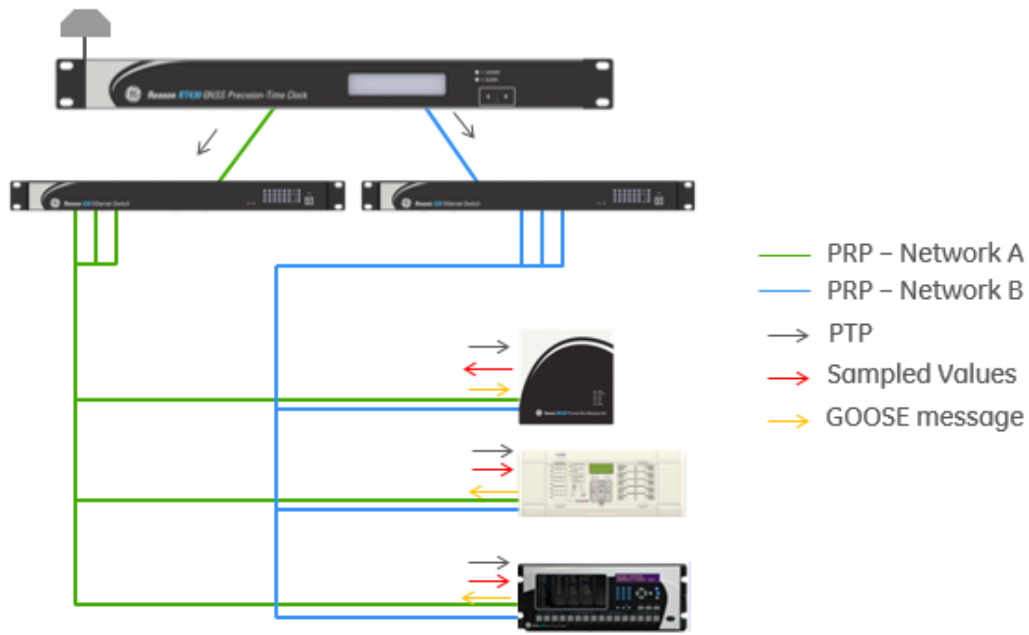


Figure 20: Process Bus application using PTP via the Station Bus network.

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.

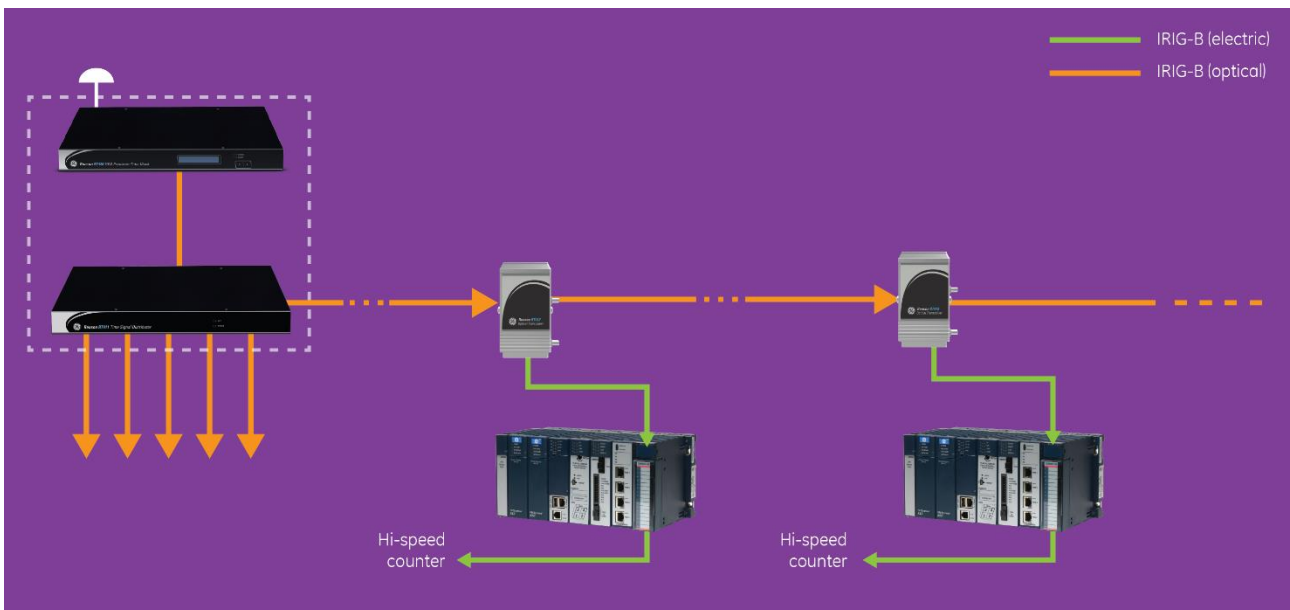


Figure 21: Time Sync expansion using RT411 and RT412

