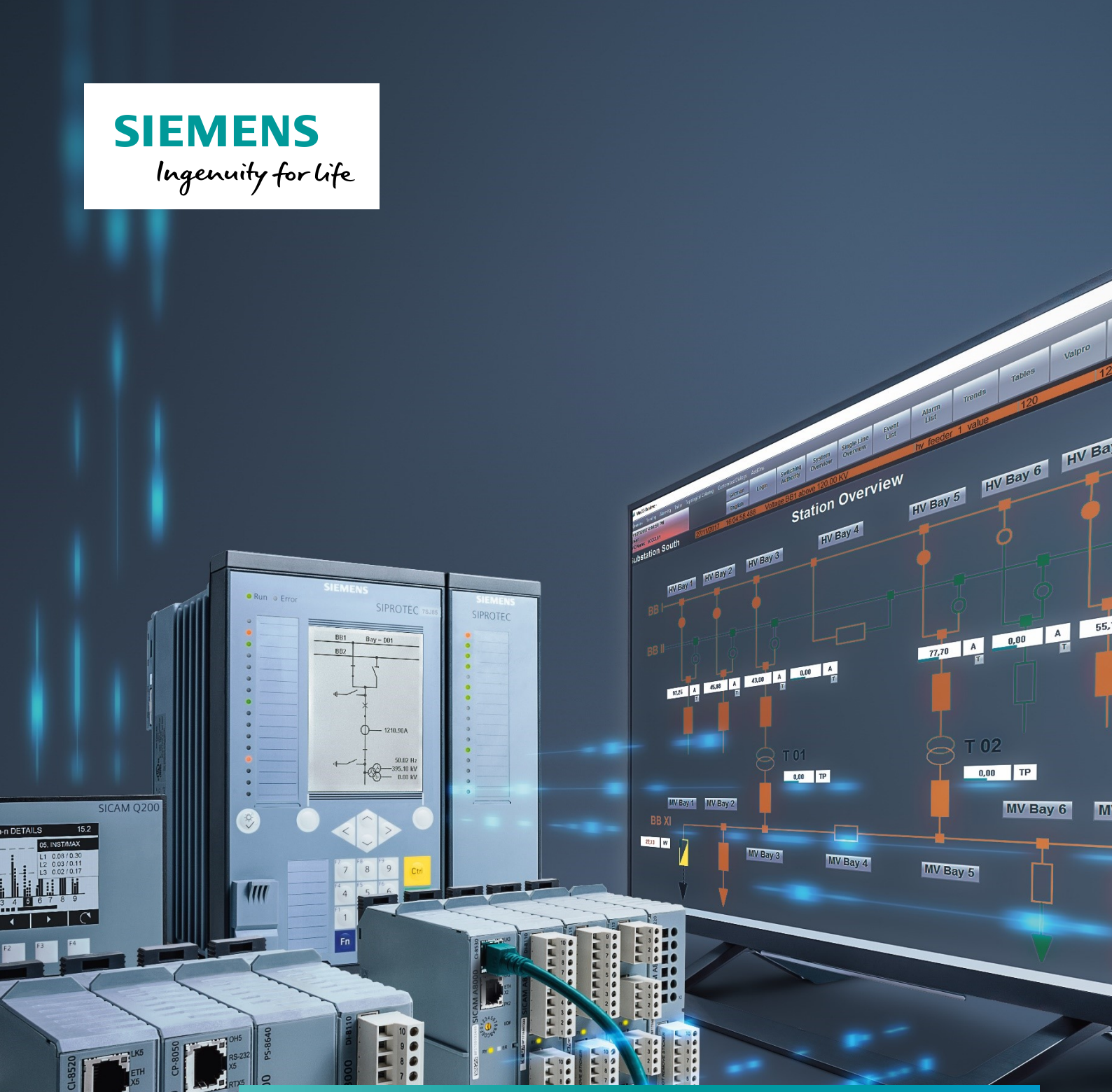
SIEMENS

Ingenuity for life



Configuration of an RSG 2488 as IEEE 1588 master clock for process bus applications

www.siemens.com/siprotec5

SIPROTEC 5 Application

Configuration of an RSG 2488 as IEEE 1588 master clock for process bus applications

APN-072, Edition 3

Content

1 Configuration of an RSG 2488 as IEEE 1588 master clock for process bus applications

1.1 Introduction

For the proper operation of the process bus it is necessary to grant the synchronization of the sampled values SV. This can be done using a PPS signal (pulse per second) or the IEEE1588v2/PTP (precision time protocol). The profile specified by the IEC 61850 and IEC 61869 for the power utility automation is the IEC/IEEE 61850-9-3.

In this application note is described how to parameterize the RUGGEDCOM RSG 2488 as IEC/IEEE 61850-9-3 master clock (IEEE 1588V2). It is usable for non-redundant distributed busbar protection or in demo setups.

Keep in mind that for complete stations it is strongly recommended the implementation of redundant communication networks. As normally several ports and even several switches are required to connect all client and server devices, it is also necessary to use independent master clocks (not integrated in the switch) with DAN (double attached node) support, i.e. with native PRP or HSR functionality, according to the communication network deployed. Siemens recommends using at minimum 2 independent master clocks in order to fulfill the N-1 criteria.

A special application case for small stations and distributed busbar protection with redundant communication, where the master clock and switch functionality are integrated in the same device, is described in the APN-073 Special network topology for distributed busbar protection.

1.2 Management of the synchronization information in the SIPROTEC 5 devices

The synchronization information depends on the edition of the IEC 61850 standard implemented.

The merging unit sends the corresponding of the following the synchronization states:

- 0: internal synchronization
- 1: local synchronization
- 2: global synchronization

a. PTP Synchronization with IEC 61850 Ed.2.1 streams

With the Edition 2.1 the merging unit sends additionally the grandmaster clock ID of the PTP master clock used for synchronization of samples. Hence samples can be aligned not only when they are globally synchronized (synchronization state=2) but also when they are synchronized to the same (PTP) clock, given when the clock ID is matching; i.e. all samples are synchronized to the same master clock.

So, when using the Edition 2.1 of the IEC 61850 is possible to keep the protection scheme operative even though no global synchronization is available, with the precondition that all sample values are synchronized to the same master. This capability provides increased availability and therefore it is our preferred option.

b. PTP Synchronization with IEC 61850 Ed.2.0 or IEC 61850-9-2 LE streams

When the use of IEC 61850 Ed.2.0 or IEC 61850-9-2 LE streams is unavoidable for backward compatibility all sample values need to have the synchronization state=2 (global) to be aligned and keep the system operative. When one or more merging units indicate State=1 (local), it is not possible to determine if all the sampled values are being synchronized to the same master and the client device will, as consequence, block the affected protection functions.

1.3 Considerations for the use of an RSG 2488

The Ruggedcom RSG 2488 provides up to 28 ports that can be configured as 10/100/1000TX copper, 100FX, 1000SX or 1000LX fiber. However, depending on the PTP functionality and the time source enabled, the ports **2/4, 4/4, 6/4, 7/2** could not support the PTP telegrams. Take into consideration the following table.

Time Source	Clock Type	PTP Profile	Ethernet Ports 2/4, 4/4, 6/4, 7/2 available?
GPS	Ordinary Clock	Power Profile	Yes
	Ordinary Clock	Power Profile v2	Yes
	Ordinary Clock	Utility Profile Level 1	Yes
IRIG B	Ordinary Clock	Power Profile	Yes
	Ordinary Clock	Power Profile v2	Yes
	Ordinary Clock	Utility Profile Level 1	Yes
Local	Ordinary Clock	Power Profile	No
	Ordinary Clock	Power Profile v2	No
	Ordinary Clock	Utility Profile Level 1	No
NTP Server	Ordinary Clock	Power Profile	No
	Ordinary Clock	Power Profile v2	No
	Ordinary Clock	Utility Profile Level 1	No
IEEE1588	Ordinary Clock	Power Profile	No
	Ordinary Clock	Power Profile v2	No
	Ordinary Clock	Utility Profile Level 1	No
GPS	OC and P2P Tclock	Power Profile	No
	OC and P2P Tclock	Power Profile v2	No
	OC and P2P Tclock	Utility Profile Level 1	No
IRIG B	OC and P2P Tclock	Power Profile	No
	OC and P2P Tclock	Power Profile v2	No
	OC and P2P Tclock	Utility Profile Level 1	No
Local	OC and P2P Tclock	Power Profile	No
	OC and P2P Tclock	Power Profile v2	No
	OC and P2P Tclock	Utility Profile Level 1	No
NTP Server	OC and P2P Tclock	Power Profile	No
	OC and P2P Tclock	Power Profile v2	No
	OC and P2P Tclock	Utility Profile Level 1	No
IEEE1588	OC and P2P Tclock	Power Profile	No
	OC and P2P Tclock	Power Profile v2	No
	OC and P2P Tclock	Utility Profile Level 1	No
Time Source	Clock Type	PTP Profile	Ethernet Ports 2/4, 4/4, 6/4, 7/2 available?

GPS	P2P Tclock	Power Profile	Yes
	P2P Tclock	Power Profile v2	Yes
	P2P Tclock	Utility Profile Level 1	Yes
IRIG B	P2P Tclock	Power Profile	Yes
	P2P Tclock	Power Profile v2	Yes
	P2P Tclock	Utility Profile Level 1	Yes
Local	P2P Tclock	Power Profile	Yes
	P2P Tclock	Power Profile v2	Yes
	P2P Tclock	Utility Profile Level 1	Yes
NTP Server	P2P Tclock	Power Profile	Yes
	P2P Tclock	Power Profile v2	Yes
	P2P Tclock	Utility Profile Level 1	Yes
IEEE1588	P2P Tclock	Power Profile	Yes
	P2P Tclock	Power Profile v2	Yes
	P2P Tclock	Utility Profile Level 1	Yes

GPS	Boundary Clock	Power Profile	No
	Boundary Clock	Power Profile v2	No
	Boundary Clock	Utility Profile Level 1	No
IRIG B	Boundary Clock	Power Profile	No
	Boundary Clock	Power Profile v2	No
	Boundary Clock	Utility Profile Level 1	No
Local	Boundary Clock	Power Profile	No
	Boundary Clock	Power Profile v2	No
	Boundary Clock	Utility Profile Level 1	No
NTP Server	Boundary Clock	Power Profile	No
	Boundary Clock	Power Profile v2	No
	Boundary Clock	Utility Profile Level 1	No
IEEE1588	Boundary Clock	Power Profile	No
	Boundary Clock	Power Profile v2	No
	Boundary Clock	Utility Profile Level 1	No

Following points are also relevant:

1. The Time Source ***NTP Server*** is not suitable for process bus applications.
2. For the options ***GPS*** and ***IRIG-B*** a PTP-Module is required. Therefore, the ports 1/1 to 1/4 won't be available.

1.4 Parameterization of an RSG 2488

The device can be configured using the RS-232 Serial Console Port, using an Ethernet Port or through a Web Server.

a. Getting connection

In this chapter is described how to set the parameters related to the IEEE 1588 synchronization using a Web Server connection.

Default IP addresses are as follows:

Port	IP Address/Mask
MGMT	10.0.0.1/8
All other Ethernet ports	192.168.0.1/24

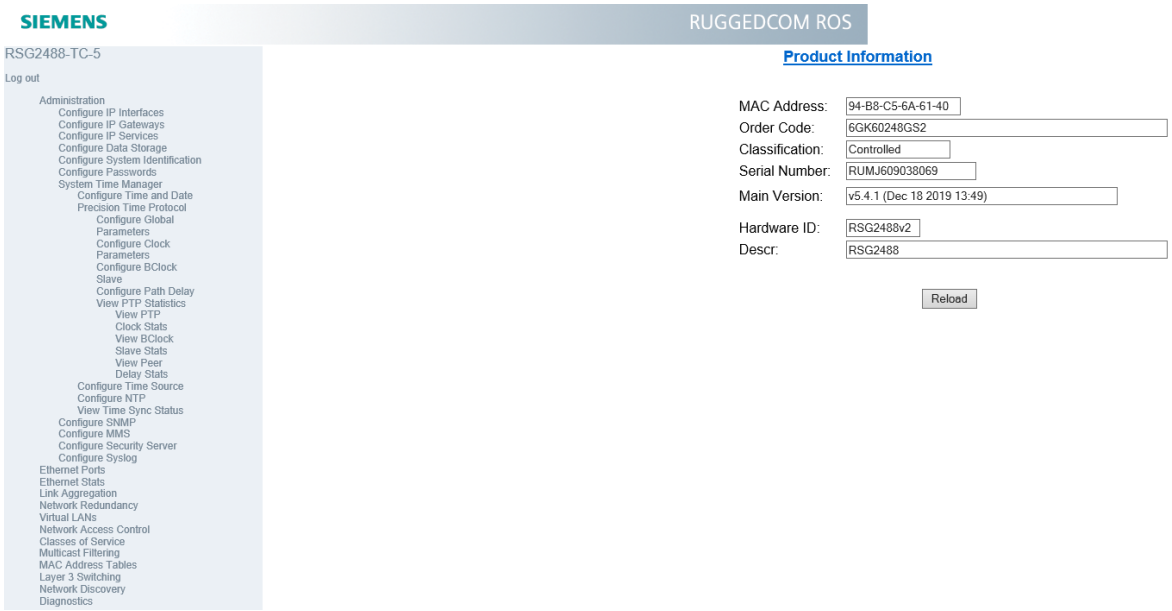
Remember using in your PC an IP address falling within the subnet of the device.

Get access to the device by typing on your browser the IP address of the connected port (for example https:// 192.168.0.1). Upon connecting to the device, some Web browsers may report the Web server's certificate cannot be verified against any known certificates. This is expected behavior, and it is safe to instruct the browser to accept the certificate. Once the certificate is accepted, all communications with the Web server through that browser will be secure.

Once the connection is established the login box appears. Below the default values

Username	Password
admin	admin

Keep in mind that if the switch has been previously configured you must know the IP address used as well as the enabled username and password.

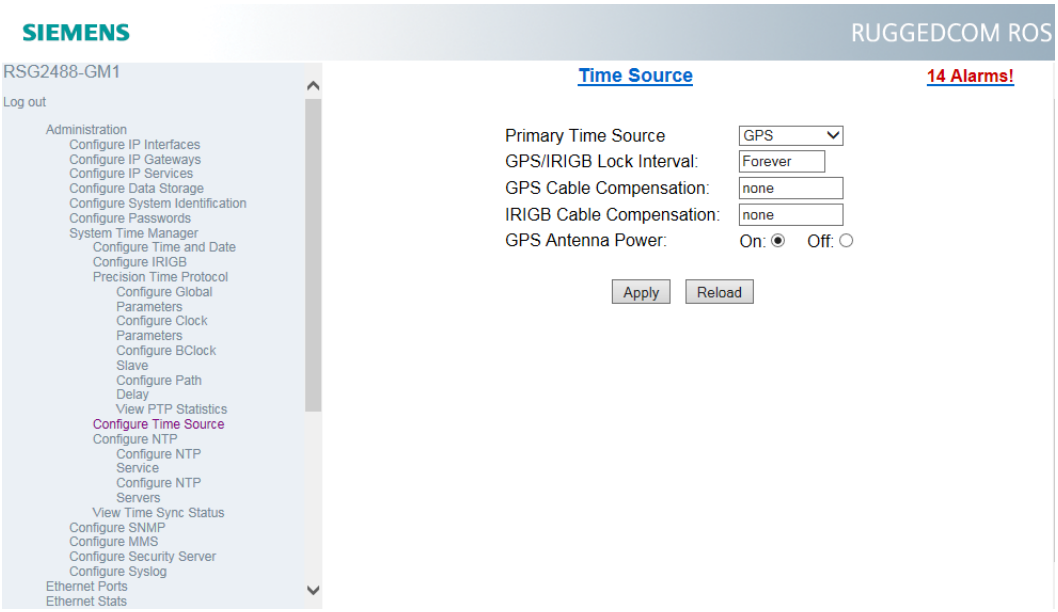


b. Configuring the device as IEEE master clock

Follow the next steps to configure the device as IEEE master clock:

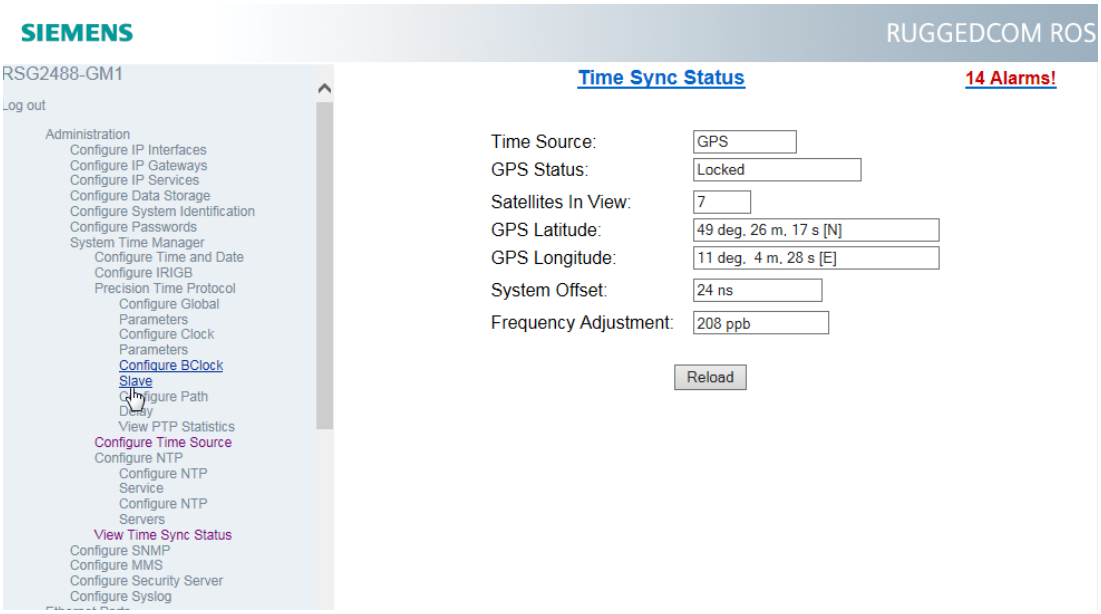
- In the menu "*Administration*" select the option "*System Time Manager*" and then go to "*Configure Time Source*".

In a normal scheme the RSG 2488 shall be connected to a GPS antenna (GNSS controlled), so select the option Primary Time Source to ***GPS***.

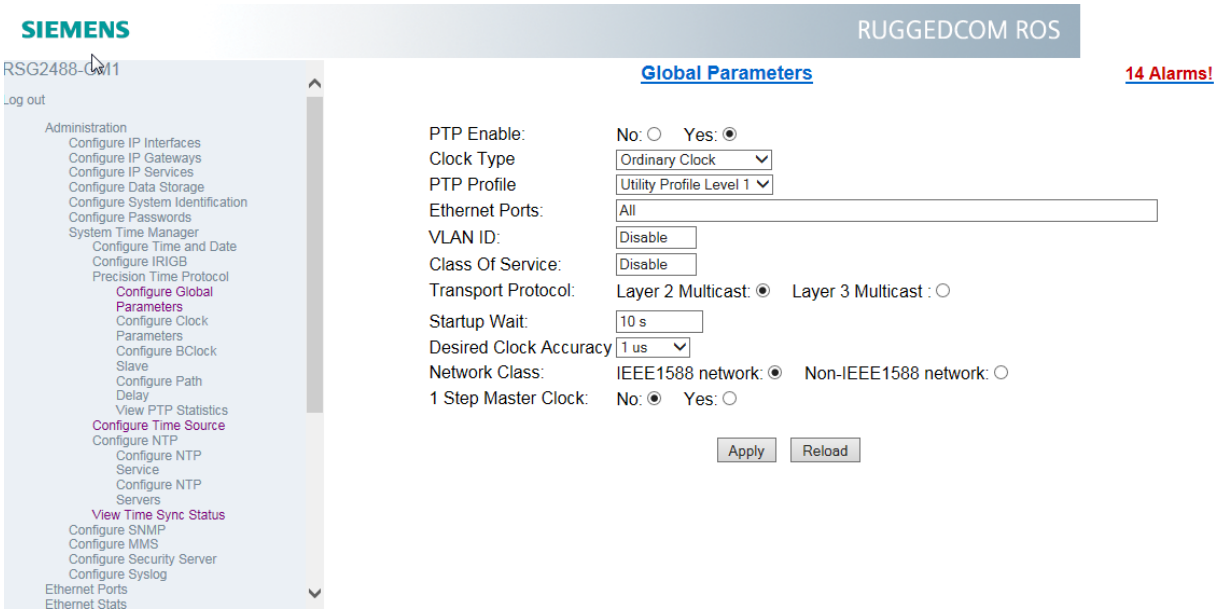


Alternative, an ***IRIG-B*** signal could be used as time source if available in the substation. The GPS Antenna Power option should be then set to *Off*.

If the GPS-Antenna cable is correctly plugged into the respective Input on the switch, then move back to „*System Time Manager*" and go to the point "*View Time Sync Status* ".
If your Antenna sends a proper signal, then it looks like this:



- Now, in the menu "*Administration*" select the option "*System Time Manager*", then go to "*Precision Time Protocol*" and there select the option "*Configure Global Parameters*" and set up the parameters as shown below:



PTP Enable: YES

Clock Type: Ordinary Clock (as the switch must be enabled to serve as master clock)

PTP Profile: Utility Profile Level 1 (it represents IEC/IEEE 61850-9-3)

Ethernet Ports: select as per your communication scheme. All available communication ports can be used to transmit the PTP signal.

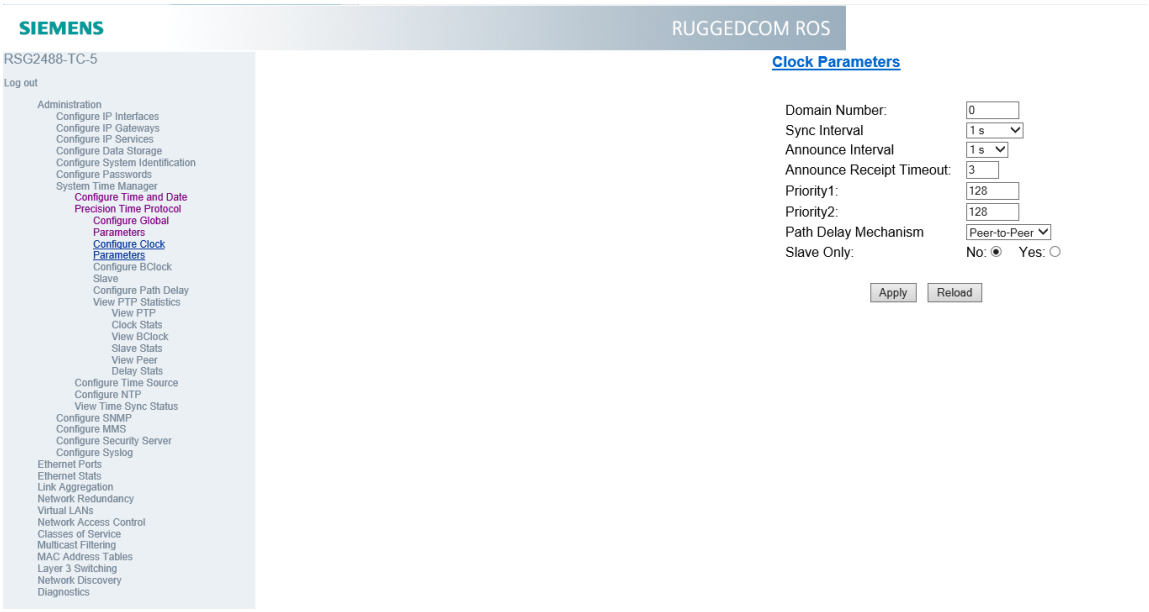
VLAN ID and Class of service: disabled

Transport Protocol: Layer 2 Multicast

Desired Clock Accuracy: 1us (or better)

Network Class: IEEE 1588 Network

- Next, in the menu "*Administration*" select the option "*System Time Manager*", then go to "*Precision Time Protocol*" and there select the option "*Configure Clock Parameters*" and set up the parameters as shown below:



Domain Number: 0

Sync Interval: 1s

Announce Interval: 1s

Announce Receipt Time out: 3

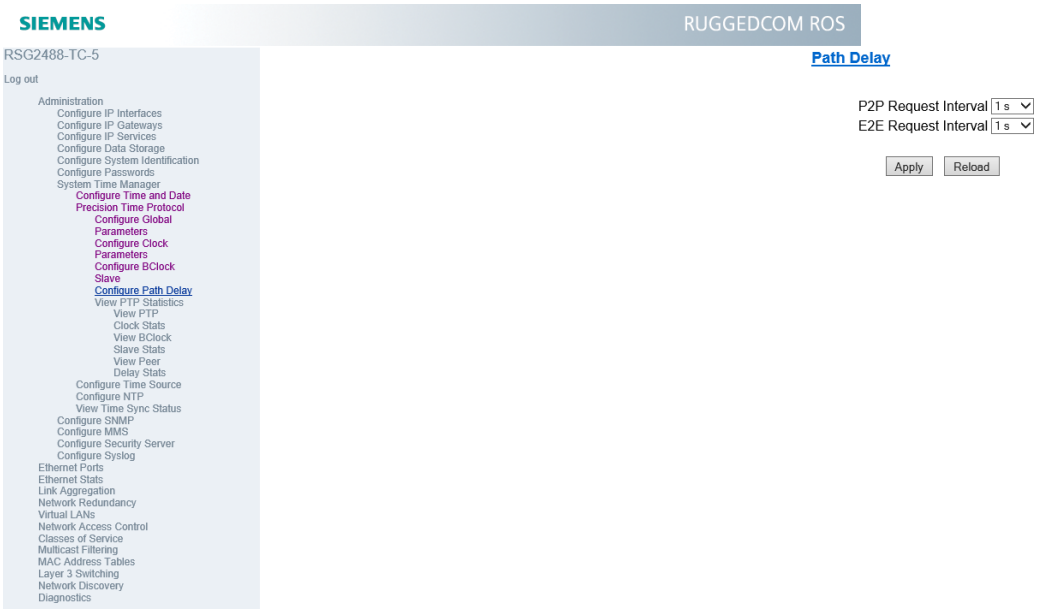
Priority1: 128 (it shall be left by default as should be the same for all master clocks)

Priority2: 128 (it shall be adapted to give priority to one of the master clocks present in the network. Lower value means higher priority)

Path Delay Mechanism: Peer-to-Peer

Slave Only: no

- Finally, in the menu "*Administration*" select the option "*System Time Manager*", then go to "*Precision Time Protocol*" and there select the option "*Configure Path Delay*" and verify the parameters as shown below:



P2P Request Interval: 1s

c. Configuring the device as NTP-Server

If the switch should additionally work as NTP-Server, go to the menu "*Administration*" - "*System Time Manager*" - „*Configure NTP*" – "*Configure NTP Service*" and make sure the service is enabled.

SNTP Parameters: Enabled

Note that the NTP-Server uses the same IP-Address configured for the Webserver.

1.5 Special case with local synchronization

In case of a demo setup where the use of an antenna is too difficult or not worthily a RUGGEDCOM RSG 2488 without PTP module could be used.

The use of local synchronization would be also possible for a busbar differential protection, only if no master clock redundancy and no communication redundancy is used. Otherwise the external synchronization is necessary to avoid the blocking of the protection system due to a difference in the internal time of the masters, in case of a master clock switching, as mentioned below. Keep in mind that under this constellation the merging units don't receive the absolute time reference and therefore the events must be time-stamped in the protection device. This time stamp will contain an error due to the transmission time between merging unit and protection device.

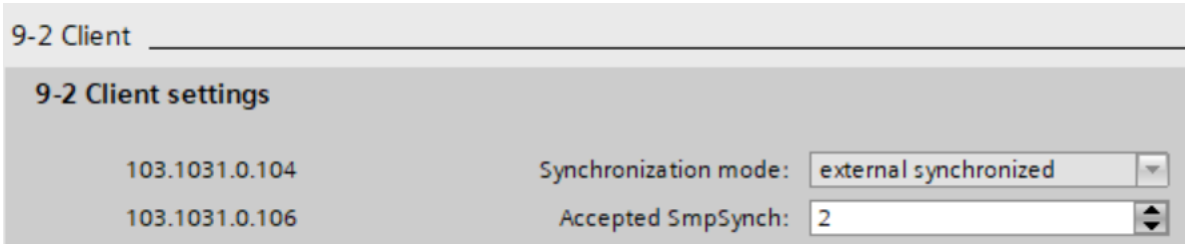
A long-term operation in a complete process bus station is not recommended based on the following:

1. The oscillator of the RSG2488 drifts in worse case 1us per minute. Over weeks, months or years this drift will accumulate, and the time stamp of the events will be correspondingly influenced making difficult the correlation with events from devices out of this synchronization system.
2. If using redundant master clocks, the time difference between masters, caused by the drift of the oscillators, will be seen by the protection devices in case of a master switching and could impact the availability of the protection functions.

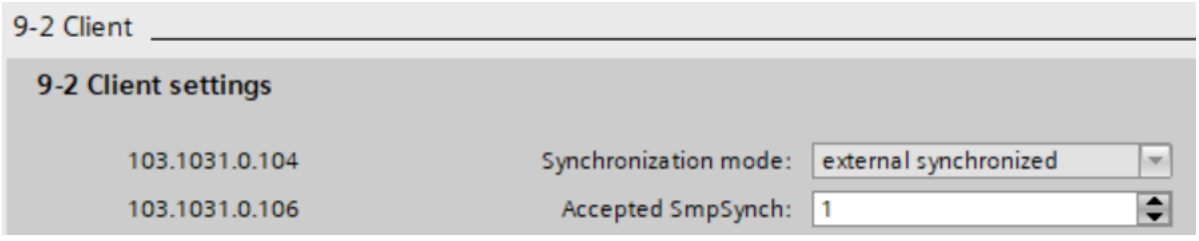
a. Parameterization in client devices

For the parameterization of the devices following scenarios are possible:

1. the connected devices use the IEC 61850 Ed2.1: it is possible take advantage of the local synchronization as explained in the chapter 1.2., so the setting can be left as global (2)



2. the connected devices use the IEC 61850 Ed2.0: you need to set the 9-2-Client Settings in the SIPROTEC 5 devices to accept SmpSynch to 1 (local). Make sure you **only** set this option if all required SV are synchronized to the same master clock all the time.

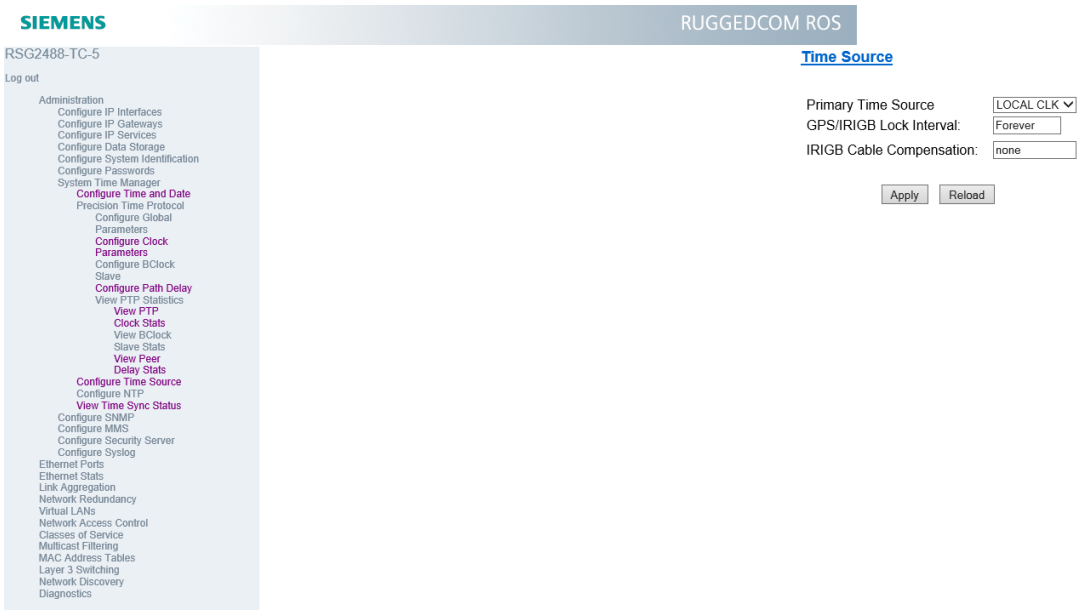


b. Parameterization of the RSG2488

The configuration of the RSG2488 is done as described in the chapter 1.3. The main difference refers to the Primary Time Source.

- In the menu "*Administration*" select the option "*System Time Manager*" and then go to "*Configure Time Source*".

Select the option Primary Time Source to **LOCAL CLK**



in the menu "*Administration*" select the option "*System Time Manager*", then go to "*Precision Time Protocol*" and there select the option "*Configure Global Parameters*" and set up the parameters as shown below:

PTP Enable: YES

Clock Type: Ordinary Clock (as the switch must be enabled to serve as master clock)

PTP Profile: Utility Profile Level 1 (it represents IEC/IEEE 61850-9-3)

Ethernet Ports: select as per your communication scheme. As example, for a switch equipped with the 28 communication ports, use the following string: 1/1-2/3, 3/1-4/3, 5/1-6/3, 7/1 (it excludes the non-PTP-compatible ports 2/4, 4/4, 6/4, 7/2). You'll have to adapt it to the actual physical ports available.

VLAN ID and Class of service: disabled

Transport Protocol: Layer 2 Multicast

Desired Clock Accuracy: 1us (or better)

Network Class: IEEE 1588 Network

Note: Using IRIG-B as primary time source is preferred over local clock, if such a signal is available. IRIG-B provides microsecond level time accuracy and avoids the disadvantages of local clock synchronization. Receiving the IRIG-B signal would still require the PTP module in the switch.

1.6 Conclusions

This application note describes how to parameterize an RSG 2488 to be used as IEEE1588 master clock. The complete sampled values synchronization scheme must be done to grant the highest availability of the protection system. For that, client and merging units involved in the same protection algorithm must be either globally synchronized or locally synchronized to the same (PTP) clock. If samples cannot be aligned the protection functionality gets blocked to avoid undesired trips.

Published by
Siemens AG

Smart Inftrastructure
Digital Grid
Humboldtstrasse 59

90459 Nuremberg, Germany

www.siemens.com/siprotec

For more information, please
contact our Customer Support
Center.

Tel.: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)

Customer Support: www.siemens.com/csc

For the U.S. published by
Siemens Industry Inc.

100 Technology Drive
Alpharetta, GA 30005
United States