SIEMENS

Ingenuity for life

Teleprotection scheme with SIPROTEC 5 devices

www.siemens.com/siprotec5

SIPROTEC 5 Application

Teleprotection scheme with SIPROTEC 5 devices

APN-013, Edition 1

Content

1 Teleprotection scheme with SIPROTEC 5 devices

1.1 Summary

The transfer of signals between substations becomes more and more important. State of breakers, but also measurement values and other information will become more important in Smart Grid solutions where devices are communicating between each others or with decentralized data concentrators. Traditionally this is done with special teleprotection equipment. Use of external equipment require additional wiring, testing and causes additional cost. If the devices can be interfaced directly to fiber optical links or communication networks the integration becomes much easier. This direct integration can be done by so called protection interfaces. Every SIPROTEC 5 device can be equipped with such a teleprotection interface and can exchange binary states and measurements with other SIPROTEC 5 devices. Various fiber optical interfaces can be used and also connections over communication networks by use of communication converters.

1.2 Solution

1.2.1 Communication topology

For a two terminal configuration each device must be equipped with a PI - interface. Module position F is used and an 820 nm fiber optical USART – module realize the direct fiber optical connection. Only one channel of this module is necessary for a two terminal PI – connection. Channel 2 may be used as spare channel or for a serial connection to a substation automation system using e.g. IEC 60870-5-103 protocol.

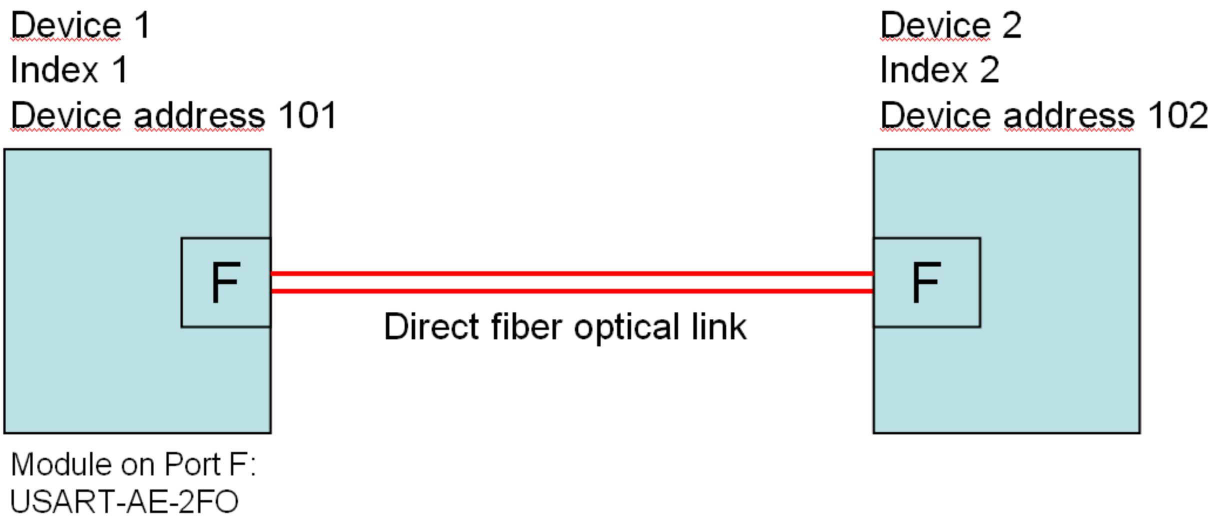

Figure 1: Example of a Protection Interface configuration with direct fiber optical link

1.2.2 Configuration assignment of device 1 in DIGSI 5

The communication module configured later with a PI - interface is taken from the hardware catalogue (right side) and assigned to module location F. Different fiber optical interfaces can be used as PI – interface. For short connections or a connection to a communication converter the USART-AD-1FO or USART-AE-2FO will be used. For direct fiber optical connection over single or multimode fiber connections other type of interfaces with 1300 nm or 1550 nm wavelength are available. Distances of up to 100 km can be spanned by these wide range modules. Best choice for a PI – interface is a direct fiber optical connection. This offers a high bandwidth connection, immunity against external disturbances and no significant delay time for the signal transfer. But also communication networks can be used for the transfer. All properties for transfer over communication networks are considered in the design of the PI – interface like delay time measurement and the permanent supervision of the quality of the data connection.

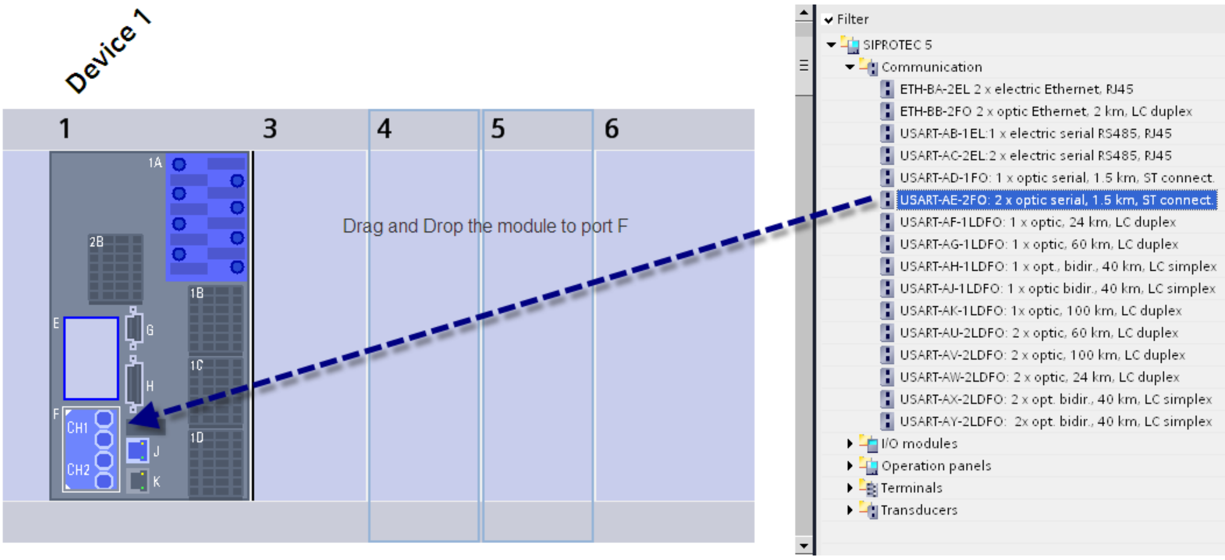

Figure 2: Assignment for module location F for the PI – interface

The settings for the first PI-interface are shown in Figure 3. The PI – interface is handled like a communication protocol which must be assigned to one channel (here channel 1) of the serial communication module (USART – module). For multiterminal (>2) connections two PI-interfaces or two channels of one communication module are required.

After this assignment of the PI-protocol the settings for the PI – interface appear. Detailed explanation for these settings is given in the manual of the devices using the PI – interface (e.g. the line protection devices 7SL8x, 7SD8x and 7SA8x).

The constellation determines how much devices are communicating with each other. Up to six are possible. Each device in a constellation must have a unique address between 1 and 65535. Here device 1 has address number 101 and device 2 number 102. Device 1 is the local device. Important is the ´Lowest appearing bitrate´. This is the slowest data connection in a device constellation and determines the number of data objects which can be transferred between the devices of a constellation. For a direct fiber optical connection it’s 2048 kBit/s and therefore the highest value. Limiting value is a 64 kBit/s connection between two devices of a constellation. Especially for a differential protection function running parallel the number of additional data objects is limited. How much data objects are possible will be described for type 1 and type 2 PI-interface in the manual.

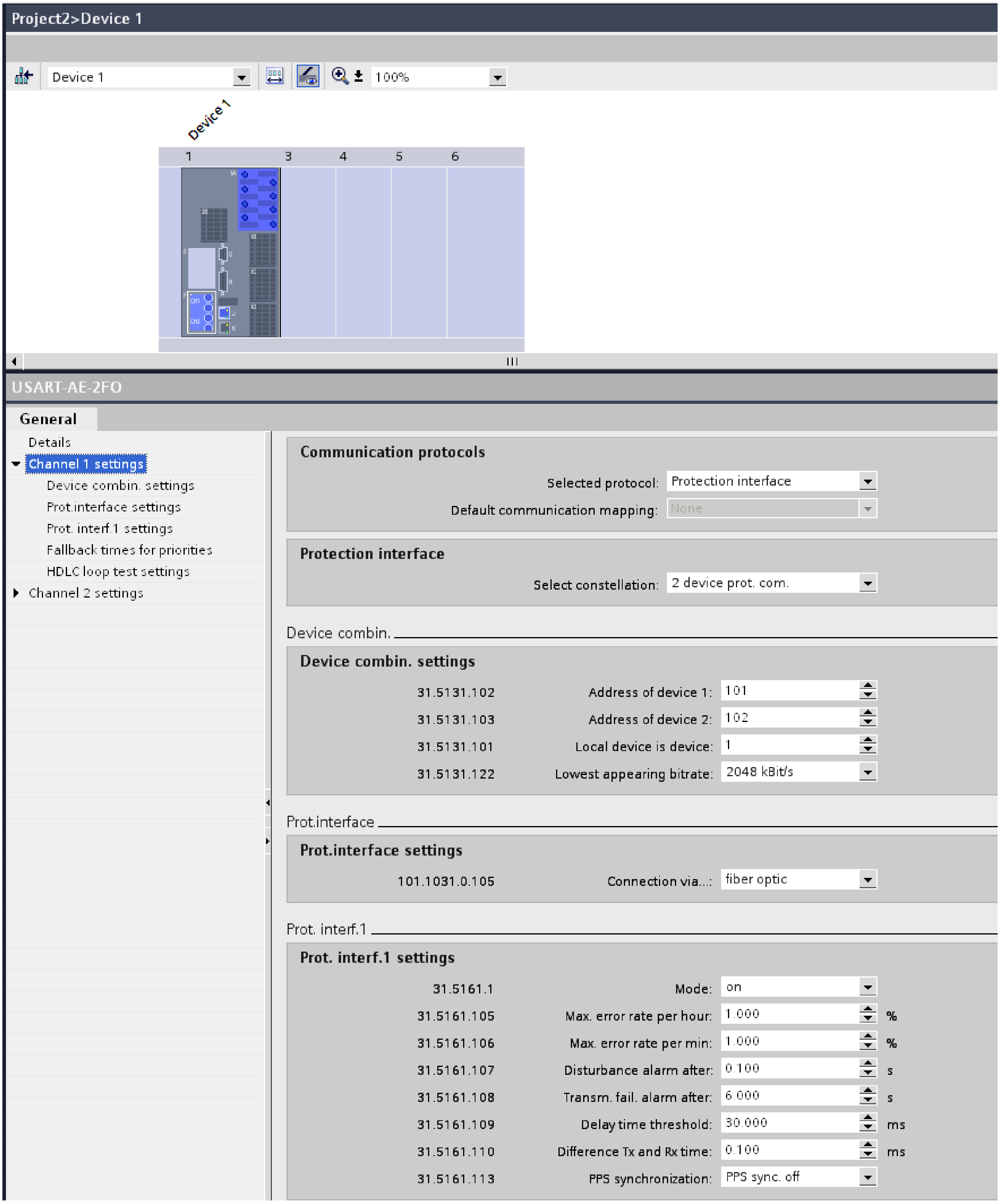

Figure 3: Settings for the PI-interface on module location F for device 1

1.2.3 Configuration assignment of device 2 in DIGSI 5

In device 2 we are using the same module and the same settings except one value. Fig. 4 show the settings for the PI – interface for device 2.

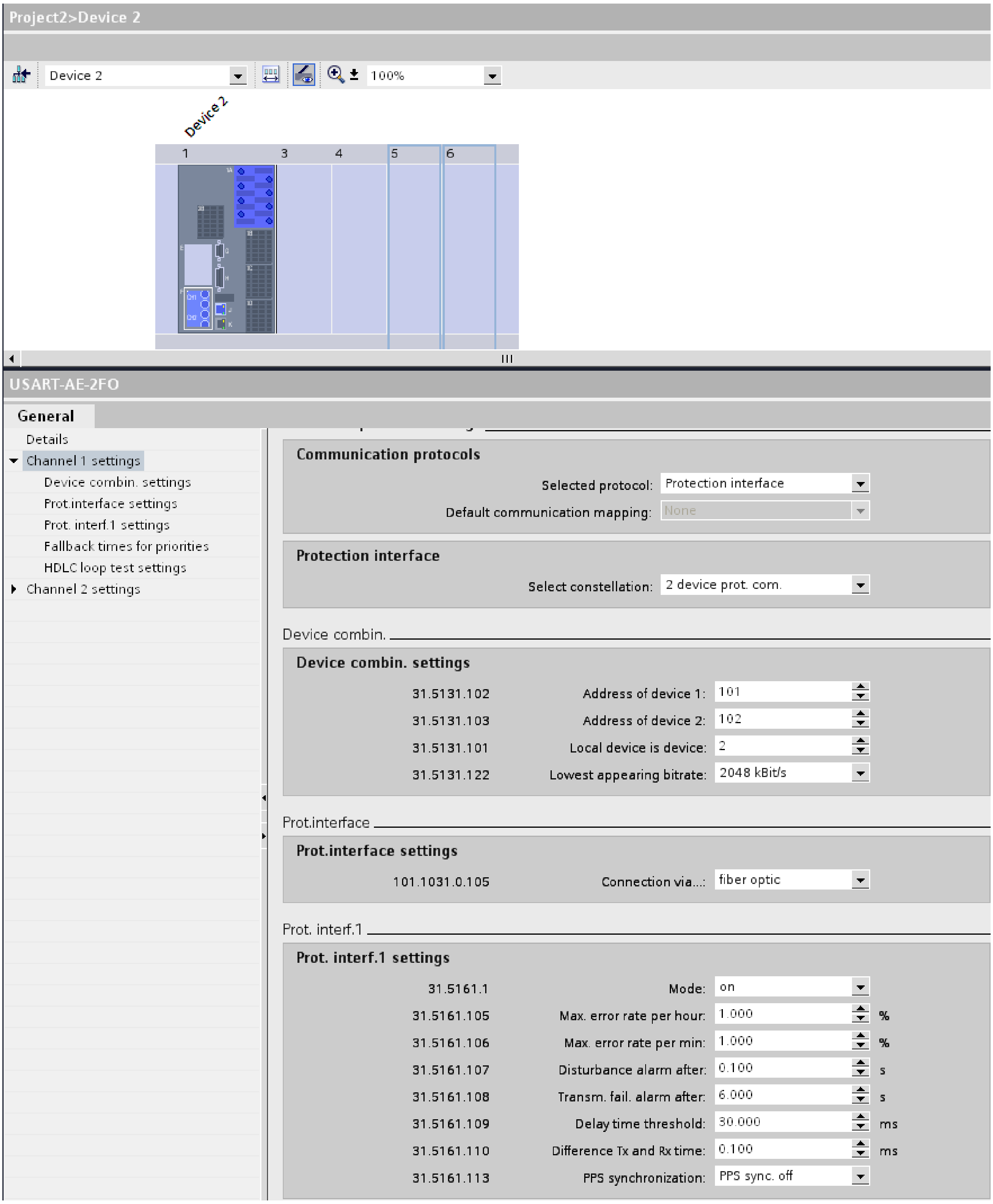

Figure 4: Settings for the PI-interface on module location F for device 2.

1.2.4 Principle of the data transfer via the protection interface

Depending on the available bit rate between the devices and the type of the interface (differential (type 1) or non-differential (type 2)) signals and measurements can be freely assigned in DIGSI 5 in a communication mapping editor. These values are transferred between devices belonging to a constellation with a common communication topology.

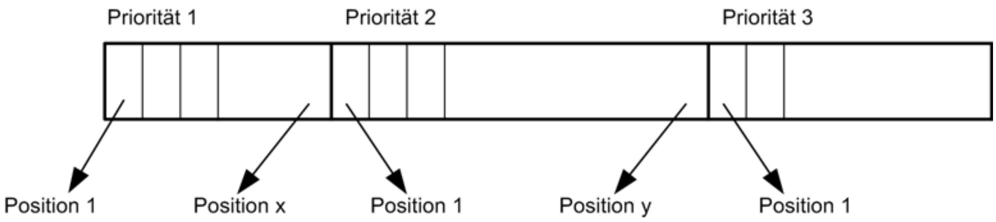

Figure 5: Principle of the data transfer via the protection data interface

The signals (data objects) can be assigned in different priority levels. The amount of signals for each level is limited by the ´Lowest appearing bitrate´ and checked by DIGSI 5 according to this setting. Please be sure this setting is valid from beginning and equal in each device of a constellation. If this setting is wrong the values in the communication matrix can not be transferred over the physical connection between the devices if the bandwidth is not available for one connection.

Signals assigned with priority 1 are send with every telegram (5 – 10 ms). Signals and measurements with priority 2 are send with every 2. telegram (10 – 20 ms). Signals and measurements with priority level 3 are send latest every 100 ms. Each signal or measurement must be assigned to a specific position inside a priority level. If e.g. a trip signal from device 1 (single point indication) is assigned to priority 1 and position 1 the other device can read the information from this position (see Fig. 5). Device 2 may assign a trip signal to priority 1 and position 2, but not to position 1, because this position is already used by device 1. So all devices share this bit – strip which is always transferred between the devices and updated by the devices. A single point indication covers one bit (position). A double point indication 2 bits and a measurement 32 bits. Important to know is that at the receiving device a data object from the same type must be configured for the reception of this data object. Normally this is a preconfigured blocking input or a user defined signal.

Because devices connected over PI-interfaces are located in different substations and different DIGSI 5 projects there are no plausibility checks for the data objects configured to the PI-interface. It’s under the responsibility of the user to configure for a send data object inside a priority the same type of data object for the receiving device on the same bit – position.

Fig. 3 shows settings for the fallback times for each priority which are valid for all received data objects assigned to this priority. If a loss of communication is detected by the receiving device after this time the value of the data object can be set to a safe state (e.g. a blocking signal with state ´1´ can be set to ´0´).

1.2.5 Assignment of signals in the routing matrix

In the routing matrix we take 8 single point signals (SPS) from the signal catalogue, rename them to ´Binary input 1´ - ´Binary input 8´ and assign them to binary inputs of the device. If a binary input is set then this signal appear as ´1´ in the device. This signal is also assigned to the fault record as a binary trace and to the operational log. Therefore the input signals are indicated in the device with date and time with millisecond resolution.

Another 8 SPS-signals are taken from the catalogue and renamed in ´Binary output 1´ - ´Binary output 8´. These signals are assigned to contact outputs, operational log and the fault record. All input and output states are indicated on LED. Output signals are received over the PI-interface from the binary inputs of the other device.

These signals are created under the function group Prot.interf.1. But in general we can use also another function group.

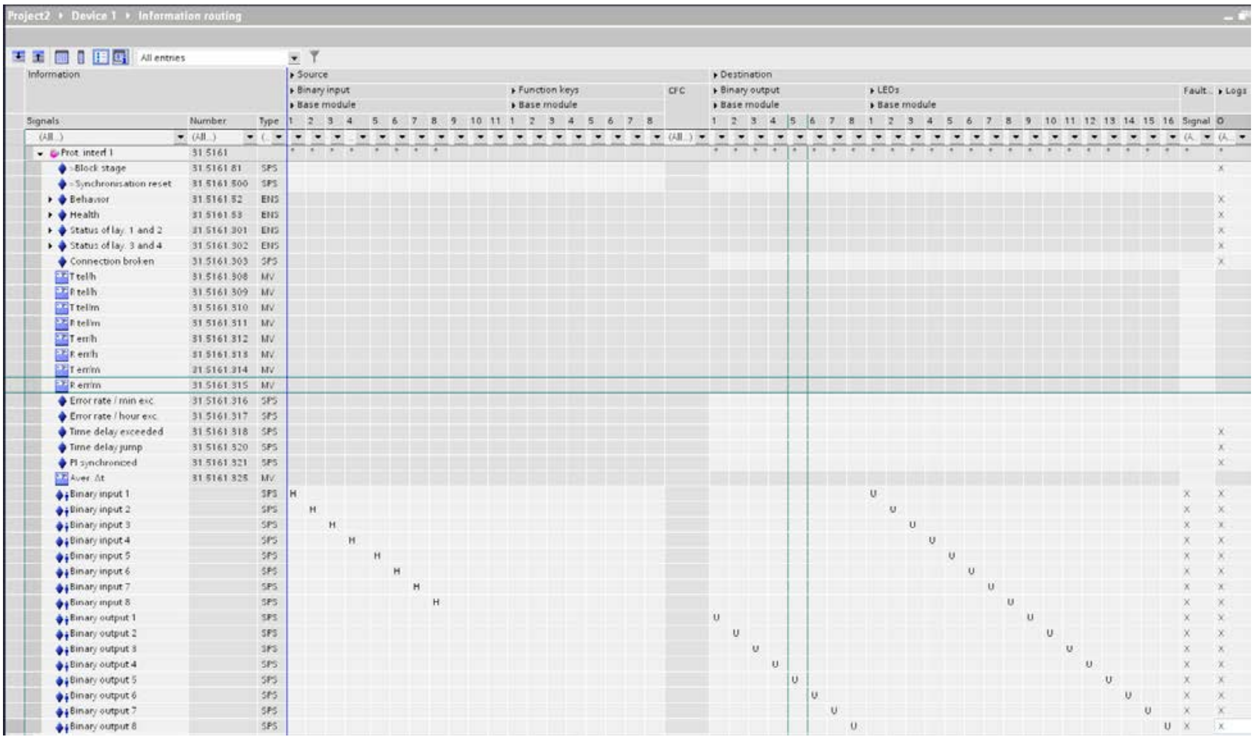

Figure 6: Assignment of user defined SPS-signals to binary inputs and outputs for device 1

For device 2 we do exactly the same assignment for this user defined signal. The task is to transfer this signals vice versa between the two devices over the protection interface. A state indicated on a binary input of device 1 or 2 shall be indicated on the contact of each opposite device.

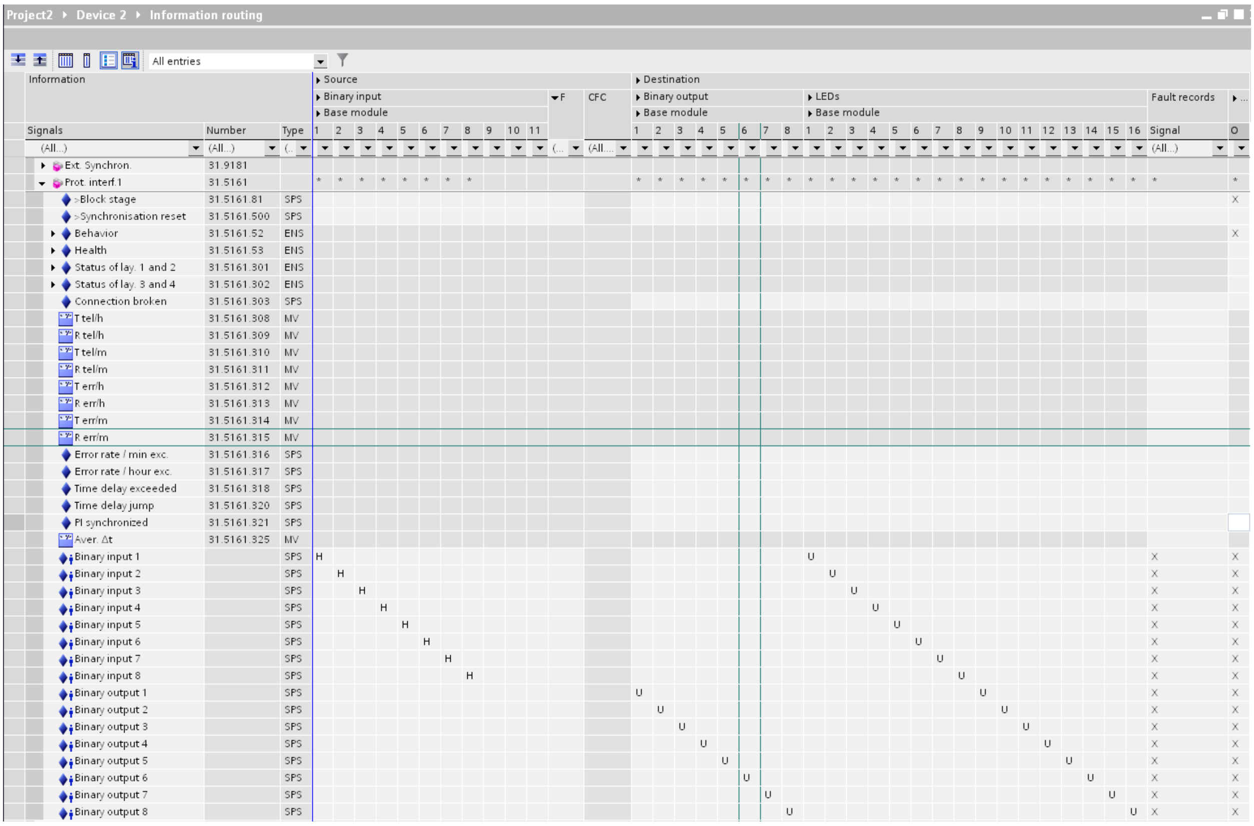

Figure 7: Assignment of user defined SPS-signals to binary inputs and outputs for device 2

1.2.6 Assignment of signals to the PI - communication mapping

The assignment to the PI-interface will be done in the communication mapping. The binary input states shall be transmitted with high priority (priority level 1) and bit position 1 – 8 shall be used. How this is done is shown in figure 8 under ´Transmit´.

Furthermore we want to receive the SPS-signals from the other device. Because bit position 1-8 of priority level 1 is used by device 1 we assign the binary output signals to position 9 – 16.

If the communication fails the state of the received signals is set to ´off´. Options are on, off or remain the actual state. This choice depends on the application. A loss of link can be indicated by a predefined signal in the PI – function furthermore. Also comprehensive supervision and monitoring functions are available described in another application.

Project2 ▸ Device 1 ▸ Communication mapping

Signals		Type	Fault records	▸ Receive				▸ Transmit	y level	Bit position
(All...)	(All...)	(...	(All...)	..	(All...)	(All...)	(All...)	(All...	(All...)	(All...)
Aver. Δt	31.5161.325	MV								
Binary input 1		SPS	X					X	1	1
Binary input 2		SPS	X					X	1	2
Binary input 3		SPS	X					X	1	3
Binary input 4		SPS	X					X	1	4
Binary input 5		SPS	X					X	1	5
Binary input 6		SPS	X					X	1	6
Binary input 7		SPS	X					X	1	7
Binary input 8		SPS	X					X	1	8
Binary output 1		SPS	X	X	1	9	off			
Binary output 2		SPS	X	X	1	10	off			
Binary output 3		SPS	X	X	1	11	off			
Binary output 4		SPS	X	X	1	12	off			
Binary output 5		SPS	X	X	1	13	off			
Binary output 6		SPS	X	X	1	14	off			
Binary output 7		SPS	X	X	1	15	off			
Binary output 8		SPS	X	X	1	16	off			

Figure 8:Assignment to PI-interface in device 1 in the communication mapping

In the communication mapping of device 2 we assign binary input 1 – 8 to bit position 9 – 16. The state is received in device 1 on that position. For the binary outputs we use position 1 – 8.

Project2 ▸ Device 2 ▸ Communication mapping

All entries | Show protocol | All protocols

Information | Fault records | ▸ F:USART-AE-2FO:Ch1:2 device prot. com.

Signals	Number	Type	Signal	R	Priority level	Bit position	Fallback value	T	Priority level	Bit position
(All...)	(All...)	(...	(All...)	..	(All...)	(All...)	(All...)	..	(All...)	(All...)
R tel/m	31.5161.311	MV								
T err/h	31.5161.312	MV								
R err/h	31.5161.313	MV								
T err/m	31.5161.314	MV								
R err/m	31.5161.315	MV								
Error rate / min exc.	31.5161.316	SPS								
Error rate / hour exc.	31.5161.317	SPS								
Time delay exceeded	31.5161.318	SPS								
Time delay jump	31.5161.320	SPS								
PI synchronized	31.5161.321	SPS								
Aver. Δt	31.5161.325	MV								
Binary input 1		SPS	X					X	1	9
Binary input 2		SPS	X					X	1	10
Binary input 3		SPS	X					X	1	11
Binary input 4		SPS	X					X	1	12
Binary input 5		SPS	X					X	1	13
Binary input 6		SPS	X					X	1	14
Binary input 7		SPS	X					X	1	15
Binary input 8		SPS	X					X	1	16
Binary output 1		SPS	X	X	1	1	off			
Binary output 2		SPS	X	X	1	2	off			
Binary output 3		SPS	X	X	1	3	off			
Binary output 4		SPS	X	X	1	4	off			
Binary output 5		SPS	X	X	1	5	off			
Binary output 6		SPS	X	X	1	6	off			
Binary output 7		SPS	X	X	1	7	off			
Binary output 8		SPS	X	X	1	8	off			

Figure 9: Assignment to PI-interface in device 2 in the communication mapping

1.3 Conclusion

Integrated PI – interfaces can be used in communication applications for a fast exchange of binary data between devices. Classical teleprotection devices can be substituted by this application. With the integrated PI-function of a SIPROTEC 5 device we can exchange binary states between two or more devices (up to six). Here it is demonstrated with user defined 8 signals.

If a direct fibre optical connections is used a large number of signals can be exchanged limited by the physical inputs and outputs of the device. If fast output contacts are used the transfer time is less than 15 ms.

In this application binary inputs are indicated furthermore in logs and the record of the device and the local and remote binary state is indicated on LED. A binary signal can be used to trigger a record.

But also other applications are possible. Received signals can be transferred via a GOOSE – message over the station bus to other devices. So the device can act as a gateway device for GOOSE – messages and convert them to a direct serial fiber optical link. Also the states may be indicated over a substation automation protocol (e.g. IEC 61850 reporting). The teleprotection device act as an IEC 61850 server. Also a logical processing of signals in a CFC – chart can be performed with logical blocks (AND, OR ...) or timers. These additional features are far beyond the functionality of teleprotection devices

Published by
Siemens AG 2016
Energy Management Division
Digital Grid
Automation Products
Humboldtstr. 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)

Email: support.energy@siemens.com