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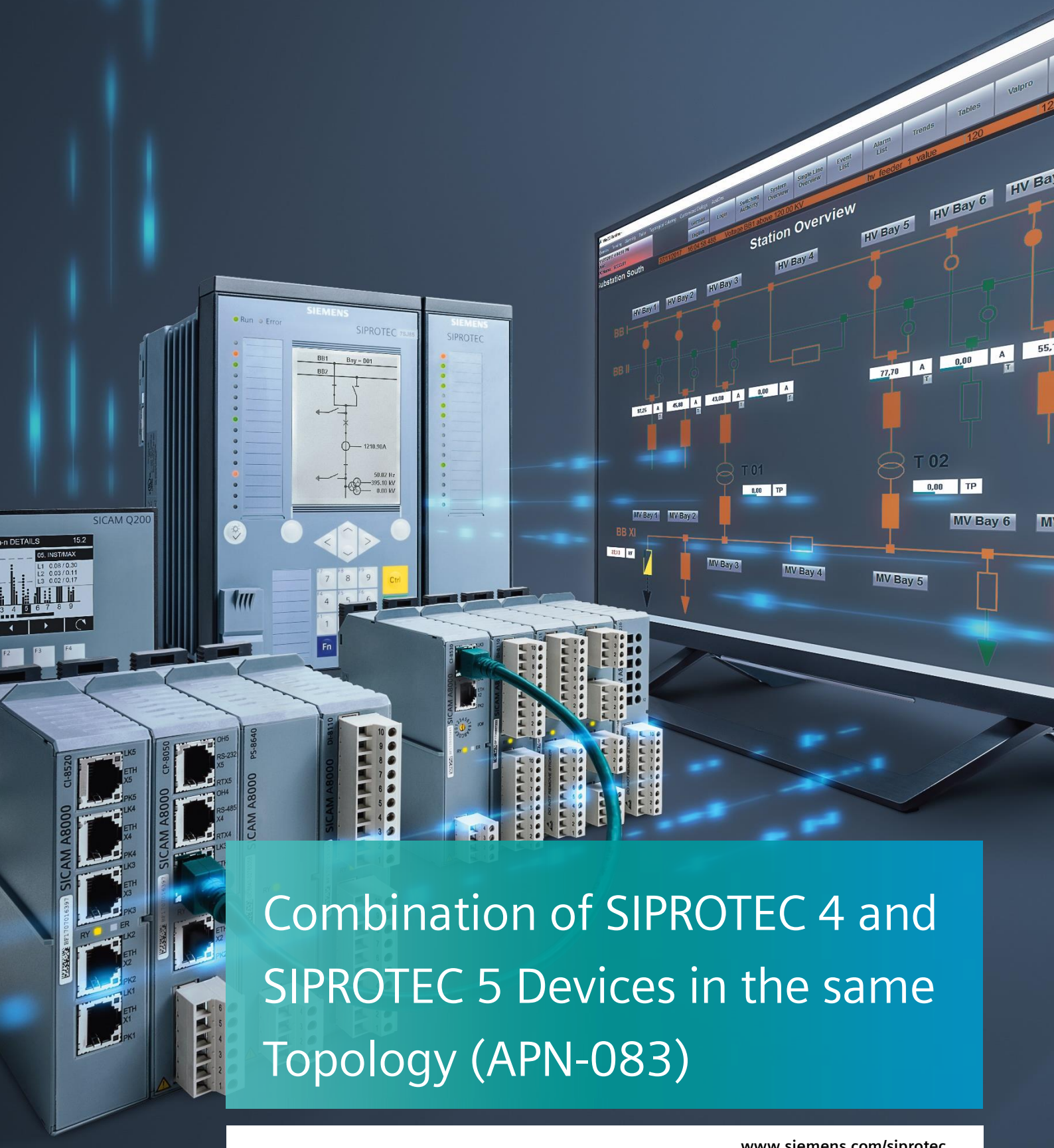

Combination of SIPROTEC 4 and SIPROTEC 5 Devices in the same Topology (APN-083)

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SIPROTEC Application

Combination of SIPROTEC 4 and SIPROTEC 5 Devices in the same topology

APN-083, Edition 1

Content

1 Combination of SIPROTEC 4 and SIPROTEC 5 Devices in the same topology

1.1 Introduction

Existing SIPROTEC 4 installations with Protection Interface (PI), for example line differential topologies with 7SD52 or 7SD6 devices, may be extended or retrofitted with SIPROTEC 5 devices. For this purpose, the Protection Interface (PI) in the SIPROTEC 5 devices has a "Compatibility Mode" that is compatible with SIPROTEC 4. The SIPROTEC 5 manuals have a chapter dedicated to this topic "Cooperation with SIPROTEC 4 Devices" as referenced to below. In this application note typical applications and the necessary steps to implement them are presented.

1.2 SIPROTEC 5 Device Manual

The dedicated chapter in the manual "Cooperation with SIPROTEC 4 Devices" should be used as the first reference for information. It contains all the information required:

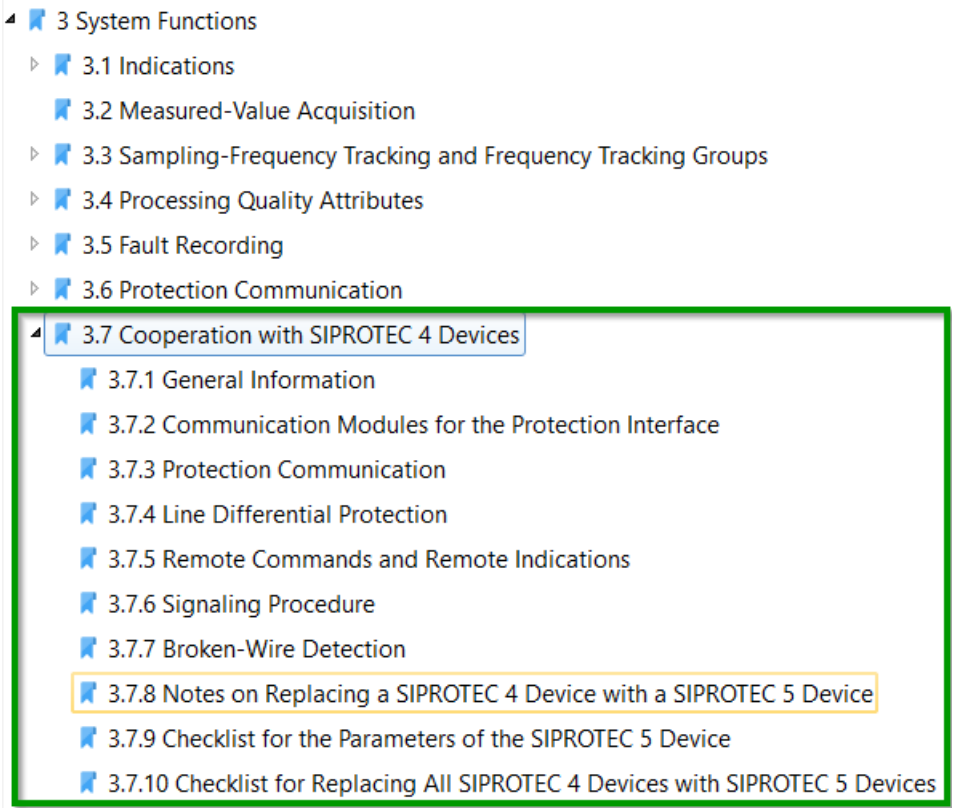


Figure 1: Chapter in SIPROTEC 5 Manual

This application note is only a supplement to the information in the manual.

1.3 Replacing one end of a (SIP4) 2-Terminal Line Differential topology with a new SIP5 device

This example is illustrated in the diagram below. It is an application with only 3 pole tripping and no distance protection capabilities. A 7SD86 will be used to replace the existing 7SD52 at the A side of the topology.

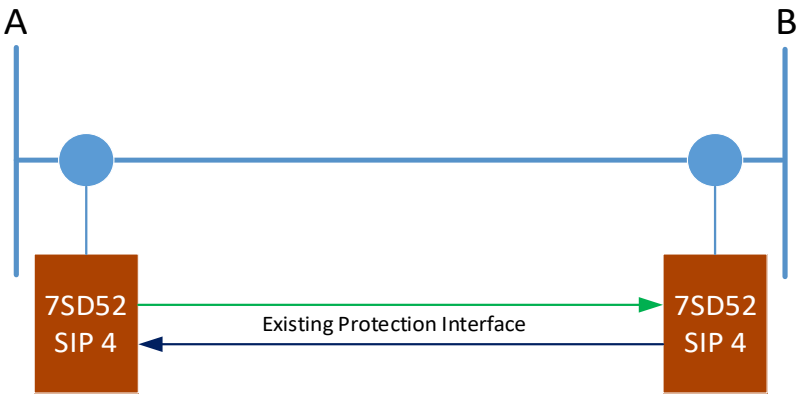


Figure 1: Existing Topology with Siprotec 4

1.3.1 Communication (Protection Interface)

The existing communication must be checked to determine if the 7SD86 can be integrated directly.

In the following 3 cases the new 7SD86 can be applied without any change to the communication link:

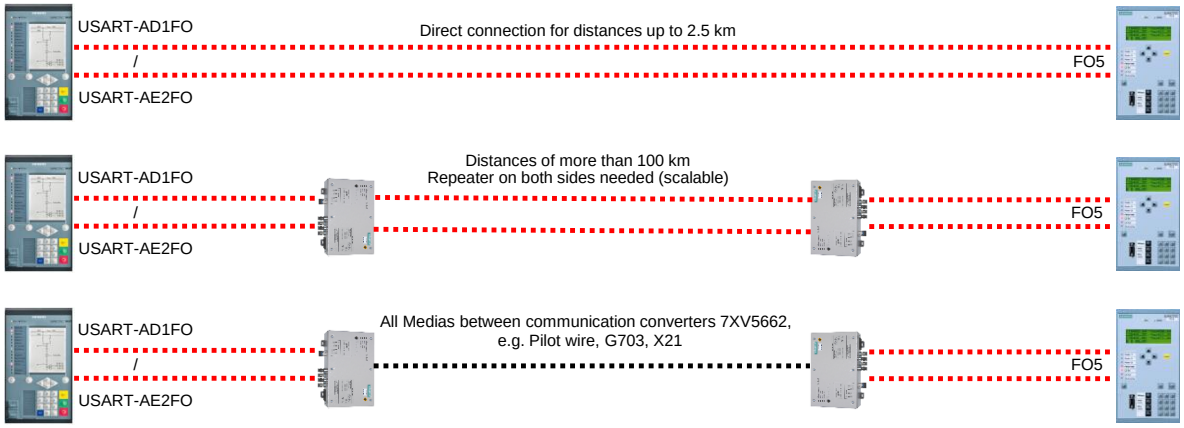


Figure 2: Communication variants that can remain unchanged after adding the SIPROTEC 5 device

In the Protection Interface variations shown in Figure 3 above, the SIPROTEC 4 relay can be directly replaced with the SIPROTEC 5 device without the need for additional convertors/repeaters.

3 examples from Figure 3	Com. Module	SIP5 Com. Module	Comment
Direct Optical Fiber < 2.5 km	FO5	AD1FO / AE2FO	Multimode Fiber
Optical Fiber, external repeater	FO5	AD1FO / AE2FO	Multimode Fiber SIP5 - repeater
Other with external converter	FO5	AD1FO / AE2FO	Multimode Fiber SIP5 - converter

The communication configuration shown in the diagram below, with direct long-distance fiber optic links, require small modifications to the communication link:

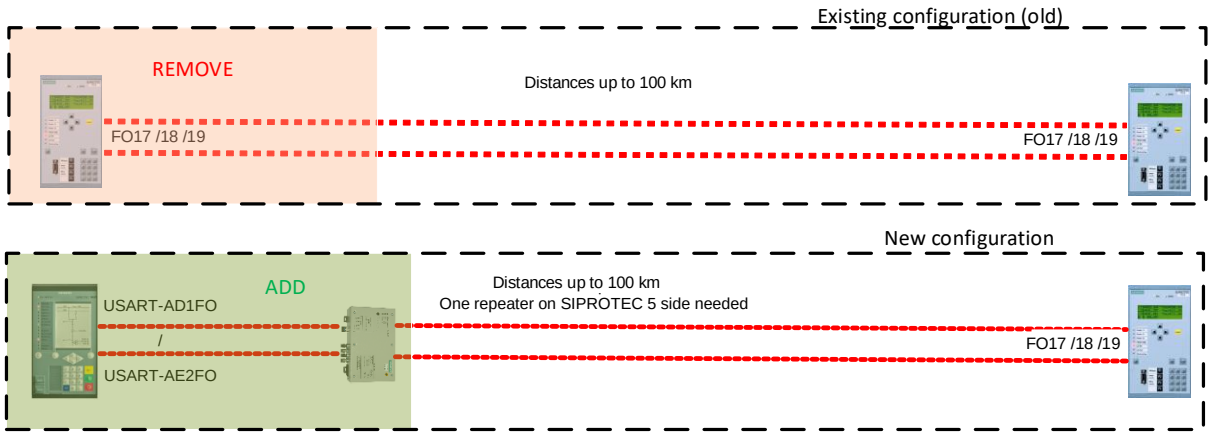


Figure 3: Replacement method for long distance direct fiber links (before and after)

Examples from Figure 4	SIP4 Com. Module	SIP5 Com. Module	Comment
Direct Optical Fiber up to 100 km	FO17 / FO18 /FO19	AD1FO / AE2FO add 7XV5461	The new SIP5 relay is connected via repeater

It is not possible to use the long-distance fiber optic modules of SIPROTEC 5 in the above configuration. The solution is to apply the optical repeater 7XV5461 as interface between the new SIP5 relay and the existing long distance (single mode) fiber.

The following must be observed in the 7SD52 relays:

SIPROTEC 4	Applied	Description
Device	7SD522	
FW	V4.74	At least V4.74
Distance protection	no	Only Line Differential
Prot. Interf. 1	e.g.FO17	This example with 24km module
Prot. Interf. 2	none	Only one channel used
Sett. Prot. Interf. 1 (Port D)	Enabled	Both must be enabled for ring
Sett. Number of relays	2 relays	The topology settings are not changed

The detailed settings for the application are described later.

The following must be observed in the 7SD86 relays:

SIPROTEC 5	Applied	Description
Device	7SD86	2 terminal capability, no 21
FW	V8.30	At least V07.90
87L Function	Yes	Line Differential applied
USART Module	USART-AD-1FO	Single channel for PI
Channel 1 Mapping	2 Device prot. Com.	For 2 device topologies
Channel 1 Connection mode:	SIPROTEC 4 7SD5	For compatibility with 7SD52

The detailed settings for the application are described later.

1.3.2 Topology Settings

The manual specifies the settings that must be applied. The table below (from manual) shows the Settings in the 7SD52 that must be applied correspondingly in the new 7SD86 that will replace it.

SIPROTEC 5 Parameters	SIPROTEC 4 Parameters
(_:5131:102) Address of device 1	(4701) ID OF RELAY 1
(_:5131:103) Address of device 2	(4702) ID OF RELAY 2
(_:5131:101) Local device is device	(4710) LOCAL RELAY
(_:102:1031:0:105) Connection via	(4502) CONNEC. 1 OVER
(_:102:1032:0:105) Connection via	(4602) CONNEC. 2 OVER
(_:5161:1) Mode in the settings of the protection interface 1	(4501) STATE PROT I 1
(_:5162:1) Mode in the settings of the protection interface 2	(4601) STATE PROT I 2
(_:5161:110) Difference Tx and Rx time	(4506A) PROT 1 UNSYM.
(_:5162:110) Difference Tx and Rx time	(4606A) PROT 2 UNSYM.

The SIPROTEC 5 parameter (_:5131:122) Lowest appearing bit rate does not exist in the SIPROTEC 4 device. The setting value of the parameter is not relevant for the cooperation with SIPROTEC 4 devices.

Figure 4: Extract from manual listing communication settings that must be conform

This is done in the new 7SD86 as follows:

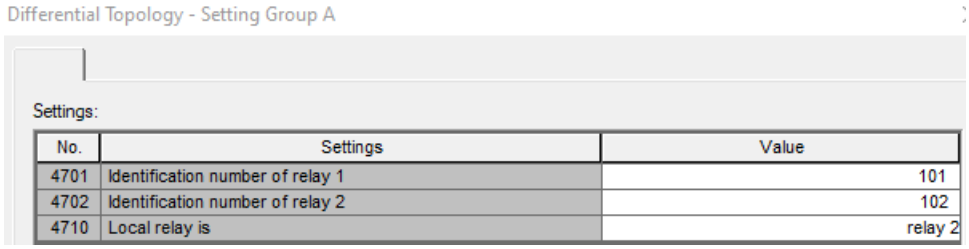


Figure 5: SIPROTEC 4 device address settings (102 is the 7SD52)

The corresponding old settings in the 7SD52 were as follows:

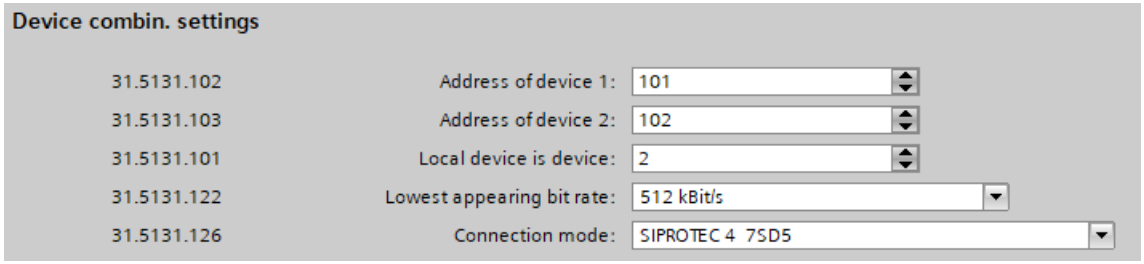


Figure 6: SIPROTEC 5 device address settings (101 is the 7SD86)

Note the “connection mode” setting in SIPROTEC 5 must be for compatibility with the 7SD5!

In this case a direct fiber optic connection is used (the optical repeater does not have to be considered in the settings).

The diagram below shows the mapping of the settings from the old 7SD52 relay to the new 7SD86.

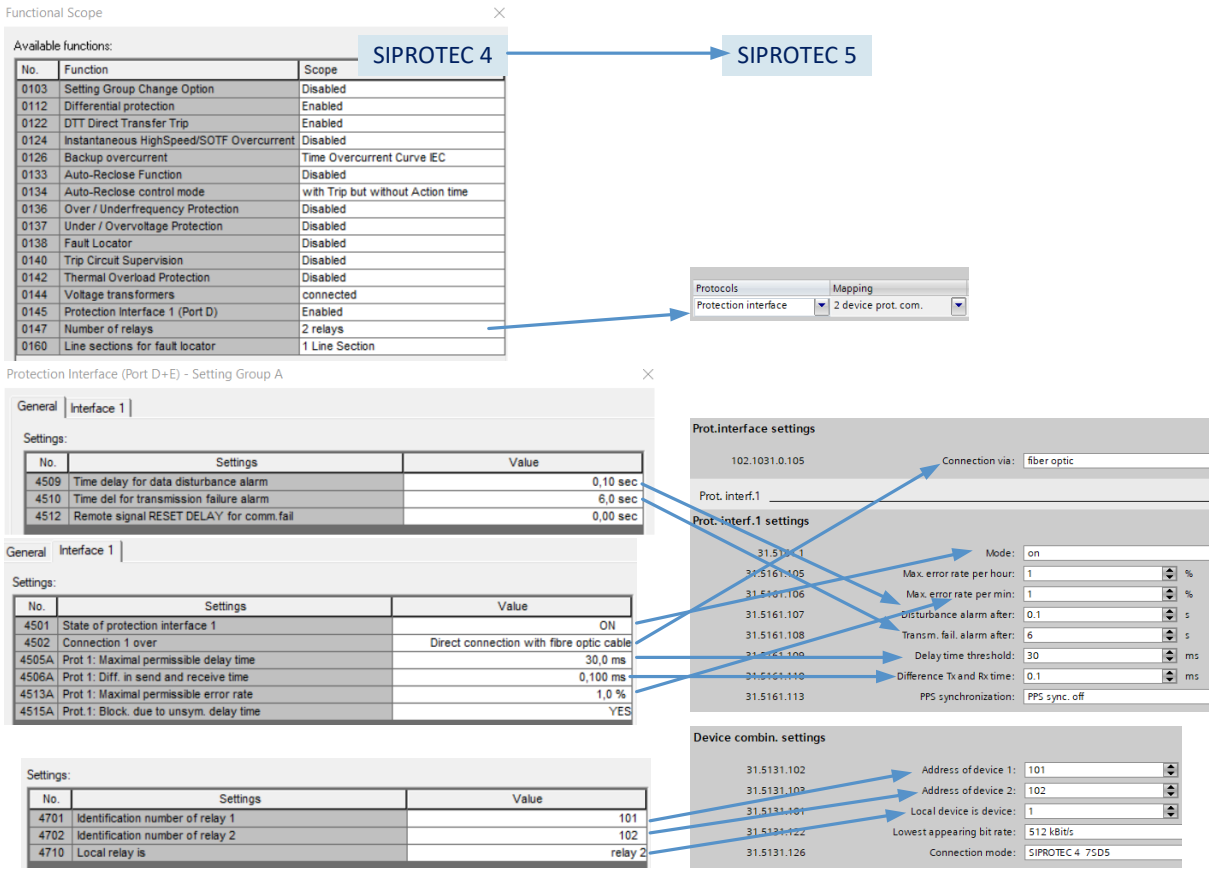


Figure 7: Mapping of Protection Interface settings from 7SD52 SIPROTEC 4 to new 7SD86 SIPROTEC 5

As shown in Figure 8 above the settings from the replaced 7SD52 can be applied to the corresponding settings in the 7SD86. Note the following:

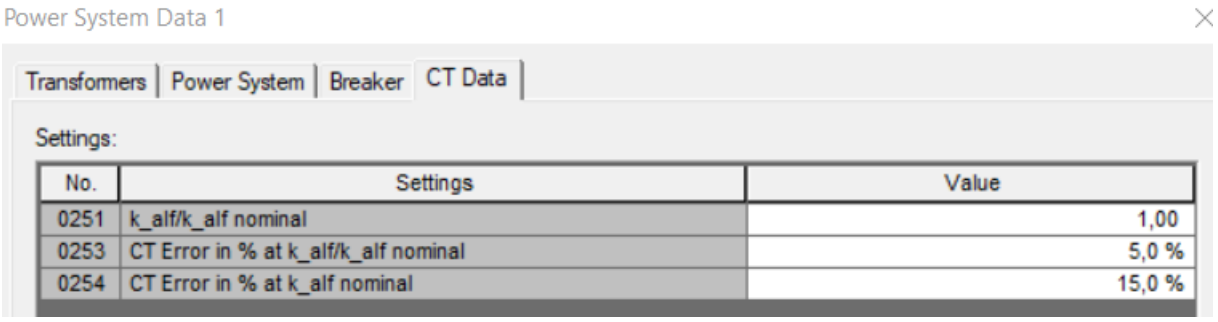
1. The MLFB of the 7SD52 did not include GPS synchronization, no settings are shown. In SIP5 leave the PPS sync off setting.
2. Block due to unsymmetrical time delay is always on in SIPROTEC 5.

1.4 Differential Protection Configuration

The method of calculating the settings (charging current calculation etc.) is not covered here. The existing settings will be transferred to the new 7SD86 relay as follows:

1.4.1 CT Parameters

In the 7SD52 the following settings are applied to take the CT errors into consideration:



Based on the SIPROTEC 4 manual, this would be the settings for a CT with class 10P or ANSI class. When using the line differential in the mixed configuration these settings must be modified as stated in the manual:

Trans-former Class	Parameter			
	SIPROTEC 4 (253) E% ALF/ ALF_N	SIPROTEC 5 (_:8881:108) CT error A	SIPROTEC 4 (254) E% K_ALF_N	SIPROTEC 5 (_:8881:109) CT error B
5P	3.0 %		12 %	
10P	5.0 %		21 %	
TPX	1.0 %		21 %	
TPY	3.0 %		21 %	
TPZ	6.0 %		28 %	
PX	3.0 %		12 %	
C100 to C800	5.0 %		21 %	

Figure 8: Table from SIP5 manual showing recommended settings for mixed operation SIP4 / SIP5

The new setting applied in the 7SD86 is therefore in accordance with table above:

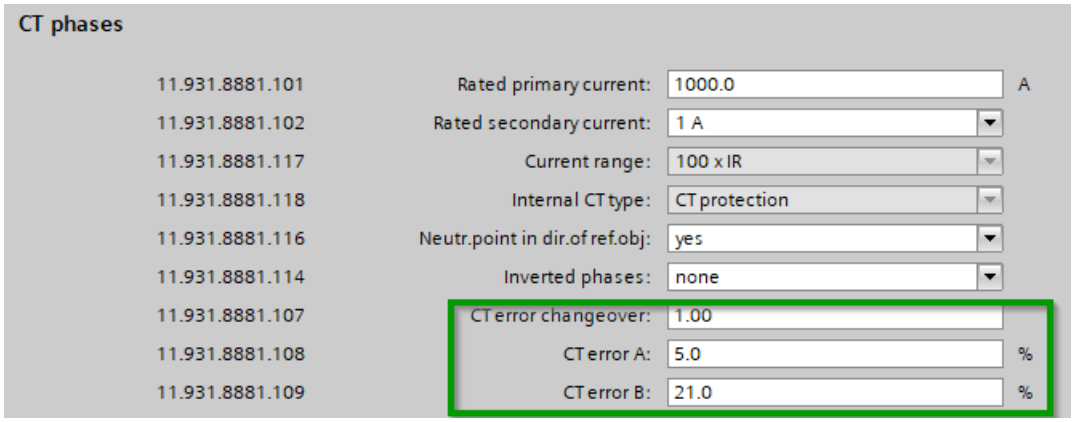


Figure 9: Modified CT error settings in 7SD86

This modification of the CT errors should be done at all devices in the mixed topology.

1.4.2 Differential Current Supervision

When combined with SIPROTEC 4, this function in the 7SD86 can only be used for reporting (or switched off):

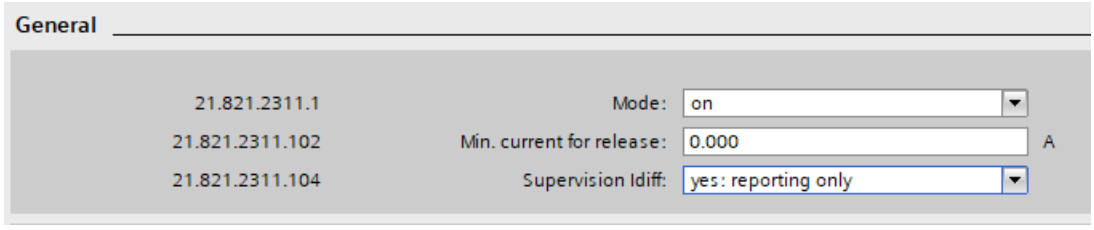


Figure 10: Settings of Differential Current supervision

It is recommended to use this function as reporting to indicate that the differential current has reached a critical value during normal operation.

1.4.3 Intertrip

As stated in the manual the following settings for Intertrip must be taken over from the SIPROTEC 4 device:

Table 3-22 SIPROTEC 5/SIPROTEC 4 Corresponding Parameters

SIPROTEC 5	SIPROTEC 4
Parameters of the **Remote trip** stage in the **Line differential protection** function	Parameters of the **Circuit-breaker intertrip and remote trip** function
(_:5551:100) Transmitting	**(1301) I-TRIP SEND**
(_:5551:101) Receiving	**(1302) I-TRIP RECEIVE**

Figure 11: Table from manual with settings relevant to intertrip

In this example, the 7SD52 settings were as follows:

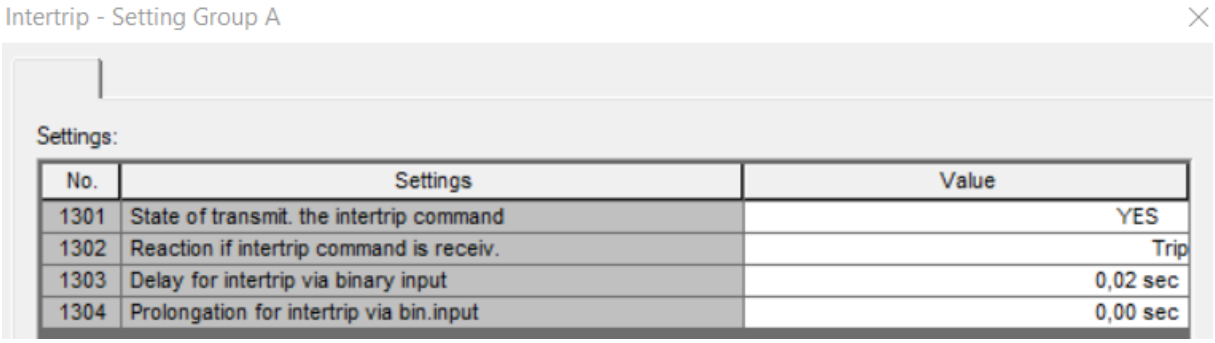


Figure 12: Intertrip settings in 7SD52

These must be taken over in the 7SD86 as follows:

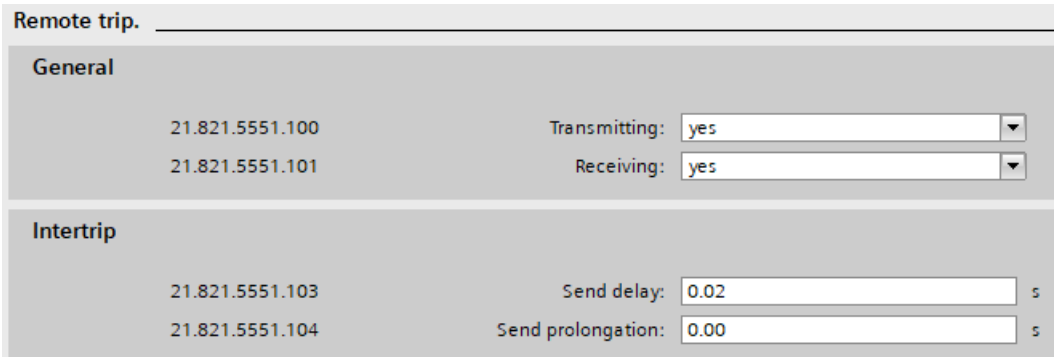


Figure 13: Remote trip parametersin7SD86 taken over from 7SD52

1.4.4 Rated Current Setting

For the differential protection this setting is very important and must be checked to ensure it is set correctly in all devices. The following was set in the 7SD52:

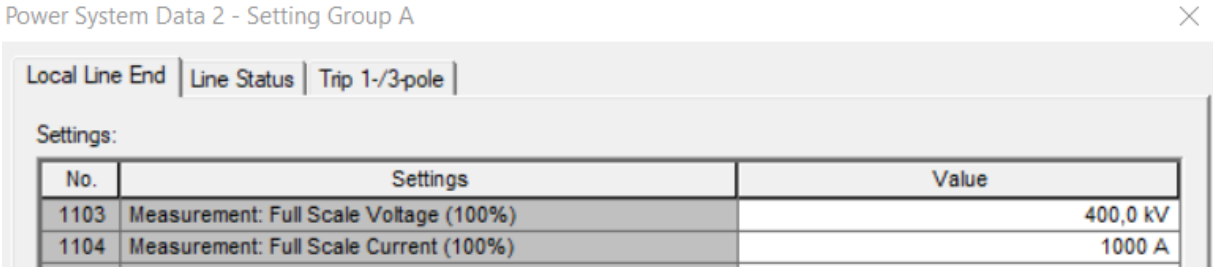


Figure 14. Set values of Full-Scale Current in 7SD52

This setting must be applied in the 7SD86 as follows (under FG Line\General):

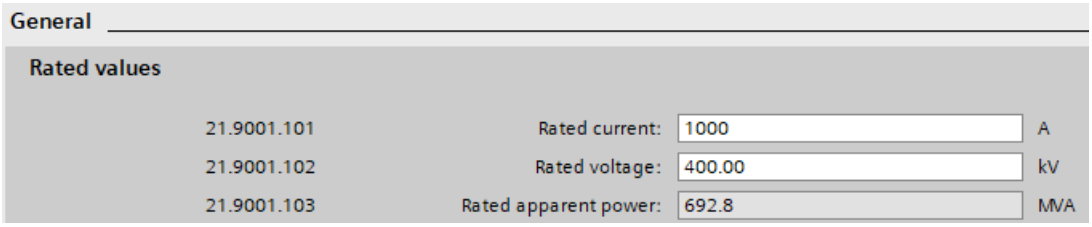


Figure 15: Setting of Rated Current in 7SD86

When there is a transformer the settings value of the rated apparent power is set instead of the current.

1.4.5 Differential Protection Stage: I-DIFF

This stage corresponds to the "I-DIFF>" stage in the 7SD52. The setting in primary must be the same in the 7SD86:

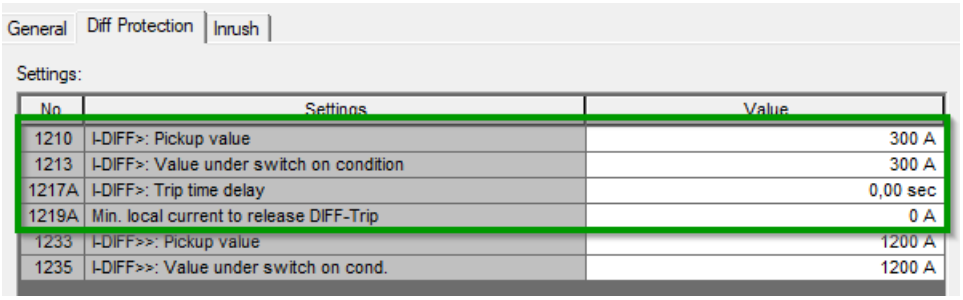


Figure 16: I-DIFF> settings in 7SD52 (primary values)

The parameter "1219A Min. local current to release DIFF-Trip" is applied under General in the 7SD86. Before applying the settings on the 7SD86, the setting mode is changed to primary. In this manner conversion calculations based on CT ratio are not required (in case the CT ratio is changed).

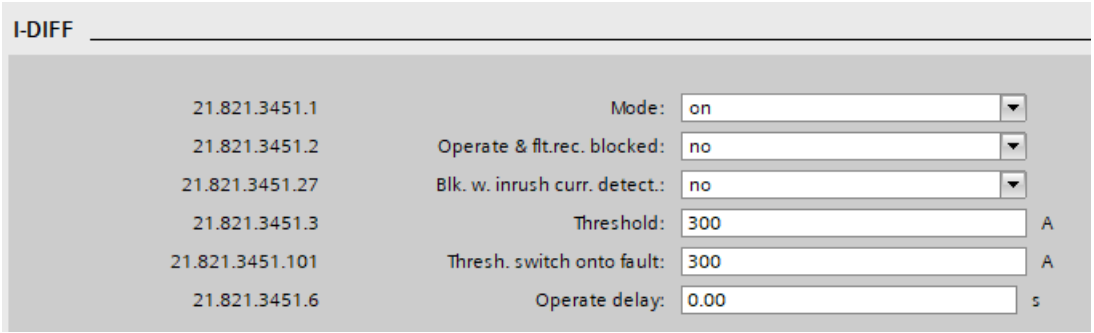


Figure 17: I-Diff stage, corresponding settings in SIPROTEC 5

The other typical settings (Mode etc.) applicable to SIPROTEC 5 relays are applied in the normal manner.

1.4.6 Differential Protection Stage: I-DIFF fast

Here it is important to **not** apply the "I-DIFF fast 2" stage. If such a stage is shown in the DIGSI settings, it must be deleted and replaced by the "normal" I-DIFF fast stage. The 7SD52 settings are shown above in Figure 17 (primary values). These must be applied to the 7SD86 as follows:

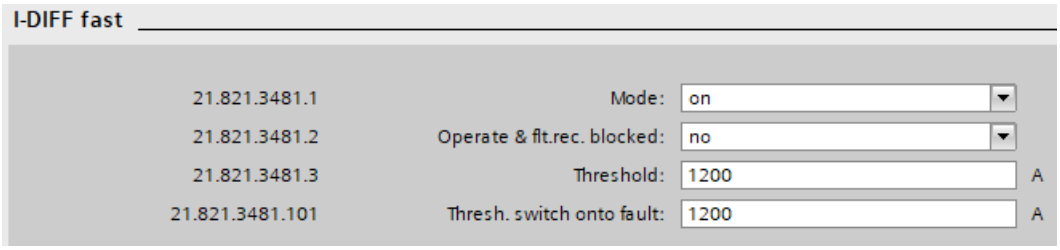


Figure 18: I-DIFF fast stage, corresponding settings in SIPROTEC 5

1.5 Remote Signals via Protection Interface

If the 7SD52 has the MLFB option “Remote Signals”, and these are used, then the corresponding configuration must be done in the new 7SD86.

In this example the following two signals are sent by the 7SD86 (triggered via binary input):

	Information				Source								
	Number	Display text	L	Type	BI								F
					1	2	3	4	5	6	7	8	
Device					×								
P.System Data 1													
Osc. Fault Rec.													
P.System Data 2						×				×			
Diff. Prot													
Intertrip													
Remote Signals	03541	>Remote CMD 1		SP							H		
	03549	>Rem. Signal 1		SP								H	

Figure 19: Remote command and remote signal sent by 7SD52

In SIPROTEC 5 there are corresponding configurations. The mapping is described in the manual (extract shown here):

SIPROTEC 5		SIPROTEC 4
Bit	**Priority**	
1 to 4	PRIO 1	Remote commands 1 to 4
5	PRIO 1	InterOn signal
6	PRIO 1	Manual Close of the 7SD5x/7SD610
1 to 24	PRIO 2	Remote indications 1 to 24

Figure 20: Table from manual with mapping of SIPROTEC 4 remote signals

Based on this table the mapping of transmitted signals in Figure 20 are applied in the 7SD86 as follows:

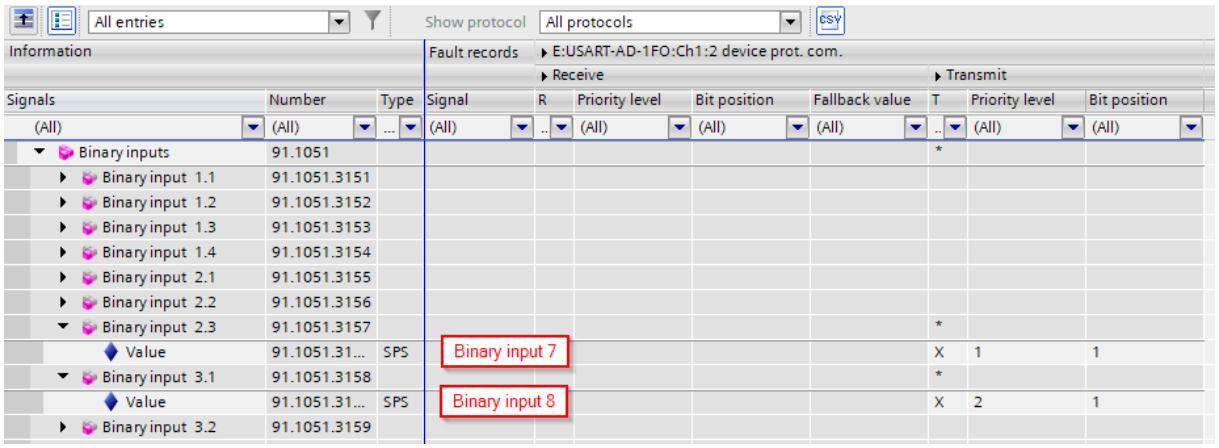


Figure 21: Transmit signals via protection interface

In Figure 22 the binary inputs are directly routed. This is an option, but it is recommended to use user defined signals for the routing – this allows better capturing of the events in the corresponding logs.

The following two received signals in the 7SD52 are routed to CFC for further processing.

	Information				S	Destination					
	Number	Display text	L	Type		BO	LED	Buffer			C	CM
								O	S	T		
P.System Data 2								*		*		*
Diff. Prot								*		*		*
Intertrip								*		*		
	03541	>Remote CMD 1		SP				IO				
	03542	>Remote CMD 2		SP				IO				
	03543	>Remote CMD 3		SP				IO				
	03544	>Remote CMD 4		SP				IO				
	03545	Remote CMD1 rec		OUT				IO				
	03546	Remote CMD2 rec		OUT				IO				
	03547	Remote CMD3 rec		OUT				IO			X	
	03548	Remote CMD4 rec		OUT				IO				
	03549	>Rem. Signal 1		SP				IO				
	03550	>Rem.Signal 2		SP				IO				
	03551	>Rem.Signal 3		SP				IO				
	03552	>Rem.Signal 4		SP				IO			X	
	03553	>Rem.Signal 5		SP				IO				

Figure 22: Received signals in 7SD52

In SIPROTEC 5 it is not possible to route signals (no allocation) to CFC directly. A user defined signal must be applied; this signal may then be applied in CFC charts.

Information			Fault records	E:USART-AD-1FO:Ch1:2 device prot. c		
				Receive		
Signals	Number	Type	Signal	R	Priority level	Bit position
(All)	(All)	...	(All)	..	(All)	(All)
Security	1331					
Line 1	21		*	*		
General	21.9001			*		
Behavior	21.9001.52	ENS				
Health	21.9001.53	ENS				
User Rem CMD 3 rec		SPS		X	1	3
User Rem Sig 4 rec		SPS		X	2	4
Rated values						

Figure 23 Received signals via protection interface

1.6 Conclusion

The steps above describe the topology dependent steps required for replacing the 7SD52 relay at one end of the 2-terminal configuration. The detailed routing and protection settings are not described here. This can be done on a function by function basis as the SIPROTEC 5 devices have function blocks at least equivalent to the 7SD52 functions.

More complex topologies are not described here. In most cases it will be very similar to what is described here. Refer to the manual for more details. The appendix 1shows some communication configurations when adding a 3rd terminal to the 2-terminal example from the above example.

1.7 Appendix 1: Extending 2-Terminal Line Diff topology (SIP4) with new 3rd End (SIP5)

This chapter will only show some communication configurations. The setting principles described above are also applicable here. The same existing 2 ended topology, with 7SD52 relays, as shown in the Figure 1 above is the starting point. In this case it will be extended to become a 3-Terminal topology by addition of a 7SD87 relay. The 7SD52 relays will maintain the same interface for the connection between them:

After the addition of the 3rd terminal the ring topology will be as shown in Figure 2. The 7SD87 will be connected to both 7SD52 to obtain a ring configuration.

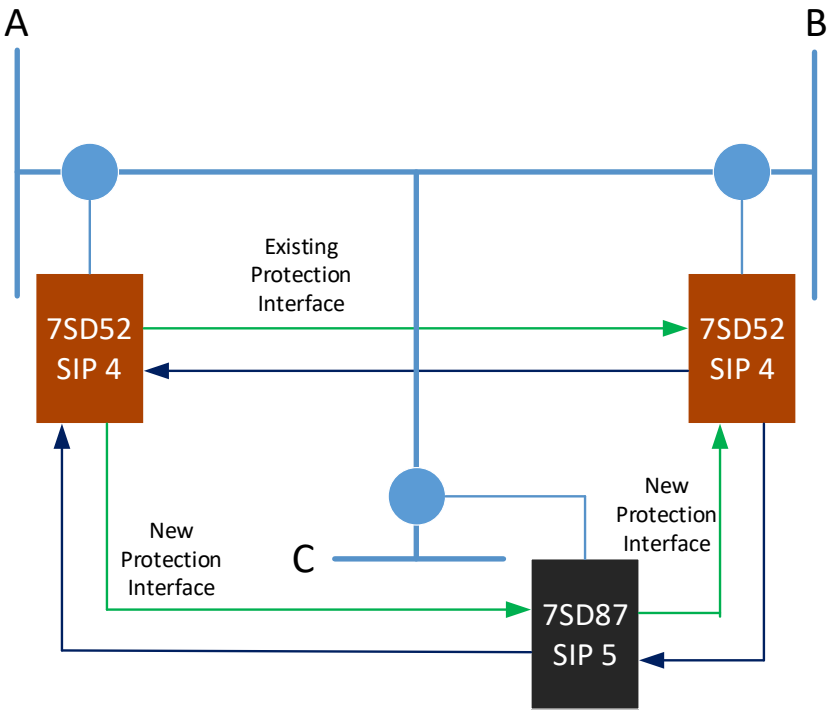


Figure 24: Topology after addition of 3rd terminal C

The structure of the Protection Interface Topology after the addition of the 3rd terminal will be as follows if the distance is short (< 1.5 km) with multimode fibers:

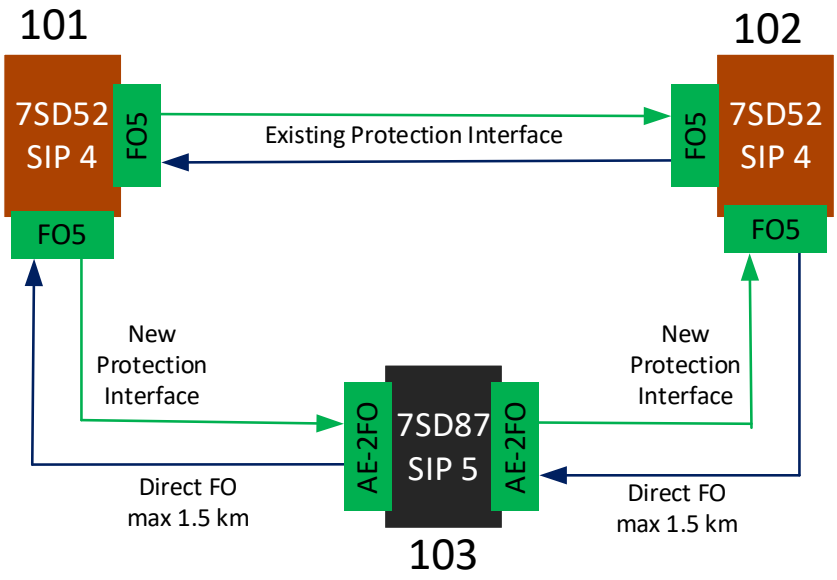


Figure 25: PI Topology after addition of 3rd terminal (< 1.5 km)

The direct connection with long distance modules is not possible. For such applications external convertors must be applied. Here is one such example.

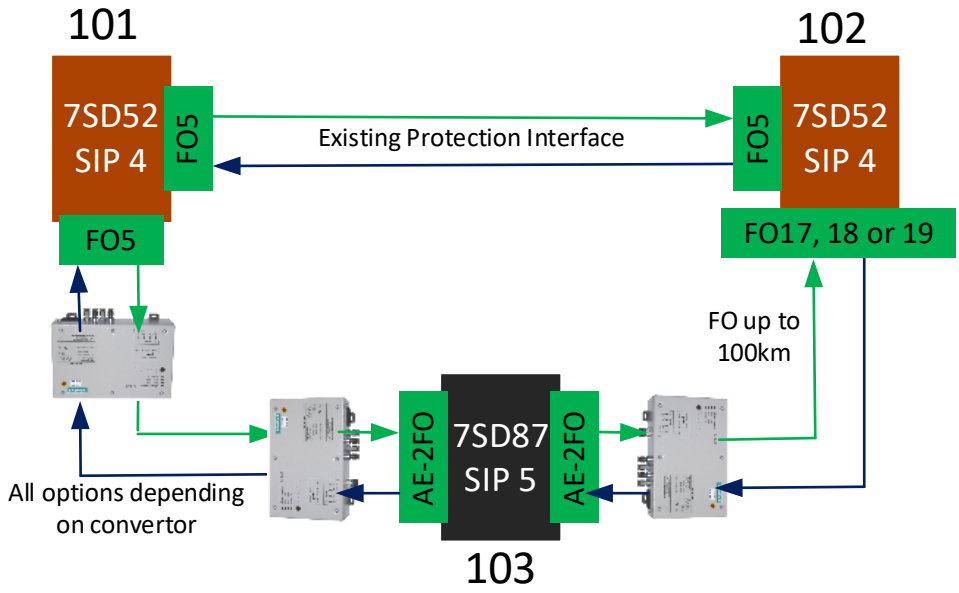


Figure 26: Alternative communication method (> 1.5 km)

The SIPROTEC 4 side may use a long-distance module, but this must terminate on a repeater. The method with one repeater (only at the 7SD86 side), or with 2 repeaters (one at each side) is possible. When using 2 repeaters/converters any type of communication is possible (e.g. pilot wire, comms network etc.)

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