SIEMENS

www.siemens.com/protection

SIPROTEC 5 Application Note

SIP5-APN-011:
Powerful commissioning with SIPROTEC 5

Answers for infrastructure and cities.

SIPROTEC 5 - Application:
SIP5-APN-001
Powerful commissioning with SIPROTEC 5

Content

1 Application: Powerful commissioning with SIPROTEC 5

1.1 Summary

For SIPROTEC 5 devices together with DIGSI 5 offers various test editors for testing the devices during commissioning and from time to time during operation. This test features help to test the hardware wiring, the functionality of applications and the communication to a substation control unit or to other devices (e.g. using GOOSE-messages). This application gives a brief overview of test features and how to use them together with DIGSI 5. With the integrated test features the time for commissioning will be reduced and external equipment like a secondary test set is not necessary in every phase of the commissioning process.

1.2 Application Introduction

During the commissioning process comprehensive testing of multifunctional devices is required. This thorough testing avoids further testing during the life time of a device. During life time the relay is tested by self test routine and correct operation e.g. during fault conditions in the network. Testing consists of several phases.
The connections to the process must be validated through checking the inputs and outputs of the device. Single and overall functionality must be tested to verify the correct relay operation during the process. Another task is the testing of communication links.
SIPROTEC 5 devices offer a lot of commissioning functions together with DIGSI 5 to improve the commissioning process and save time and money during the commissioning process. This applications focus on 3 test functions. A lot of other test functions are available to make life easier and allow device diagnostic and monitoring.
With the integrated secondary test unit (simulation unit) functions can be tested without secondary injection to the device. The CT, VT and binary inputs are isolated from the process and stimulated with test sequences coming from the simulation unit. This test sequences are crated by a program ´Sequencer´ which is integrated in DIGSI 5. This allows functional pretesting without secondary test set or primary values from the process. Also this function can be used to debug logic plans (CFC).

A further test allows testing the inputs and outputs of SIPROTEC 5 devices. Using a common Ethernet network where devices and DIGSI 5 PC are connected testing of wiring connections can be done more efficient then today.

A third test procedure focus on communication protocol testing. Events in the device (e.g. a trip) can be set during this test which are then transmitted via the specific communication protocol to a serial master or to an Ethernet client or server e.g. with IEC 61850 reports or GOOSE messages. This allows communication bit tests without external test equipment and the specific knowledge of the functions whose communication mapping should be tested.

1.3 Test with the integrated secondary test unit

Introduction into the concept of the integrated test device

State of the art for testing of protection functions, CFC-logic or communication connections is the use of a secondary test device like Omicron CMC or quantities which coming from the primary process. This requires the connection of currents, voltages and binary signals to the device terminals. SIPROTEC 5 devices have an inbuilt simple secondary test unit. Activation this unit with DIGSI 5 switches over the CT, VT and binary inputs of the device from the device terminals to the integrated unit. It's like an integrated test switch. Now the quantities calculated before by DIGSI 5 in a test sequences are used instead of input values from the device terminals

Calculation test sequences with DIGSI 5

In DIGSI 5 a program ´Sequencer´ is integrated. Sequences can be prepared in Offline Mode for special test cases in the office. This editor allows calculating test sequences with maximum 6 steps. One step may be a prefault condition with normal load; the next step is the fault condition with a fault current and a drop of the fault voltage during the fault and a third step may be the post fault condition with current zero and nominal voltage. These calculated quantities are assigned to the analogue inputs the so called measuring points of the device.

Furthermore binary signal state can be set also in each step which are assigned to the binary inputs of the device. If an input is assigned with a blocking event it can be tested if this function is really blocked during a short circuit condition.

Fig. 1 shows a screenshot of the sequencer. The analogue values are set by there magnitude and phase angle for each measuring point. Harmonics can be added to the fundamental quantities. As an option the voltage or current can follow a ramp function with a continuous change of the signal. In this case the approximate end value of the ramp will be calculated from DIGSI 5. Also different frequency values can be used for meas.points e.g. to test the synchronization function.

The binary signals are set for each binary input which can be assigned with voltage OFF (zero state) or voltage ON (one state). This simulates the physical input voltage at a binary input.

For support of the CFC-debugging also internal input signals for CFC-plans can be set. These internal signals may also simulate signals coming from a GOOSE-message. This feature is not shown in Figure 1.

By these settings one step of a sequence will be created. With ´Add step´ further steps can be added. A whole test sequence consists of one up to six individual test steps. A sequence can be prepared and stored/exported for a specific test case so a sequence can be used also for other devices.

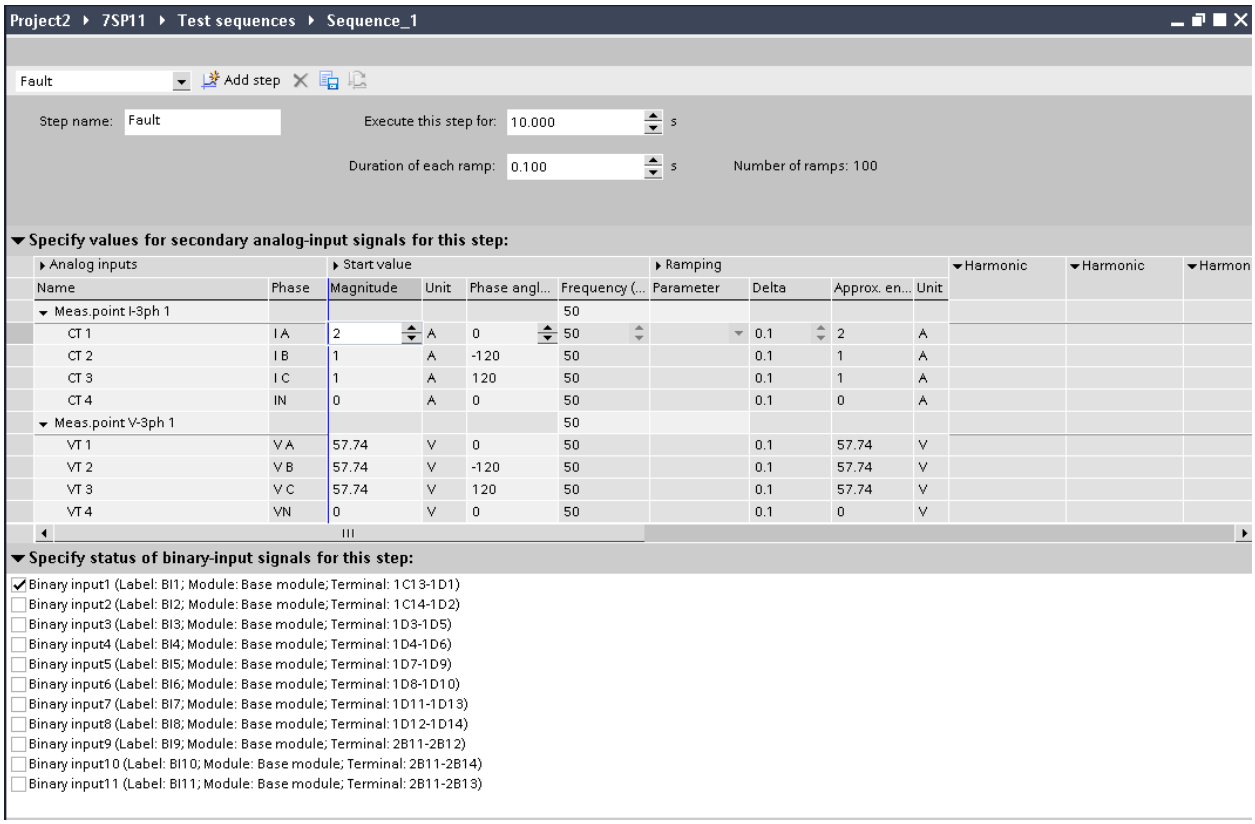


Figure 1: Editor for test sequences in DIGSI 5

Start of a test sequence for a protection function test

We want to test a protection function with a sequence. We go into the editor for testing a protection function (see Figure 2). DIGSI 5 must be Online with the device (here over an Ethernet interface in the PC)

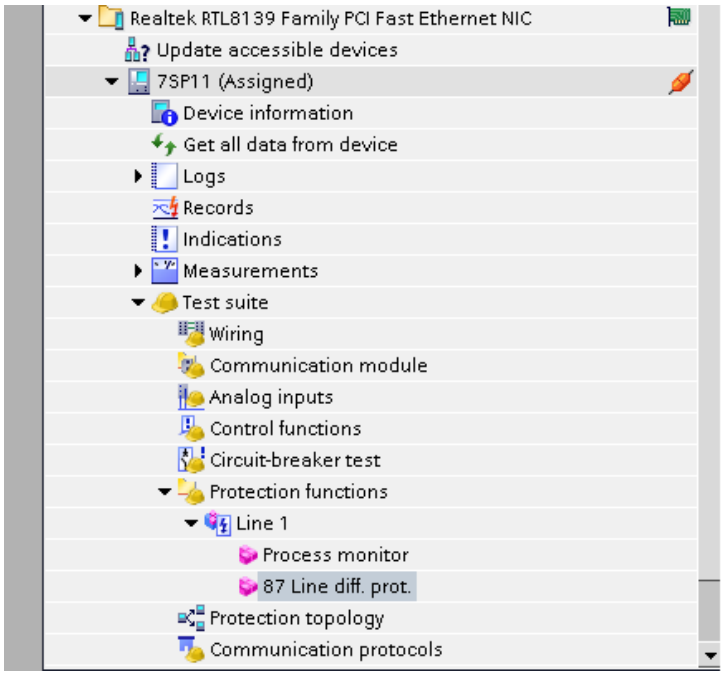


Figure 2: Open the editor for testing protection functions

In this editor we can use signals coming from a test sequence (right side) instead of a secondary test set.
In this use case the device must be ´Restarted in simulation mode´ and operates afterwards in a special simulation mode. After the device restart this mode is indicated in DIGGI 5 and in the device display.
We start the test sequence with DIGSI 5, via a signal on a physical binary input (input selectable in DIGSI 5) or immediately after it's loaded into the device. Using a binary input allows starting a test in several devices at the same time for scheme testing.

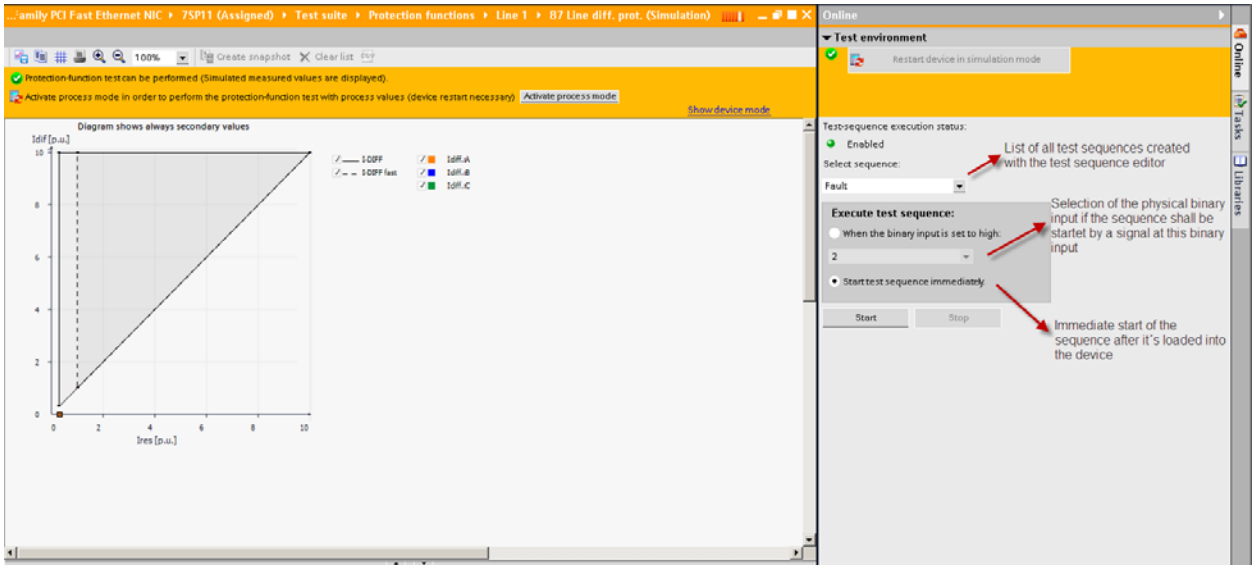
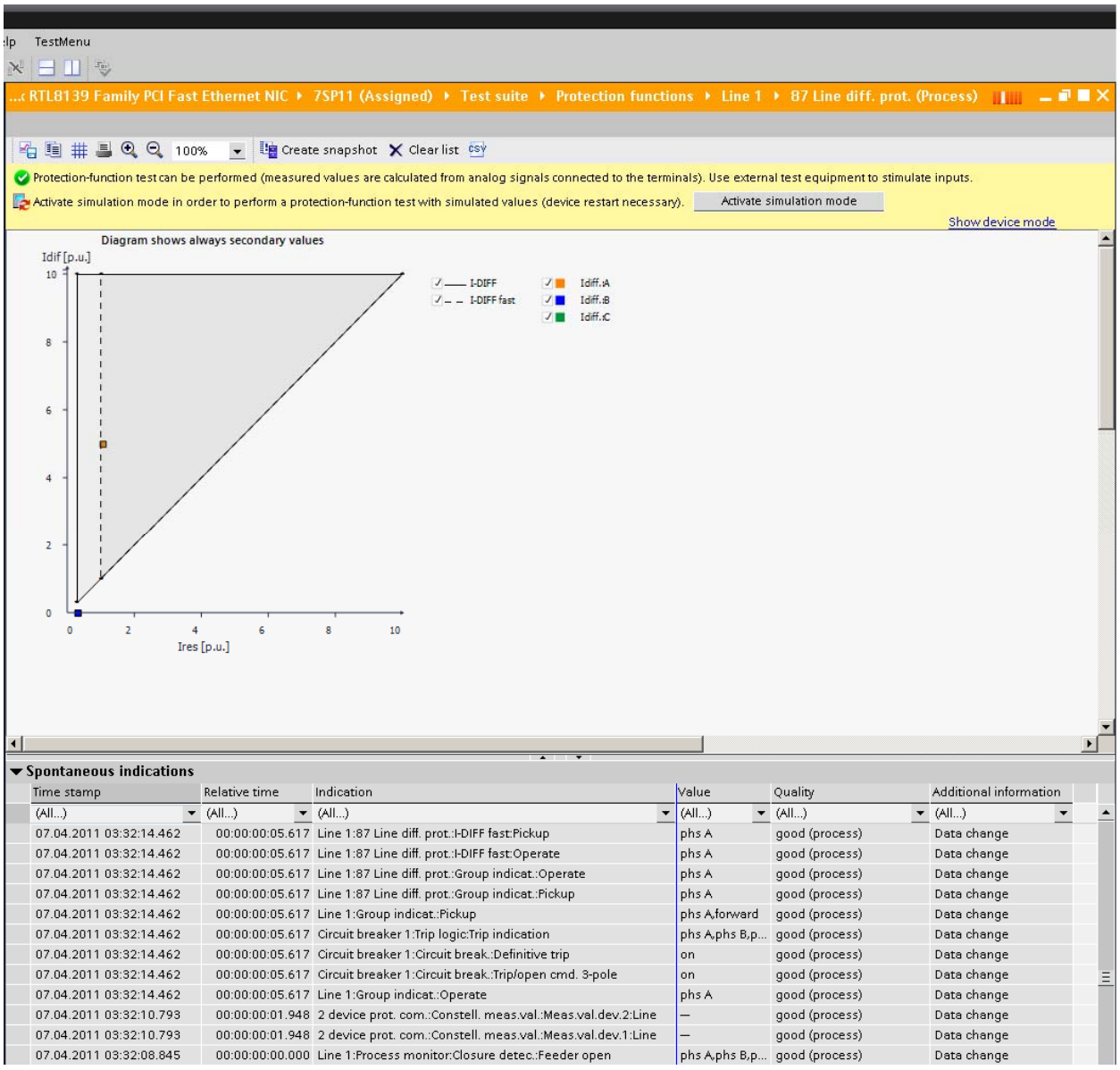


Figure 3: Testing a protection function with a test sequence created by the sequence editor

We can investigate the reaction of the protection function in the tripping characteristic in DIGSI 5 in Figure 4. Because all trip indications and a fault record is generated and the device may be communicating over communication interfaces we can study the device behavior fully for that specific fault situation simulated by the simulation unit. No secondary test set is necessary for that test function. When the tests are finished the device will be switched back into the process mode and operate with quantities coming from the device analogue and binary input terminals.



Time stamp	Relative time	Indication	Value	Quality	Additional information
(All...)	(All...)	(All...)	(All...)	(All...)	(All...)
07.04.2011 03:32:14.462	00:00:00:05.617	Line 1:87 Line diff. prot.:I-DIFF fast:Pickup	phs A	good (process)	Data change
07.04.2011 03:32:14.462	00:00:00:05.617	Line 1:87 Line diff. prot.:I-DIFF fast:Operate	phs A	good (process)	Data change
07.04.2011 03:32:14.462	00:00:00:05.617	Line 1:87 Line diff. prot.:Group indicat.:Operate	phs A	good (process)	Data change
07.04.2011 03:32:14.462	00:00:00:05.617	Line 1:87 Line diff. prot.:Group indicat.:Pickup	phs A	good (process)	Data change
07.04.2011 03:32:14.462	00:00:00:05.617	Line 1:Group indicat.:Pickup	phs A,forward	good (process)	Data change
07.04.2011 03:32:14.462	00:00:00:05.617	Circuit breaker 1:Trip logic:Trip indication	phs A,phs B,p...	good (process)	Data change
07.04.2011 03:32:14.462	00:00:00:05.617	Circuit breaker 1:Circuit break.:Definitive trip	on	good (process)	Data change
07.04.2011 03:32:14.462	00:00:00:05.617	Circuit breaker 1:Circuit break.:Trip/open cmd. 3-pole	on	good (process)	Data change
07.04.2011 03:32:14.462	00:00:00:05.617	Line 1:Group indicat.:Operate	phs A	good (process)	Data change
07.04.2011 03:32:10.793	00:00:00:01.948	2 device prot. com.:Constell. meas.val.:Meas.val.dev.2:Line	—	good (process)	Data change
07.04.2011 03:32:10.793	00:00:00:01.948	2 device prot. com.:Constell. meas.val.:Meas.val.dev.1:Line	—	good (process)	Data change
07.04.2011 03:32:08.845	00:00:00:00.000	Line 1:Process monitor:Closure detec.:Feeder open	phs A,phs B,p...	good (process)	Data change

Figure 4: Testing a protection function with a test sequence. Reaction in the tripping characteristic and spontaneous fault indication of the device

1.4 Test of inputs and outputs with DIGSI 5

For SIPROTEC 5 devices binary inputs, binary outputs and LED can be set by the user or the state of the inputs is indicated in DIGSI 5 in a wiring test editor. If the devices are connected over an Ethernet network a contact in one device can be closed with DIGS I 5 and the reaction on a binary input of another device can be seen in the test editor of this device at the same time. This allows checking e.g. the physical wiring between devices before functionality will be tested afterwards.

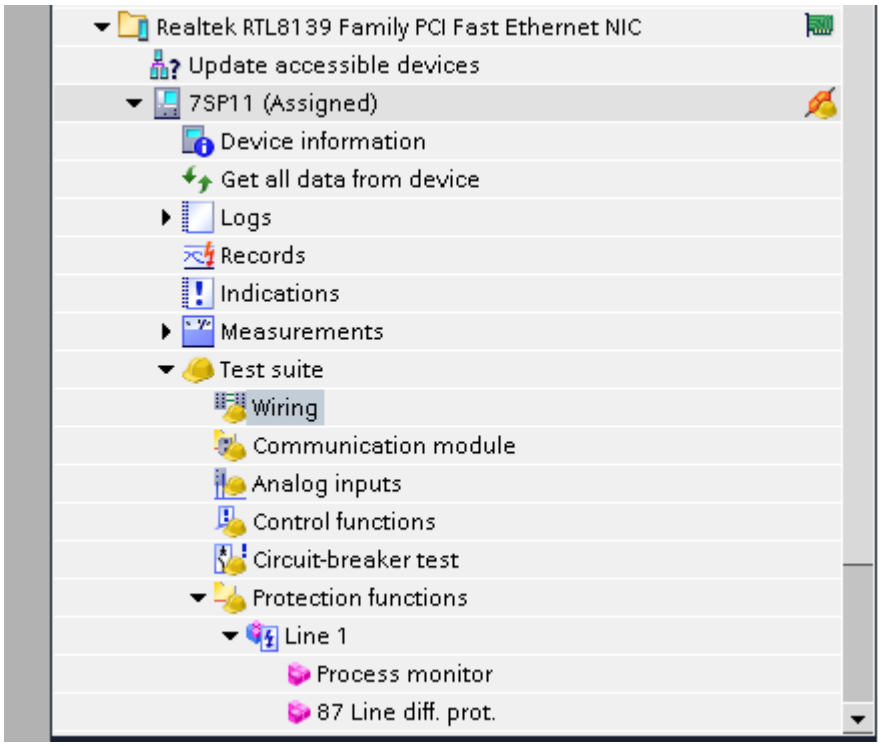


Figure 5: Test editor for the wiring test in DIGSI 5

Before this editor is activated the device is switched into the commissioning mode. These causes a device restart. The state of all inputs and outputs is stored and restored if the test editor is closed. Also a time out is foreseen so the device will not remain in this test mode permanently.

In this editor (see Figure 6) all inputs and outputs of a device with the terminal description and assignment in the routing matrix are listed in a table. Furthermore the actual state of the outputs and inputs are shown in the table. The state of a binary input can be checked if a contact is closed in another device. This can be forced by a ´New value´ for this contact in the test editor of the other device which is Online at the same time.

Online access ▸ Realtek RTL8139 Family PCI Fast Ethernet NIC ▸ 7SP11 (Assigned) ▸ Test suite ▸ Wiring (Commissioning)

csv

Wiring test can be performed.

Activate process mode

Show device mode

Change the state of binary inputs, outputs, and LEDs

Binary inputs/outputs an...	Mapped to signal(s)	Terminal	Current value	New value
Binary inputs				
Binary input1		1C13-1D1	on	off
Binary input2		1C14-1D2	off	on
Binary input3		1D3-1D5	off	on
Binary input4		1D4-1D6	off	on
Binary input5		1D7-1D9	off	on
Binary input6		1D8-1D10	off	on
Binary input7		1D11-1D13	off	on
Binary input8		1D12-1D14	off	on
Binary input9		2B11-2B12	off	on
Binary input10		2B11-2B14	off	on
Binary input11		2B11-2B13	off	on
Binary outputs				
Binary output1		1B9-1B10	off	on
Binary output2		1B11-1B12	off	on
Binary output3	Line 1:87 Line diff. prot.:I-DIFF:Operate	1B14-1B13	off	on
Binary output4	Line 1:87 Line diff. prot.:I-DIFF fast:Operate	1C2-1C1	off	on
Binary output5		1C3-1C4-1C6	off	on
Binary output6		1C7-1C8-1C10	off	on
Binary output7		2B3-2B4	off	on
Binary output8		2B5-2B6-2B8	off	on
LEDs				
LED1	Line 1:87 Line diff. prot.:I-DIFF:Operate		on	off
LED2	Line 1:87 Line diff. prot.:I-DIFF fast:Operate		on	off
LED3	Line 1:87 Line diff. prot.:I-DIFF:Inactive		on	off
LED4	Line 1:87 Line diff. prot.:I-DIFF fast:Inactive		on	off
LED5			off	on
LED6			off	on
LED7			off	on
LED8			off	on
LED9			off	on
LED10			off	on
LED11			off	on
LED12			off	on
LED13			off	on
LED14			off	on
LED15	2 device prot. com.:Device combin.:Device 1 available		on	off
LED16	2 device prot. com.:Device combin.:Device 2 available		on	off

Figure 6: Wiring test editor for monitoring and testing of binary inputs, binary outputs and LED

1.5 Test of communication interfaces

Introduction into the communication test

Multifunctional field devices are often equipped with one or more communication interfaces. This interfaces can be serially connected to a substation controller e.g. via IEC 60850-5-103 protocol or via Ethernet to a client with IEC 61850 protocol. Also devices can communicate with each other with IEC 61850 GOOSE – messages or with protection interfaces (PI) in a point to point connection. This communication may replace physical wiring between devices. All communication links must be tested. Therefore serial or Ethernet based telegrams can be forced by a communication test editor. All protocol content generated with this editor has the quality ´Test´ per default if the protocol supports the test flag.

Communication test editor

Figure 7 shows the access to the editor for communication testing. DIGSI 5 is Online with the device. After opening the editor the device must be switched in the commissioning mode which causes a reset of the device. Afterwards the device is in a special operating mode which allows stimulating signals. If these signals are assigned to communication interfaces they are send out over this interfaces with the specific protocol.

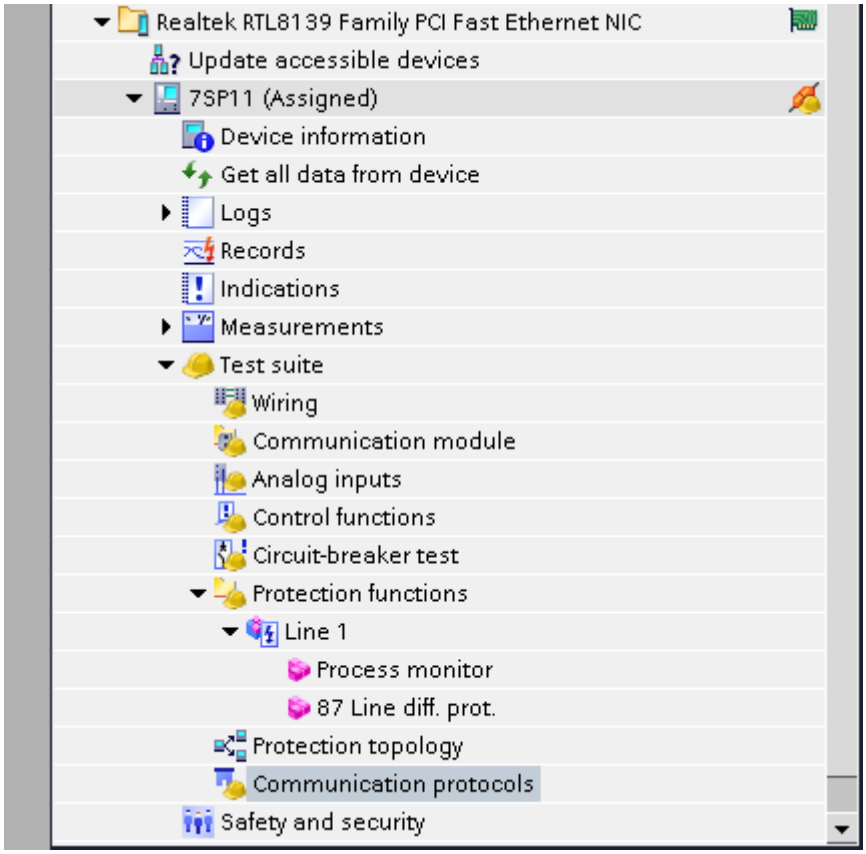


Figure 7: Opening the communication protocols test editor in DIGSI 5

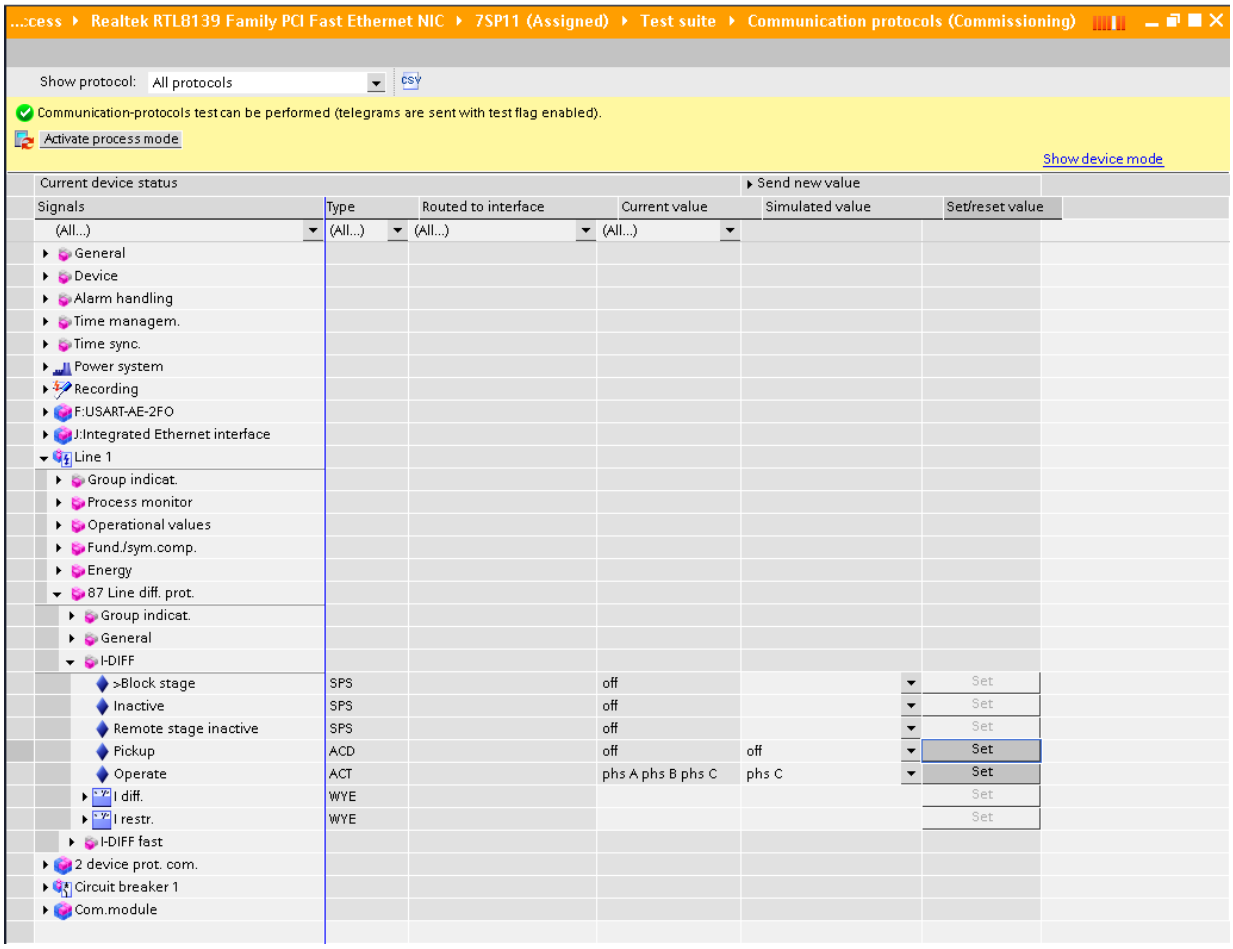


Figure 8: Communication protocol test editor in DIGSI 5

The left row show a list of all available signals in the device which can set or reset during the test. Also the signal type is show to indicate if it's a binary signal type (e.g. SPS) or a measurement value signal type (e.g. WYE). The next row shows if the signal is routed to a communication interface in the communication routing. Special cases are signals for IEC 61850. Because reports can be created dynamically by a client pre – routing in DIGSI 5 does not exist and therefore not shown in this row.

Current state and new state are shown in the next column and can be set there. With the start button the signal switch from current state to the new state and is transferred over the communication link if it's assigned to one or several interfaces.

Published by and copyright © 2013:

Siemens AG

Infrastructure & Cities Sector

Smart Grid Division

Humboldtstr. 59

90459 Nuremberg, Germany

Siemens AG

Infrastructure & Cities Sector

Smart Grid Division

Energy Automation

Humboldtstr. 59

90459 Nuremberg, Germany

www.siemens.com/protection

Printed on elementary chlorine-free bleached paper.

For more information, please contact
our Customer Support Center.
Tel.: +49 180 524 8437
Fax: +49 180 524 24 71
(Charges depending on provider)
E-mail: support.ic@siemens.com

Application note: SIP5-APN-011