SIEMENS

SIPROTEC 5 Compact
Efficient Test and Commissioning
APN – C.003

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SIPROTEC 5 Compact Application

Efficient test and commissioning of SIPROTEC 5 Compact with DIGSI 5 Test Suite

APN-C.003, Edition 1

Content

1 Efficient test and commissioning of SIPROTEC 5 Compact with DIGSI 5 Test Suite

1.1 Introduction

The goal of extensive test and diagnostic functions, which are available to the user at SIPROTEC 5 Compact together with DIGSI 5, is to shorten test and commissioning time. All test functions are integrated into the test suite in DIGSI 5. Thus, the engineering including the device test can be carried out with a tool. The most important functions are to be listed here as an example. Depending on the device type, further specific test functions are available.

The other SIPROTC 5 test and commissioning tools Web UI with a browser-based user interface and the SIPROTEC DigitalTwin for virtual testing are not considered in this application, additional descriptions are available.

1.2 Testing with integrated secondary test unit (Test sequencer)

1.2.1 Integrated test sequencer

The built-in test sequencer allows you to check functions using the test sequencer built into the device. Normally, analog and binary signals are fed into the device by the process or by an external secondary testing device. Protection function testing and communication testing have so far only been carried out with such sizes. SIPROTEC 5 devices allow these quantities to be replaced in a simulation operation with values fed from an integrated test facility. For this purpose, the analog and binary inputs are decoupled from the process and connected to the integrated test sequencer. With DIGSI 5, the tester creates a test sequence, e.g. a short-circuit history, loads it into the device and puts it into simulation mode.

With the test sequencer in DIGSI 5, up to six test steps can be combined into one test sequence. This test history, which is loaded into the device, is played back in real time, and simulates the functions of the device like a real course of binary and analog inputs. Protection functions, control, logic functions and communication can be tested in real time without a secondary testing device. The inspection process is started manually from DIGSI 5 or via a binary input. Thus, the interaction of several devices can also be tested.

1.2.2 Settings

The setting of test sequences can be prepared in offline mode for special test cases in the office. For example, a step can be a pre-error condition with normal load, the next step is the error condition with an error current and an undershoot of the error voltage during the error, a third step could be the post-error condition with zero current and rated voltage. These predetermined measures are assigned to the analog inputs of the so-called measuring points of the device. For each sequence, the state of the binary inputs of the device can be set. If a binary input is assigned a blocking event, it can be tested whether this function is blocked in the event of an error.

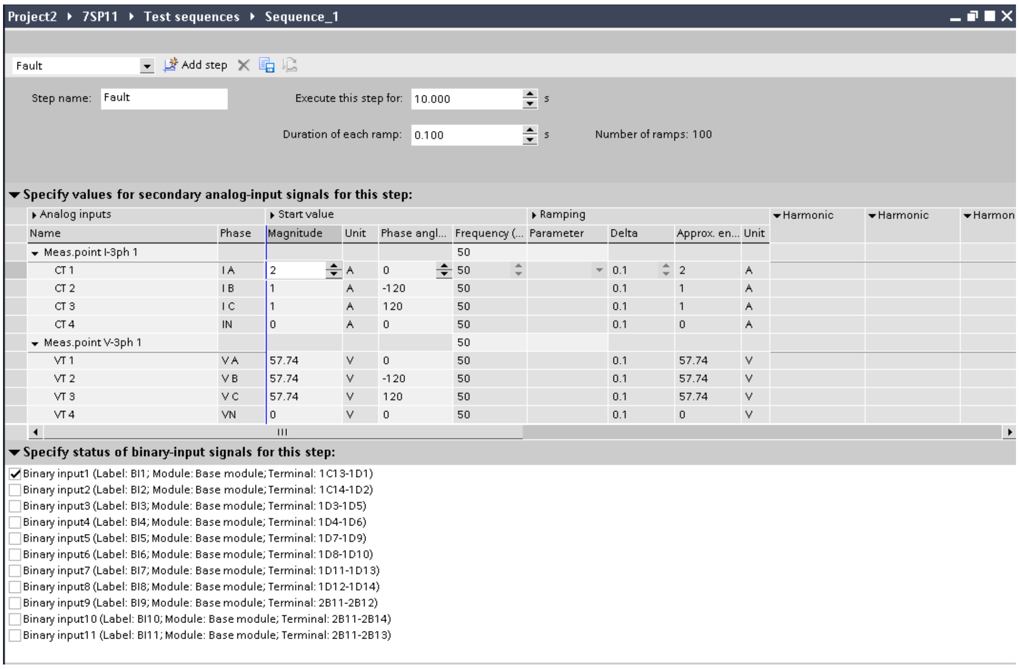


Abbildung 1: Editor für Prüfsequenzen in DIGSI 5

Fig. 1 shows a screenshot of the sequencer. The analog sizes are set according to their height and the phase angle for each measuring point. Harmonics can be added to the base sizes. As an alternative, voltage or current can follow a ramp function with a continuous signal change. In this case, the approximate final value of the ramp is calculated by DIGSI 5. Different frequency values for measuring points can also be used to test the synchronization function, e.g.

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

To support CFC troubleshooting, internal input signals for the CFC plans can also be set. These internal signals can also simulate signals coming from a GOOSE message. This feature is not shown in Figure 1. Abbildung 1

These settings create a step of a sequence. Further steps can be inserted with the "Add step". A complete test sequence consists of up to six individual test steps. A sequence can be prepared and stored/exported for a specific test case, so a sequence can also be used for other devices.

1.2.3 Start of a test sequence for a protective function check

We want to check a protection function with a sequence. We go to the editor to perform a protective function check (see Figure Figure 2). DIGSI 5 must be in dialogue with the device (here via an Ethernet interface in the PC).

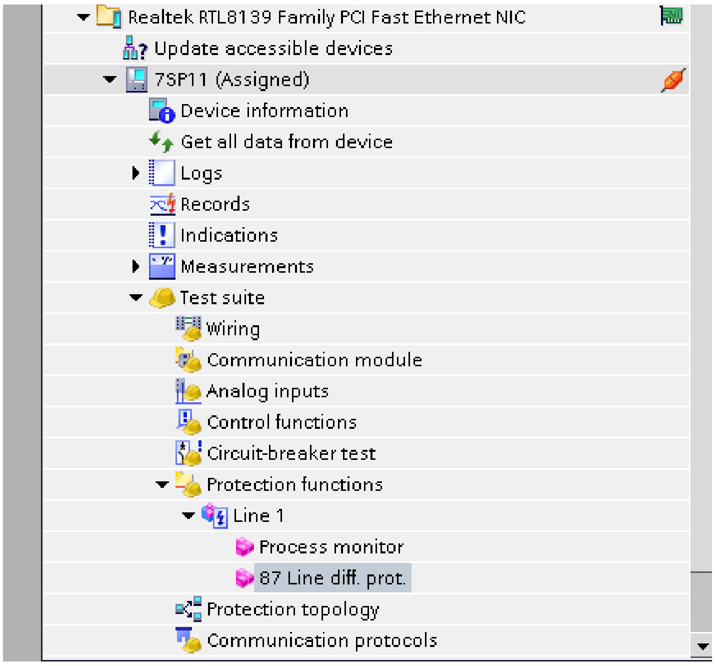


Figure 2Open the screen checking editor.

In this editor, we can use signals coming from a test sequence (right side) instead of a secondary measurement system.

In this case, the device must be 'restarted in simulation mode' and then runs in a special simulation mode. After the device is restarted, this mode is displayed in DIGSI 5 and in the device display.

We start a test sequence with DIGSI 5 via a signal at a physical binary input (input can be selected in DIGSI 5) or immediately after it has been loaded into the device. The use of a binary input allows the execution of a test in several devices simultaneously to check the realized solution.

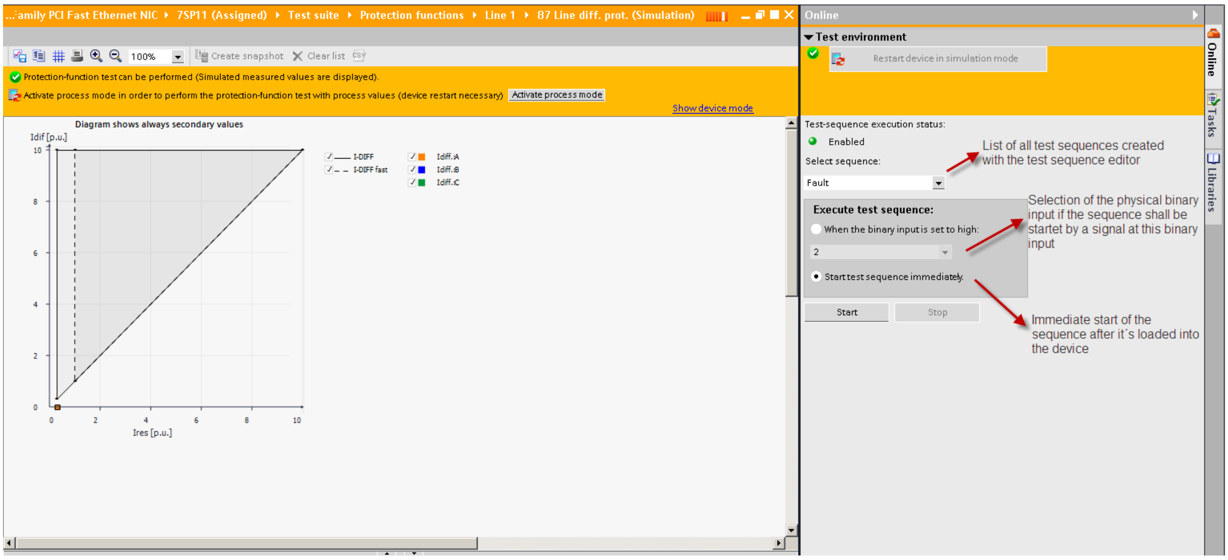


Figure 3Checking a Protection Function with a Test Sequence Created by the Sequence Editor

We can check the reaction of the protection function in the trigger characteristic in DIGSI 5 (Figure Figure 4 Since all trigger messages and a fault message are generated and the device can communicate via communication interfaces, we can fully investigate the behavior of the device for this specific error situation simulated by the simulation unit. No secondary measuring system is required for this test function. When the tests are finished, the device is switched back to process mode and works with sizes from the analog and binary device input terminals.

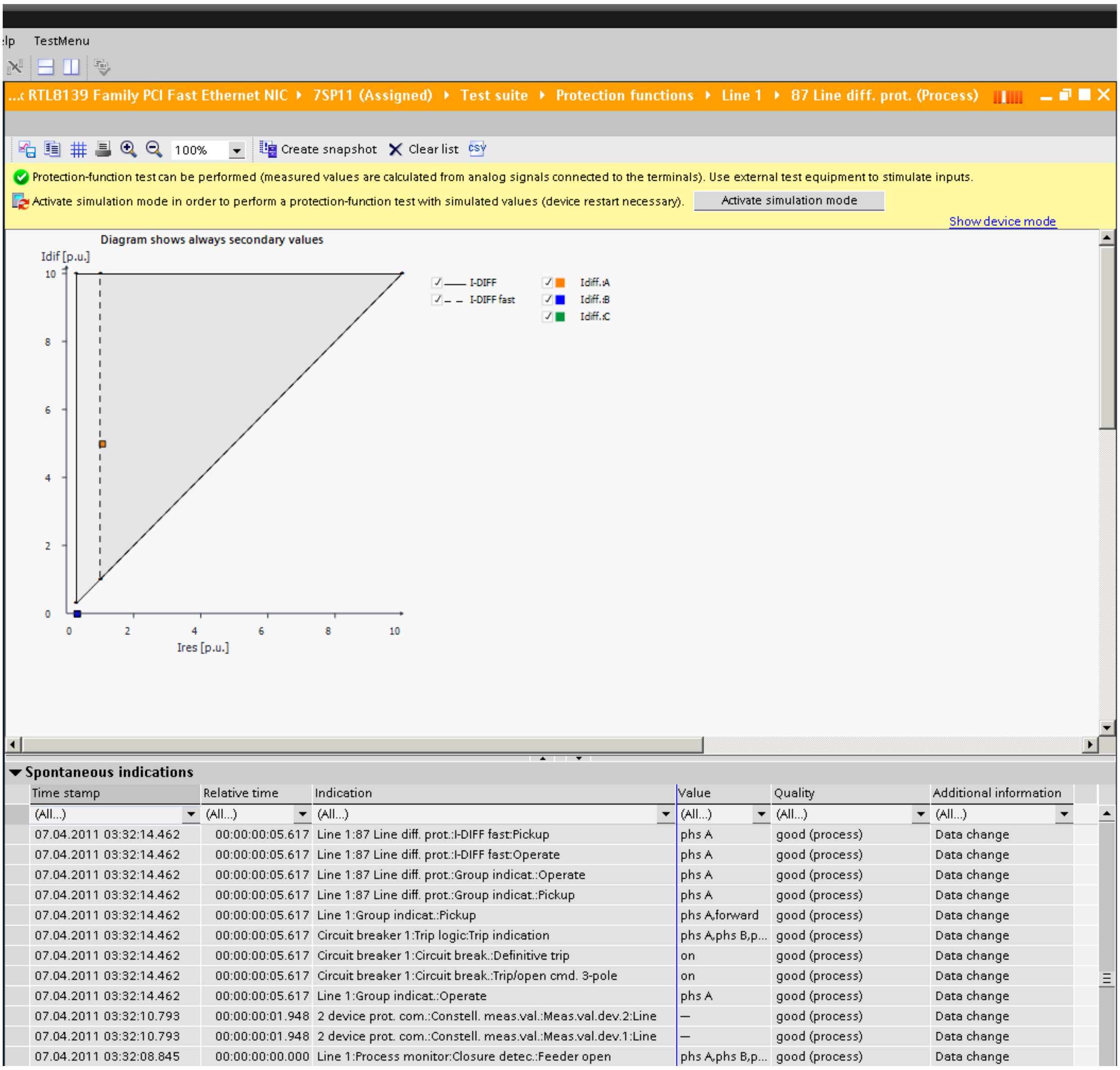


Figure 4: Checking a protection function with a test sequence reaction in the trigger characteristic and spontaneous error display of the device

1.3 Hardware Test

During the hardware test, the state of binary inputs can be read out by DIGSI 5, contacts and LEDs can be switched on test or set by DIGSI 5. The quantities measured at voltage and current inputs are shown in pointer diagrams, divided by amount and phase angle. Thus, an exchange of the connections in the measurement wiring, the switching group or the direction between current and voltage can be easily detected and checked. For devices that are connected via actuated connections, analog measuring points of distant ends can also be displayed as pointers. The stability of a differential protection can thus be easily over-checked.

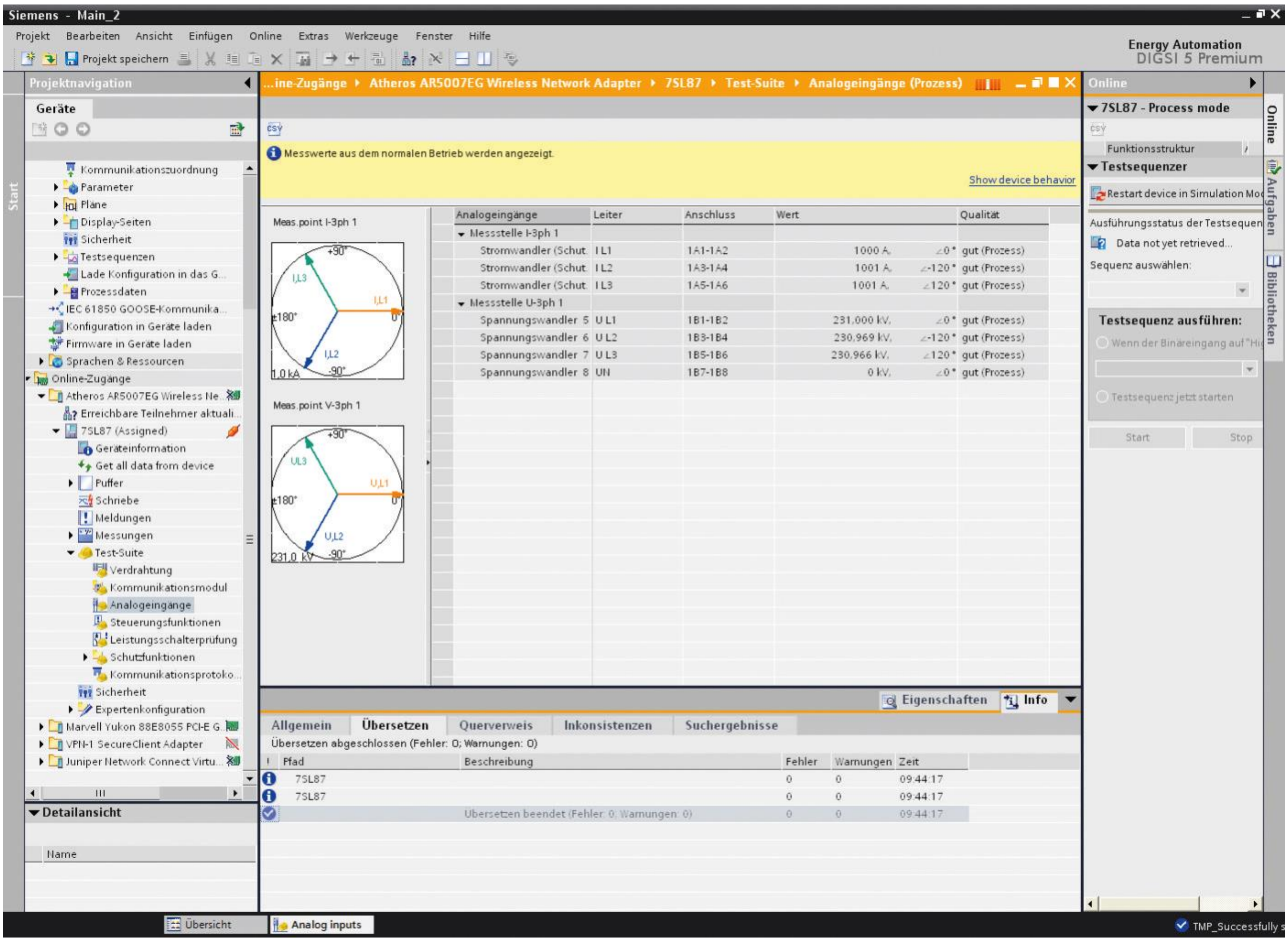


Figure 5: Display of analog measuring points in pointer diagrams

Before the test editor is activated for wiring, the device is put into commissioning mode. The device will now restart. The state of all inputs and outputs is saved and restored when the test editor is closed. This is timed out so that the devices do not remain permanently in this state.

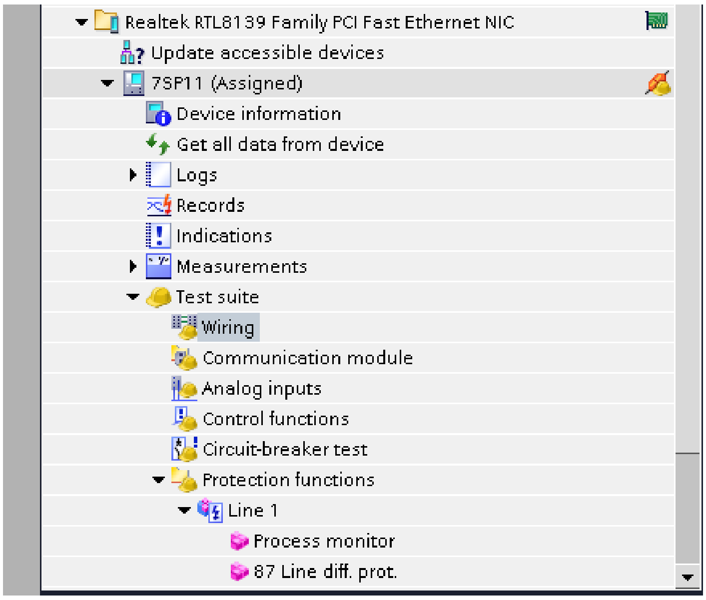
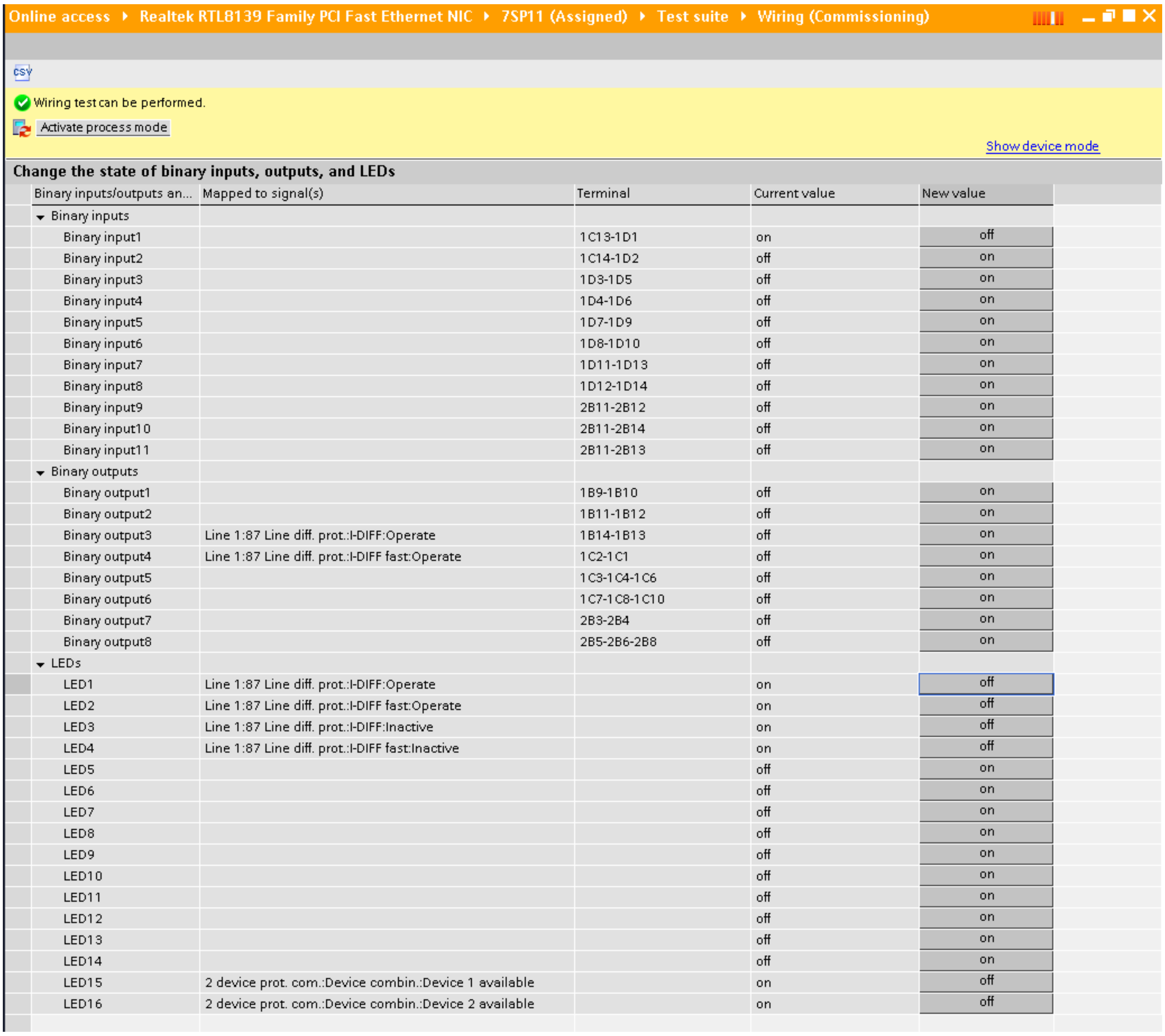


Figure 6: Test Editor for wiring test in DIGSI 5

In this editor (see Figure 6), all inputs and outputs of a device with the description of the terminals and the assignment in the shunting matrix are listed in a table. Furthermore, the actual state of the inputs and outputs is shown in the table. The state of a binary input can be checked when a contact is closed in another device. This can be enforced 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)

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 7: Wiring Test Editor for Monitoring and Testing Binary Inputs, Binary Outputs, and LED

1.4 Functional and protective functional tests

The graphical representation of characteristic curves or diagrams of protection functions supports not only the parameter izing, but also the tester of the protection functions. In this check, the working point of a protection function is graphically displayed in the diagrams, e.g. the calculated impedance of a distance protection in the zone diagram. In addition, messages of the protection function are logged, e.g. their excitation or triggering. This test can be performed with signals from the process or with the integrated test device of the device.

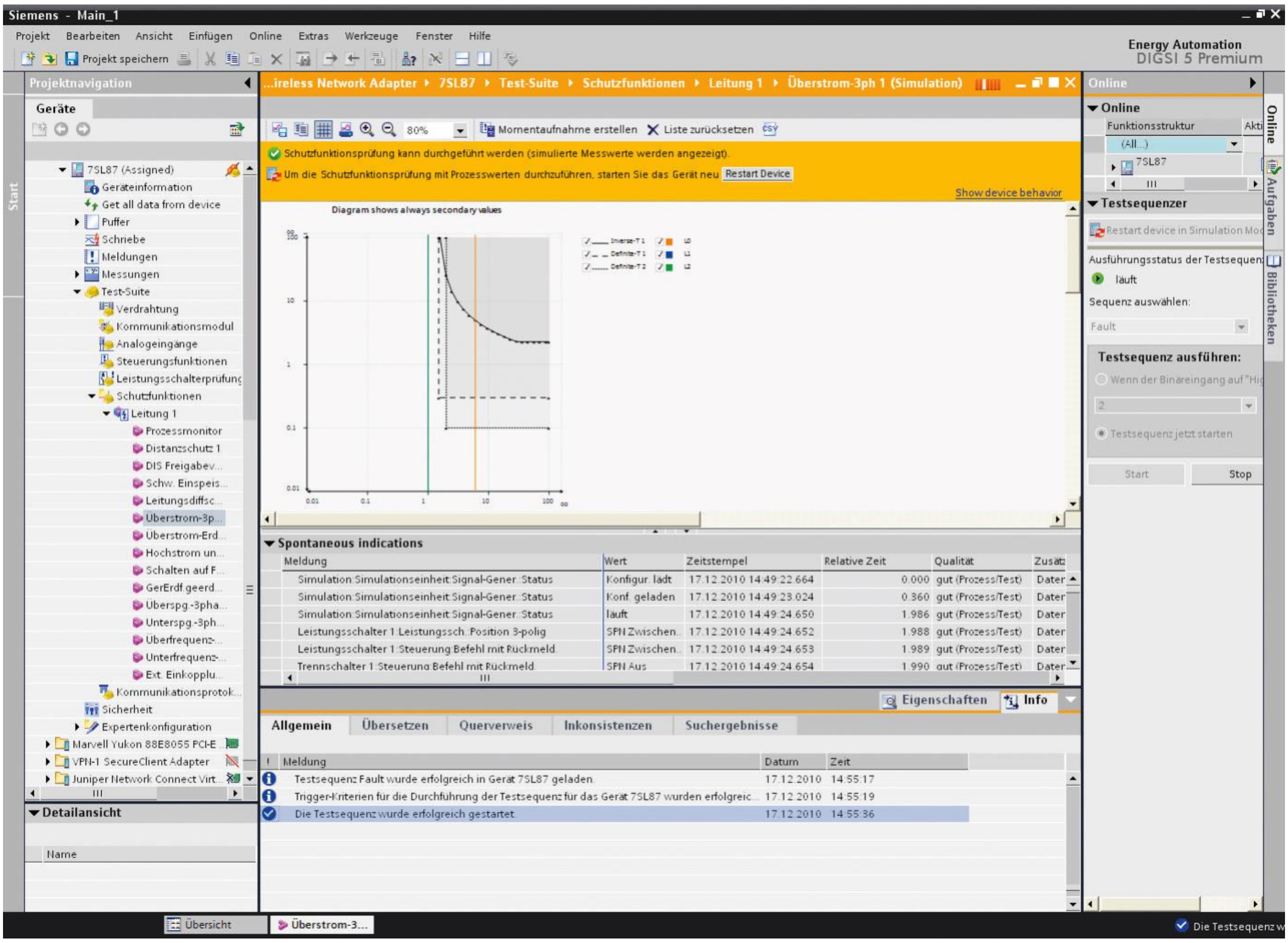


Figure 8: Protection function check with working point of the protective function

1.5 Testing of communication

Since communication is an integral part of the devices and they are connected to each other or to a control technology. These interfaces can be connected serially. B via the IEC 60850-5-103 protocol or via Ethernet to a client with IEC 61850 protocol to a station control device. Devices can also communicate with IEC 61850 GOOSE messages or with interaction interfaces (PI) in a point-to-point connection. Communication must be fully checked during commissioning and constantly monitored during operation. The integrated test aids support the user in the efficient verification and monitoring of communication channels.

Figure 7 shows access to the communication check editor. DIGSI 5 is in dialogue with the device. After opening the editor, the device must be put into commissioning mode, which will cause the device to be reset. The device is then in a special operating mode that allows stimulating signals. If these signals are assigned to communication interfaces, they are sent out via these interfaces using the specific protocol.

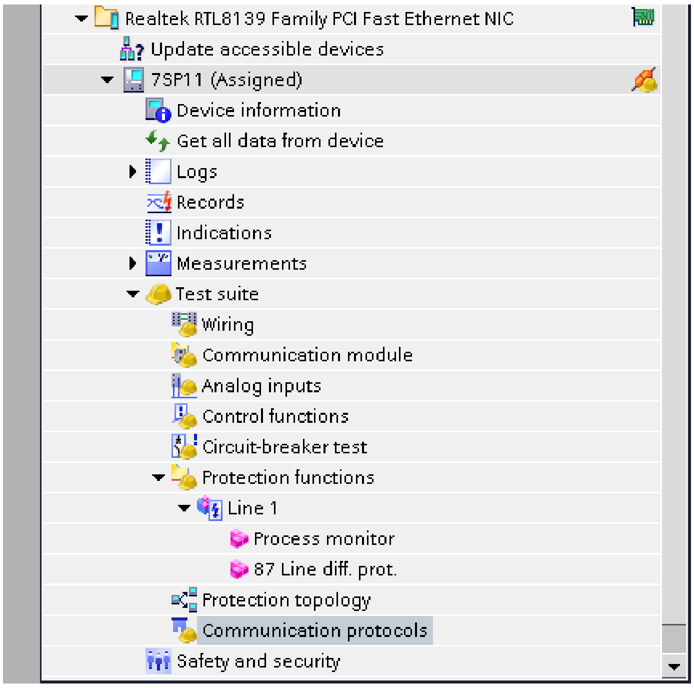


Figure 9: Opening the Test Editor for Communication Protocols in DIGSI 5

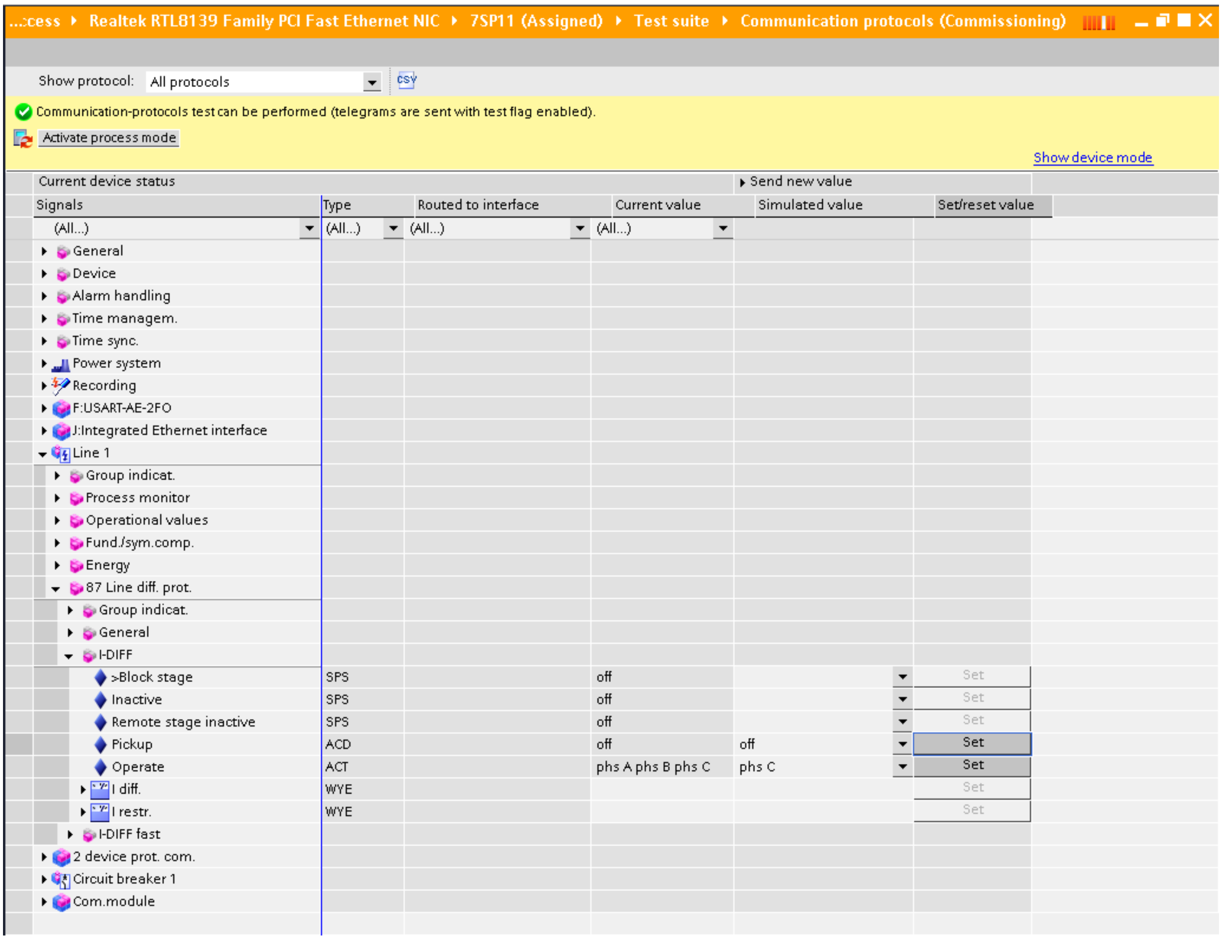


Figure 10: Test Editor for Communication Protocols in DIGSI 5

The left row shows a list of all available signals in the device that can be reset or deferred during the check. The signal type is also displayed to show whether it is a binary signal type (e.g. PLC) or a measurement signal type (e.g. star). The next line shows whether the signal is passed to a communication interface when the communication is shunting. Signals for IEC 61850 are special cases. Because protocols can be generated dynamically by a client, DISGI 5 does not prerouting, so it is not listed in this line.

The current and new states are displayed in the next column and can be set there. With the help of the start button, the signal is switched from the current state to the new state and transmitted over the communication connection if it has been assigned to one or more interfaces.

1.6 Evaluation of logic plans (CFC-Debugging)

Logic plans created as function plans (CFC) can be tested offline in DIGSI 5. For this purpose, test sequences can be generated with the DIGSI 5 sequencer, which act on logical inputs of the function plan or on the analog and binary inputs of the device. This allows not only the function plan, but also the interaction with upstream and downstream functions to be tested. During this check, the value of variables is displayed and their time history is logged in writings, which can later be analyzed with SIGRA.B. This way, even complex time dependencies can be easily analyzed. Function plans (CFC) can be created and tested offline in the office without the need for a device.

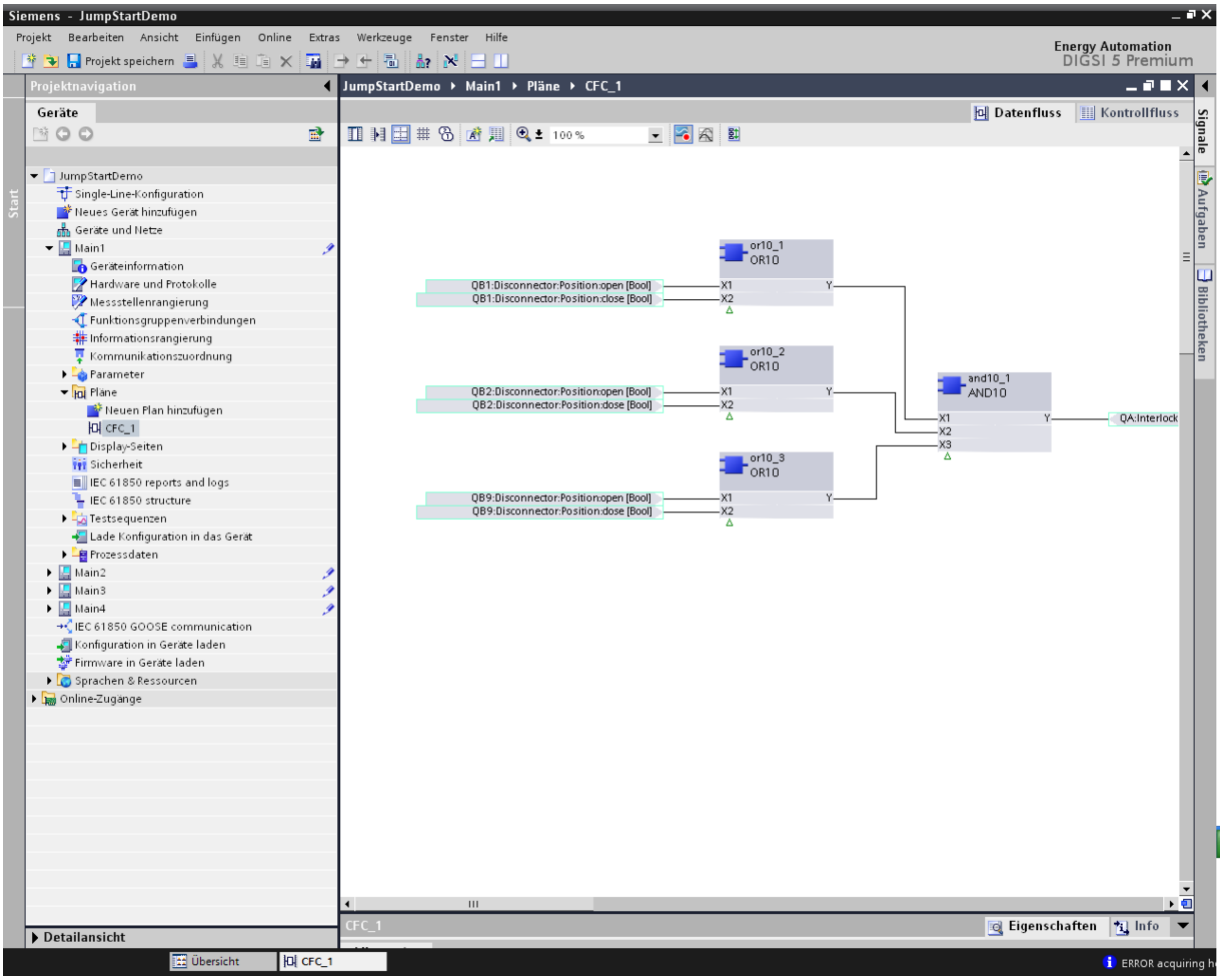


Figure 11: Easy Analysis of Function Plans

1.7 Conclusion

For SIPROTEC 5 Compact with the DIGSI 5 Test Suite, various test editors are available to inspect the devices during commissioning and from time to time during operation. These test features help to check hardware wiring, application functionality, and communication to a station control system or other devices (e.g. use of GOOSE messages). This means:

- Significant reduction in test and commissioning time
- IBS support personnel in the oncoming station is not mandatory
- The test routines performed are documented.
- Testing by secondary testing device becomes almost superfluous.

In addition, the full functionality of the DIGSI 5 Test Suite can be used around the clock, from anywhere and without hardware using SIPROTEC DigitalTwin.

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