

Test Tutorial

Equipment Type: Protection Relay

Brand: Siemens

Model: <u>7UT86</u>

Function: <u>32R or PDOP – Power Directional</u>

Tool Used: CE-6006; CE-6707; CE-6710; CE-7012 or CE-7024

Objective: Perform tests on the reverse power function to verify its directionality

Version control:

| Version | Descriptions | Date | Author | Reviewer |
|---------|-----------------|------------|--------|----------|
| 1.0 | Initial release | 24/05/2022 | M.R.C. | G.C.D.P. |



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| | INSTRUMENTOS PARA TESTES ELÉTRICOS | |
|------------|------------------------------------|--|
| APPENDIX B | | |



Statement of responsibility

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Suggestions for improvement of this material are welcome, just user contacts us via email suporte@conprove.com.br.

The tutorial contains knowledge gained from the resources and technical data at the time was writing. Therefore, CONPROVE reserves the right to make changes to this document without prior notice.

This document is intended as a guide only; the manual of the equipment under test should always be consulted.



The equipment generates high current and voltage values during its operation. Improper use of the equipment can result in material and physical damage.

Only suitably qualified people should handle the instrument. It should be noted that the user must have satisfactory training in maintenance procedures a good knowledge of the equipment under test and also be aware of safety standards and regulations.

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INSTRUMENTOS PARA TESTES ELÉTRICOS Sequence for testing the Siemens 7UT86 relay in the Power Directional software

1. Relay connection to CE-6710

Appendix A shows the relay terminal designations.

1.1 Auxiliary Source

Connect the positive (red terminal) of the Aux source. Vdc to pin B1 of slot 2B of the relay and the negative (black terminal) of the Aux Vdc supply to pin B2 of slot 2B.



1.2 Current and Voltage Coils

To establish the connection of voltage coils, connect voltage channels V1, V2 and V3 to pins B1, B3 and B5 of relay slot 3B respectively, and their common to pins B2, B4 and B6 respectively. If the relay commons are short-circuited, just connect the three commons of the voltage channels to that point. To connect the current coils, connect channels I1, I2 and I3 with pins A1, A3 and A5 of slot 1A of the relay terminal and common to pins A2, A4 and A6. If these last three points are short-circuited, connect all commons to this point.







1.3 Binary Inputs

Connect the CE-6710 binary inputs to the relay binary outputs.

• BI1 to pin D1 and its common to pin D2;

The following figure shows the details of the connection.



2. Communication with 7UT86 relay

First connect a USB cable from the notebook with the relay. Then double-click on the software icon and "*DIGSI 5*".



When opening the program, click on the "Project" menu then choose the "New" option.





Figure 5

Enter a name for the project and then click "Create" as highlighted below.

| Create a new project | × |
|----------------------|--------------------------------------|
| Project name: | PDOP |
| Path: | C:\Users\Michel\Documents\Automation |
| Author: | Michel |
| Comment: | |
| | ~ |
| | Create Cancel |

Figure 6

When creating the project, add the relay that will be tested, to do this double-click on *"Add New Device"* as highlighted below.



| ŀ | DIGSI 5 V7.50 - C:\Users\Michel\Documents\Automation\PDOP\PDOP | | | |
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| | Devices | | | |
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| Start | PDOP Single-line configuration Add new device Devices and networks IEC 61850 stations Document information Frames Cover pages | | | |
| | G Languages & resources | | | |
| | Gnline access | | | |

Figure 7

Enter the relay short code located on a "*TAG*" side of the relay, then click "*Verify*" as highlighted below.

| Add new device | × |
|---|------------------|
| → Step 1: Select device type | |
| Enter short product code (TNS) or paste long product code | P1F115685 Verify |
| or configure in Hardware and protocols Editor: | Configure |
| O Step 2: Select device properties | |
| Voltage variant: | |
| Integrated Ethernet interface (port J): | . |
| Significant feature: | ¥ |
| Select function-point class: | v |
| • Step 3: Select application template Application-template selection: | |
| Step 4: Select communication versions Communication configuration: | |
| Open Hardware and protocols Editor after device creation | |
| Update short product code (TNS) list | ОК Сапсе |

Figure 8

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202
Phone (34) 3218-6800Phone (34) 3218-6800Fax (34) 3218-6810Home Page: www.conprove.comE-mail: conprove@conprove.com.br



Select the basic *"Template"* whose firmware version is consistent with that of the relay (To verify, just look at the relay HMI when it is turned on). Then click *"OK"*.

| Add | new device | | | | × |
|----------|--|--|-----------------|--------|----|
| 0 | Step 1: Select device type | | | | |
| | Enter short product code (TNS) or paste long product code: | 7UT86-DAAA-AA0-0WWW0-AG0111-12111B-BAA000 | -000AC0-CC1BA1- | Verify | |
| | or configure in Hardware and protocols Editor: | Configure | | | |
| 0 | Step 2: Select device properties | | | | |
| | Voltage variant: | DC 60 V to 250 V, AC 115 V to 230 V | | | - |
| | Integrated Ethernet interface (port J): | Only DIGSI 5 connection | | | ŢŢ |
| | Significant feature: | No significant feature available for selected device | tunes | | Ţ |
| | significant leature. | sito significant leature available for selected device | , type> | | |
| | Application-template selection: | Application templates | Configuration | Status | |
| | Application-template selection: | Application templates | Configuration | Status | |
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| | | Two-winding transformer (87T, 50BF, 90V) | V06.21.03 | • | |
| | | Two-winding transformer (87T, 50BF, 90V) | V06.03.02 | | ≡ |
| | | Motor prot. (87M, 50BF, 59, 27, 81, 46, 49) | V07.31.03 | | |
| | | Motor prot. (87M, 50BF, 59, 27, 81, 46, 49) | V07.00.15 | | |
| | | Motor prot. (87M, 50BF, 59, 27, 81, 46, 49) | V06.21.03 | | * |
| | | | | | |
| ~ | Step 4: Select communication versions | | | | |
| | Communication configuration: | V07.31 | | | - |
| | | | | | |
| | Open Hardware and protocols Editor after device creation | | | | |
| | Update short product code (TNS) list | | ОК | Cancel | |

Figure 9

Note that a generic relay has been added (highlighted in green below). The next step is to establish communication with the equipment, for that go to the "Online" menu and choose the option "Connect to device and retrieve data".





Figure 10

After establishing communication with the relay, it is necessary to read the parameterized settings. Right-click on the target relay (highlighted in green above) and choose the option "Update configuration from target device".



Figure 11

Click "Yes" to the following message:



There were other warning messages (not shown), click "Yes" on all. If the procedure works, the following screen will appear.

| Update configuration from target device Update configuration from target finished successfully. Overview Status Update results Successfully updated the offline configuration from the target device. | |
|---|-------------|
| Update configuration from target finished successfully. Overview | × |
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| | |
| | Save result |
| | ОК |

Figure 13

Export the created file in ".dex5" format in order to have a backup of the settings.



Figure 14



There are other ways to extract information from Siemens Siprotec 5 relays, but the mode shown here is the most efficient way for those who will commission a relay already parameterized and installed in a panel.

3. Parameterization of the 7UT86 relay

3.1 Device Settings

After the connection has been established, open the "7UT86" device section. Then open the "Settings" section, finally choose the "Device Settings" option. Check that group 1 is active, the rated frequency is 60Hz and the minimum operating time is zero seconds.

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Figure 15

3.2 General

Open the "Power System" section and select the "General" option. Check the parameterized phase sequence.



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Figure 16

3.3 Meas. Point I-3ph 1

Select the option "*Meas. Point I-3ph 1*". Adjust primary and secondary current values, magnitude compensation factors and <u>disable supervision functions.</u>

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Figure 17

Click on the "Info" tab to hide it and enlarge the settings window.



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| ▼ <u>□</u> 7UT86 | | ies |
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| Communication mapping | | |
| 🔻 👆 Settings | | |
| Device settings | 11.931.2431.1 Mode: off | |
| 🎔 Time settings | 11.931.2431.102 Threshold: 0.50 | A |
| | 11.931.2431.101 Slope factor: 0.10 | |
| 😜 General | 11 931 2431 6 Delayrupanizion alarm: 5 00 | |
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| A lest sequences | | |

Figure 20

3.4 Meas. Point V-3ph 1

Select the option "*Meas. Point V-3ph 1*". Set the values of primary, secondary voltages and magnitude compensation factor for the first winding and <u>disable</u> supervision functions.

| DIGSI 5 V7.50 - C:\Users\Michel\Documents\Automation\PDOP\PDOP | | _ # X |
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| Project Edit View Insert Online Options Tools Window Help | | Energy Automation |
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| 🗧 🕂 Single-line configuration | | |
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| Devices and networks | 11.0/1.9011.102 Dated second students 115 | |
| • 🛄 7UT86 🧳 | Nateu secondary voltage. 115 | |
| Device information | 11.941.8911.103 Matching ratio Vph / VN: 1.73 | L2 AS |
| Hardware and protocols | 11.941.8911.104 VT connection: 3 ph-to-gnd volt. + VN 💌 | A |
| Measuring-points routing | 11.941.8911.106 Inverted phases: none | AN |
| Function-group connections | 11 941 8911 111 Tracking: active | |
| Generation routing | | |
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| Weas.point I-3ph 2 | VII | |
| Weas.point V-3ph 1 | | |
| ▶ ⁴ / Recording | 11.941.3811.103 Magnitude correction: 1.000 | |
| Motor side 1 | 11.941.3811.108 Phase: VA | |
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| Motor differential 1 | | |
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Figure 21

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| Motor side 2 | | |
| Motor differential 1 | 11.941.3814.103 Magnitude correction: 1.000 | |
| QT Circuit breaker 1 | 11 0/1 291/ 109 Phase: VAL | |
| Charts | 11.541.5014.100 Tildse. VN | 100 V |
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Figure 22

| BIGSI 5 V7.50 - C:\Users\Michel\Documents\Automation\PDOP\PDOP | | _ # X |
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| Add new device | Wode. On | ibr |
| Devices and networks | 11.941.2521.101 Release threshold: 57.500 V | |
| TUT86 | 11.941.2521.102 Threshold min/max: 0.75 | S. |
| Device information | 11.941.2521.6 Delay supervision alarm: 5.00 s | |
| Hardware and protocols | | |
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| Motor side 2 | | |
| Motor differential 1 | Supv. sum v | |
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| In Charts | 11.941.2461.1 Mode: off | ~ |
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3.5 General

Open the "*Motor side 1*" option and double-click on the "*General*" option to make the voltage and power adjustments.



| DIGSI 5 V7.50 - C:\Users\Michel\Documents\Automation\PDOP\PDOP | | _ • X |
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| Europhic connections | | |
| Information routing | Rated apparent power: 5.90 MVA | A0 13 |
| Communication mapping | 871.1781.14671.102 Motor rated voltage: 6.00 kV | R I I I I I I I I I I I I I I I I I I I |
| - Settings | 871,1781.14671.101 Motor rated current: 568 A | AS |
| P Device settings | | |
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| Recording | Side data | |
| 🕶 🍕 Motor side 1 | | |
| 😜 General | 871.1781.14611.130 Side number: Side 1 | AG |
| Process monitor | 871.1781.14611.210 MI3ph1 usesMeasP with ID: 1 | AS |
| 😜 50/51 OC-3ph-A1 | 871,1781.14611.215 CTmismatch MI-3ph 1: 1.321 | AD |
| 😜 Inrush detect. | | |
| 67N Dir.OC-gnd-A1 | Measurements | |
| 59 Overvolt3ph 1 | | |
| S9 Overvolt-V0 1 | 871.1781.14611.158 P. O sign: not reversed | |
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| | | |

Figure 24

3.6 Inserting function 32

Click on the "Libraries" option and follow the path "Global DIGSI 5 Library > Types > Transformer differential protection > 7UT86 Transformer, 3 sides > FG Motor diff > Power protection > 32R Revers. pow.". Drag the "32R Revers. pow." above the "Motor side 1" icon and release.



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3.7 32R Revers. pow.

Double click on "32R Revers. pow." to perform reverse power directional function adjustments.

| DIGSI 5 V7.50 - C:\Users\Michel\Documents\Automation\PDOP\PDOP Project Edit View locatt Online Online Tools Window Help | | | | | _ | _ a × |
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| 27 Lindervolt -3nh 1 | | 871.331.2311.102 | Minimum voltage V1: | 5.750 | v | Ties . |
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| 32R Revers.pow. 1 | | Add new stage | Delete stage | | | |
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| Motor differential 1 | Stage 1 | | | | | |
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| Safety and security | | 871.331.991.2 | Operate & flt.rec. blocked: | no | • | |
| Test sequences | | 871.331.991.3 | Threshold: | -10.00 | % | |
| Process data | | 871.331.991.4 | Dropout ratio: | 0.60 | | |
| Charts - Trend/dynamic display & force table | | 871 221 001 102 | Dropout delaus | 0.00 | | |
| IEC 61850 stations | | 071.351.351.102 | biopour delay. | 0.00 | · | |
| Load configuration to devices | | 8/1.331.991.6 | Operate delay: | 0.50 | s | |
| Toad firmware to devices | | 871.331.991.103 | Operate delay stop valve: | 0.00 | s | |
| Impocument information | | • | | | | |
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| | | | | | | |

Figure 26

3.8 Information Routing

In the *"Information Routing"* option, the trip signal of function 32 must be associated with the physical output. For easier viewing, maximize the window.

| Save project → R (= L= X →) ± (= 1 | | | | | | | | | | | DIGSIS | Pren |
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| Device information | | Device | 4171 | | | | | | | | | |
| Hardware and protocols | | Alarm handling | 5971 | | | | | | | | | |
| Measuring-points routing | | Se Time managem. | 8821 | | | | | | | | | |
| Function-group connections | | Sync. | 8851 | | | | | | | | | |
| Information routing | | Res. binary outputs | 4711 | | | | | | | | | |
| Communication mapping | | Res. LED not in Grp. | 7411 | | | | | | | | | |
| 🔻 👆 Settings | | ▶ p ^P Power system | 11 | | | | | | | | | |
| 📝 Device settings | | Recording | 51 | | | | | | | | | |
| 🎐 Time settings | | 🕨 🮯 J:Onboard Ethernet | 101 | | | | | | | | | |
| | | Motor side 1 | 871 | | | | | | | | | |
| 😜 General | | Motor side 2 | 872 | | | | | | | | | |
| 🔪 Meas.point I-3ph 1 | | Motor differential 1 | 861 | | | | | | | | | |
| Meas.point I-3ph 2 | | Gircuit breaker 1 | 201 | | | | | | | | | |
| Meas.point V-3ph 1 | | E:ETH-BB-2FO | 102 | | | | | | | | | |
| 🕨 🐓 Recording | | 🕨 🧮 Main menu | | | | | | | | | | |
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| Process monitor | | | | | | | | | | | | |
| 😂 50/51 OC-3ph-A1 | | | | | | | | | | | | |
| Inrush detect. | | | | | | | | | | | | |
| 67N Dir.OC-gnd-A1 | | < | 11 | | | | | | | | | |
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| 59.Overvalt-V0.1 | v | | | | | | Griop | erties | Suno 4 | | nostics | |

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The first columns are associated with the binary inputs of the relay. In that case they will not be used. Double-click the *"Source"* option to hide these settings.

| Project Edit View Inset Online Option: Tools Window Help POP > 7UT86 > Information routing POP > Informatio | ŀ | DIGSI 5 V7.50 - C:\Users\Mich | el\Documents\A | utomation | INPDOP | PDOP | | | | | | | | _ | | | | _ | _ | | | _ | _ | | _ | | _ | | - | ∎ X |
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| Image: Proversystem 11 Image: Proversystem 51 Image: Proversystem 101 Image: Proversystem 102 Image: Proversystem 102 Image: Proversystem 102 Image: Proversystem 102 | | Res. LED not in Grp. | /411 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| > > Nectioning > N > > > Nectioning > N > < | | Proversystem | 51 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Image: Second Science Control 871 Image: Second Science Control 871 Image: Second Science Control 871 Image: Second Science Control 861 Image: Science Control 861 | | Recording | 51 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Image: Second | | J.Onboard Ethemet | 971 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Image: Second Secon | | Motor side 7 | 977 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| • • • • • • • • • • • • • • • • • • • | | Motor differential 1 | 861 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Image: Eff-H8b2PO 102 Image: Eff-H8b2PO 102 | | Gircuit breaker 1 | 201 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Main menu | | E:ETH-BB-2EQ | 102 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Main menu | 102 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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Figure 28

Enter the options "Motor side 1 > 32R Revers. wow. 1 > Stage 1".

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| | | | | Binary | output | | | | | | | | ▶ LEDs | | | | | | | | | | |
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| Signals | Number | Туре | | 1.1 1. | 2 1.3 | 1.4 | 2.1 | 2.2 3 | .1 3.2 | 3.3 3 | .4 3.5 | 3.6 | 1.1 1 | 1.2 1.3 | 1.4 | 1.5 | 1.6 | 1.7 1.8 | 1.9 | 1.10 | 1.11 | .12 1.1 | 3 1.14 |
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| J:Onboard Ethernet | 101 | | | | | | | | | | | | | | | | | | | | | | |
| 🔻 🍕 Motor side 1 | 871 | | | | | | | | | | | | | | | | | | | | | | |
| Group indicat. | 871.4501 | | | | | | | | | | | | | | | | | | | | | | |
| Reset LED Group | 871.7381 | | | | | | | | | | | | | | | | | | | | | | |
| Inrush detect. | 871.4141 | | | | | | | | | | | | | | | | | | | | | | |
| Process monitor | 871.1131 | | | | | | | | | | | | | | | | | | | | | | |
| Operational values | 871.761 | | | | | | | | | | | | | | | | | | | | | | |
| Fund./sym.comp. | 871.771 | | | | | | | | | | | | | | | | | | | | | | |
| 50/51 OC-3ph-A1 | 871.201 | | | | | | | | | | | | | | | | | | | | | | |
| 67N Dir.OC-gnd-A1 | 871.1471 | | | | | | | | | | | | | | | | | | | | | | |
| 59 Overvolt3ph 1 | 871.51 | | | | | | | | | | | | | | | | | | | | | | |
| 59 OvervoltV0 1 | 871.101 | | | | | | | | | | | | | | | | | | | | | | |
| 27 Undervolt3ph 1 | 871.131 | | | | | | | | | | | | | | | | | | | | | | |
| B1 OverfreqA 1 | 871.11 | | | | | | | | | | | | | | | | | | | | | | |
| S1 UnderfreqA 1 | 871.31 | | | | | | | | | | | | | | | | | | | | | | |
| S2R Revers.pow. 1 | 871.331 | | | | | | | | | | | | | | | | | | | | | | |
| Group indicat. | 871.331.450 | 1 | | | | | | | | | | | | | | | | | | | | | |
| General | 871.331.231 | 1 | | | | | | | | | | | | | | | | | | | | | |
| Stage 1 | 8/1.331.991 | | | | | | | | | | | | | | | | | | | | | | |
| Motor side 2 | 872 | | | | | | | | | | | | | | | | | | | | | | |
| Motor differential 1 | 861 | | | | | | | | | | | | | | | | | | | | | | |
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Figure 29

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202
Phone (34) 3218-6800Phone (34) 3218-6800Fax (34) 3218-6810Home Page: www.conprove.comE-mail: conprove@conprove.com.br



Assign the "general" signal within the "Operate delay expired" to the 1.1 output. Look at the columns for that signal "Destination > Binary output > Base module".

| ŀ | DIGSI 5 V7.50 - C:\Users\Michel\Docum | ents\Automat | ion\PD(|)P\PDC | Р | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | | _ | _ | _ | | | _ • × |
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| | 67N Dir.OC-gnd-A1 | 871.1471 | | | | | | | | | | | | | | | | | | | | | | | S |
| | 59 Overvolt3ph 1 | 871.51 | | | | | | | | | | | | | | | | | | | | | | | |
| | 59 OvervoltV0 1 | 871.101 | | | | | | | | | | | | | | | | | | | | | | | |
| | Description of the second s | 871.131 | | | | | | | | | | | | | | | | | | | | | | | |
| | S1 OverfreqA 1 | 871.11 | | | | | | | | | | | | | | | | | | | | | | | |
| | S1 UnderfreqA 1 | 871.31 | | | | | | | | | | | | | | | | | | | | | | | |
| | S2R Revers.pow. 1 | 871.331 | | | * | | | | | | | | | | | | | | | | | | | | |
| | Group indicat. | 871.331.450 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | 🕨 🤤 General | 871.331.231 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | ▼ 😜 Stage 1 | 871.331.991 | | | * | | | | | | | | | | | | | | | | | | | | |
| | >Block stage | 871.331.99 | SPS | | | | | | | | | | | | | | | | | | | | | | |
| | >Stop valve closed | 871.331.99 | SPS . | | | | | | | | | | | | | | | | | | | | | | |
| | Inactive | 871.331.99 | . SPS | | | | | | | | | | | | | | | | | | | | | | |
| | Behavior | 871.331.99 | ENS | | | | | | | | | | | | | | | | | | | | | | |
| | Health | 871.331.99 | ENS | | | | | | | | | | | | | | | | | | | | | | |
| | Pickup | 871.331.99 | . ACD | | | | | | | | | | | | | | | | | | | | | | |
| | Operate delay expired | 871.331.99 | . ACT | | | | | | | | | | | | | | | | | | | | | | |
| | general | 074 004 00 | SPS | | U | | | | | | | | | | | | | | | | | | | | |
| | Operate | 871.331.99 | ACT | | | | | | | | | | | | | | | | | | | | | | |
| | Operate del. stop val. | 871.331.99 | ACT | | | | | | | | | | | | | | | | | | | | | | |
| | • • Operate w. stop valve | 871.551.99 | . Aci | | | | | | | | | | | | | | | | | | _ | | | _ | ~ |
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| 300 | and at a second s | | | | | | | | | | | | | | | | | | C.I.S. | , and | | | | | |

Figure 30

The option "U" must be used, which means "Unlatched", that is, the relay activates and when the fault ceases, it automatically returns to the initial state of the binary. If the user chooses the "L" or "Latched" option, the relay activates and remains activated even if the fault has been extinguished. (This option is not indicated for the test).

Click on the "Start" option so that the main window is shown again.

3.9 Sending adjustments

To send the changes in the parameterization right-click on the relay icon "7UT86" and choose the option "Load configuration to device".



| P DIGSI 5 V7.50 - C:IUsersiMicheliDocumentsiAutomationIPDOPIPDOP | | | | | | | | | | | | | | - " |
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| ▼ [] 7UT86 | 🔸 눻 67N Dir.OC-gnd-A1 | 871.1471 | | | | | | | | | | | | |
| Device information | 59 Overvolt3ph 1 | 871.51 | | | | | | | | | | | | |
| Paste Ctrl+C | S9 OvervoltV0 1 | 871.101 | | | | | | | | | | | | |
| Measuring-points routi | > 27 Undervolt3ph 1 | 871.131 | | | | | | | | | | | | |
| Function-group conner Delete Deletete Deletete Delete | S1 OverfreqA 1 | 871.11 | | | | | | | | | | | | |
| Information routing | S1 UnderfreqA 1 | 871.31 | | | | | | | | | | | | |
| Communication mapp 🔿 Export | S2R Revers.pow. 1 | 871.331 | | | * | | | | | | | | | |
| Settings Import | Group indicat. | 871.331.450 | 1 | | | | | | | | | | | |
| Device settings Upgrade configuration version | General | 8/1.331.231 | 1 | | | | | | | | | | | = = |
| Compare devices | Stage 1 | 8/1.331.991 | 6.06 | | | | | | | | | | | |
| Prover system Connect to device and retrieve data. Alt+Ctrl+O | >Block stage | 871.331.99. | . SPS | | | | | | | | | | | - 11 |
| Connect to device and redieve data Art+Cur+O | Stop valve closed | 871 331 99 | . 5F5 CPC | | | | | | | | | | | |
| Load configuration to device | Behavior | 871 331 99 | ENS | | | | | | | | | | | |
| Load firmware to device | Health | 871.331.99. | ENS | | | | | | | | | | | |
| Recording | Pickup | 871.331.99. | ACD | | | | | | | | | | | |
| Motor side 1 Initialize device | Operate delay expired | 871.331.99. | . ACT | 1 | * | | | | | | | | | |
| Seneral Assign device | 🔶 general | | SPS | | U | | | | | | | | | |
| Process monito Remove assignment | Operate | 871.331.99. | . ACT | | | | | | | | | | | |
| 50/51 OC-3ph-A Upgrade device functionality | Operate del. stop val. | 871.331.99. | . ACT | | | | | | | | | | | |
| So Inrush detect. | Operate w. stop valve | 871.331.99. | . ACT | | | | | | | | | | | ~ |
| 67N Dir.OC-gnd Rrint preview | | | | | | | | | | | | | | > |
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| | | | | | | | | | | and y Giol | | Sciolary | nus open. | |

Figure 31

Reminding that the default password for Siemens SIPROTEC 5 is: "222222".

| En | ter confirmation ID | | | X |
|----------------------|--|-----------------|---------------------------------------|---|
| Ye pr Er Se | our requested action for device 7L roceeding further. hter the confirmation ID for anyone tttings / operation | JT86 requires t | the confirmation ID for ing users: | |
| | Enter confirmation ID: | **** | | |
| | | ОК | Cancel | |
| | Fig | ure 32 | | |

In the next two windows not shown, choose the "Yes" option.

4. Power Directional software adjustments

4.1 Opening the Power Directional

Click on the "Conprove Test Center" application manager icon.





Click on the Power Directional software icon.





| 📴 🗋 🔐 🚽 Power Directional 2.02.182 (6 | (64 Bits) - CE-6710 (0970322) | - 0 × |
|---|--|---|
| Sart Config Hrd & Config GOOSE | Settings X | |
| Direc Channels () Connection | S General Inform. System Notes & Obs. Explanatory Figures Check List Others Connections Test: | |
| Shooting Search Route Test Settings | Directional Descr: Date: Date: | |
| Insert / Edit Points Edit Point Edit Point Definitions | Tested device: Model V Identf: V Model V Type: V Manufacturer: V | Type ABC Subtile: |
| NEW Point ✓ IS:: 0.00 VA Ø Load: Ind ✓ cosØ | 0 Location: | Untested Points Tested Points |
| Remove I: 0.00 A V System Angle | a Bay: Address: k City: State: | Colors NT OK Error S: 1,305 VA ; Ø: 131,399 * P: -0.663 W ; Q: 0.579 VAr P: -0.663 W ; Q: 0.579 VAr 49P 40P 40P 40P |
| Remove All Test Points Tested Points | Responable: | |
| No. S[VA] AngS[*] P[W] Q | Tool Test: CE-6710 Series Num.: 09703227CCM33222211U5HVRGLGLGL2Z0RXD | H |
| Tipo: Points V General Info 🛃 Powe | Default OK Cancel | |
| Error List Protection Status | | |
| New | Aux font: 0,00 V Heating: 0% | |
| | Figure 25 | |

Figure 35

4.2 Configuring the Settings

When opening the software, the "Settings" screen will open automatically (provided that the option "Open Settings when Start" found in the "Software Options" menu is selected). Otherwise click directly on the "Settings" icon.





Inside the "Settings" screen, fill in the "General Inform." with details of the tested device, installation location and the person responsible. This makes reporting easier, as this tab will be the first to be shown.



| · · | General Inform Surtem | Noton & Oba Evolution / Figurea | Check List Othe | m Connections | |
|---------------------------------------|-----------------------|---------------------------------------|-----------------|-------------------|--------|
| General | | Notes & Obs. Explanatory Figures | Check List Othe | rs Connections | |
| | lest: | | | | |
| Power | Descr: Reverse Pov | ver Directional | Date: | | |
| | Tested device: | | | | |
| | Identi | : 23031982 | Model | 7UT86 | ~ |
| | Ture | · Transformer Protection | Mapufacturer | Siemene | |
| | Type | | Manuracturer. | Siemens | ~ |
| | Location: | | | | |
| | Substation | : Conprove | | | ~ |
| | Bay | : 1 ~ |] | | |
| | Address | Visconde de Ouro Preto 75. Custódio I | J Pereira | | ~ |
| | | | | | |
| | City | Uberlandia | ~ | State | £ MG ∨ |
| | Responsible: | | | | |
| | Name | : Michel Rockembach de Carvalho | | | ~ |
| | Sector | | Begistov: | 00001 | |
| | | | nogiouy. | 00001 | |
| | Tool Test: | | | | |
| | CE-6710 | Series Num.: | 09703227CCM33 | 222211U5HVRGLGLGL | 2Z0RXD |
| | | | , | | |
| | | | | | |
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| | | | | | |
| · · · · · · · · · · · · · · · · · · · | | | Preferences | ОК | Cancel |

4.3 System

In the following screen, within the "*Nominal*" sub tab, the values of frequency, phase sequence, primary and secondary voltages, primary and secondary currents, transformation ratios of VTs and CTs are configured. There are also two sub-tabs "*Impedance*" and "*Source*" whose data are not relevant for this test.





Figure 38

There are other tabs where the user can insert "*Notes & Obs.*", *Explanatory Figures, and* "*Check List*" of the procedures for carrying out the test and even create a diagram with all the schematic of the connections between the test set and the test equipment.

5. Channel Direction and Hardware Configurations

Click on the icon illustrated below.







Then click on the highlighted icon to configure the hardware.



Figure 40

Choose the channel configuration; adjust the auxiliary source and the stopping method of the binary inputs. To finish click on "OK".



| ngs | |
|--|--|
| ster Slave 1 Slave 2 | Main Sampled Value Others |
| lodel CE-6710 V Serial Number 09703227CCM33222211U5HVRGLGLGL2Z0RXD V | Binary Outputs: Auxiliar Source: Initial State Initial State 250 V BO1: NO V BO3: NC V |
| Standard - Voltages: 4 x 300 V; 100 VA 2 x 600 V; 180 VA 2 x 300 V; 150 VA 1 x 600 V; 350 VA 1 x 300 V; 250 VA | BO2: NO BO4: NC - 220 V BO5 and BO6 type: - 60 V - 60 V O Conventional BO5: NO - 48 V BO6: NO - 24 V O IRIG (BO5) /Clock (BO6) - Other - Other - Off |
| Customized Assoc. Cannect VTs Standard - Currents: 6 4x 32 A: 210 VA 3 x 64 A: 400 VA 2 x 96 A; 550 VA 2 x 10,00 A; 300 VA 1 x 192 A; 1100 VA 1 x 6,00 A; 360 VA | Binary / Analog Inputs: BI1: BI - Contact BI2: BI - Contact BI3: BI - Contact BI4: BI - Contact BI5: BI - Contact BI6: BI - Contact BI7: BI - Contact BI8: BI - Contact |
| Electromechanical: 1 x 75 A; 700 VA 1 x 50 A; 700 VA | BI9: BI - Contact BI10: BI - Contact BI11: BI - Contact BI12: BI - Contact Considers absolute values to Voltage-BI AI 1-6 : 2V: 20V: 600V AI 7-12 : 200mV; 2V: 600V |

Figure 41

On the next screen choose "Basic" and on the next window (not shown) choose "YES", finally click on "Confirm".

| Cha | nnels Direct. | | | × |
|-------|---|-----|---------|---|
| Local | Model Reset for Hard. © Basic | | Confirm | |
| - N | CE-6710 V Connected Set O Advanced | | Cancel | |
| ote | Serial Number: | | | |
| Rem | 09703227CCM33222211U5HVRGLGLGL2Z0RXD V IN ON Line So S. Value | Exp | ort | |
| | | | | |

Figure 42

6. Power Directional Adjustment

6.1 Directional Power Screen > Definitions

In this tab you can adjust the pickup definition, power, time and angle tolerances. These tolerances should be consulted in the relay manufacturer's manual (available in Appendix A). There is also the option of limiting a maximum value for both voltage and current.





Figure 43

6.2 Directional Power Screen > Directional Power Elements > Active

Here the reverse power directional element is configured. To do this, click once on the highlighted "+" icon.





Figure 44

For the first element change the name to 32R, choose the directionality as reverse, set the pickup value and the run time. Remembering that the pickup value must be referenced to the secondary according to the following formula:

 $P_{secundary} = \frac{P_{primary}}{VTR * CTR}$ $P_{secundary} = \frac{5,9M}{\left(\frac{6,0K}{115}\right) * \left(\frac{750}{5}\right)}$ $P_{secundary} = 753,88W$

$$P_{secundary} = 0,1 * 753,88 \approx 75,39W$$

In the "Individual Directionality" tab set the "Reverse" option, the maximum torque angle "ATM" should be set "Normal" and the positive and negative angular offset as 90° and -90° .





7. Test Structure for function 32

7.1 Test Settings

In this tab, you must configure the trip signal direction with the binary input, in addition to configuring the generation channels. Enter a pre-fault with rated voltage and current with a time of 100ms.



| t ^Q P | 🗋 💕 🛃 🕫 🗌 | Power Directional | 2.02.17 | 1 (64 Bits) - CE-6 | 710 (0970322) | | | | | | | - 0 × |
|------------------|---|--|--------------------|--|---|-----------------------------|------------------|------------|--|------------------------------------|------|--|
| Arqui | ivo Start | Display Softw | are Opt | tions | | | | | | | | ^ () |
| Dir Chan | Config F Config S ec nels () Connect Hard | Hrd €S Config GC Sync ª, Config SV Lion dware | DOSE | Start Stop | > Next Point >> Next Line | ✔ Clear test ∰ Clear all | Settings | Report | Image Service Control Serv | Rebuild Restore Graphics Layout | View | |
| Shoo | ting Search | Route Test Set | tinas | | | | | | | | | |
| Dire | ec. Generation Cha | annels | 🖉 Er | nable Pre-Simulatio | on 1 | Enable I | Pre-Simulation 2 | Enable | e Post-Simi | lation | | Modo de Teste |
| | Generat | ion Channel | Mod | e Trif I | En ABC | - | | _ | | | | Mode V Const 💌 |
| V | a AO V01 (| (Hrd: V1) | V1 | 66.40 V | 0. | | | | | | | V-FN 50.00 V |
| V | b AO_V02 (| (Hrd: V2) 🔻 | V2 | 66,40 V | 240,0 ° | | | | | | | |
| V | c AO_V03 (| (Hrd: V3) 👻 | V3 | 66,40 V | 120.0 ° | | | | | | | RTPDesloc / RTPPhase: |
| V | D | - | | | | | | | | | | 1,00 |
| la | AO_101 (F | Hrd: I1) 🔻 | 11 | 5,00 A | 0 ° | | | | | | | RTCTerra / RTCPhase: |
| lb | AO_102 (H | Hrd: 12) 🔹 | 12 | 5.00 A | 240,0 ° | | | | | | | 1,00 |
| lc | AO_103 (F | Hrd: 13) 🔻 | 13 | 5,00 A | 120,0 ° | | | | | | | Dy TP's Phase |
| IE | | • | | | | | | | | | | Inv. TP Shift |
| Bin Bi | ary & Goose Outpu D 0; 0; O] Simulate Error S | ts - Missing ;0;0;0;0 | Binary BO GO | Pre-Simulation Tin & Goose Outputs 0; 0; 0, imulate Error San | me1: 100,00 ms - Pre-Simulation 1 ; 0; 0; 0 mpled Value / GC | | | | | | | ☐ Inv. TC's Phase ☐ Inv. TC Tena |
| Dire | ec. of the Interface | s of Operation | | | | _ | | | | | | Search Test |
| Α | ctive Reactive | Apparent | | | Initial NA 🚿 | <u> </u> | | | | | | Initial step: Absolute Resolution: 100,00 mA |
| Γ | No Curve | | | Interf. Trip |) |] | | | | | | Min Resolution V Relative Resolution: 0,10 % |
| 1 | 1 32R | | | BI01 (Hrd: I | BI1) 🔻 | | | | | | | Max Wait Time Region NO Operation: 2,00 s |
| | | | | | | | | | | | | Waiting Overtime Operation Region: 100,00 ms |
| | | | | | | | | | | | | Reset time: 100,00 ms |
| Ē | | | 1 | | | | | | | | | Number of renatitions in case of generation error: 2 |
| | Start Interf. Softv | vare ~ | Sta | arting Logic | | | | | | | | Based Only on Generated Values 🧹 |
| | | Wait for PPS | Sta | arting Delay 0,00 s | S | | | | | | | Cycle to Cycle Generation 🧹 |
| () | ON Line | New | | | | | Aux font | = 110,00 V | Heat | ting: 0% | | |
| | | | | | | | | | | | | |

Figure 46

7.2 Shooting Screen

In this tab click on *"Sequence"* and choose the value of the initial and final power and the step. Repeat the process for the angles as shown in the following figure.

| 🎇 🗋 🚘 📕 🚽 Power Directional 2.02.171 (64 Bits) - CE-6710 (0301018) | × |
|--|---|
| Arquivo Start Display Software Options | ^ @ |
| Channels & Connig Irid & Config GOOSE Direc & Config Sync %, Config SV Channels & Connection | Report de rel Rebuild Restore View Graphics Layout |
| Hardware Generation options | Report Unids Layout |
| Shooting Search Route Test Settings | |
| Insert / Edit Points | Graphic V Waveform V Phasors V Trajectories |
| Prinef / Edit General Options Fast Type Test Type NEW Point ISI 300.00 VA Sequence ISI 300.00 VA P: 259.81 W Q: 150.00 VA Bemove I: 2.00 A Remove All System Angle (0.0° Sequence Sequence Cap cost? 0.00 VA 9.00 VA Sequence Stat: 100.00 VA Sast: 100.00 VA Stat: 300.00 * System Angle (0.0° Sep; 100.00 VA | Wr. v/let 80.00 Yuy, +/hr. Type ABC 50.00 Subtle: Ф. Untested Points 50.00 50.00 • Tested Points 30.00 20.00 • Tested Points 20.00 • Total Points • Tested Points • Total Points • Total Points • Total Points • Total Points • Total Points • Total Points • Total Points • Total Points • Total Points • Total Points • Total Points • Total Points • Total Points |
| Test Points Tested Points No. SIVAL AnaSI'I PIWI QIVAI Element Region Acted Time Time | |
| Theo: Points Conneral Info Prover FP Ref Bem. Performance Time V & I Error List Protection Status | -141/2. -141/2. |
| 🚯 ON Line New Aux font: | : 110,00 V Heating: 0% |
| Fi | igure 47 |



Start the generation by clicking on the icon highlighted below or using the command "Alt + G".



Figure 48

7.3 Final Result of the Shooting Test

In this test, it can be verified that within the operating region the relay operates within the predicted time plus its tolerance. In the case of the non-operation region, the relay does not act, proving the correct functioning of the function.

| Direc | Config Config Is () Conne | Hrd 😵 Co Sync 5, Co ction | onfig GOOSE | Start | > Ne > Ne Stop | ext Point 🧹 ext Line 🐇 | Clear test Clear all | Settings | Waveform Phasors Trajectory | Report ds red Graphics Layout - |
|----------------------|--|--|--|---|---|---------------------------|-------------------------|--------------|-----------------------------------|--|
| Chaotie | Ha Search | rdware Reute | Cast Cattings | | Gener | ation | | opti | ons | Report Unids Layout |
| | ert / Edit Poir | nts | est Settings | | | | | | | Graphic Waveform Phasors Trajectories |
| NE NE Tested | <pre>/ Edit Edit Point W Point w Point w equence t Points Points</pre> | General Test Typ Definition ISI: Load: (P: I: | Options a ABC ons 800,00 VA Cap 259,81 W 2,00 A | ©: 330.0 cosØ: 0.87 Q: -150.0 V: 50.00 | D ° 10 VAr V | | | | | Wr. +VAr Type ABC 2000 +Wr. +VAr 2000 ⊕ Untested Points 000.0 Total Points Colors NT OK Em Si33391 Wr.(p.+212.883) © \$203 \$203 |
| No. | S [VA] | AngS[°] | P [W] | Q [VAr] | Region | Acted | Time Nominal | Time Real | Status | |
| | | 300,0 * | 150,0 W | -259,8 VAr | Not Operation | Not | - | - | Approved | |
| 33 | 300,0 VA | | | | Not | Mat | | | | |
| 33 34 | 300,0 VA | 330.0 * | 86,60 W | -50,00 VAr | Operation | INOL | - | - | Approved | |
| 33 34 35 | 300,0 VA 100,0 VA 200,0 VA | 330,0 * 330,0 * | 86,60 W 173,2 W | -50,00 VAr -100,0 VAr | Operation Not Operation | Not | - | - | Approved | |
| 33 34 35 36 | 300,0 VA 100,0 VA 200,0 VA 300,0 VA | 330.0 ° 330.0 ° 330.0 ° | 86,60 W 173,2 W 259,8 W | -50,00 VAr -100,0 VAr -150,0 VAr | Operation Not Operation Not Operation | Not | | - | Approved Approved Approved | |

7.4 Search screen

In this tab, the power value that starts the relay is evaluated. For convenience, a sequence of values will be inserted, set the "*Test Type*" field to "*ABC*". The field "*Line Definition*" was defined as "*P*", with an initial value of -50.0W and a final value of -100.0W. In the "*Variable (Q)*" field, the initial value was 100.0Var, the final value was -100.0Var and with a step of -50.0Var.



| 👺 🗋 🗃 🚽 🚽 Power Directional 2.0 | J2.171 (64 Bits) - CE-6710 (0301018) | | | | | × |
|--|---|--|----------------|---|----|--------------------------|
| Arquivo Start Display Softwar | e Options | | | | | ~ 🔞 |
| Direc Channels N Connetion Hardware | rSE Start Stop Stop Stop Stop Stop Stop Stop Sto | Settings Trajectory options Rep | port Unids | Rebuild Restore Traphics Layout | | |
| Shooting Search Route Test Setting | js | | | | | |
| Insert / Edit Points | | - | Graphic | Waveform Phasors Trajectorie | 25 | - |
| Insert / Edit General Options Edit Line Test Type AB New line ✓ Is: [111.80 VA Sequence F. 50.00 W Benove Is: [114.42 VA F. Remove &/J Is: [100.00 W 1.00.00 W | Ø -116.57* Ø -116.57* Ø -100.00 VAr V Iso.00 V Ø -135.00* Ø -135.00* Ø -100.00 VAr Ø -135.00* Ø -100.00 VAr V 50.00 V Ø -100.00 VAr V 50.00 V | No. of Points: ✓ /5 Vatable (Q) nt: 100.00 V/A al: >100.00 V/A p: >50.00 V/A | 344.4464 | 80.00 70.00 60.00 50.00 40.00 30.00 20.00 00 00 00 00 00 00 | | Ar. Type ABC Subttle: |
| Test Points Tested Points No. S[VA] AngS[*] P [w] Too: Points Too: | Q [VAr] Element Time Time Reference Nominal Real | Va Vb | NVWAR | | | , , , |
| New New | | Aux font: 1 | 10,00 V Heatin | ng: 0% | | |
| | | Fig | uro 50 | - | | |

Figure 50

Start the generation by clicking on the icon highlighted below or using the command "Alt + G".



Figure 51

7.5 Final search test result



| | 🚰 🛃 🔻 | Power Dire | ectional 2.02. | 171 (64 Bits) | - CE-6710 (0 | 301018) | | | | | | | – a × |
|----------------|--------------------|--|--|--------------------------|--------------|-----------------------------|-------------------------|---|----------|--|-----------------------------|---------------------|---|
| Direc | Config | Hrd 😵 Co Sync 5, Co ction | onfig GOOSE | Start | Stop | ext Point 🧹 ext Line 🛛 👹 | Clear test Clear all | Image: Settings Image: Seting Image: Settings Image: Seti | eport | ● ~ ● ■ </th <th>Rebuild Res Graphics Lay</th> <th>tore View</th> <th>N N</th> | Rebuild Res Graphics Lay | tore View | N N |
| | Ha | rdware | | | Gene | ration | | options | Report | Unids | Lay | out | |
| Shooting | Search | Route | Test Settings | | | | | | | Carabia | Chille of the | D | Trintein |
| _ Inset | Ent / Edit Poli | General | Ontiona | | | | | | | Graphic | waveform | r Phasors | rs rajectories |
| Ne | dit Line | Test Type Ini Poin ISI: 11 P: 5 | e ABC t 11.80 VA 0.00 W 75 A | Ø: -116.57 Q: -100.00 | 7 °) VAr | | | | | | | <u> </u> | 1300 100 100 1000 Subtle: Subtle: 0000 0000 Points Found 0000 |
| Test | equence | . 10. | | 1. 100,00 1 | | | | | | 117 | \mathcal{H} | \langle / X | 50,00 Colors NT OK Error |
| Tested | Points | | | | | | | | | HT | 7 🎭 | 97 | 5: 127,241 VA ; Ø: 141,120 * P: -99,052 W ; Q: 79,868 VAr |
| No. | Test | S [VA] | AngS[°] | P [W] | Q [VAr] | Element Reference | Status | | | | | TH- | 2000 1900 |
| 01 | ABC | 125,4 VA | 127,1 ° | -75,59 W | 100,0 VAr | 32R | Approved | | | | • | | |
| 02 | ABC | 90,69 VA | 146,5 * | -75,66 W | 50,00 VAr | 32R | Approved | | | () | M/M | K | \$E\$7\$4/////// |
| 03 | ABC | 75,47 VA | 180,0 ° | -75,47 W | 0,0226 pVAr | 32R | Approved | | | M | 14. | $\langle U \rangle$ | |
| 04 | ABC | 90.46 VA | -146,4 ° | -75,39 W | -50,00 VAr | 32R | Approved | | | YH | M/ | SE | |
| 05 | ABC | 125,2 VA | -127,0 ° | -75,29 W | -100,0 VAr | 32R | Approved | | | $\langle \rangle \rangle$ | | \succ | |
| Tipo: Error | Points List Pro | Gen Gen | ueral Info 🗹 | Power 🗹 F | Ref Elem. 🗌 | Time 🗌 V | 81 | | | W:-VAN | | | |
| () () () | N Line | Nev | v | | | | | Aux font | • 110,00 | v неа е 52 | ting: 09 | | |

It is verified that all active power values are then within the tolerance region provided by the manufacturer

8. Report

After finishing the test, click on the "*Present Report*" icon in the previous figure or using the "*Ctrl* +*R*" command to call up the report pre-configuration screen. Choose the desired language as well as the options that should be part of the report.

| Presentation Setting | | × |
|---|-----|--------|
| Language Inglês En-US 🗸 🗸 | | |
| V All General Data Test General Data of Tested Dev General Data of Tested Dev Vere Constant Settings Test Settings Overcurrent Settings Selected Simulation Charts Notes and Observations Explanatory Figures Connections | ice | |
| (| ОК | Cancel |
| h | | |

Figure 53





Figure 54



APPENDIX A

A.1 Terminal Designations



²⁾ Use these terminals to root the binary inputs.

Positions for printed circuit board assemblies on the rear side

Figure 55



A.2 Technical Data

Times

| Pickup times | Approx. 360 ms at f = 50 Hz |
|---------------|-------------------------------|
| | Approx. 300 ms at f = 60 Hz |
| Dropout times | Approx. 360 ms at f = 50 Hz |
| | Approx. 300 ms at $f = 60 Hz$ |

Tolerances

| Reverse power | 0.15 % S_{rated} or 5 % of the setting value | |
|---------------|--|--|
| | when Q < 0.5 S _{rated} | |
| Time delays | 1 % or 10 ms | |

APPENDIX B

Equivalence of software parameters and the relay under test.

| Table 1 | | | | |
|----------------------------|--------|---------------|--------|--|
| Power Directional Software | | 7UT86 Relay | | |
| | | | - | |
| Parameter | Figure | Parameter | Figure | |
| Pkp 3Ф | 45 | Threshold | 26 | |
| Time | 45 | Operate delay | 26 | |