ARGUS
Copper Box v3 Manual

Version: 1.03.1 / **EN**

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1 Introduction

ARGUS Copper Box v3

With the ARGUS Copper Box, intec offers an expansion for the xDSL multitesters ARGUS 151, ARGUS 152, ARGUS 155, ARGUS 162 and ARGUS 165. This USB box enables you to detect dangerous voltages and currents early on and reliably assess the physical quality of the line – particularly when DSL synchronisation is not possible or the data rate is low due to asymmetry, interference sources or other mechanical line problems.

The box is connected to the ARGUS tester simply via the USB host interface. You can select the box and perform all measurements easily and rapidly via the ARGUS graphical user interface.

The ARGUS Copper Box is equipped with four standard banana sockets. These sockets are designed for a four millimeter (4 mm) thick, contact-protected banana cable.

Further features of the ARGUS Copper Box v3:

- Multiple, preconfigured measurement profiles can be executed as an **auto test.**
- **Voltage measurement** enables measurement of the supply voltage (e.g. SHDSL, ISDN-BRI U, POTS), as well as external voltages caused e.g. by contact between two wires or isolation faults.
- With the aid of **capacitive symmetry measurement**, it is possible to detect asymmetry in the subscriber line that can result in signal distortions or transmission errors.
- **Capacitance measurement** detects interruptions as well as typical input capacitances of connected devices and enables estimation of line lengths.
- **Isolation resistance measurement** reveals damage to cable isolation, moisture penetration or oxidised contact points.
- With the aid of **resistance symmetry measurement**, it is possible to detect irregularities in the subscriber line that can result in signal distortions or transmission errors.
- **Loop resistance measurement** aids detection of short circuits and estimation of line lengths.
- **DC current measurement** can be used to detect emergency, external and normal power feeds as well as breaks in the line.
- **Unbalance measurement (LCL):** This measurement uses a frequency of 1 MHz to measure asymmetry in a line pair.
- **NEXT measurement:** Measurement of near-end crosstalk at a frequency of 1 MHz.
- **Signature detection** is used to detect the signatures and test terminations (PPAs) connected to the subscriber line.
- The integrated **remote instrument kit control** lets you remotely set the line end to the desired state either manually or automatically using an electronic instrument kit.

All measurements can be executed as highly accurate automatic TRG (Tip, Ring, Ground) measurements.

With its light weight of less than 160 grams and sturdy plastic housing, the ARGUS Copper Box is not only extremely compact but also insensitive to impacts, falls, and other mechanical hazards. Despite its exceptional performance and high measuring voltage, the Box can operate for exceptionally long periods, as it is supplied by the powerful Li ion battery pack of the ARGUS tester.

Its compatibility enables the Box to be used with multiple test devices. For example, an installation team can expand multiple ARGUS testers with measuring boxes independently of each other and use all necessary additional functions of the Box. It is not necessary to return testers for servicing in order to expand their functionality. A special protective rubber jacket forms the USB box and the ARGUS tester into a single unit.

The Copper Box can be kept up to date quickly and easily via firmware updates.

The standard scope of supply includes a high-quality connection lead (twisted), a ground lead and this manual.

For further questions, please contact:
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2 Safety information

General instructions:
The ARGUS Copper Box may only be operated using the accessories supplied with the device. The use of other accessories can result in faulty measurements or even damage to the ARGUS Copper Box and the connected equipment. Only use the ARGUS Copper Box according to the instructions contained in this manual. Any other use can result in injuries to persons and destruction of the ARGUS and/or the ARGUS Copper Box.

1. Before connecting the ARGUS Copper Box to an access, make sure that no dangerous voltages or currents are present for which the ARGUS Copper Box or its accessories are not specified. Also keep in mind that the voltage can change over the time that the device is connected.
2. The ARGUS Copper Box is intended solely for use in telecommunications networks with limited power. It is not intended to be used e.g. to measure mains voltages (230 V/50 Hz).

   Specifications:

DC voltage U_{DC} (U=):	0 V to 220 V
AC voltage U_{AC} (U~):	0 V to 210 V (50 Hz sine)
Capacitance measurement C (C, Csym):	0.01 nF to 8 µF @8Hz
Isolation resistance measurement Iso (Iso):	0.1 to 1 GΩ, (105 V, max. 1 mA) 0.1 to 40 MΩ, (8 V, max. 8 mA)
Loop resistance R (R, Rsym):	0 to 40 MΩ, (13 V, max. 15 mA)
DC current IDC (I=):	0 mA to 500 mA
Longitudinal conversion loss, (LCL):	Attenuation for 1 MHz @120 Ω
Near-end crosstalk (NEXT):	Crosstalk attenuation for 1 MHz @120 Ω

3. Use the ARGUS Copper Box only according to its intended purpose at all interfaces and accesses. It is intended for the measurement and acquisition of physical quantities in low-power telecommunication networks. The ARGUS Copper Box is not designed for any other applications (e.g. measuring electronic components, determining the output quantities of voltage sources, etc.).
4. In each measurement, avoid any contact with electrically live components (sockets, plugs, cables, adapters, etc.) under all circumstances.
5. Voltages over 50 V AC and 120 V DC can cause death.
6. The ARGUS Copper Box may only be used by trained personnel.
7. The ARGUS Copper Box is not water-tight. Therefore, protect the ARGUS Copper Box against water penetration.
8. The USB connection lead of the ARGUS Copper Box may only be connected to approved ARGUS testers (ARGUS 151, ARGUS 152, ARGUS 155, ARGUS 162, ARGUS 165). Each of these testers must be enabled using an individual option key provided especially for this purpose. The USB lead should not be extended.

9. The electromagnetic compatibility (EMC) was tested according to the regulations specified in our declaration of conformity. The ARGUS Copper Box is a class A device. This device can cause radio interference in residential areas.
   In this case, the user may be required to implement appropriate measures.

10. If the ARGUS Copper Box is operated under extreme conditions, an internal protective mechanism (protection element) can be activated to protect the device, the Box and the user. In this case, the Box may no longer be used, and may only be repaired by authorized personnel. The device may not be opened by unauthorized personnel.

11. To ensure dependable, long-term operation of the ARGUS Copper Box, always make sure that it is optimally protected against high temperatures. The ARGUS Copper Box may only be operated with the temperature range permitted for the ARGUS device (-10 °C to +50 °C in battery operation, 0 °C to +40 °C in adapter operation).

Instructions for use:

1. Even a measurement on low-power telecommunications networks can present hazards - particularly in the event of a fault; consequently, always first check the line to be tested for a supply (DC voltage) and an external voltage (DC or AC voltage). If even one of these conditions is present, safely de-energise this voltage and secure it against being switched on again before conducting any further tests.
2. Once ARGUS detects the ARGUS Copper Box, an auto test can be executed or each separate measurement can be started and stopped individually. If you change the measurement without first stopping, the measurement is stopped automatically.
3. Never switch the ARGUS Copper Box from line to line while a measurement is running. This would bypass the safety voltage measurement conducted before the start of each measurement. Connecting the Box with a running resistance measurement to a line with a regular supply voltage, for example, could destroy the Box even if this voltage is within the specification for voltage measurement. In general, the Copper Box automatically checks before every measurement (except current measurement) whether the line is carrying a voltage, and stops the measurement with a message as necessary.
4. The ARGUS Copper Box is equipped with an automatic “TRG-opt.” measurement. This means that the measurement quantities can be measured between different wires, such as a (Tip), b (Ring), Ground and optional socket (opt.). The ARGUS tester displays for selection the pairings that the ARGUS Copper Box supports for the various measurements. Except for measurement of isolation resistance, the ARGUS Copper Box performs a continuous measurement when only one wire pair (e.g. Tip/Ring or Tip/Ground or Ring/Ground) is selected, i.e. changing values appear immediately on the display.

Special instructions for individual measurements

Voltage

Be sure to observe the permissible measuring range specified above when measuring voltage.

Capacitance/capacitive symmetry:

Before measuring, make sure that the voltage thresholds given in the table below (see page 10) are not exceeded during the measurement. Certain measurements can require a longer settling time. An automatic “TRG-opt.” measurement can thus take some time.

Isolation resistance:

Before measuring, make sure that the voltage thresholds given in the table below (see page 10) are not exceeded during the measurement. During the measurement, the ARGUS Copper Box can apply a measuring voltage of up to 105 V max. 1 mA) to the line. Certain measurements can require a longer settling time. An autotest can thus take some time.

Loop resistance/resistance symmetry

Before measuring, make sure that the voltage thresholds given in the table below are not exceeded during the measurement. During the measurement, the ARGUS Copper Box can apply a measuring voltage of up ton 13 V (max. 15 mA) to the line.

DC current:

Be sure to observe the permissible measuring range specified above when measuring DC current. Make sure you connect the ARGUS Copper Box in the circuit in series.

Longitudinal conversion loss/NEXT:

Before measuring, make sure that the voltage thresholds given in the table below are not exceeded during the measurement. When measuring LCL or NEXT using the ARGUS Copper Box, any type of additional measurement lead can falsify the measurement. Both the length and the position of the measurement leads with respect to each other can influence the measurement result significantly. The specification values apply only for the Box itself and not for the system comprising the Box and the measurement leads. Consequently, connecting the telecommunications line directly to the Box is recommended.

Signature detection/remote kit control

Before measuring, make sure that the voltage thresholds given in the table below are not exceeded during the measurement.

Voltage thresholds		
Measurement	**UDC (V) to**	**UAC (Veff) to**
R*	3.5	30
R-sym*	30	30
ISO-R*	5	30
C*	17	17
C-sym*	17	17
LCL **	3	3
NEXT**	3	3
Signature**	3	3
Remote box**	3	3
* Measured on 200 kΩ load		
** If the internal resistance (Ri) of the source is > 1 MΩ, voltage is measured up to 3.5 V.		

Return and environmentally compatible disposal

Current environmental law restricts the use of certain hazardous substances in electrical and electronic devices, in particular the concentration or use of lead (Pb), cadmium (Cd), mercury (Hg), hexavalent chromium [Cr(VI)], polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE).
We hereby confirm that, according to the assurances, marking and documentation of our suppliers, ARGUS brand measuring products do not contain any substances in concentrations, compounds or applications whose marketing is prohibited according to the valid provisions of the RoHS Directive 2011/65/EU of the European Parliament and Council dated 8 June 2011.
Our registration number issued by the EAR is: WEEE REG. no. DE 92829367.

Since October 2005, we have been marking all our measuring devices with this symbol, in compliance with WEEE 2002/96/EC and the corresponding German statute ElektroG:

() (DIN EN 50419).

In other words, ARGUS and its accessories, may not be disposed of as household waste. Please consult with our Service department with respect to the return of old devices.

3 General technical data

Device specifications:

Dimensions/weight	**Inputs/outputs**
Height: 125 mm Width: 74 mm Depth: 22 mm Weight: approx. 160 g	- 4 x 4 mm banana sockets (contact-protected) - USB-A plug

Temperature range

Operating temperature (ARGUS in battery mode): -10 °C to +50 °C
Storage temperature: -20 °C to +60 °C
Humidity: up to 95 % relative, non-condensing

Miscellaneous

ARGUS user safety tested according to EN60950-1

RoHS conformity pursuant to the WEEE directive

The electromagnetic compatibility (EMC) was tested according to the regulations specified in our declaration of conformity.

CE marking
The ARGUS Copper Box complies with EC directives 2004/108/EC and 2009/C197/03. We will be happy to provide a detailed declaration of conformity on request.

The ARGUS Copper Box is intended solely for measurements in telecommunications networks with limited power.

Make sure that the inserted banana plugs of the measuring leads are completely enclosed by the sockets of the Copper Box.

Measuring accuracies:

Voltage:		
DC voltage measurement (U=):		
Measuring range:	Resolution:	Accuracy:
0 V - 9.99 V	0.01 V	±(0.5 % + 2 digits)
10 V - 220 V	0.1 V	±(0.5 % + 2 digits)
AC voltage measurement (sine, 50 Hz) (U~):		
Measuring range:	Resolution:	Accuracy:
0 V - 9.99 V	0.01 V	±(2 % + 2 digits)
10 V - 210 V	0.1 V	±(1.5 % + 2 digits)
Frequency: 10 Hz to 200 Hz; 0.2 Hz; ±(1.5 % + 2 digits); sine		

Capacitive symmetry measurement (C_{Sym}):		
Measuring range:	Resolution:	Accuracy:
10 nF - 4 µF	0.01 nF	relative capacitance ± 0.1 %

Capacitive measurement, measuring frequency 8 Hz (C)		
Measuring range:	Resolution:	Accuracy:*
0.01 nF - 9.99 µF	0.01 nF	±(4 % + 4 digits)
10 nF - 99.99 µF	0.01 nF	±(4 % + 4 digits)
100 nF - 999.9 µF	0.1 nF	±(3 % + 1 digit)
1 nF - 8 µF	1 nF	±(3 % + 1 digit)
* All specifications relate to a comparison measurement using film capacitors.		

Isolation resistance measurement with 105 V, max. 1 mA (Iso.):		
Measuring range:	Resolution:	Accuracy:
0.1 Ω - 99.9 kΩ	0.1 kΩ	±(2 % + 1 digit)
100 Ω - 999 kΩ	1 kΩ	±(2 % + 1 digit)
1 MΩ - 9.99 MΩ	10 kΩ	±(2 % + 1 digit)
10 MΩ - 99.9 MΩ	100 kΩ	±(5 % + 1 digit)
100 MΩ - 1 GΩ	100 kΩ	±(5 % + 1 digit)

Isolation resistance measurement with 8 V, max. 8 mA (Iso.):		
Measuring range:	Resolution:	Accuracy:
0.1 Ω - 99.9 kΩ	0.1 kΩ	±(2 % + 1 digit)
100 Ω - 999 kΩ	1 kΩ	±(2 % + 1 digit)
1 MΩ - 9.99 MΩ	10 kΩ	±(2 % + 1 digit)
10 MΩ - 40 MΩ	100 kΩ	±(5 % + 1 digit)

Resistance difference (R_{Sym}):		
Measuring range:	Resolution:	Accuracy:
10 Ω - 5 kΩ	0.1Ω	± 0.2 % of Rs ± 0.2 Ω

Loop resistance measurement with 13 V, max. 15 mA (Iso.):		
Measuring range:	Resolution:	Accuracy:
1 Ω - 999.9 kΩ	0.1Ω	±(1 % + 3 digits)
1 Ω - 9.999 kΩ	1 Ω	±(1 % + 1 digit)
10 Ω - 99.99 kΩ	10Ω	±(1 % + 1 digit)
100 Ω - 999.9 kΩ	100Ω	±(1 % + 1 digit)
1 MΩ - 9.999 MΩ	1 kΩ	±(2 % + 1 digit)
10 MΩ - 40 MΩ	10 kΩ	±(5 % + 1 digit)

DC current measurement (I=):		
Measuring range:	Resolution:	Accuracy:
0.1 mA - 500 mA	0.1 mA	±(2.5 % + 3 digits)

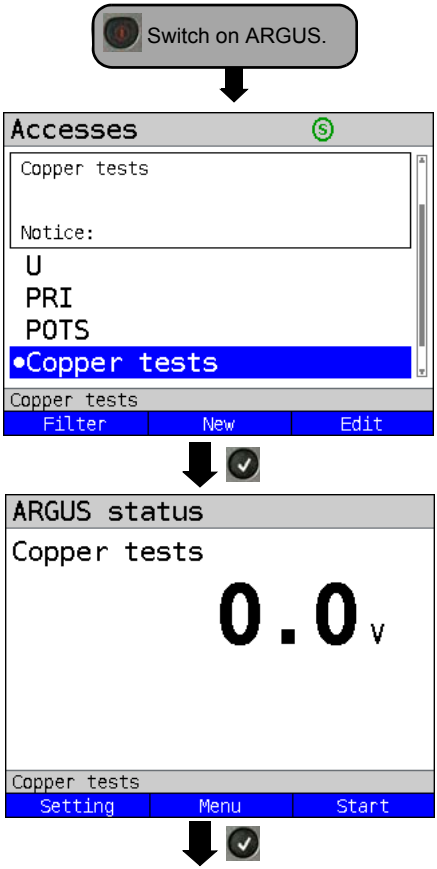
Unsymmetrie balance at 1 MHz (LCL):		
Measuring range:	Resolution:	Accuracy*:
0 dB - 55 dB	0.1 dB	± 1.5 dB
55.1 dB - 65 dB	0.1 dB	± 3 dB
The length of the measuring leads can significantly affect the measurement. Therefore, always use the original accessories for measuring.		

Near-end crosstalk at 1 MHz (NEXT):		
Measuring range:	Resolution:	Accuracy:
0 dB - 65 dB	0.1 dB	± 1 dB
The length of the measuring leads can significantly affect the measurement. Therefore, always use the original accessories for measuring.		

Reference conditions (calibration):
- Temperature: +23 °C to 5 °C
- Humidity: 50 % ± 20 %, relative, non-condensing
- Frequency of measurement quantity: 50 Hz ± 5 Hz, sine

4 Configuring accesses

This section describes how to select and configure the access type "Copper Test". First though, note that ARGUS offers 100 user-configurable accesses, which can be configured as DSL, ISDN or copper test accesses according to the customer's requirements. Generally, some of these 100 accesses are pre-configured before delivery. At least one access with the name "Copper tests" should appear in the list of accesses when you power up ARGUS. This should be sufficient, as the Copper Box can be started on this access as an individual test just like TDR or Line scope.



The most recently used access is indicated on the display with ● .

ARGUS additionally displays a preview of the selected access settings. The preview window opens after 2 seconds.

<Filter>	Switches to Access, see ARGUS manual.
<New>	Creates an access, see ARGUS manual.
<Edit>	Edits an access, see ARGUS manual.
	Toggles softkey assignment, see ARGUS manual.
	Switches to main menu.

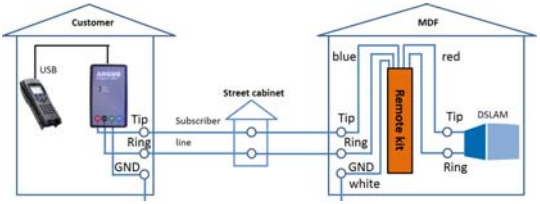
See section 5.4 of the ARGUS manual for instructions on editing notices.

You can also change the access name "Copper tests", e.g. to in Copper Box, TDR similar. See the ARGUS manual for instructions on editing access names.

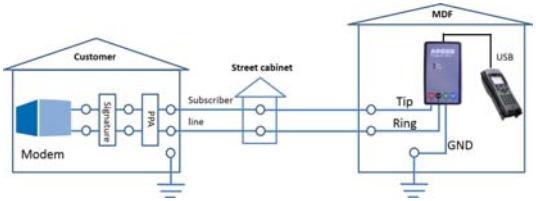
5 Using the ARGUS Copper Box v3

First connect the ARGUS Copper Box with the USB host interface of an ARGUS tester. You may need to enter an option key in the ARGUS tester under Settings/Device/Software options. Then connect the device to the measurement configuration as shown in the connection examples.

Connection example 1 (DSLAM direction):

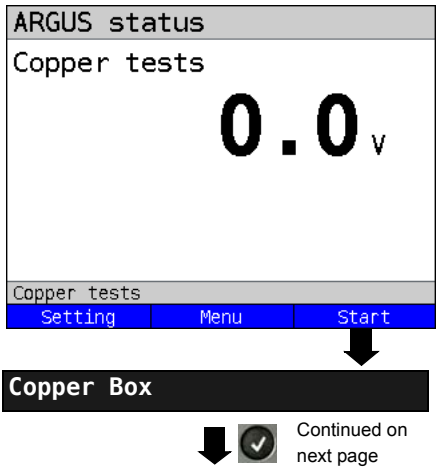


Connection example 2 (Modem direction):



5.1 Selecting and activating the Copper Box

The chapter "Configuring accesses", page 17, explains how to set up the connection type "Copper test".



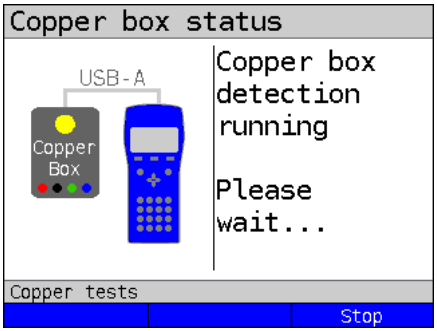
Continued on next page

ARGUS in the status display.
The device always measures the DC voltage at the line socket (pins 4/5) before executing a copper test. This value should warn of the presence of a voltage at the line socket (e.g. TDR, Line scope) when a copper test is executed.

⚠ This is not the value that the Copper Box measures between the Tip and Ring wire.

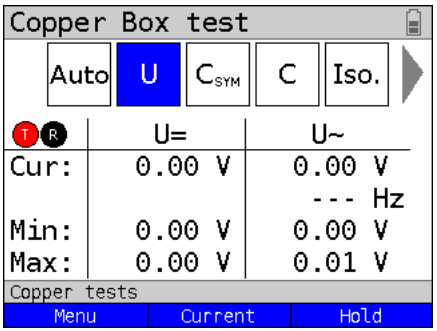
<Setting> ARGUS automatically switches to the Copper Box auto test configuration, page 25.

Select one of the copper tests. In this example Copper Box.



ARGUS detects the Copper Box. This can take a few seconds. If a conflict occurs, update your firmware or consult our Service Department.
When detection is complete, ARGUS activates the Copper Box and starts voltage measurement immediately.

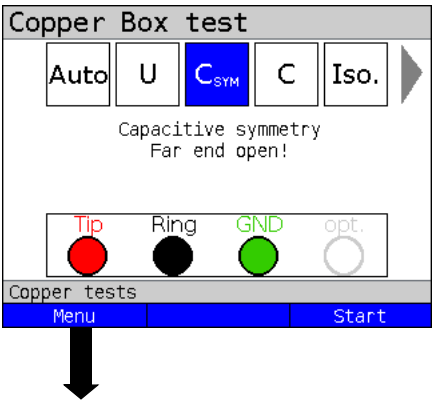
ARGUS is in the Copper Box status display.



The voltage between the Tip and Ring wire is measured continuously here.

<Current> Shows the current measured value.

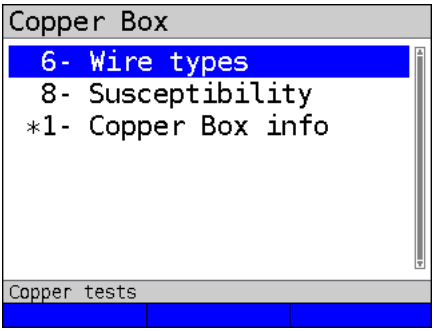
<Hold> The continuing measurement is paused.



You can use the cursor keys to select individual tests, in this example capacitive symmetry measurement.

<Menu> Opens the Copper Box menu, see page 20.

<Start> Starts the capacitive symmetry measurement.



Copper Box menu.

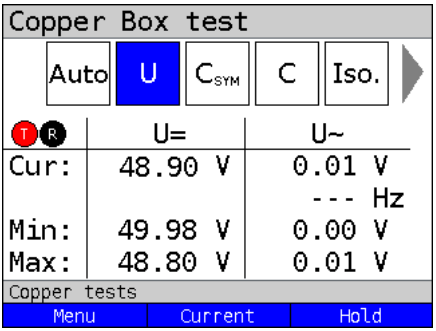
Depending on the currently selected test, you can choose among the following configurations:

5.2 Hotkeys

Hotkey	
Number key 0	Reset (only for active (min/max display))
Number key 1	Auto test profile
Number key 3	Polarity (Iso. only)
Number key 4	Range limit (Iso. only)
Number key 5	Measuring voltage (Iso. only)
Number key 6	Wire types (R, R_{Sym}, C, C_{Sym})
Number key 7	QR code (only at the end of an auto test)
Number key 8	Wire types (R, R_{Sym}, C, C_{Sym})
Number key 9	Display mode
Press one after another  and 	Copper Box info
Press one after another  and 	Save (only at the end of an auto test)
	Input resistance

You can find more information on the respective configurations in the chapter "Tests".

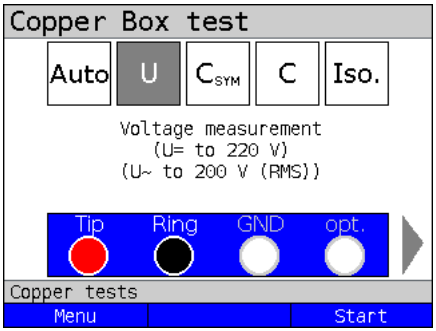
5.3 Changing socket selection



By default, tests are conducted on the T/R sockets.

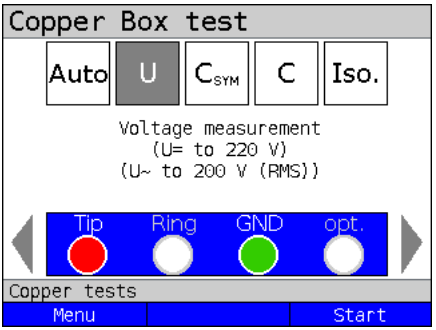
Switch to socket selection using the cursor keys.

Use socket selection to choose between which wires you want to measure.



You can select a variety of socket combinations using the cursor key.

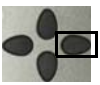
In this example, a measurement between sockets Tip and Ground are selected.



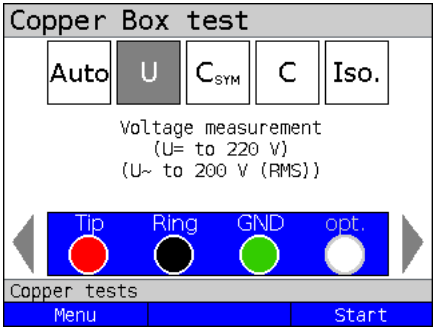
	Red	Tip (a-wire)
	Black	Ring (b-wire)
	Green	GND
	Blue	opt. (optional)
	White	not selected

<Menu> Opens the Copper Box menu, see page 20.

<Start> Starts voltage measurement between sockets Tip and GND.



3x right cursor key



In this example, sockets Tip, Ring and GND are selected.

<Menu>	Opens the Copper Box menu, see page 20.
<Start>	Starts voltage measurement via sockets Tip. Ring and GND.

Each measurement between two sockets (e.g. on Tip/Ring) is always performed in real time.

5.4 Alarm tones

ARGUS generates various alarm tones in conjunction with the Copper Box, for instance as soon as a fault occurs or a test has been concluded. The alarm tones must be activated in the ARGUS settings, see Main Manual.

Short - short	Fault: - Immediately when an external voltage is detected. - In the absence of a loop or ground (R_{Sym}). - In the absence of a ground/line or presence of a loop (C_{Sym}).
Short - long	Test complete: - After every test that ended automatically. - After every auto test - (not after every individual test here).
Short - short - long	In the event of a fault at the end of a test.
Long	Prompts for user input.

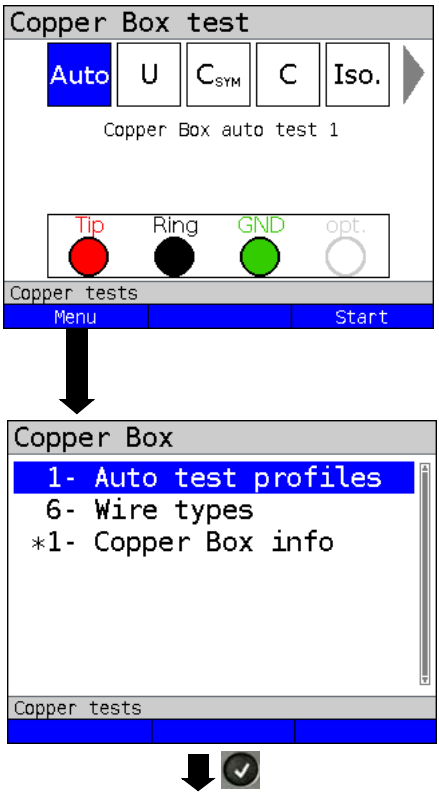
6 Auto test

ARGUS executes various tests automatically, depending on the configured auto test profile. Five user-configurable profiles (including measurement assistance control) are available for auto test.

A voltage check is performed before every measurement (except current measurement) in which the voltage limits given in the table (see page 10) may not be exceeded.

The measuring ranges, resolutions and accuracies of the respective measurement may be found in the chapter Technical data, see page 13.

Auto test settings

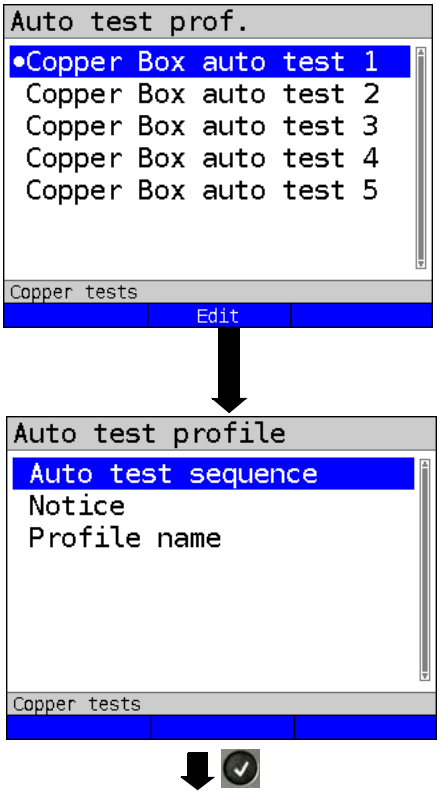


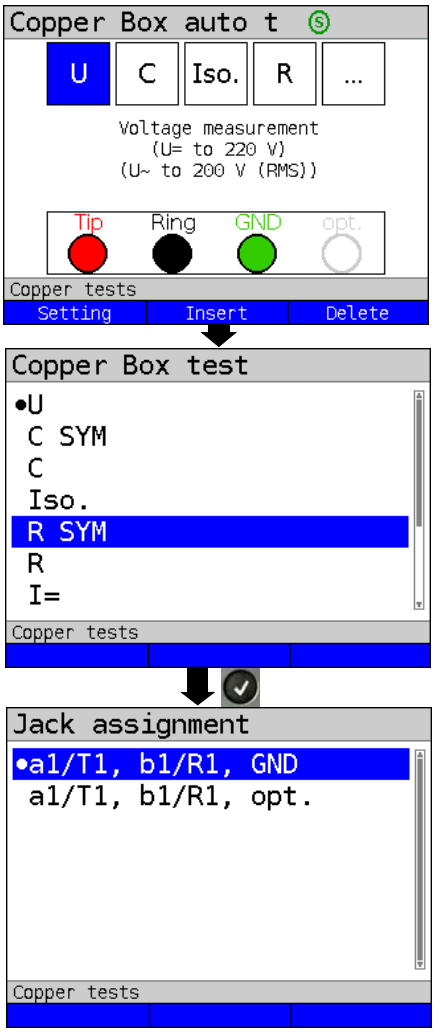
ARGUS in the status display.

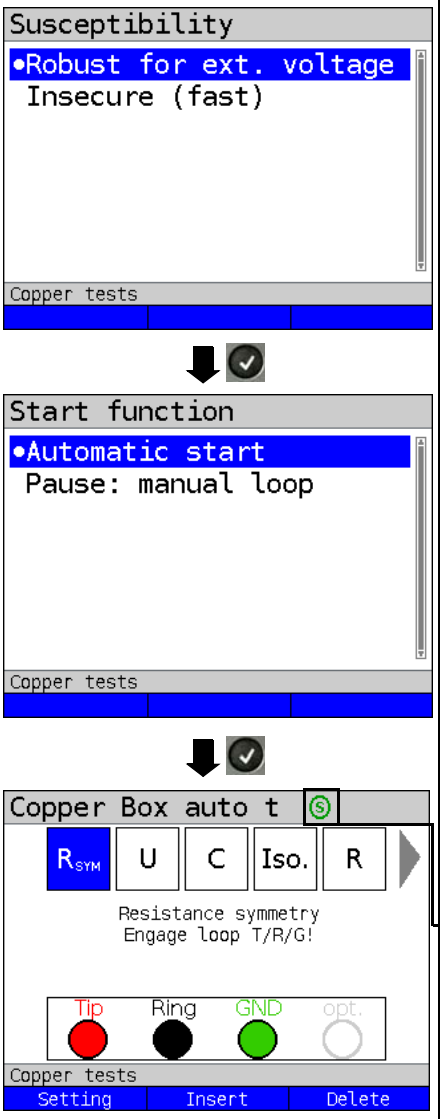
The auto test is not yet started.

See the respective chapters for details on the individual measurements. In the following, the procedure is described using an auto test example.

- 1 - Auto test profiles


Auto test prof.
•Copper Box auto test 1
Copper Box auto test 2
Copper Box auto test 3
Copper Box auto test 4
Copper Box auto test 5
Copper tests
Edit
Auto test profile
Auto test sequence
Notice
Profile name
Copper tests

Settings	Description
Auto test profiles:	
Auto test/ auto test with instrument kit/ Copper Box auto test	All available Copper Box tests can be compiled in an automated test. Five different profiles are available for saving.
Auto test sequence	 **<Setting>** Sets the wait interval until the next test. This setting only applies for the respectively selected test. Range: 100 ms to 5000 ms. Default: ***100 ms*** **<Insert>** Adds further tests. **<Delete>** Deletes the currently selected test. Selection of e.g. R_{Sym} Different socket combinations are available depending on the selected test, see page 27. Confirm socket selection with.



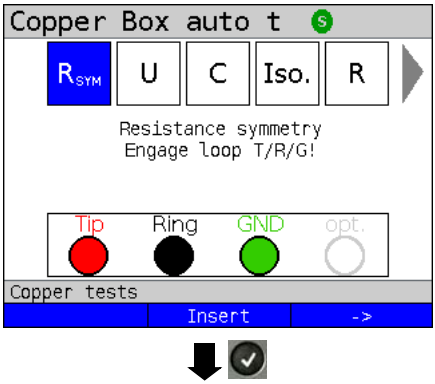
Selection of susceptibility to interference, see also page 55.

Select the start function:
- Automatic start
- Pause: manual loop

ARGUS waits for user input to confirm that the loop is connected.

The selected test, in this example R_{Sym}, has been added to the auto test.

Switches softkey assignment

<table>
<tr><td></td><td colspan="2"> 

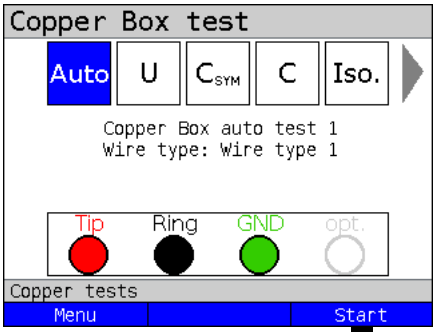
< -> > Shifts the marked test one position to the right.

< <- > Shifts the marked test one position to the left.

The added test and the test sequence are saved.</td></tr>
<tr><td></td><td colspan="2">Different socket combinations are available depending on the test.</td></tr>
<tr><td></td><td>U / R / Iso. / C</td><td>Possibility 1: a1/T1, b1/R1
Possibility 2: a1/T1, GND
Possibility 3: b1/R1, GND
Possibility 4: a1/T1, b1/R1, GND
Possibility 5: a1/T1, opt.
Possibility 6: b1/R1, opt.
Possibility 7: a1/T1, b1/R1, opt.
Possibility 8: a1/T1, b1/R1, GND, opt.</td></tr>
<tr><td></td><td>I=</td><td>Possibility 1: a1/T1, b1/R1
Possibility 2: a1/T1, GND
Possibility 3: b1/R1, GND
Possibility 4: a1/T1, opt.
Possibility 5: b1/R1, opt.</td></tr>
<tr><td></td><td>C_{Sym} / R_{Sym}</td><td>Possibility 1: a1/T1, b1/R1, GND
Possibility 2: a1/T1, b1/R1, opt.</td></tr>
<tr><td></td><td>Rem.</td><td>Possibility 1: short-circuit a/T-b/R
Possibility 2: exchange connect
Possibility 3: short-circuit a/T-b/R-GND
Possibility 4: open circuit
Possibility 5: activate tone generator</td></tr>
<tr><td></td><td colspan="2">You must confirm the selected socket combination with .</td></tr>
<tr><td>Notice</td><td colspan="2">Allows you to enter a note, see main manual.</td></tr>
<tr><td>Profile name</td><td colspan="2">Enter/modify name of editable auto test profile</td></tr>
</table>

Wire types:	
ARGUS enables configuration of up to 20 different wire types. Default: ***No wire type***	
Propagation speed	To determine the correct distance, the calculation must take into account a correction value dependent on the wire type that specifies the ratio of the pulse propagation speed in the cable to the speed of light in a vacuum (c_0 = 299.792458 m/µs). For cable types, the pulse time is also specified in V/2. Minimum: 45.0 m/µs (VoP 30 %) Maximum: 149.7 m/µs (VoP 99.9 %) Default: ***100.0 m/µs (VoP 66.7 %)*** The choice of propagation speed as V/2 or VoP is saved.
Specific resistance	Sets the specific resistance per kilometer Range: 20 Ω/km to 300 Ω/km Default: ***160 Ω/km***
Specific capacitance	Sets the specific capacitance per kilometer Range: 35 nF/km to 100 nF/km Default: ***49 nF/km***
Name	Enter the name of the wire type. Default: ***No wire type***

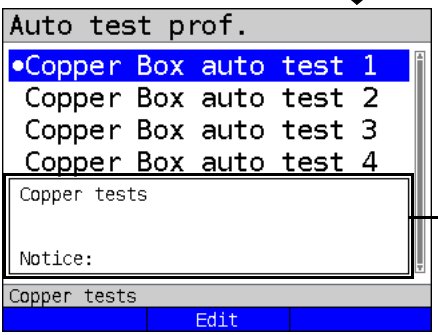
Starting auto test



ARGUS in the status display.

The auto test is not yet started.

Screen display for selection of a wire type or auto test profile (in this example Copper Box auto test 1 and wire type 1).

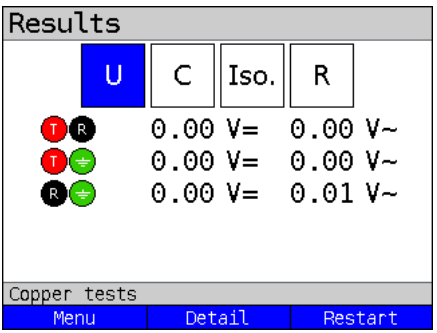


The default is the most recently used auto test profile, in this example Copper box auto test 1.

ARGUS displays the stored notice in the preview.

Starts the auto test using the selected auto test profile.

ARGUS executes the tests stored in the profile in consecutive order.



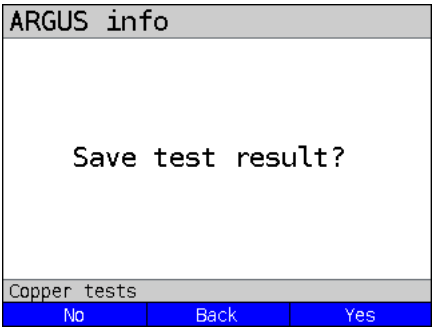
During the tests, you can select the respective results using the cursor keys.

You can use the cursor keys to select individual test results, in this example capacitance measurement.

<Menu> Opens the Copper Box menu, see page 20.

<Restart> Starts a new auto test.

The auto test has been executed.



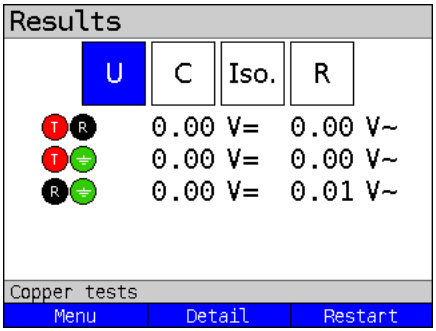
Press one after another and ARGUS saves the current measurement

<Yes> ARGUS saves the result of the auto test to the first free storage slot in internal memory.

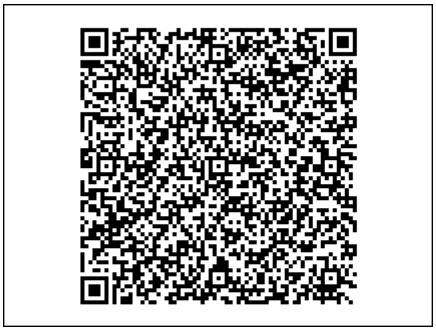
<Back> ARGUS returns to the test result without saving results.

<No> ARGUS returns to the last selection menu without saving results.

Alternative display of measuring results

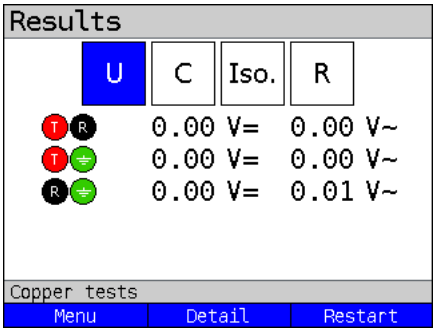


You can display the measuring result in the form of a QR code using the number key .



The results can then be transferred to other systems in csv format using a camera or a suitable QR code reader.

exits QR code display and the results are displayed as plain text.



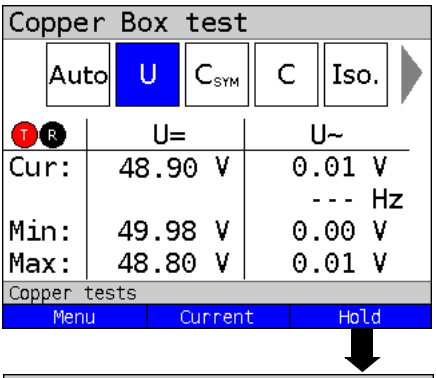
7 Voltage measurement (U= and U~)

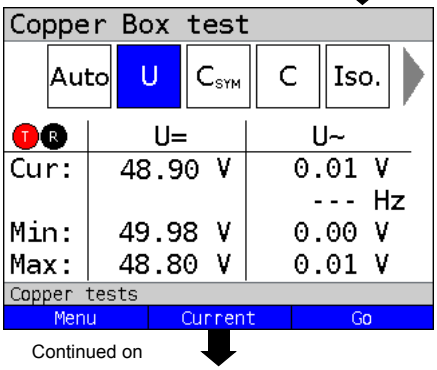
Voltage measurement enables detection of e.g. connected accesses (such as ISDN-BRI U or POTS) and supply voltages (as for SHDSL using ZWR) and external voltages, such as a connection to another line.
In AC voltage measurement, the frequency (10 - 200 Hz) is additionally displayed. This also enables identification of call switching and coupled voltages as well as carrier or power frequencies.

Note that unexpected or hazardous mixed voltages or hazardous voltage peaks can occur.

See the chapter Technical data page 13 for information on measuring ranges, resolutions and accuracies of voltage measurement.

Starting voltage measurement





Continued on next page

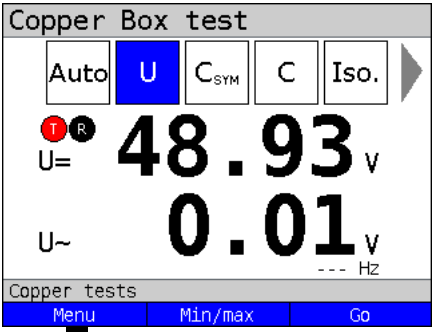
ARGUS in the status display.

Voltage measurement starts automatically when the Copper Box is activated. In this example, the
- Current voltage in volts
- Current frequency of AC voltage in hertz
- Minimum voltage in volts
- Maximum voltage in volts

are measured.

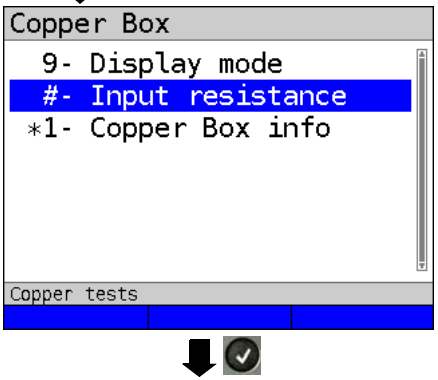
<Menu>	Opens the Copper Box menus, see page 20.
<Current>	Displays the current measured value, see page 32.
<Hold>	The continuing measurement is paused.

<Current>	Displays the current measured values.
<Go>	Continues measuring.



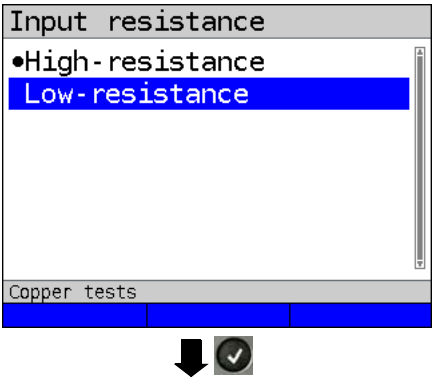
Display:
- Current DC voltage in volts
- Current AC voltage in volts
- Current frequency of AC voltage in hertz

<Menu>	Opens the Copper Box menu, see page 20.
<Min/Max>	Display of minimum and maximum measured values.
<Go>	Continues measuring.

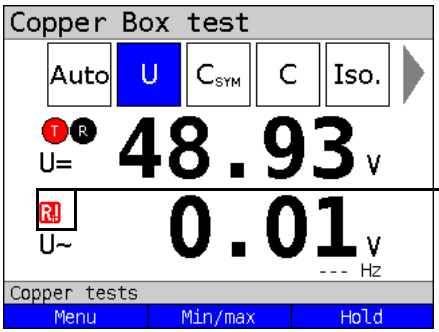


By default, voltage measurements are carried out using high-ohm values.
A change in the input resistance is stored until ARGUS is restarted.

For high-ohm measurement, the input resistance is at least 1 MΩ (depending on the measuring range).



Voltage measurement can also be set to a low-ohm range. Low-ohm measurement is carried out using a 200 kΩ resistor connected parallel to the input impedance that is dependent on the measuring range. Low-ohm measurement permits discharge of coupled voltage on lines (charged lines).
This load indicates the state (low-ohm, high-ohm) of the source of any external voltage.



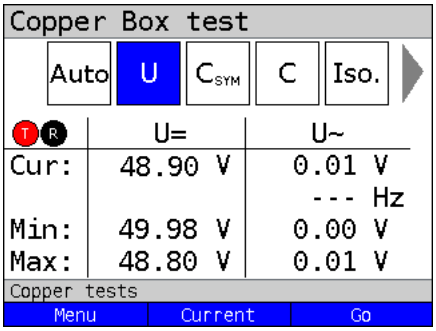
The example here shows a low-ohm (loaded) measurement.

The input resistance can only be switched over during a two-pole measurement.

Switches the input resistance.

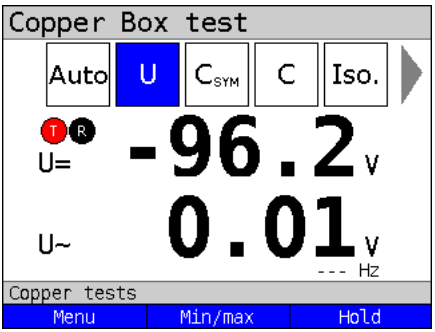
To measure voltage using a different socket combination, see page 21.

Example measurements:



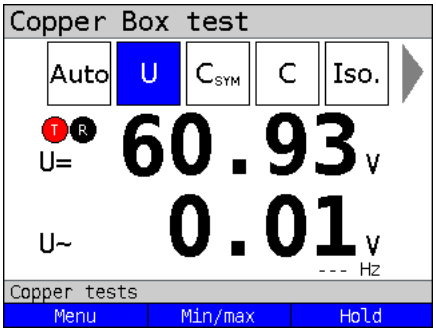
The measured DC voltage of 48.90 V can indicate the POTS access of a PBX.

Typical POTS PBX voltages are 48 V, 32 V or 24 V DC.



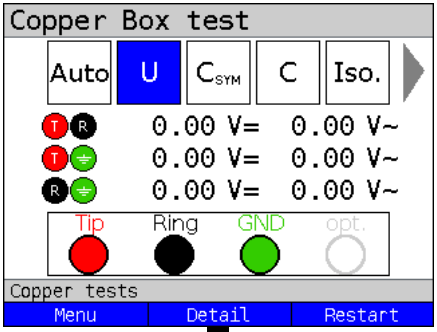
The measured DC voltage of 96.2 V can indicate an ISDN-BRI U access.

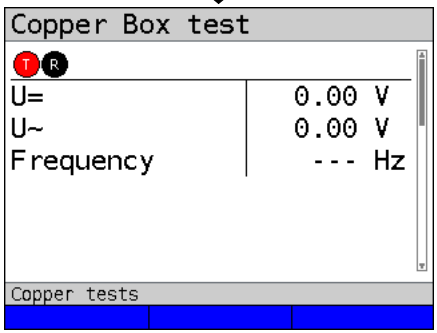
The voltage for an ISDN-BRI U access is normally between 91 V and 99 V.



The measured voltage of 60.93 V could indicate an POTS access.

The normal voltage range of an POTS access is between 50 V and 72 V.





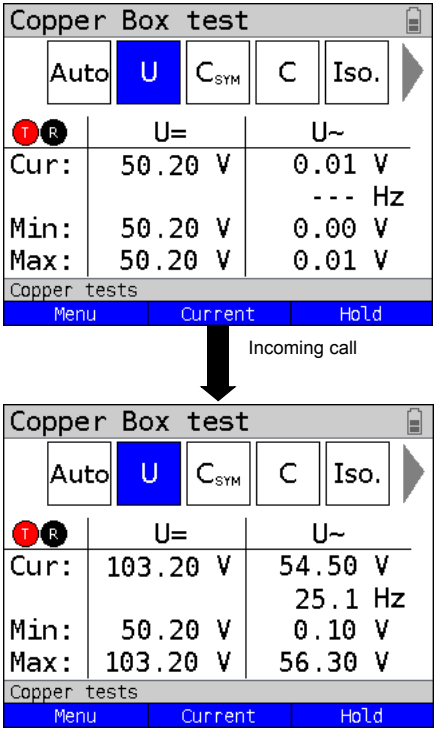
Ideally, no AC voltage should be measured between individual wires. Still, AC voltages can be coupled to the wires directly via a line termination or indirectly through the air.
The typical call-switching voltage can occur transiently between Tip and Ring.

<Detail> Opens the measuring results for the wire pairs.

Display of the measurements between the Tip (a-wire) and Ring (b-wire).
- Display of DC voltage in V
- Display of AC voltage in V
- Frequency of AC voltage in hertz

You can open the measuring results of the wire pairs using the cursor keys.

Example: AC voltage measurement



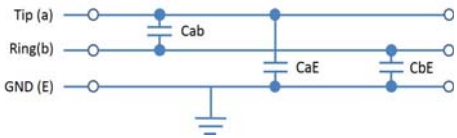
In this example the Copper Box is connected so as to measure the voltage of an POTS access.
A typical DC voltage is measured.

This example shows an incoming call. In addition to the DC voltage, we can see a call-switching voltage with the typical frequency of 25 Hz.

8 Capacitive symmetry measurement (C_{Sym})

With the aid of capacitive symmetry measurement, it is possible to detect irregularities in the wiring that can result in signal distortions or transmission errors. The line must be open.

In a real line, a network of serial and parallel capacitances is formed between the individual reference points, as illustrated the following diagram.



The total capacitance Cab of the series connection of CaE and CbE is actually measured between a (tip) and b (ring). The measured value shows the mutual capacitance (Cm) value. This applies correspondingly for measurements between a (tip) and ground (E) and between b (ring) and ground.
These measurements for the basis for calculating the actual values of Cab, CaE and CbE. The calculated values are then used in determining symmetry.

The basis of the three-way measurement of Cab, CaE, CbE, with C1, C2, C3 as total capacitance of the respective capacitance network:

Cab = $\frac{C1+C2-C3}{2}$

CaE = $\frac{C1-C2+C3}{2}$

CbE = $\frac{-C1+C2+C3}{2}$

Additionally, the absolute deviation of the two capacitances CaE and CbE with respect to ground and the relative deviation are determined.

Relative deviation (in %) = 2x $\frac{absolute\ Abweichung\ (CaE-CbE)}{CaE+CbE}$

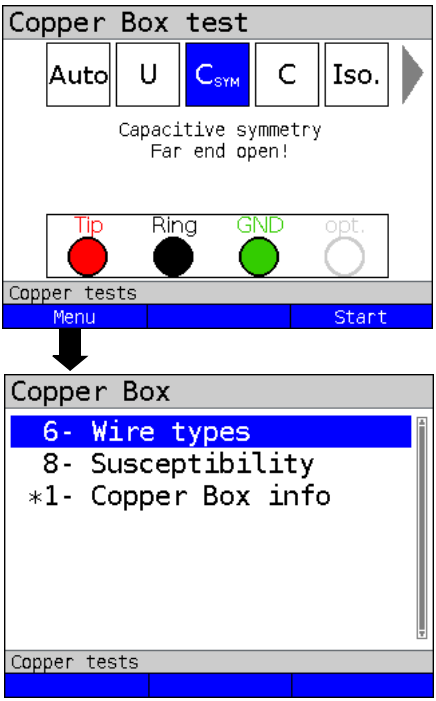
Absolute deviation (in nF) = absolute difference (CaE-CbE)

The calculated values represent the actual values CaE, CbE and Cab for the individual capacitances. As the capacitances with respect to ground CaE and CbE are particularly important for the symmetry of a line, the absolute and percentage values are also given here for the sake of clarity. The relative value should not exceed 1 % (recommendation). The absolute deviation is of particular importance on extremely short lines, as even small differences here can result in a higher-percentage deviation. It must be reviewed on a case-by-case basis whether this is acceptable.

The line must be open. This can be achieved e.g. using the instrument kit function "open circuit". A voltage check is performed before the measurement in which the voltage limits given in the table (see page 10) may not be exceeded.

See the chapter Technical data page 13 for information on capacitive symmetry measurement.

Capacitive symmetry measurement settings



ARGUS in the status display.

Capacitive symmetry measurement is not yet started.

When you select the susceptibility "insecure (fast)", the red warning "ATTENTION: susceptible" appears on the display.

If a wire type has been selected, this is shown in the display.

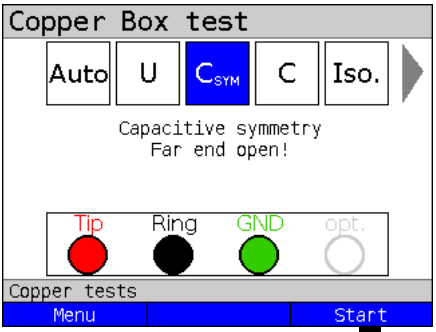
<Menu> Opens the Copper Box menu, see page 20.

<Start> Starts capacitive symmetry measurement.

Settings	Description
Wire types:	
See page 28 for an explanation of wire types.	
Susceptibility:	
Selects the susceptibility with which ARGUS performs capacitive symmetry measurement.	
Robust for external voltage:	The measurement is reliable in the event of external voltages up to 17 V.
Insecure (fast):	Using another measuring method, the measurement is extremely fast but much more susceptible to interference.
Default:	***Reliable for external voltages***

Under certain circumstances, the capacitive symmetry measurement can abort. Possible causes include the presence of an external voltage, absence of a line or the existence of a loop.

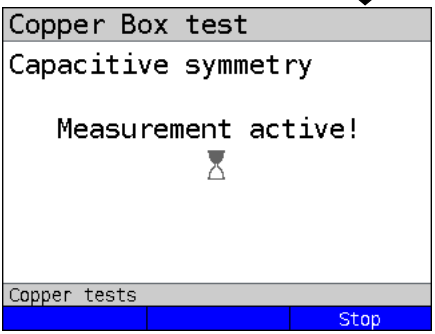
Starting symmetry measurement



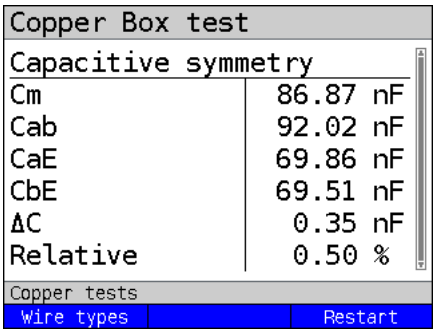
ARGUS in the status display.

When you select the susceptibility "Insecure (fast)", a warning appears in the display.

<Start> Starts capacitive symmetry measurement.



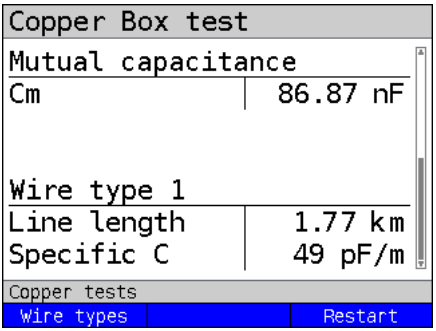
Depending on the line characteristics, the measurement can take a few seconds.



Display:

- Cm (operating (mutual) capacitance) (in nF)
- Cab (capacitance between Tip and Ring) (in nF)
- CaE (capacitance between Tip and Ground) (in nF)
- CbE (capacitance between Ring and Ground) (in nF)
- ΔC (absolute deviation between CaE and CbE) (in nF)
- Relative deviation (in %)

When a wire type is selected the line length is calculated, see page 42.

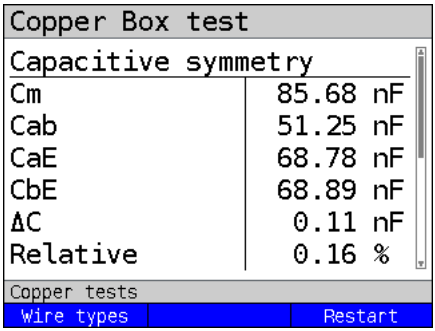


When a wire type is selected the specific capacitance and measured operating capacitance are used to calculate the line length.

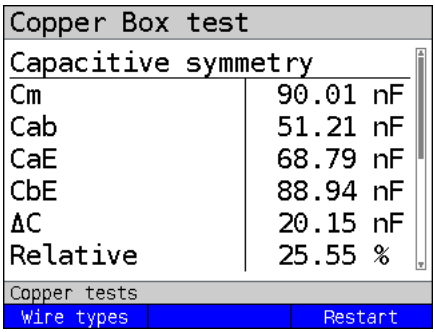
Display:

- Cm (operating (mutual) capacitance) (in nF)
- Line length in km
- Specific capacitance of wire type

Example measurements:



The capacitances CaE and CbE are very close together. The relative deviation is below 1 %. The wires are extremely homogeneous.



The capacitances CaE and CbE deviate greatly. The relative deviation is significantly greater than the recommended 1 %.
The wires are extremely asymmetrical.

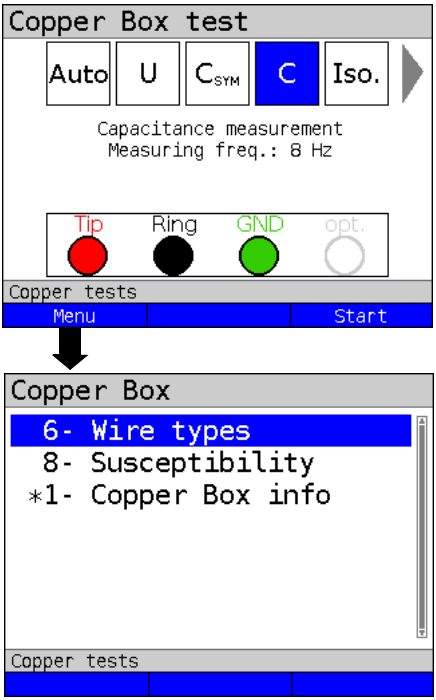
9 Capacitance measurement (C)

Capacitance measurement shows the typical input capacitance of connected devices or the capacitance of the open line.

The line must be open. This can be ensured using the instrument kit function "open circuit". Before the measurement, a voltage check is performed in which the voltage limits given in the table (see page 10) may not be exceeded.

The measuring ranges, resolutions and accuracies of the capacitance measurement may be found in the chapter Technical data, see page 13.

Capacitance measurement settings



ARGUS in the status display.

Capacitance measurement is not yet started.

When you select the susceptibility "Insecure (fast)", the red warning "ATTENTION: susceptible" appears on the display.

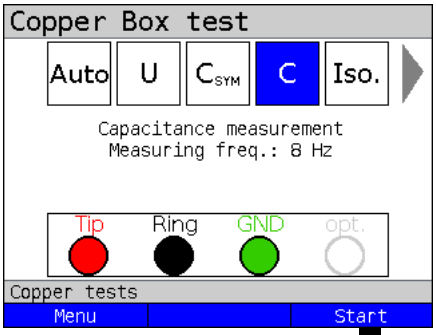
<Menu> Opens the Copper Box menus, see page 20.

<Start> Starts capacitance measurement.

Once you have measured C-symmetry, you no longer need to measure capacitance.

Settings	Description
Wire types:	
See page 28 for an explanation of wire types.	
Susceptibility:	
See page 40 for an explanation of susceptibility.	

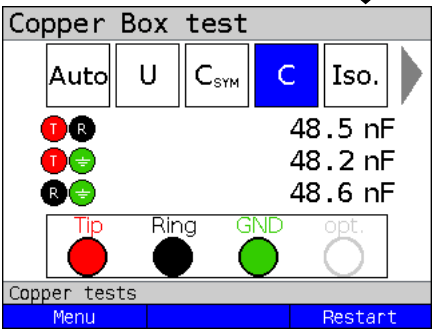
Starting capacitance measurement



ARGUS in the status display.

When you select the susceptibility "Insecure (fast)", the red warning "ATTENTION: susceptible" appears on the display.

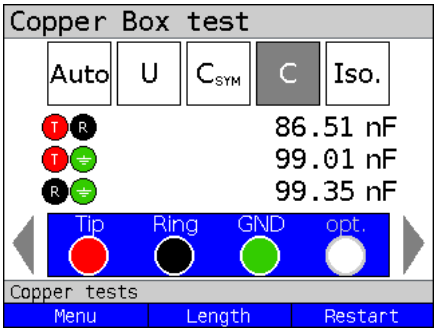
<Start> Starts capacitance measurement



In this example, a capacitance of approx. 48 nF is measured between each of the sockets Tip/Ring and Ground.
For a specific capacitance of approx. 50 nF/km, this value indicates that the line is approx. 1 km long and open.

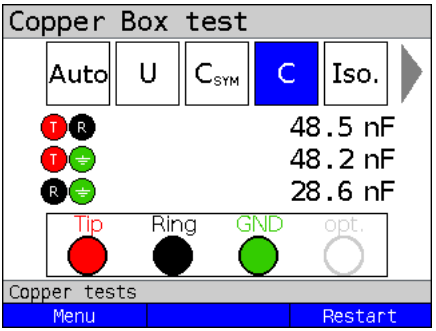
No measurement is possible on a closed line. ARGUS indicates this with the message "Loop?".

Example measurements:



In this example, a capacitance of approx. 86.51 nF is measured between the sockets Tip/Ring.

<Length> Switches to the line length parameters, see page 47.



Ideally, the line should be in capacitive balance. However, if the capacitance between Tip and Ground and between Ring and Ground differ by more than 2-3 %, this can indicate an asymmetry. You can investigate this hypothesis by measuring the symmetry (see Chapter 8), which delivers a much more accurate determination of symmetry.

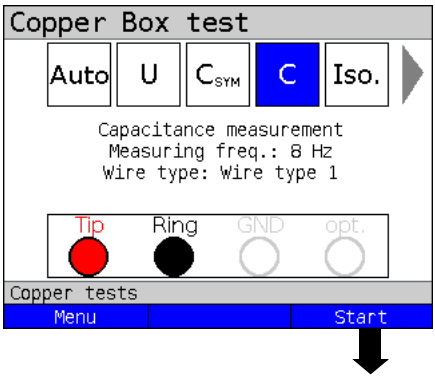
9.1 Calculating line length

Every telecommunication cable has a certain loop resistance and operating capacitance per unit of length. As the type of cable laid is generally known, this value too is known. The values are design-related and relatively constant, as the cables are laid in the earth and subject to relatively minor temperature and humidity effects. However, a typical subscriber line can consist of multiple segments. In these segments, the wire cross-sections, and thus the technical specifications, can vary.

This can only be determined for a measurement between the Tip- and Ring-wires. The measurements with respect to Ground can be subject to random influences and thus cannot be specified with a general capacitance or resistance value per unit of length. The line length calculations can then be compared with the line length, which is generally also known, thus providing information about faults. Using the calculated value, you can roughly compare the line lengths and conduct further fault-finding (e.g. with a TDR) in the event of discrepancies.

A wire type must be selected to enable calculation of the line length using a C or R measurement. See page 28 for these and further settings.
The wire type can be selected and configured during or after the measurement.

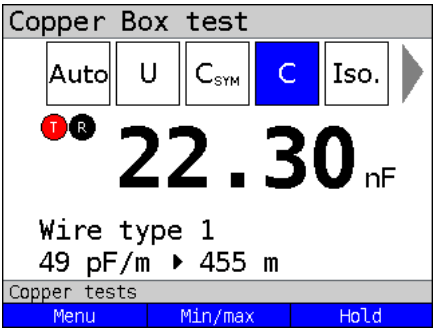
Starting capacitance measurement.



ARGUS in the status display.

In this example, capacitance measurement is carried out with a measuring frequency of 8 Hz and the values stored for wire type 1.

<Menu>	Opens the Copper Box menus, see page 20.
<Start>	Starts capacitance measurement.

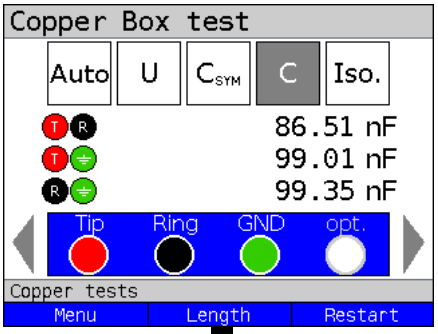


In this example, a capacitance of approx. 22.30 nF is measured between Tip/Ring. On the basis of the values stored under wire type 1, this corresponds to a 455 m line.
For a two-pole measurement the measured value is displayed in real time.

<Menu> Opens the Copper Box menu, see page 20.

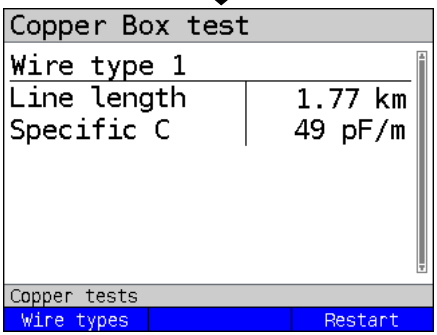
The wire type can be selected and configured during or after the measurement.

Example measurements:



In this example, a capacitance of approx. 86 nF is measured between Tip/Ring. For a capacitance of approx. 49 nF/km, this value indicates that the line is approx. 1.77 km long.

<Menu> Opens the Copper Box menu, see page 20.



Display:

- Calculated line length of Tip/Ring in km
- Specific capacitance of wire type

<Wire types> Switches to the wire type settings.

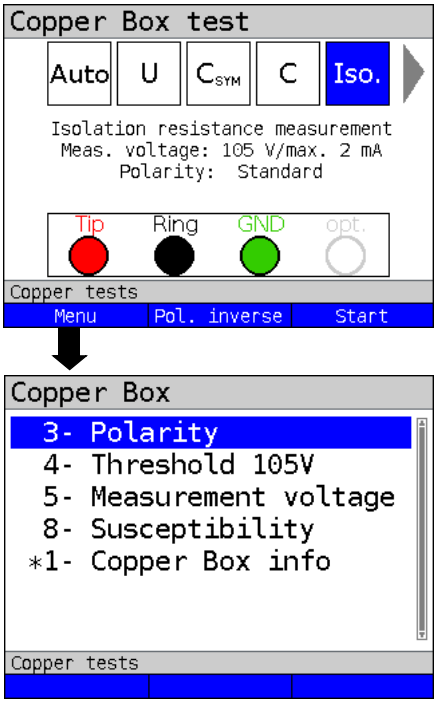
10 Isolation resistance measurement (Iso.)

Isolation resistance measurement can indicate damage to cable isolation, moisture penetration or oxidised contact points on the line.

A voltage check is performed before the measurement in which the voltage limits given in the table (see page 10) may not be exceeded.

See the chapter Technical data page 13 for information on measuring ranges, resolutions and accuracies of isolation resistance measurement.

Isolation resistance measurement settings



ARGUS in the status display.

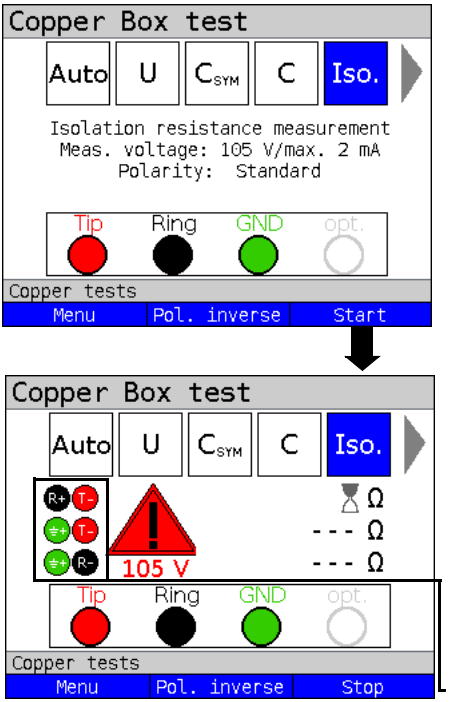
Isolation resistance measurement is not yet started.

Before the measurement, the selected test parameters are displayed.
- Measuring voltage (in this example 105 V)
- Measuring current (in this example max. 2 mA)
- Polarity (in this example standard)

<Menu>	Opens the Copper Box menu, see page 20.
<Pol. inverse>	The polarity is inverted/ reversed, see page 49.
<Start>	Starts the isolation resistance measurement.

Settings	Description
Polarity:	
Determines whether the polarity of the measurement is inverted. Standard is selected such that e.g. a correctly connected passive test termination (PPA) is non-conducting. If the PPA is reversed due to reversed connection, the display shows the value PPA (~470 kΩ). If this occurs, reverse the polarity. Default: ***Standard***	
Range limit:	
Sets the limiting thresholds for isolation resistance measurement (see also page 13). The measurement is only carried out up to the set threshold. The threshold applies for isolation resistance measurement when a measurement voltage of 105 V is selected. Default: ***1000 MΩ***	
Measurement voltage:	
Determines whether isolation measurement is to be conducted at a high 105 V or low 8 V voltage. With 8 V, it is possible e.g. to measure against a connected NTBA, so that this does not become low-ohm (above approx. 10 V) and falsify the measurement. Default: ***High voltage (105 V)***	
Susceptibility:	
Selects the susceptibility with which ARGUS performs isolation resistance measurement.	
Robust for ext. voltage: Insecure (fast): Default:	The measurement is reliable in the event of external voltages up to 17 V. Using another measuring method, the measurement is extremely fast but much more susceptible to interference. ***Reliable for external voltages***
Display mode:	
Determines whether the standard display (Normal display mode) or min./max display (incl. Min./max. display mode) is used. Default: ***Normal display***	

Starting isolation resistance measurement



ARGUS in the status display.

Isolation resistance measurement is not yet started.

<Menu> Opens the Copper Box menu

<Pol. inverse> Inverts the polarity, see page 49.

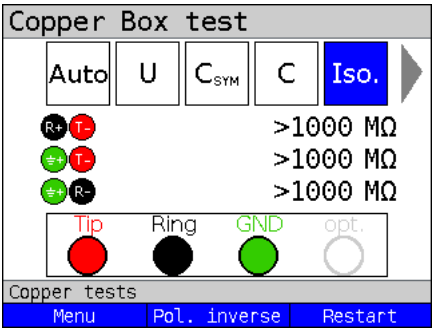
<Start> Starts the isolation resistance measurement.

⚠ When isolation resistance measurement is started, a warning is displayed when a measurement voltage of 105 V is used.
ARGUS generates a voltage of 105 V at the start of the measurement.
Special care is necessary due to this generated voltage.

Current measuring polarity

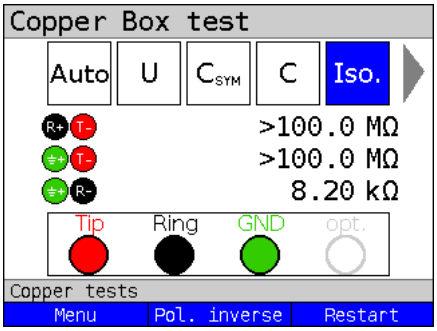
<Stop> Stops the test.

Example measurements:



The example shows the measurement of a resistance between Tip/Ring, Tip/Ground and Ring/Ground of > 1000 MΩ. This indicates that the line is not damaged. Depending on the requirement, a value of e.g >300 MΩ is considered good. Values <300 MΩ and >5 MΩ should be examined more closely. Values under 5 MΩ indicate an isolation fault.

<Restart> Starts a new measurement.

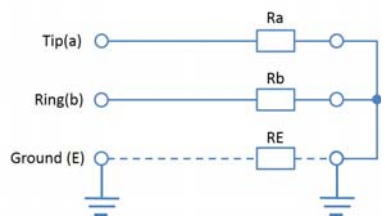


In this example, the measurement shows a markedly low resistance between Ring and Ground. This indicates a fault.
Ideally, the values of Tip to Ground and Ring to Ground should always be in balance.
A value of 470 kΩ indicates a passive test termination.
The value should be verified by reversing the polarity with **<Pol. inverse>.**

11 Resistance symmetry (R_{Sym})

This measurement determines the resistance symmetry of a line. Of primary importance for resistance symmetry are the two resistances Ra and Rb, i.e. the resistances of the two signal wires. To great a difference in resistance between the two wires can result in signal distortions and transmission errors. In a real line, a network of serial resistances is formed between the individual reference points, as illustrated the following diagram.

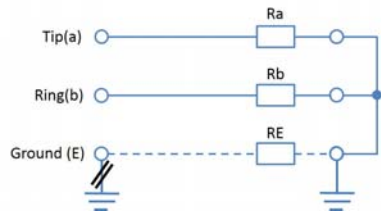
Ideal measure arrangement:



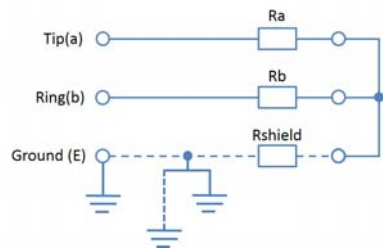
The resistances Ra and Rb are actually measured between Tip and Ring. The same is true for measurements between Tip and Ground and Ring and Ground.
These three measurements form the basis for calculating the actual values of Ra, Rb and RE. The calculated values are then used in determining symmetry.

Here, RE depends on the measuring current and serves as an auxiliary quantity. RE is generally significantly lower (RE << Ra resp. Rb) than Ra or Rb.

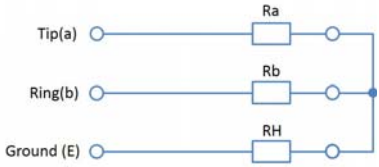
Special features for RE (Examples):



1st measurement site, e.g. APL/TAE:
The measurement does not work if the ground at one of the connection points is faulty.



2nd measurement site, e.g. APL:
The measurement works when the shield is continuously connected with a ground point. However, RE is not the same as Rshield, as the shield can also have the ground potentials of the clamps in the earth.



If a further intact wire is used as an auxiliary potential instead of ground, RE = RH. RH then has a magnitude on the order of Ra and Rb.

Calculation basis:
The following calculation basis is used for a 3-way measurement Rab, RaE, RbE, with R1, R2, R3 as the total resistance of the respective line pairs.

$$Ra = \frac{\mathrm{Rab} + \mathrm{RaE} - \mathrm{RbE}}{2} \qquad Rb = \frac{\mathrm{Rab} - \mathrm{RaE} + \mathrm{RbE}}{2} \qquad RE = \frac{-\mathrm{Rab} + \mathrm{RaE} + \mathrm{RbE}}{2}$$

Additionally, the absolute deviation of the two resistances Ra and Rb and the relative deviation are determined.

Relative deviation (in %) = 2x $\frac{absolute\ Abweichung\ (Ra-Rb)}{Ra+Rb}$

Absolute deviation (in Ω) = absolute deviation (Ra - Rb)

The maximum allowable deviation is assessed on the basis of the equation:

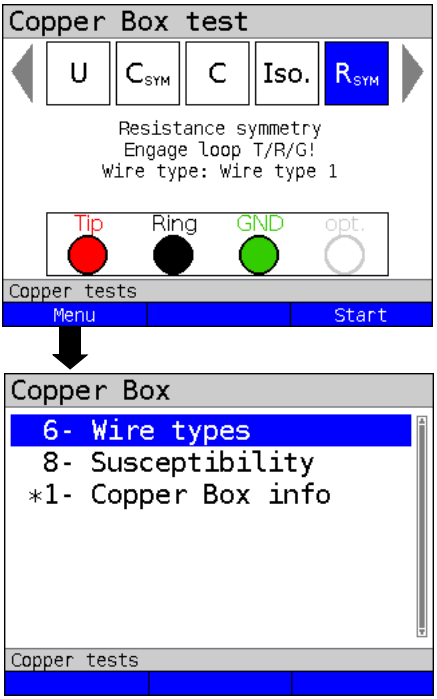
ΔR max. (maximum resistance difference) = $0.5 * \sqrt{(\frac{Rs}{30})}$

whereby Rs equals the sum of the adjusted Ra and Rb values.
The calculation is no longer performed when values exceed 10 kΩ, as no real fault-free line would show such a high resistance

A voltage check is performed before the measurement in which the voltage limits given in the table (see page 10) may not be exceeded. A loop must be created between Tip-Ring-Ground. This can be achieved using the instrument kit function "Tip-Ring-Ground".

See the chapter Technical data page 13 for information on measuring ranges, resolutions and accuracies of resistance symmetry measurement.

Resistance symmetry measurement settings



ARGUS in the status display.

The measurement is not yet started.

When you select the susceptibility "insecure (fast)", the red warning "ATTENTION: susceptible" appears on the display.

If a wire type has been selected, this is shown in the display (in this example wire type 1).

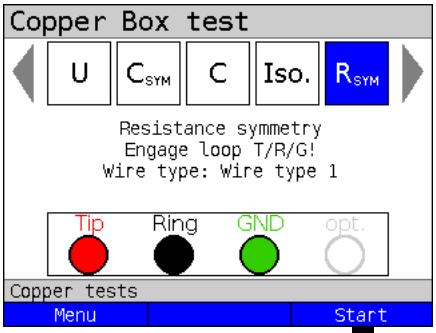
<Menu> Opens the Copper Box menus, see page 20.

<Start> Starts the resistance symmetry measurement.

Settings	Description
Wire types:	
See page 28 for an explanation of wire types.	
Susceptibility:	
Selects the susceptibility with which ARGUS performs resistance symmetry measurement.	
Robust for external voltage:	The measurement is reliable in the event of external voltages up to 30 V.
Insecure (fast):	Using another measuring method, the measurement is extremely fast but much more susceptible to interference.
Default:	***Robust for external voltages***

Under certain circumstances, the resistance symmetry measurement can abort. Possible causes include the presence of an external voltage, absence of a line or of a loop.

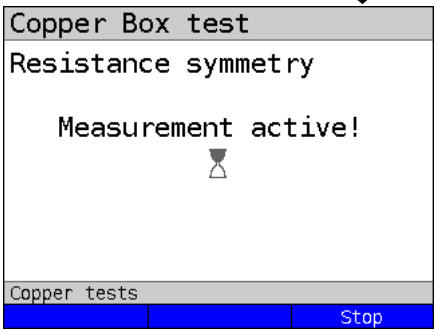
Starts resistance symmetry measurement



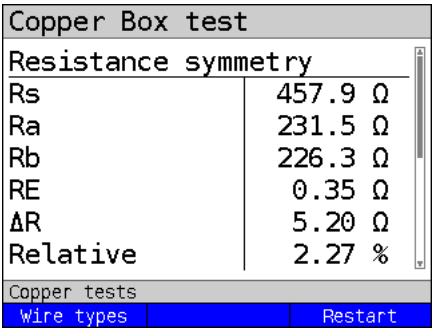
ARGUS in the status display.

The resistance symmetry measurement is not yet started.

<Menu>	Opens the Copper Box menus, see page 20.
<Start>	Starts the resistance symmetry measurement.

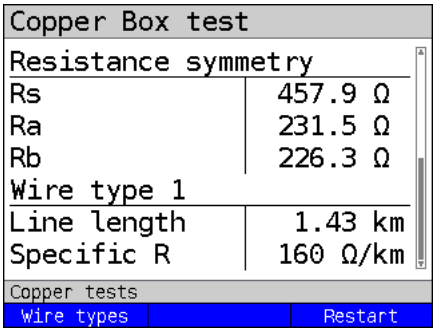


Depending on the line characteristics, the measurement can take a few seconds.



Display:

- Rs (loop resistance) (in Ω)
- Ra (resistance of Tip-wire) (in Ω)
- Rb (resistance of Ring-wire) (in Ω)
- RE (resistance of Ground) (in Ω)
- ΔR (absolute deviation between Ra and Rb) (in Ω)
- Relative deviation (in %)

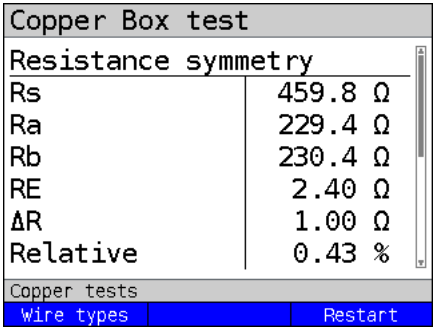


When a wire type is selected, the line length is calculated from the specific resistance.

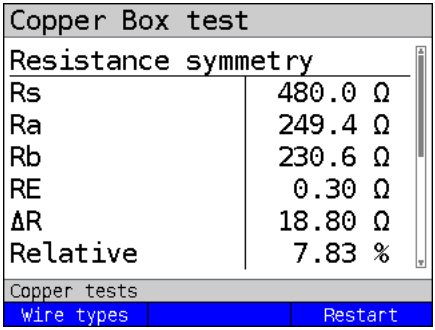
Display:

- Rs (sum of loop resistances) (in Ω)
- Ra (resistance of Tip-wire) (in Ω)
- Rb (resistance of Ring-wire) (in Ω)
- Line length in km
- Specific resistance of the selected wire type

Example measurements:



The resistances Ra and Rb are very close together. The relative deviation is below 1 %. The wires are extremely homogeneous.



The resistances Ra and Rb deviate greatly. The relative deviation is considerably above the recommended 1 %. The wires are extremely asymmetrical.

12 Loop resistance measurement (R)

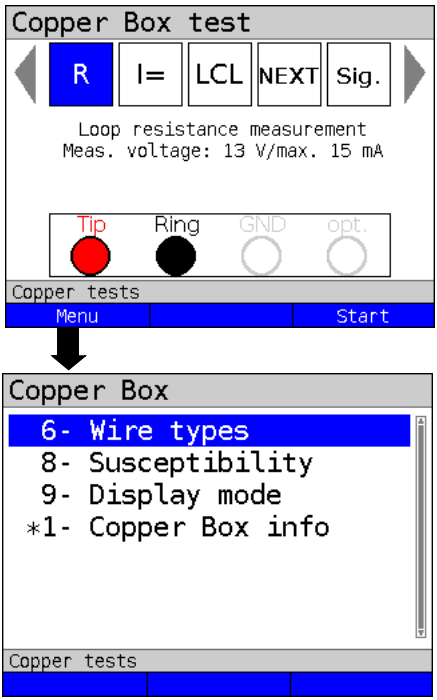
Loop resistance measurement enables you e.g. to detect short-circuits and estimate line lengths, among other things.

A voltage check is performed before the measurement in which the voltage limits given in the table (see page 10) may not be exceeded. A loop must be created. This can be ensured using the instrument kit function "short circ. Tip-Ring-Ground".

Loop resistance measurement is not intended for single-wire determinations. Use resistance symmetry measurement for this purpose, see page 53.

See the chapter Technical data page 13 for information on measuring ranges, resolutions and accuracies of loop resistance measurement.

Loop resistance measurement settings



ARGUS in the status display.

The loop resistance measurement is not yet started.

When you select the susceptibility "Insecure (fast)", the red warning "ATTENTION: susceptible" appears on the display.

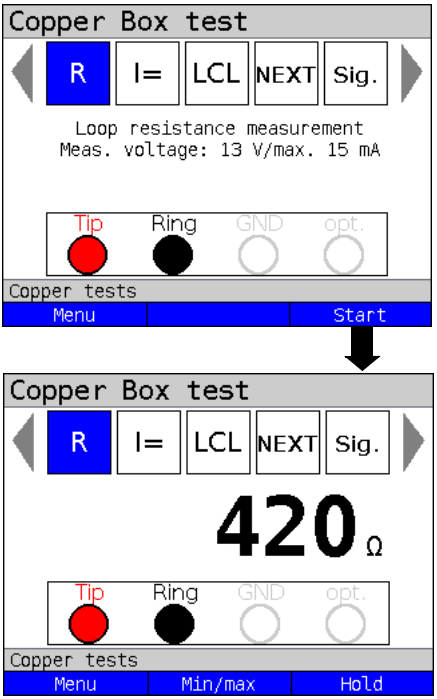
<Menu> Opens the Copper Box menus, see page 20.

<Start> Starts loop resistance measurement.

Loop resistance is always measured continuously.

Settings	Description
Wire types:	
See page 28 for an explanation of wire types.	
Susceptibility:	
Selects the susceptibility with which ARGUS performs loop resistance measurement.	
Robust for external voltage:	The measurement is reliable in the event of external voltages up to 3.5 V DC and 30 V AC.
Insecure (fast):	Using another measuring method, the measurement is extremely fast but much more susceptible to interference.
Default:	***Robust for external voltages***
Display mode:	
Determines the normal display (current measured value) or min./max display (Min./max. values) is used. Default: ***Normal display***	

Starts loop resistance measurement



ARGUS in the status display.

The loop resistance measurement is not yet started.

<Menu> Opens the Copper Box menus, see page 20.

<Start> Starts loop resistance measurement.

In this example, a loop resistance of 420 Ω is measured.

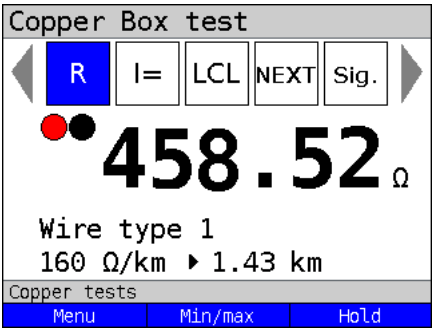
<Min/Max> Display of minimum and maximum measured values.

<Hold> The continuing measurement is paused, see also page 32.

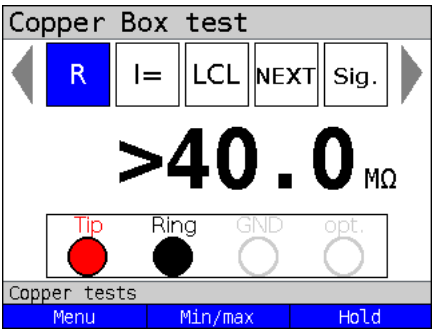
To perform a loop resistance measurement using another socket combination, see page 21.

Loop resistance measurement can also return no result (---) e.g. due to excessive influence. The polarity is reversed up to 20 kΩ.

Example measurements:



The example shows a measurement of 458 Ω. For a copper cable with a specific resistance of 160 Ω / km, this indicates a short-circuited twisted pair with a length of 1.43 km.
As an explanation, the line can be deliberately shorted at one end, or is unintentionally shorted due to a fault in an unknown location.



A large value such as 20 MΩ or >40 MΩ indicates that no line loop (intentional shorting) has been set up.
Loop resistance cannot be measured then.

12.1 Calculating line length

See page 46 for calculation of line length using the R-values.

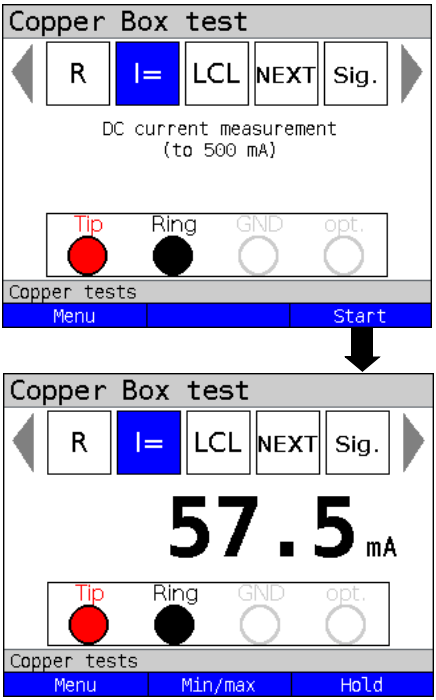
13 DC current measurement (I=)

DC current measurement enables detection e.g. of feeds, emergency feeds or line terminations.

Before measuring, make sure that the Copper Box is connected in the circuit in series.

The measuring range, resolution and accuracy of DC current measurement are described in the chapter Technical data, see page 13.

Starting DC current measurement



ARGUS in the status display.

The DC current measurement is not yet started.

<Menu>	Opens the Copper Box menu, see page 20.
<Start>	Starts the DC current measurement.

In this example, a DC current of 57.5 mA is measured.

<Min/Max>	Display of minimum and maximum measured values.
<Hold>	The continuing measurement is paused, see also page 32.

To measure DC voltage using a different socket combination, see page 21.

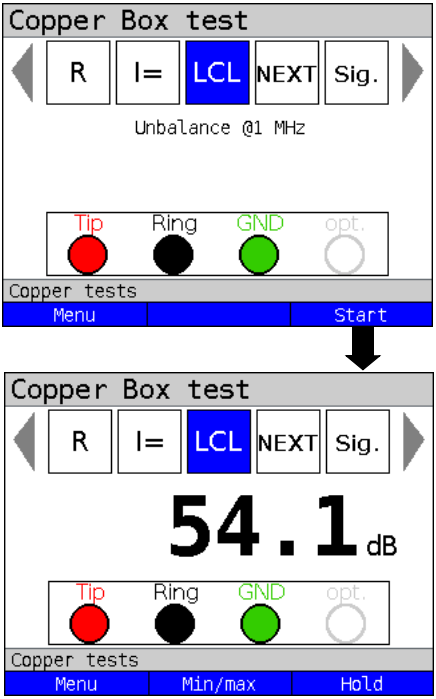
14 Longitudinal conversion loss (LCL)

LCL measurement (asymmetry attenuation) looks at the balance between the Tip-wire with respect to Ground (GND) compared to the Ring-wire with respect to Ground. In this measurement, a tone is fed symmetrically to the wires with respect to Ground at 1 MHz. If a difference can be measured between the two wires, an asymmetry is present.

A voltage check is performed before the measurement in which the voltage limits given in the table (see page 10) may not be exceeded.
The length of the measuring leads can significantly affect the measurement, so you should always perform your measurements using the original accessories.

The measuring ranges, resolutions and accuracies of the LCL measurement are set out in the chapter Technical data, see page 13.

Starting LCL measurement



ARGUS in the status display.

The LCL measurement is not yet started.

<Menu> Opens the Copper Box menu, see page 20.

<Start> Starts LCL measurement.

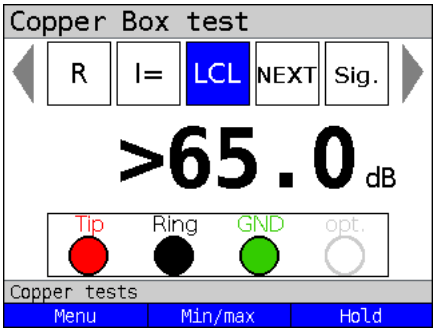
In this example, an asymmetry attenuation of 54.1 dB is measured.

<Min/Max> Display of minimum and maximum measured values.

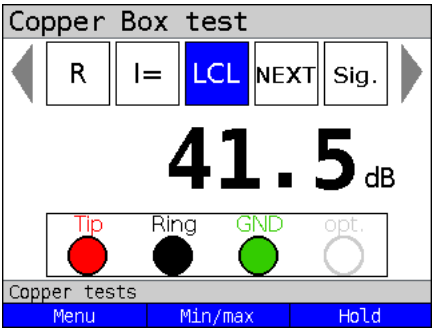
<Hold> The continuing measurement is paused, see also page 32.

It is not possible to change the socket combination for LCL measurement.

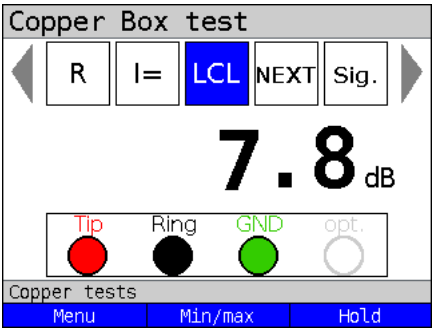
Example measurements:



If the two wires are symmetric, i.e. identical in their mechanical properties, a max. value is measured (in this example > 65 dB). Such a high value can only be expected in ideal situations or in the event of a short circuit between Tip and Ring or an extremely short open line.
A value greater than 65 dB means that the result is above the measuring range.



However, a value > 40 dB (as in this example 41.5 dB) is considered sufficiently symmetric.



If a value <40 dB is measured, or even 7.8 dB as in this example, Tip or Ring may be shorted to Ground.

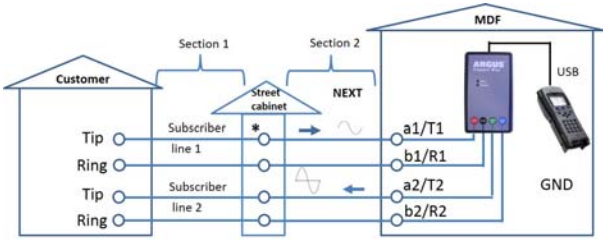
15 Near-end crosstalk (NEXT)

ARGUS generates a 1 MHz tone on line pair 1 and measures the crosstalk on the adjacent line pair 2, which can cause severe performance issues for DSL. A customer's line can pass through multiple segments. In this case, the measurement must be performed segment by segment, and different line pairs may need to be used as the measuring lines.

A voltage check is performed before the measurement in which the voltage limits given in the table (see page 10) may not be exceeded.
The length of the measuring leads can significantly affect the measurement, so you should always perform your measurements using the original accessories.

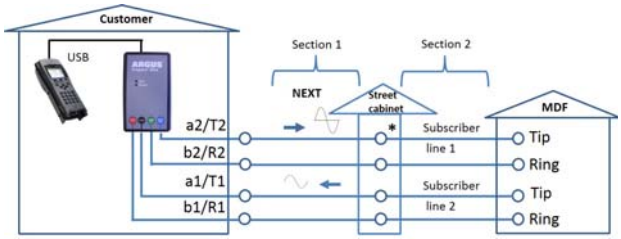
The measuring ranges, resolutions and accuracies of NEXT measurement are set out in the chapter Technical data, see page 13.

Connection example (towards to the customer)



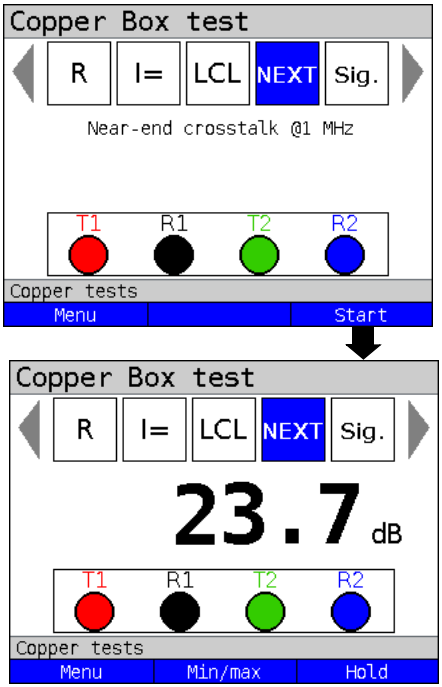
* Measurement is also possible from the street cabinet towards the customer (segment by segment).

Connection example (towards to the MDF)



* Measurement is also possible from the street cabinet towards the MDF (segment by segment).

15.1 Starting NEXT measurement



ARGUS in the status display.

The NEXT measurement is not yet started.

<Menu>	Opens the Copper Box menu, see page 20.
<Start>	Starts NEXT measurement.

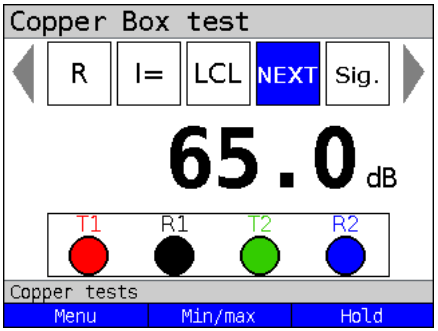
The NEXT measurement is started.

In this example, a crosstalk attenuation of 23.7 dB is measured.

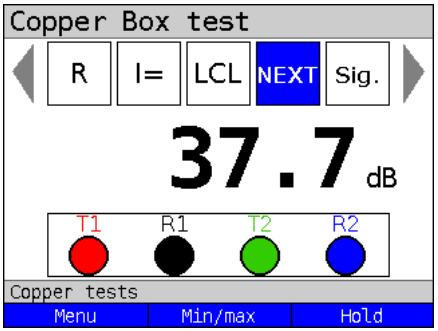
<Min/Max>	Display of minimum and maximum measured values.
<Hold>	The continuing measurement is paused, see also page 32.

It is not possible to change the socket combination for NEXT measurement.

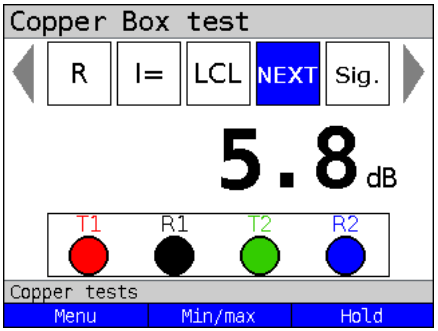
Example measurements:



If there is no crosstalk between line pair 1 and line pair 2 (adjacent line), a maximum value is reached (in this example 65 dB).



However, a value > 37 dB (as in this example 37.7 dB) considered sufficient. The crosstalk to the adjacent line is tolerable.



If a value <37 dB is measured, or even 5.8 dB as in this example, there may be a short between the two wire pairs. The tone is 100 % cross-coupled and severely interferes with the line.

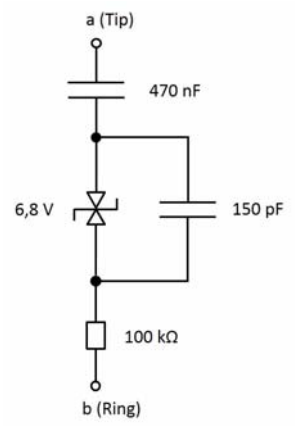
16 Signature detection/termination detection

Signature detection makes it possible to detect e.g. a passive test termination (PPA).

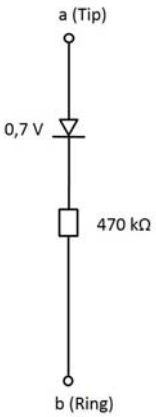
A voltage check is performed before the measurement in which the voltage limits given in the table (see page 10) may not be exceeded.

Circuit diagrams:

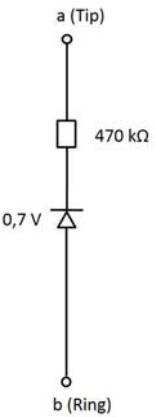
Signature



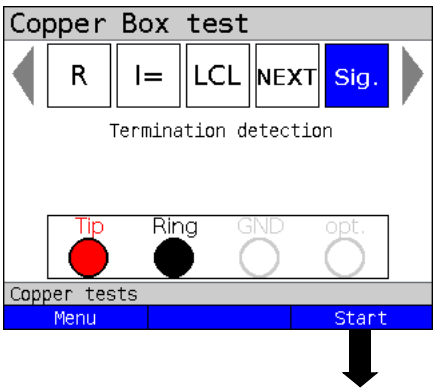
PTT



PTT (inverted)



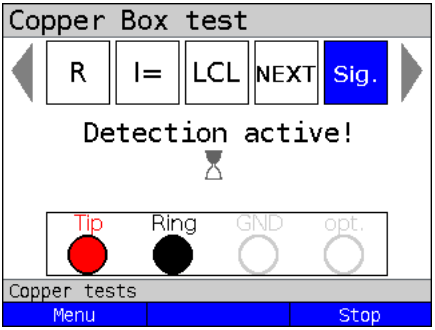
Starting signature detection



ARGUS in the status display.

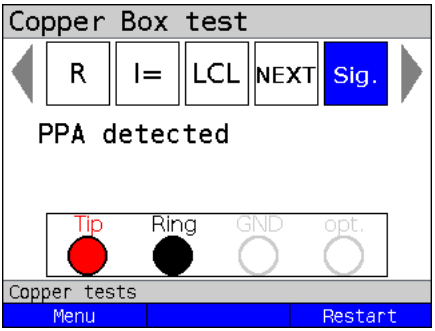
Signature detection is not yet started.

<Menu>	Opens the Copper Box menu, see page 20.
<Start>	Starts signature detection.



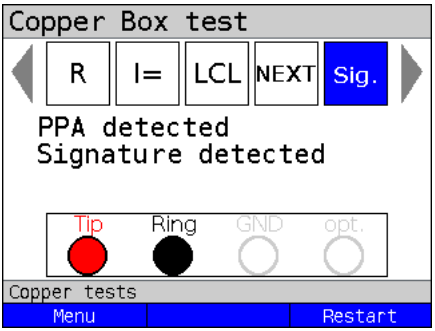
Signature detection can take a few seconds.

<Stop> Stops the test.



In this example, a passive test termination (PPA) was detected between Tip and Ring.
See the table on page 71 for possible results.

<Restart> Starts a new signature detection.



In this example, a PPA and a signature circuit between Tip and Ring were detected.

<Restart> Starts a new signature detection.

16.1 Possible results

Test	Possible results	Characteristic features	Remark
PPA	PPA detected		
	PPA inverted detected		PPA with reversed polarity (inverted) detected.
	Multiple PPAs?		Potentially multiple PPAs connected in parallel detected.
	Multiple inv. PPAs?		Potentially multiple PPAs with reversed polarity (inverted) connected in parallel detected.
	2x PPA/Iso fault?		Potentially double PPA antiparallel detected or isolation fault.
Signature	Signature detected		Signature circuit detected.
	Signature?		Signature possibly present: External voltage, isolation resistance or additional connected devices can influence detection such that an unambiguous result is no longer possible.
	Unknown termination	Cp > 500 nF	Unknown termination: Cancellation, as no further detection is possible, e.g. NTBA connected, extremely long line.
Other	No termination detected		
	Loop?	R < 8 kΩ	Cancellation, as no further detection possible.
	Isolation fault?	Rp < 1 MΩ	Cancellation, as no further detection possible.

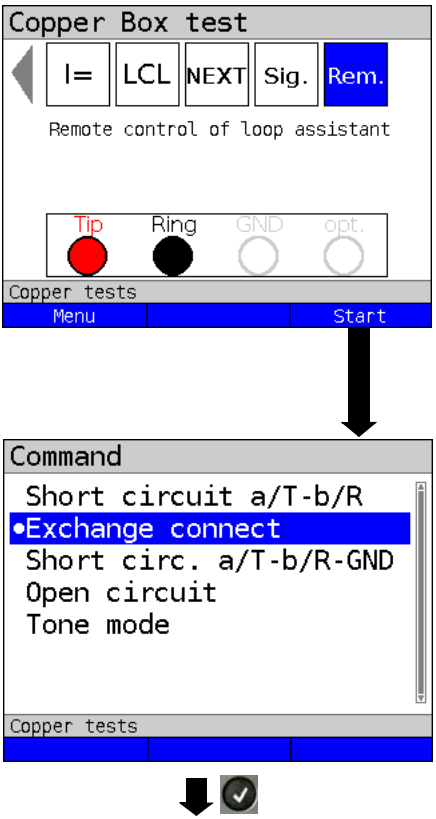
17 Remote kit control (Rem.)

The Copper Box remote instrument kit control (Rem.) function enables ARGUS to control commonly available electronic instrument kits, such as the TX915/916.

Before using the remote control function, make sure that the voltage limits specified in the table on page 10 are not exceeded during the measurement.

Remote control of other electronic instrument kits that may offer additional functoins is only possible using the commands listed below.

Starting remote kit control



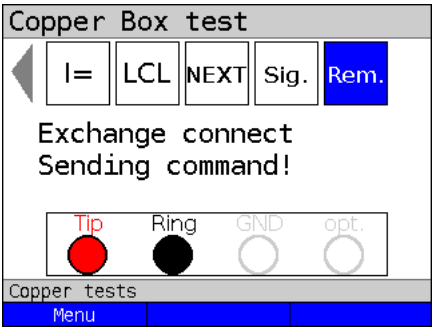
ARGUS in the status display.

<Menu> Opens the Copper Box . menus, see page 20.

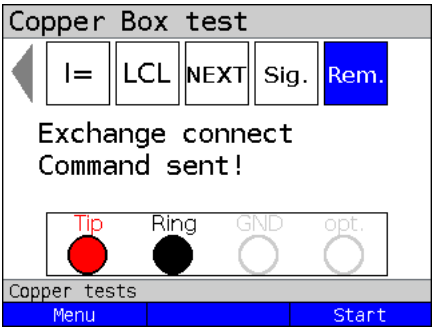
<Start> Selects the command for remote kit control.

In this example, the command "Exchange connect" is selected.

Confirm the command.



The command "Exchange connect" is sent to the remote unit.



The command has been sent to the remote unit.

<Start> Selects and sends a new command.

Commands:	**Description:**
Short circuit a/T-b/R	The instrument kit short-circuits the Tip and Ring wires, e.g. for loop resistance measurement.
Exchange connect	The instrument kit switches the line through. On a DSL access for example directly to the DSLAM.
Short circuit a/T-b/ R/R/GND	The instrument kit shorts Tip, Ring and Ground, e.g. for resistance symmetry measurement.
Open circuit	The instrument kit opens a line, e.g. for a capacitance measurement.
Tone mode	The tone generator in the instrument kit is activated. The tone can be followed.

18 Appendix

A) Abbreviations

	Characters
@	at
Ω	Ohm (unit of electrical resistance)
ΔC	Absolute deviation between CaE and CbE
ΔR	Absolute deviation between Ra and Rb
	A
a	a-wire (tip)
A	Ampere
a/b	Analogue interface (a-wire and b-wire)
APL	APL (German) copper line termination point
	B
b	b-wire (ring)
	C
C	1. Celsius
	2. Capacitance
Cm	Operating capacitance (mutual capacitance)
Cp	Parallel capacitance
csv	File format (comma-separated values)
C_{Sym}	Capacitive symmetry
	D
D	Germany
dB	Decibel
DE	Deutsch (German)
DIN	Deutsches Institut für Normung - German Institute for Standardization
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
	E
E	Ground (earth)
EC	European Community
EMC	Electromagnetic compatibility
EN	European standard
	F
F	Farad (unit of electrical capacitance)
	G
g	Gram
GND	Ground (earth)

	H
Hz	Hertz (unit of frequency)
	I
I	Electric current
IDC	DC current
ISDN	Integrated Services Digital Network
Iso.	Isolation resistance measurement
	L
LCL	Longitudinal conversion loss
	M
m	Meter
max	Maximum
min	Minimum
	N
NEXT	Near-end crosstalk
NTBA	Network termination for ISDN basic rate access
	O
opt.	Optional
	P
PPA	Passive test termination
Pol.	Polarity
	Q
QR	Quick response
	R
R	1. Resistance (electrical resistance)
	2. Ring (b-wire)
Ra	Resistance a-wire
Rb	Resistance b-wire
Rem.	Remote (instrument kit control)
RC	Resistance (R) and capacitance (C)
RE	Ground resistance
Ri	Internal resistance
Ring	b-wire
RoHS	Restriction of Hazardous Substances
Rs	Loop resistance
R_{Sym}	Resistance symmetry
	S
S/N	Serial number
SHDSL	Single-Pair High-speed Digital Subscriber Line
Sig.	Signatures
Sym	Symmetry

	T
T	Tip (a-wire)
TAL	Subscriber line
TDR	Time domain reflectometry
TRG	Tip, Ring, Ground
	U
U	Voltage
U_{AC}	AC voltage
U_{DC}	DC voltage
USB	Universal Serial Bus
Uk0	U_{k0} interface (U_{k0} access)
	V
V	Volt
V/2	Pulse propagation time
VoP	Velocity of propagation
V_{pp}	Volts Peak-to-peak
	W
WEEE	Waste Electrical and Electronic Equipment

B) Software licenses

The ARGUS firmware contains code from open-source packages published under a variety of licenses (GPL, LGPL, MIT, BSD, etc.).
Additional information can be found on the CD-ROM included with your device (where ordered, see Software_License.htm) or on the internet at:
http://www.argus.info/web/download/Software_License.
If you are interested in the sources listed under GPL/LGPL, please contact support@argus.info. intec Gesellschaft für Informationstechnik mbH will provide you with a machine-readable copy of the source texts for a nominal fee to defray the costs of the physical copying process. This offer is valid for 3 years.

C) Index

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