Cable Scanner
MI 2014
Instruction Manual

Code No.:20 750 429

METREL®

Distributor:

Manufacturer:

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CE Mark on your equipment certifies that this equipment meets the requirements of the EU (European Union) concerning safety and interference causing equipment regulations

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1. Cable Scanner MI 2014

The Cable Scanner Tester is a portable handheld battery powered instrument intended for testing LAN installations and cables.

Main features

- Fast Cable Test : most of connectivity tests can be performed by one operater
- Complete Cable Test (with Remote Unit): ***performs complete cable connectivity test***
- ***Cable identification*** (with Remote Unit or Locators)
- Cable length up to 300m, calibration facilities for ***accurate length measuring***
- ***Amplitude and location of reflections*** are provided by an in built Time Domain Reflectometer.
- Tone generator for ***tracing hidden cable paths*** and wire determination
- Talk function for ***communication over the cable link*** (with optional Talk Remote unit)
- Supports coax and twisted pairs cables

The instrument is supplied with all accessories necessary for carrying out the tests.
The manual is divided into three sections, each covering a particular aspect of the operation.

Section I	General information
Section II	Specifications
Section III	Cable Scanner operation

Section I General information

2. Safety and operational precautions

2.1 Warnings

- **Never connect the test equipment to an active network.**
- **Service is allowed to be carried out only by an authorised person!**
- **Use only standard or optional test accessories supplied by Metrel!**
- **Use only connector types equivalent to those built in to avoid damage to the instrument components.**
- **If the test equipment is used in a manner not specified in this Users Manual, the protection provided by the equipment may be impaired!**

2.2 Battery replacement

Note

- Insert cells correctly, otherwise the instrument will not operate and the batteries could be discharged.
- If the instrument is not to be used for a long period of time, remove all batteries from the battery compartment.
- Battery compartment is protected with a fuse to prevent abnormal use of battery.
- External charger is not intended for supplying the instrument without batteries.

Warnings

- **Do not charge alkaline batteries.**
- **Use only chargers delivered from Metrel or distributor of the test equipment to avoid possible fire or electric shock.**
- **In case of blown fuse consult your distributor.**

2.3 Service and recalibration

It is essential that test instrument is regularly calibrated in order technical specification listed in this Instruction Manual to be guaranted. We recommend the calibration to be carried out once per 2 years.
Metrel encloses to every new instrument an original calibration certificate.
For recalibration and repairs under or out of warranty time please contact your distributor for further information.

Name and address of manufacturer:

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SI-1354 Horjul
Tel.: +386 1 755 82 00
Fax.: +386 1 754 92 26
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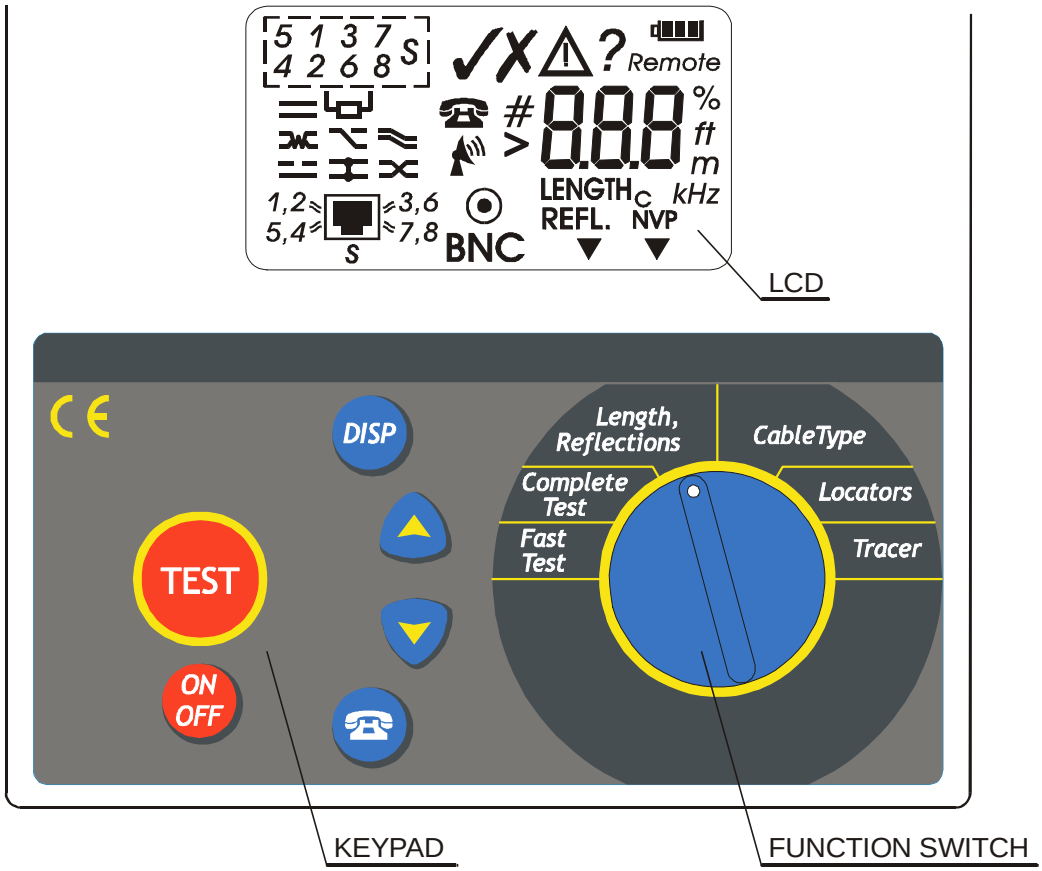
E-mail:metrel@metrel.si

2.4 Maintainance and cleaning

Use a soft cloth, slightly moistened with soapy water, or cleaning alcohol, to clean the surface of the instrument. Leave the instrument to dry completely before using it.

3. Cable scanner description

3.1 Front panel



Front panel layout

Function switch selects one of six fuctional/operating menus:

Functional Menu	Description
FAST TEST	**Fast connectivity and TDR test (no Remote unit needed):** - determines cable **length** or **termination** - finds **cause** and **location of most frequently** cable and connectivity **faults**
COMPLETE TEST	**Complete connectivity and TDR test (with Remote unit):** - determines cable **length** - finds **cause** and **location of all possible** cable and connectivity **faults** - cable **identification**
LENGTH& REFLECTIONS	Complete TDR cable check, calibration facilities - finds **cable length** and **termination** - location and amplitude of **cable** reflections. - **calibration facilities** (on base of known NVP or cable length) for accurate length measurements
CABLE TYPE	Selectable 7 different cable types and wiring standards
LOCATORS	**Identification** of up to 26 cables
TRACER	**Tracing** of cables and wires (with optional Tracer)

Keypad

▲ , ▼ ……. Selecting cable type, viewing subresults, calibration parameters

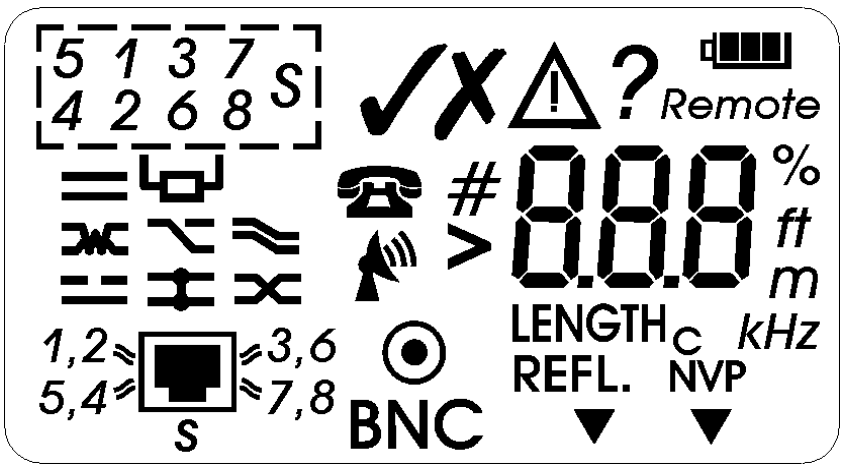
DISP …….Selecting calibration type, viewing subresults

ON OFF…….To turn on or off the instrument (**Auto off** after 10 minutes)

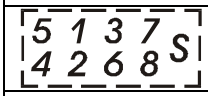
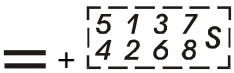
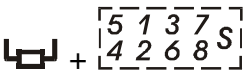
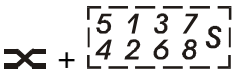
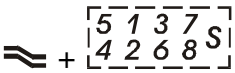
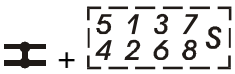
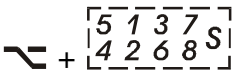
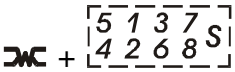
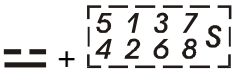
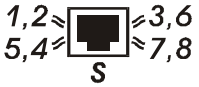
☎…….Talk&Trace interface for talking over cable/ locating the Talk Remote Unit

TEST ……. ……Starts test procedures, confirmation of selected items

Display



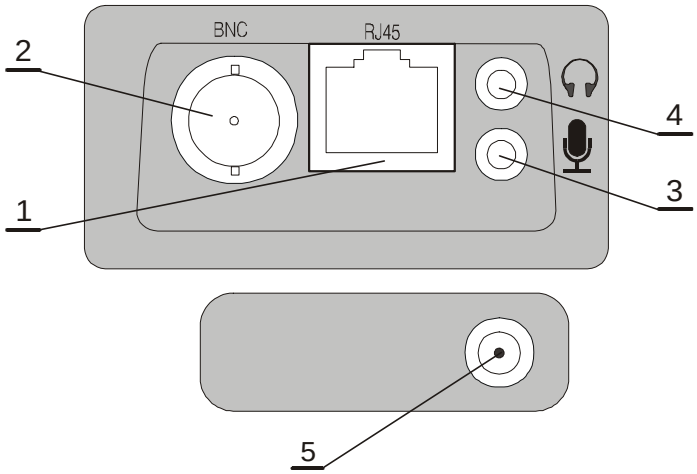
Description of displayed symbols

SYMBOL	NAME
	Wires/ Pairs result field
	Unselected wires / pairs connected
	Pair terminated
	Wires reversed
	Pair crossed
	Wires/ pairs shorted, short to shield
	Unknown connectivity fault
	Splited pair
	Broken / open wire, shield
	Selected twisted pair cable standard / type
	Coax cable selected
	Tone Generator active
	Talk & Trace function active
	Test passed
	Test failed
	Warning (redundant pairs / reflections detected)
#	Cable Identification Number is displayed
>	Result out of limit
LENGTH	Distance / Amplitude of length is displayed
$LENGTH_C$	NVP calibrated on known cable length (for precize length mesurements)
m,*ft*	Meters, feets
REFL.	Distance / Amplitude of reflection is displayed

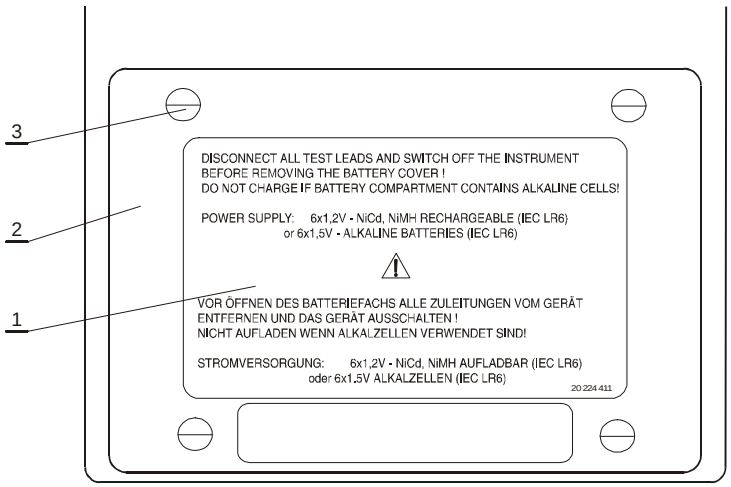
NVP	Nominal velocity of pulse is displayed
?	Faults / Reflections / Redundant connections are displayed
Remote	Disconnect the Remote unit (Fast Test) / No Remote detected (Complete Test)
	Battery indication (change battery if no segment is displayed)

3.2 Connector panels

1. RJ 45 connector
2. BNC connector
3. Audio jack: Microphone input
4. Audio jack: Phone output
5. External charger input



3.3 Bottom



Bottom View Layout

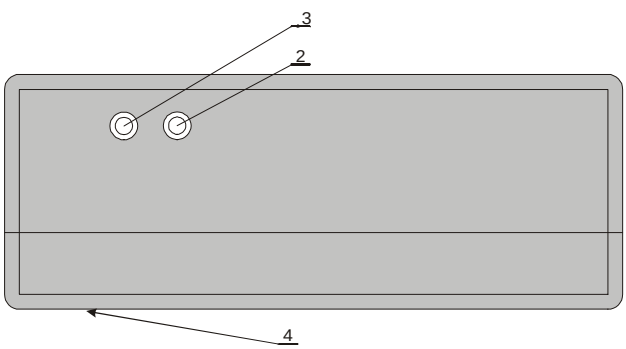
1. Information label
2. Battery compartment cover
3. Retaining screws (unsrew to replace batteries)

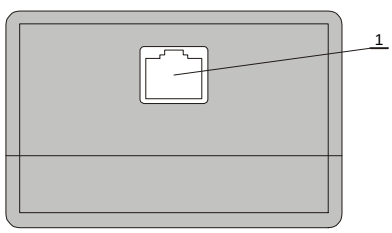
4. Standard remote units description

1. Male RJ 45 plug
2. Female RJ 45 connector
3. Identification number

5. Talk remote unit description

1. Female RJ 45 connector
2.Audio jack: Microphone input
3.Audio jack: Phone output
4. Battery compartement
5. On/Off switch





Section II Specifications

6. Standard set

	Ordering number
	MI2014
Cable Scanner	
Cat 5 Patch Cable Metrel PC-2, 1pc	
Standard Remote #1	
Locators #1 - #4	
Cable Scanner User Manual	
Calibration Certificate	
List of warranty	
Declaration of conformity	

7. Optional accessories

Talk Remote Unit set Headphones set	**S 2004**
Standard remote set #2-#6	**S 2005**
Standard remote set #7-#15	**S 2006**
Battery charger with NiCd battery pack	
Locator set II (#5..#16)	**A 1044**
Locator set III (#17..#28)	**A 1045**
Tracer	**A 1082**

8 Technical specifications

8.1 Fast Test

RJ45 output only
Length (highest distance of all pairs is shown, refer to 3.3 for accuracy) Detection of: - broken wire on connector or cable + distance to fault - short between wires + distance to fault - short to shield - split pairs - cable termination

8.2 Complete Test (with Remote units)

RJ45 output only
Length (highest distance of all pairs is shown, refer to 3.3 for accuracy) Detection of: - broken wire on connector or cable + distance to fault - short between wires + distance to fault - short to shield - splited, crossed, reversed, transposed pairs
Cable identification #1 - #15

8.3 Length & Reflections

Measuring principle: Time Domain Reflectometer
Output impedance: 100Ω RJ45 output, 50Ω BNC output

Twisted Pair cable

Distance	Resolution	Accuracy
0.0 – 99.9m 100 – 300m	0.1m	±(3%+5dig) of reading ±(5%+1dig) of reading
Amplitude Range		
-99% - 100%	1%	±(5%+5dig) of reading

Coax cable

Distance	Resolution	Accuracy
0.0 – 99.9m 100 – 300m	0.1m	±(3%+5dig) of reading ±(5%) of reading
Amplitude Range		
-99% - 100%	1%	±(5%+5dig) of reading

Calibration (see page 20)

Calibration cable length	adjustable 2m – 200m
Propagation velocity rate (NVP)	adjustable 0.50-0.99

Up to three highest reflections (faults) are reported.
Additional error sources that must be considered when measuring length:

Uncertainity of NVP (nominal propagation speed)

Pulse attenuation at high frequencies effects the accuracy at long distances (over 100m).

Accuracy of length is defined on opened, shorted and with remote unit terminated cables only.

8.4 Locators

Locators	#1 - #28

8.5 Tracer

Tone generator frequency	0.80kHz..1.20kHz
Tone generator amplitude	RJ45 output: 7V BNC: 5V

9. General specifications

9.1 General Data

Display: custom, 85 segments
Operating temperature range: 5°C÷40°C
Storage temperature range: 0°C÷70°C
Relative humidity: 90% up to 40°C declining to 70% up at 45°C
Pollution degree: 2
Protection degree: IP44
Power supply main unit:
6x1.5V AA alkaline batteries or
6x1.5 NiCd or NiMH AA rechargeable batteries
Charger input (nominal charge voltage): 9V=
Typical battery life (alkaline batteries): 10 hours
Talk remote unit supply:
9V alkaline battery
Typical battery life (alkaline battery): 25 hours
Auto Off time: 10 min
Standards applied: EMC: EN50081-1,EN50882-1
Safety: EN61010-1

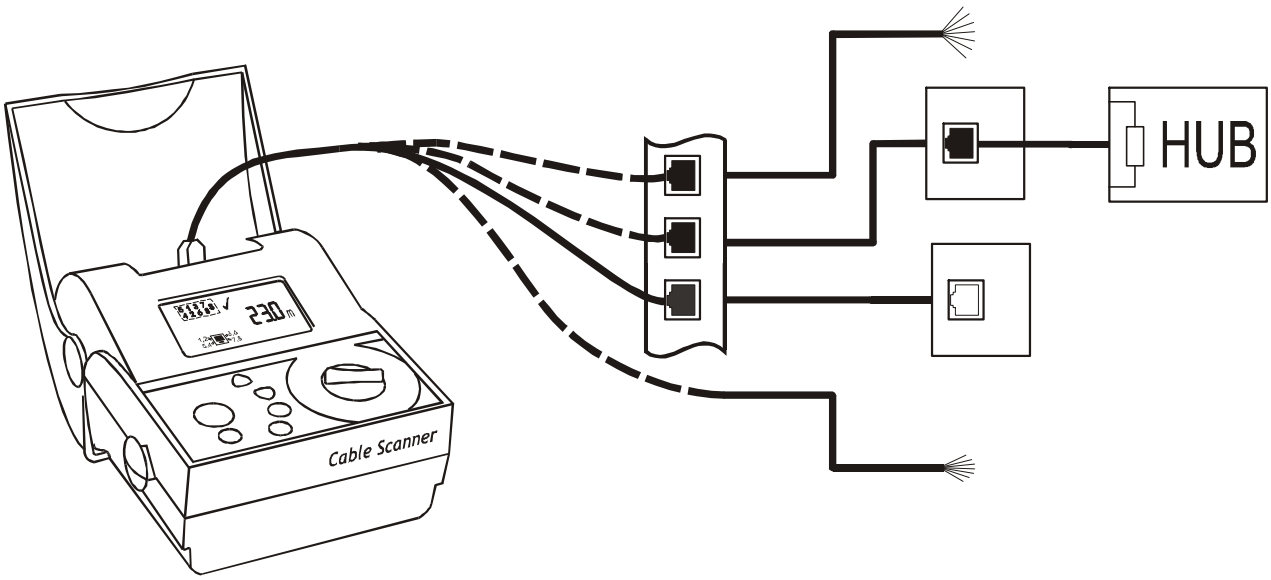
9.2 Output connector, patch cable wiring: T568B

Pair 1:	**wire 5, blue-white**
	wire 4, blue
Pair 2:	**wire 1,orange-white**
	wire 2, orange
Pair 3:	**wire 3, green-white**
	wire 6, green
Pair 4:	**wire 7,brown-white**
	wire 8, brown

Section III Cable Scanner operation

10. Fast test

The Fast Test function enables fast and convenient checking of the installation. Its main advantage is that the test can be performed by one person, without using the Remotes. Most likely connectivity faults like bad contacted connector and shorts between wires can be found with Fast Test. The cable length is also reported, together with the distance to eventual problems.
We recommend to use this test for fast connectivity checks during bulding of the installation.
For thorough cable connectivity tests the Complete Test should be used.
For thorough cable quality tests the Length&Reflections function should be used.

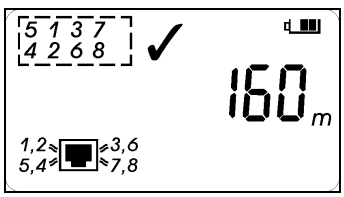


Typical Cable Scanner connections in Fast Test

Test procedure

1. Select Fast Test with rotary switch.
2. Check the selected cable type and pin configuration (refer to chapter 8 for more information), Connect the cable under test to the instrument and press TEST.

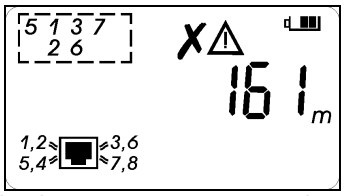
If the test passed succesfully following items are displayed:
- the ✓sign
- the cable length
- correctly connected wires



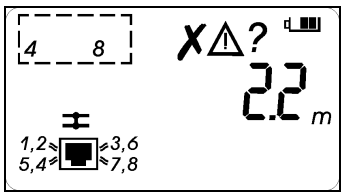
test successfully passed

If one or more faults are detected following items are displayed:
- the ✗ and ⚠ signs
- correctly connected pairs
- length if available (depends on the kind of the fault)

The related wires, type and distance to fault (if available) can be viewed by using ▲ and ▼ keys. During displaying faults the ? sign is displayed.



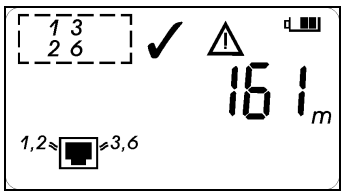
test failed, wires 5,1,2,3,6,7 correctly connected



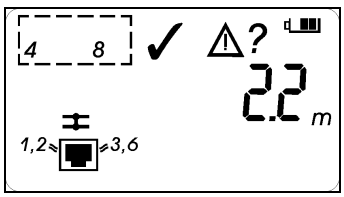
test failed, shorted wires 4 and 8 at 2.2m

If the test passed succesfully on the cable pairs defined in selected Cable Type but other connections were found that are not in accordance with the defined cable type following items are displayed:
- the ✓ and ⚠ signs
- the cable length
- correctly connected pairs

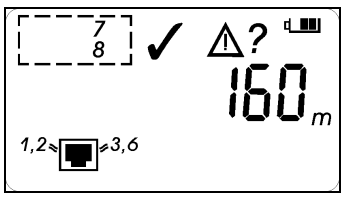
The redundant wire and pairs connections can be viewed by using ▲ and ▼ keys. During displaying them the ? sign is displayed.



test conditionally passed, unselected connected wires detected



test conditionally passed(shorted wires 4 and 8 at 2.2m. The wires are not determined in the selected cable type)

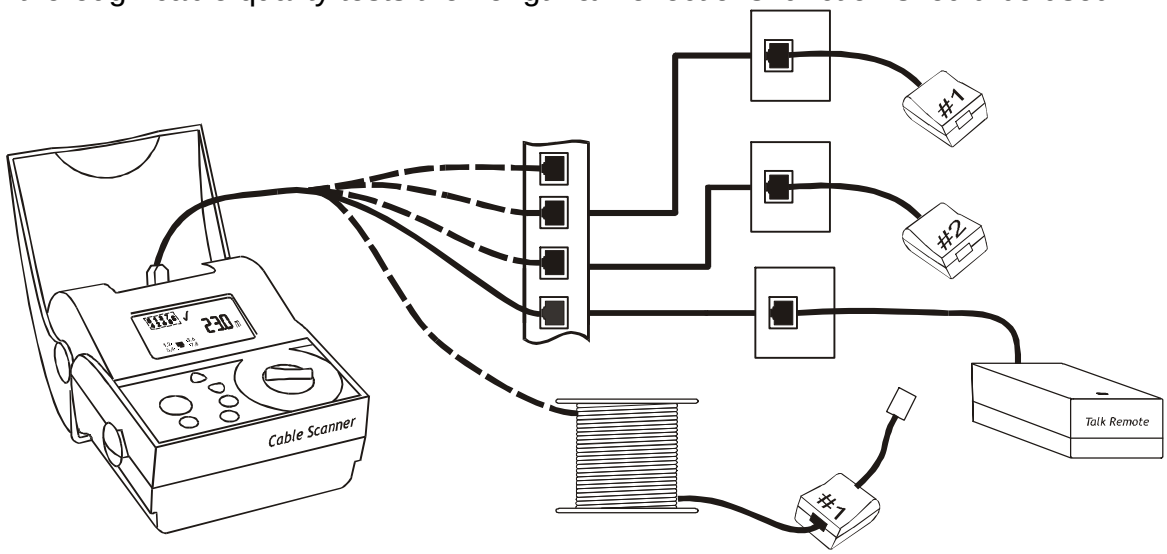


test conditionally passed (Pair 4 is connected. The pair is not determined in the selected cable type)

Note:
The Fast Test is considered to be performed on cables opened at the far end. If the cable is terminated by a hub the termination is detected and displayed as a fault.
If a Remote is connected at the far cable end ***Remote*** is displayed and the test is not performed.
Fast Test is not applicable when BNC output is selected.
Broken wires (inside the length tolerances) close to the the far end can't be detected with this test.
Length can't be measured on terminated cables.

11. Complete test

Complete test checks the installation against all possible connectivity faults. Beside the complete connectivity test the cable identification and cable lenght are performed. Remote units must be connected to the far cable end while performing Complete Tests. We recommend to use this test after the installation is built and before certifying it. For thorough cable quality tests the Length & Reflections function should be used.



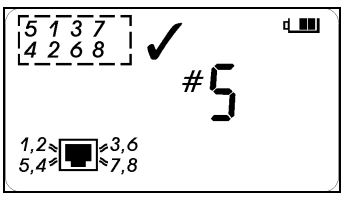
Typical Cable Scanner connections in Complete Test

Test procedure

1. Select Complete Test with rotary switch.
2. Check the selected cable type and pin configuration (refer to chapter 8 for more information). One of the Remote Units must be connected at the far cable end.

   Connect the cable under test to the instrument and press TEST.

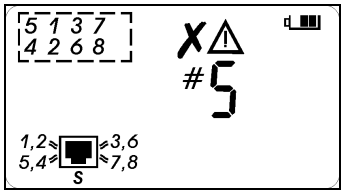
If the test passed succesfully following items are displayed:
- the ✓ sign
- the identification number
- correctly connected wires



test successfully passed

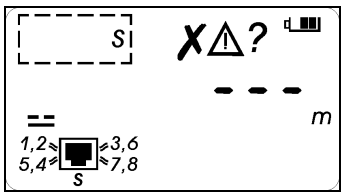
With the DISP key it can be switched between length and identification number (if available).

If one or more faults are detected following items are displayed:
- the ✗ and ⚠ signs
- correctly connected pairs
- the identification number if available (depends on the kind of the fault)



test failed, wires 1 to 8 correctly connected

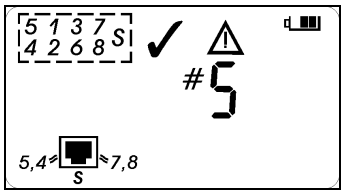
The related wires, type and distance to fault (if available) can be viewed by using ▲ and ▼ keys. During displaying faults the ? sign is displayed.



test failed, shield is broken or not connected

If the test passed succesfully but additional connections were detected that are not defined in the set Cable Type following items are displayed:

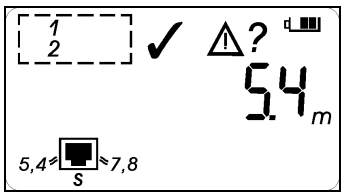
- the ✓ and ⚠signs
- the identification number if available
- pairs connected according to the set type



test conditionally passed, unselected connected wires 1,2,3,6 detected

By using DISP key it can be switched between length and identification number (if available).

The redundant wire and pairs connections can be viewed by using ▲ and ▼ keys. During displaying them the ? sign is displayed.



test conditionally passed (pair 2 is connected. The pair is not determined in the selected cable type)

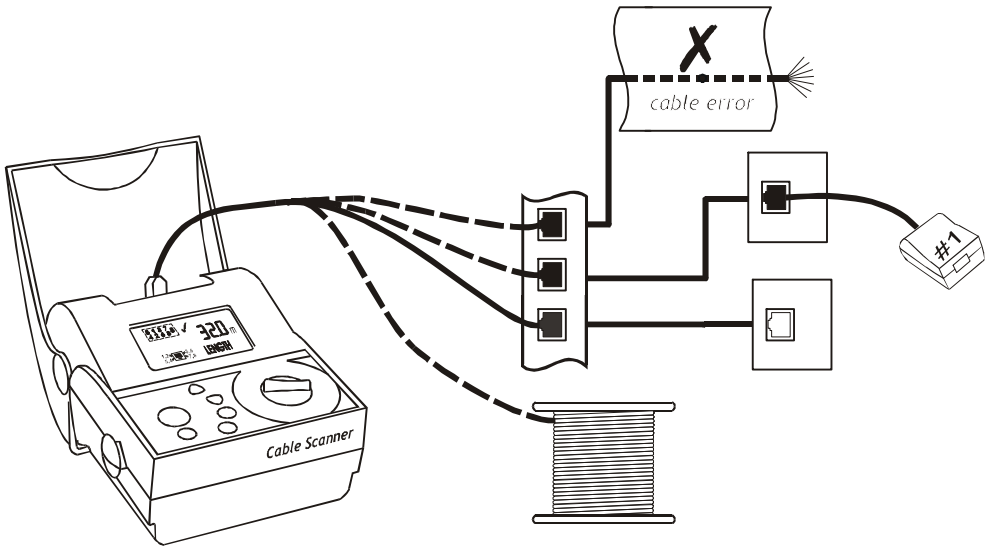
Note:
If no Remote Unit is connected at the far cable end ***? Remote*** is displayed.
Remotes #1 - #5 are applicable on all cable types.
Remotes #6 - #15 are applicable only on cables where all 4 pairs are used.
Complete Test is not applicable when BNC output is selected.

12. Length and reflections

This function enables accurate cable length and quality measurements. Up to 3 largest reflections caused by cable damages, impedance mismatches or other reasons are also detected.
There are many applications where the Length & Reflection test can be used

- checking new cables against possible damages
- checking cable lengths
- determining location of cable problems (broken, shorted, damaged cable)
- checking connection and junction points quality

The in built Time Domain Reflektometer provides the distance and amplitude information of
reflected pulses. That helps to determine the reason of cable problem.



Typical Cable Scanner connections in Length & Reflections Test

Amplitude information

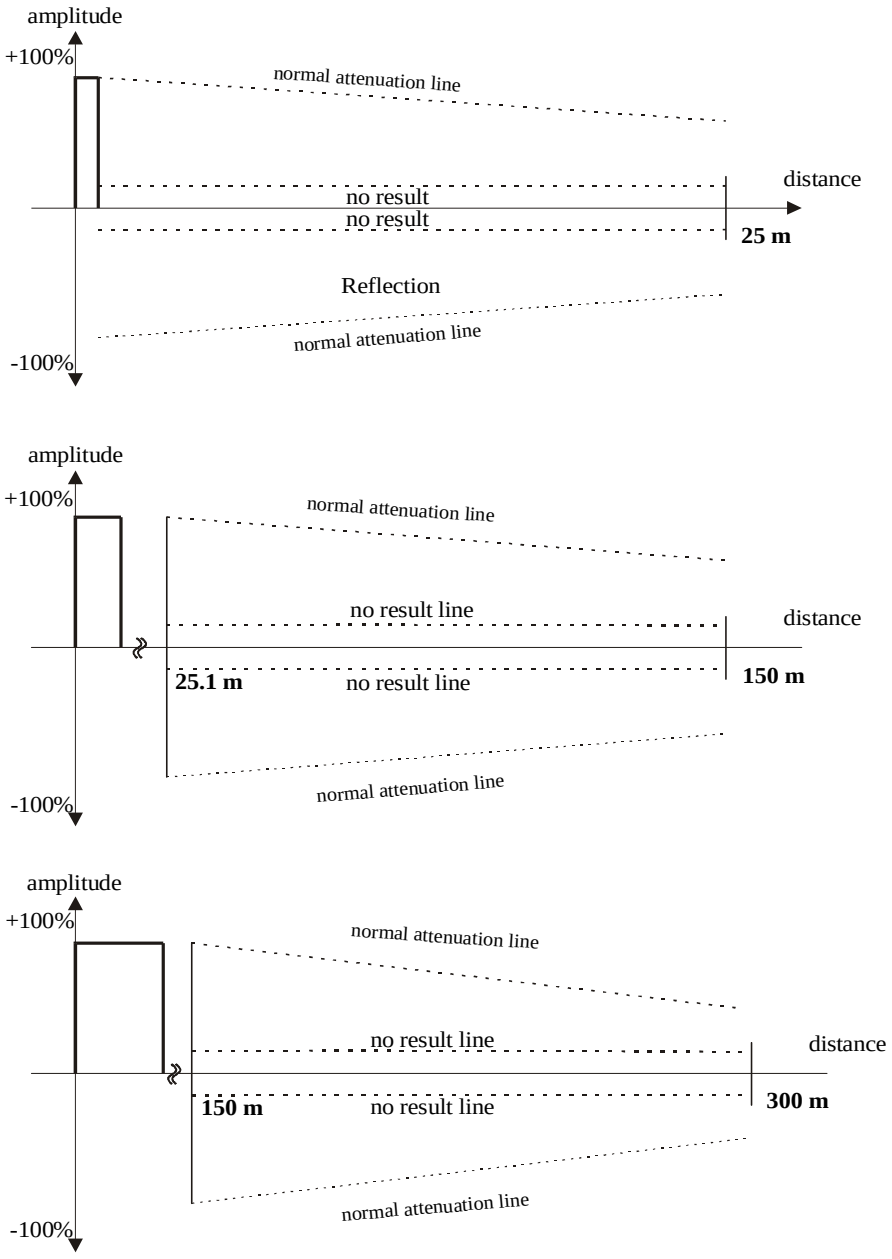
The amplitude of the reflected pulses is available as a subresult providing important information about the cause of problem (exessive attenuation, shorted or open end, improper termination, unproper connector assembling etc) – see pictures below.
100% equals the amplitude of the pulse at the output connector into a 100Ω UTP Cat 5 cable.

Pulse length, reflections

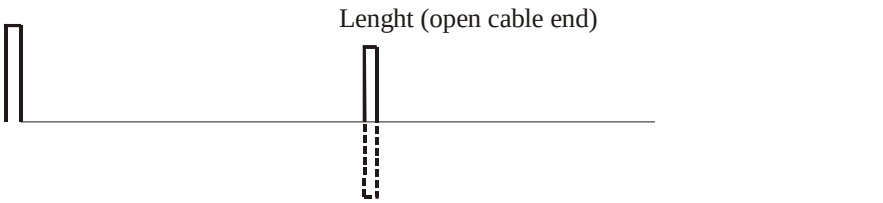
Due to cable attenuation along the cable the reflected pulse weakens when the distance increases.
Three pulse lenghts are used to compensate for the cable attenuation.
Special algorithms are used to evaluate the 3 largest reflections regardless of the pulse energy and to differ between length and reflections.

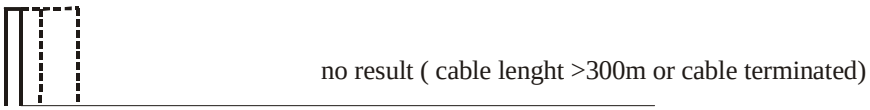
Principle of Cable Scanner Length&Reflections operation

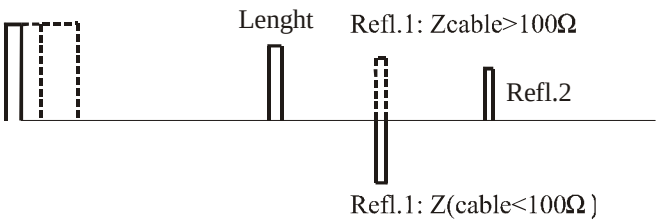
To encounter the attenuation effect the reflections amplitudes are compared to the normal attenuation line. This means that a reflection with smaller amplitude at higher distance can be treated as higher then a reflection with higher amplitude at the begin of the measuring range.
Reflections below the No result line are ignored.

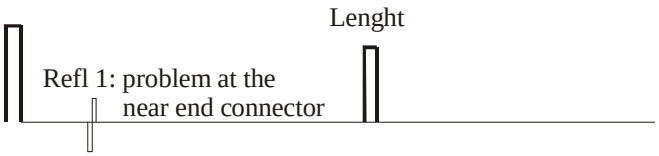


Some typical TDR results





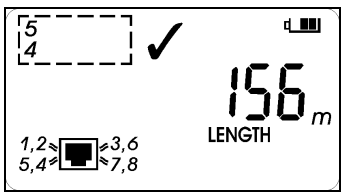




Length and Reflections Test procedure

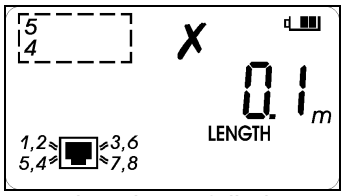
1. Select Length&Reflections function with rotary switch.
2. Check the selected cable type (refer to chapter 8 for more information).
3. Connect the tested cable to the instrument and press TEST.

If the test passed succesfully following items are displayed (the lengths of measured pairs should not differ for more then 5%±0.5m):
- the ✓ sign
- the length of the displayed pair



length test successfully passed

If the test failed because of different lengths of measured pairs following items are displayed:
- the ✗ sign
- the length of the displayed pair



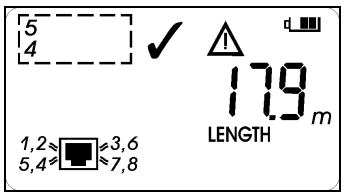
length test failed

By using the DISP key it can be switched between length and amplitude. Before amplitude the pulse

length (short ⊓, middle ⌐¬, long ⌐‾¬) is displayed for 0.5s.
By using ▲ and ▼ keys the lenghts or amplitudes of other pairs are displayed.

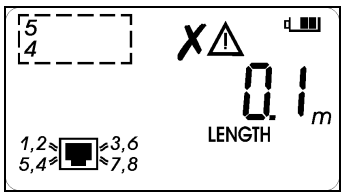
Note
(If different pair lengths were measured with different pulse lengths differences in amplitude can occur. The operater must consider this effect when comparing amplitudes.)

If the length test (lengths of measured pairs are not differ for more then 5%±0.5m) passed succesfully but additional (one to three) reflections are detected following items are displayed
- the ✓ and ⚠ signs
- the length of the displayed pair



length test successfully passed, additional reflections are detected

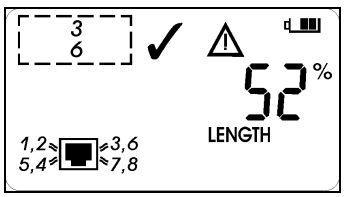
If the length test fails and additional reflections are detected following items are displayed:
- the ✗ and ⚠ signs
- the length of the displayed pair



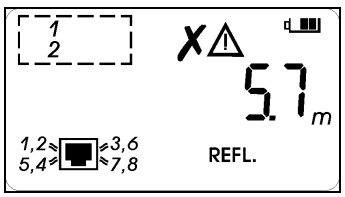
length test failed, additional reflections are detected

By using ▲ and ▼ keys the lengths of other measured pairs and reflections are displayed.
By using the DISP key it can be switched between distance and amplitude. Before amplitude the pulse length (short ⊓, middle ⌐¬, long ⌐‾¬) is displayed for 0.5s.

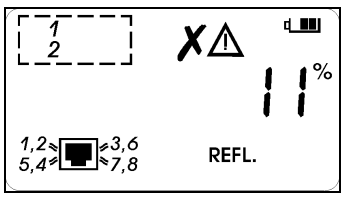
Some typical subresult screens are shown below:



amplitude of length of pair 3, additional reflections are detected



distance to the exessive reflection on pair 2



amplitude of the exessive reflection on pair 2

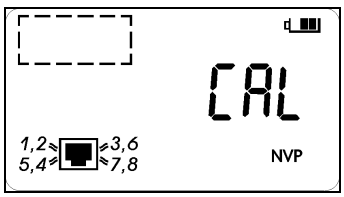
12.1 Cable Length Calibrations

The accuracy of the length measurement is calculated from the time it takes the pulse to travel along the cable and reflect back to the instrument. For this reason the cable NVP (nominal velocity of pulse propagation) must be known. Cable NVP factors differs between different cable types and are further influenced by ageing and temperature. By using the Length Calibration this errors are eliminated and very precize length measurements can be performed.
Two calibration types are available with Cable Scanner:

- Calibrations based on known NVP. Use this calibration when the exact NVP factor is known from the manufacturer data sheet or others.
- Calibration based on known cable length. In this mode the NVP is calculated from a cable sample of known length. Best results can be obtained this way especially if performing the calibration on the same cable or cable of the same type.

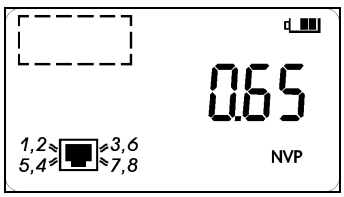
Setting a new (known) NVP factor manually

1. After selecting Length&Reflections with rotary switch press (DISP) twice . The 'NVP Calibration' screen is displayed.



NVP calibration display

2. Select new NVP factor with (▲) /(▼) key.



displayed NVP factor

3. Press (TEST). After that the new NVP is displayed for about 1 second together with the ✓ sign.

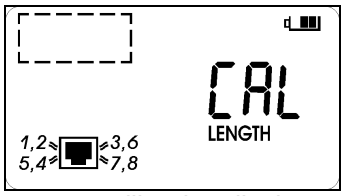
Checking the set NVP factor (without changing it)

1. After selecting Length&Reflections with rotary switch press twice to enter the 'NVP Calibration' screen.
2. Press (▲) or (▼) key once. The currently set NVP is displayed.
3. Press (DISP) to return to basic screen without changing the settings.

Setting a new NVP on base of a known cable length

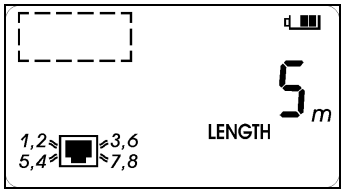
Best results are obtained when performing a calibration on the same cable or cable type on a known length.

1.Select Length&Reflections with rotary switch and press (DISP) afterwards. The 'Length Calibration' screen is displayed.



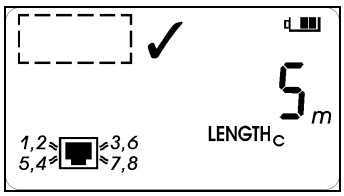
NVP calibration display

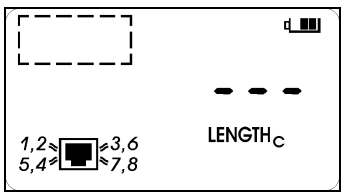
2.Connect the cable of known length to the instrument and set the length with (▲) /(▼) keys. The cable must be opened or shorted at the far end.



set known cable length

3. Press(TEST). The calibration is successfully performed if the new NVP is displayed for about 1 second and the C subscript appears near the length sign, together with the ✓sign.





successfully performed calibration

Otherwise the ✗ sign together with the length measured with the former set NVP is displayed for about 1 second (if the calculated NVP lies outside the 0.5 – 0.99 range because of incorrect length set).

Note:

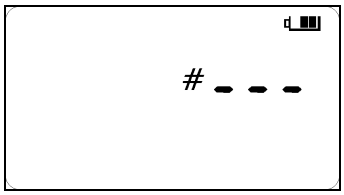
Any other action than pressing (TEST) will cancel the calibration.
The set NVP (C subscript near the length sign) stays in memory until a new NVP is manually corrected or the instrument is reinitalized to default values (default NVP=0.69).

13 Locators – Identification of cables

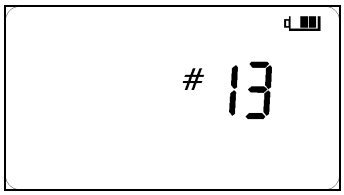
Test procedure

Locators are used for finding the correct cable connector in wiring closets, patch panels etc. In this mode the instrument decodes which identificator is connected to the far cable end.
28 simple Locators are available for fast and simple cable identification.

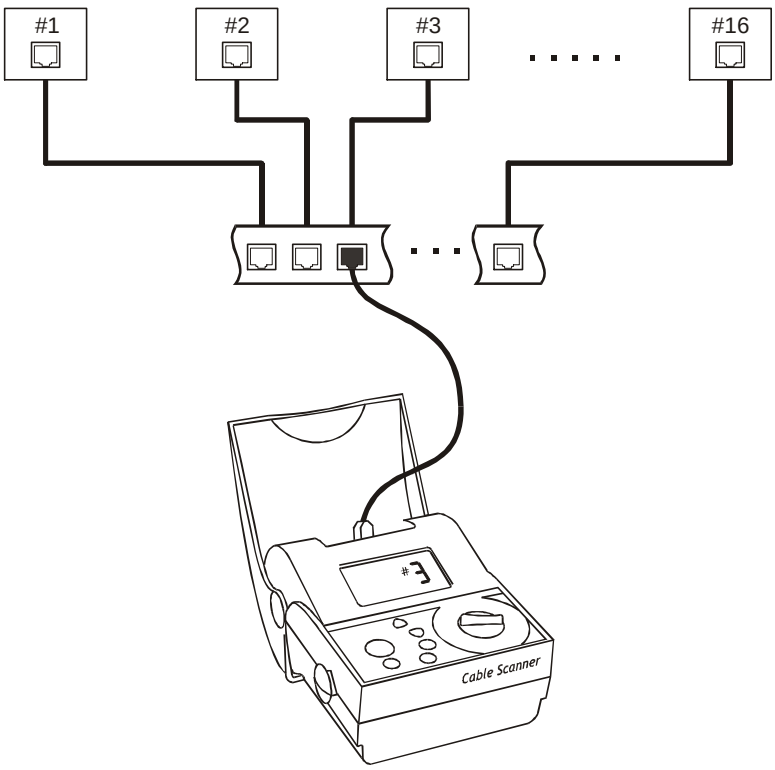
1. Select Locator function with the rotary switch.



2. Connect the coded (the code is printed on the locator) locators in far cable end sockets.
On the display the code of the locator on the far cable end is shown.



Locator 13 connected at the other cable side



Typical Cable Scanner connections in Locators Test

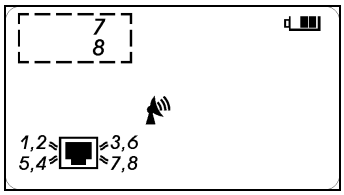
Important
The Standard Remotes and Talk Remote can't be used instead of Locators.

14. Tracer – Tracing of cables and wires

The in built tone generator can be used together with different Tracers for identifying cable pairs, conductors within a bundle, tracing cables under walls etc.

Test procedure

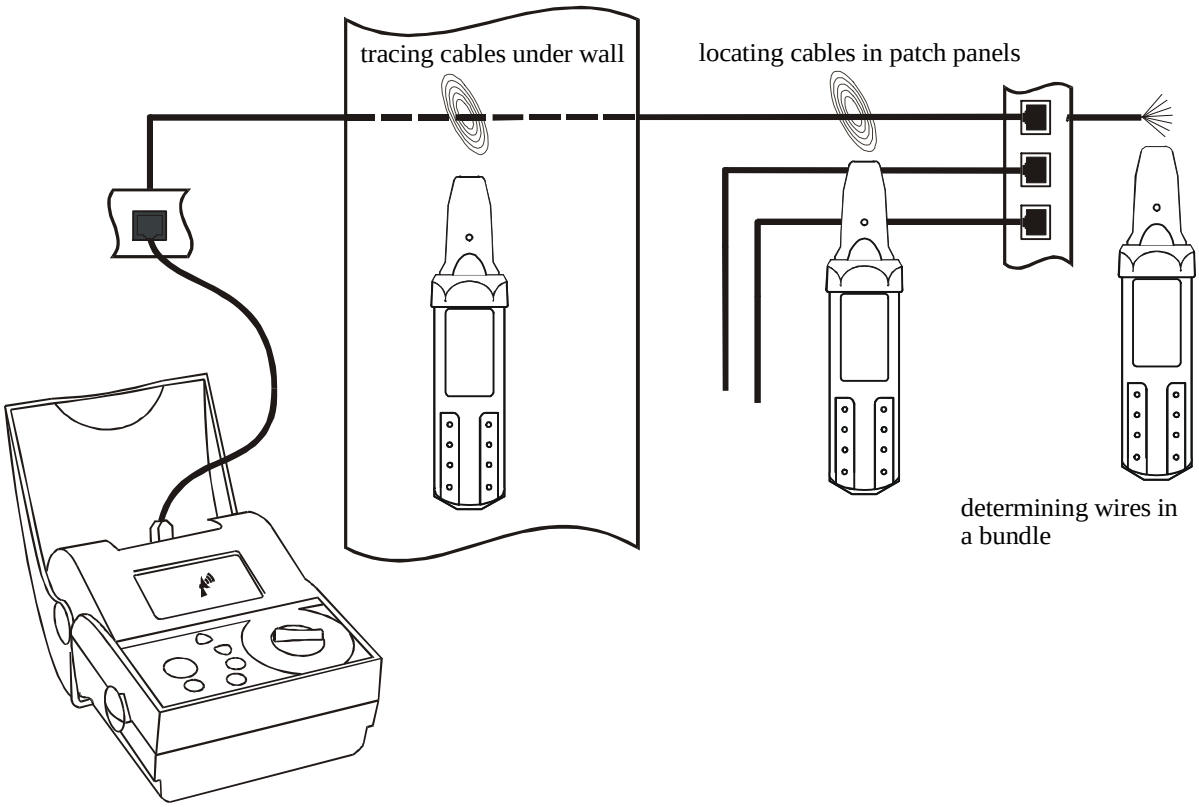
1. Select Locator function with the rotary switch and press DISP to enter Tracing screen. Check if the correct cable type is selected.
2. When using the RJ45 output the cable pair in which the tone signal is generated can be select by using ▲ /▼ keys.



tone generator emittes the signal in pair 4

Refer to Tracer instructions for more information about tracing cables, wire pairs etc.

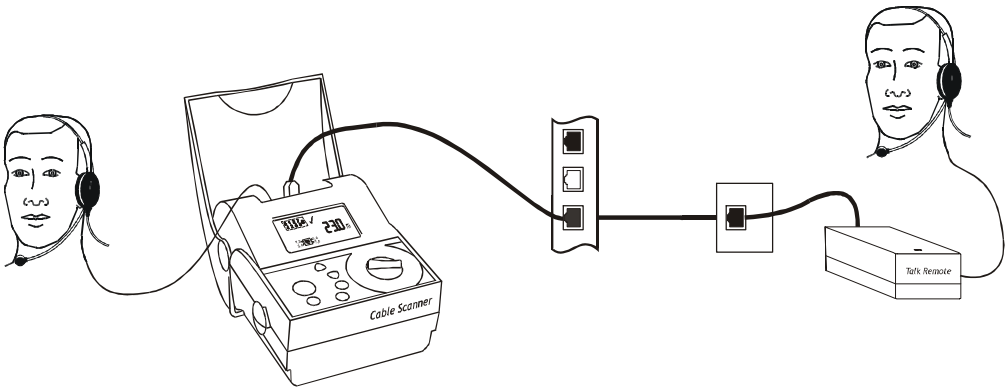
Typical Tracer applications



Typical Cable Scanner connections in function Tracer

15. Talk & Trace function

The in built Talk & Trace interface enables full duplex voice communication over the cable when using the Talk Remote Unit. The communication works perfectly regardless of the cable length and attenuation.
The interface can be used also for determining and locating cables. After the Talk Remote Unit
connects with Cable Scanner a connection 'beep' is heared on both units. No headphones are used
in this case.



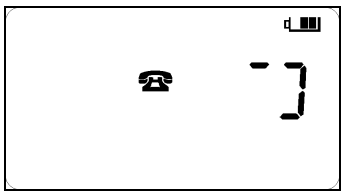
Cable Scanner connection during voice communication

15.1 Establishing a voice communication

Before talking both operators must put on the headphones. Both jacks (mic and phone) must be plugged in both units.

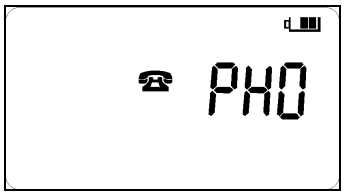
.

1. The function Talk & Trace is set by pressing the ☎ key regardless of the function currently set . The "Searching" sign is moving on the display and the Cable Scanner tries to connect itself with the Talk Remote unit.



Talk&Trace 'searching' mode

2. After the Remote unit is found and successfully connected PHO is displayed together with a confiramtion beep and the communication can begin.
   At the same time the Talk LED on the Talk Remote Unit lights up together with a confirmation beep.



Talk Remote unit detected at the far cable end

If the communication between both units is broken off (e.g. when changing to another plug in a patch panel) the main unit returns to "Searching" mode so the communication can proceed immediately after the Talk Remote Unit is reconnected to the same cable as the instrument..

15.2 Breaking off the connection

The connection can be concluded at any time from the Cable Scanner by pressing ☎ key again. The instrument returns to the state it was before the connection.

15.3 Locating cables

The procedure described in 6.1 and 6.2 can be used when locating cables in patch cables, computer rooms etc. This can be done without using headphones.

Note:
At least one pair must be connected correctly to ensure proper operation.
The 'Searching sign' is moving very slowly if a Standard Remote is connected at the far cable end (communication is not possible).

15.4 Talk Remote Unit operation

The Talk Remote Unit can be used as a Standard Remote Unit for performing Complete cable connectivity and identification tests (refer to chapter 2).
The in built Talk & Trace interface enables full duplex voice communication with the Cable Scanner during performing cable tests.Two LEDs indicate the current unit status.

Test mode

When powered ON the Talk Remote Unit behaves same as the Standard Remote Unit #1.

Talk mode

The Talk Remote Unit automatically switches to 'Talk' mode when the Talk command from the instrument is detected. The TALK LED lights on and a confirmation beep indicates that both units are connected.
This allows the operator on the remote side to recognize that the operator on the main side wants to establish a voice connection (Main unit is set in Talk & Trace mode) and that the Talk Remote Unit was found. Use headphones to communicate. After both units are disconnected or the Talk&Trace mode on the instrument is left the TALK LED extinguishes.

Low battery indication

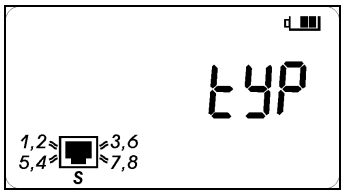
Flashing Power LED indicates that the supply voltage is too low for proper operation. The power supply battery must be changed.

16. Cable type

In this menu the active output (RJ45 or BNC) connector and different cable standards/types can be set. The selected cable type is displayed in all functions (excepting the Locator function)
For some cable and communication standards just two of four twisted pairs are used. Shielded (STP, ScTP, FTP), unshielded (UTP) twisted pair cables and coax cables can be set depending on the application.
Selecting the right cable type and standard easifies the Fast and Complete Tests since nonselected pairs and shield are ignored in the ✓ /✗ judgment. The ⚠ sign.is displayed if wires or pairs not defined in the selected cable type are connected.

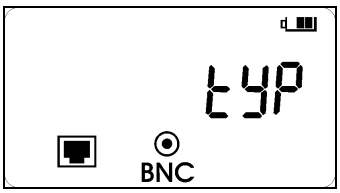
Selecting connector output and cable type/standard

1. Select Cable Type position with the rotary switch. The latest set cable type/standard is displayed.



4 twisted pairs shielded cable selected

2. Select a new cable type with ▲ /▼ key (6 different types RJ45 outputs and BNC output are available). The currently displayed type/standard remains in memory until selecting a new one or reinitializing the instrument.



BNC cable selected

17. Reinitialisation (setting default values / length unit)

The default set cable type, default NVP factor and length unit are set if reinitalizing the instrument.

Press ▲ key while powering on the instrument (**rES** is displayed) and press TEST afterwards. Any other action that pressing TEST will break off the reinitalisation .

Deafult Cable Type: UTP , all 4 pairs connected
Default NVP factor : 0.69
Default length unit: meters

The length unit can be set by pressing the DISP key while powering up the instrument.

Select the unit with ▲ /▼ keys and press TEST afterwards.

In the table below typical NVP values for some popular cable types can be found.

Cable Standard	***Cable Type***	***NVP***
Class C, Class D, Cat 5, Cat 5E	UTP, ScTP, STP, FTP 100Ω	0.69
	STP 120Ω	0.69
	STP 150Ω	0.78
Cat 4	UTP, ScTP 100Ω	0.66
Cat 3	UTP, ScTP 100Ω	0.62
Coax Cables	Coax 10Base2 50Ω	0.67
	Coax 10Base 5 50Ω	0.78
	Coax RG58 50Ω	0.74
	Coax RG8 50Ω	0.84
	Coax RG59 75Ω	0.78
	Coax RG62 93Ω	0.84