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TS90

TelScout™

Tempo Europe Limited Unit 3, Maesglas Industrial Estate, Newport, NP20 2NN
Tel.: +44 (0) 1633 225 600 Fax: +44 (0) 1633 225 601
Email: contact@cve.co.uk Web: www.tempo.textron.com

TEMPO – TS90 TelScout™

TIME DOMAIN REFLECTOMETER OPERATING MANUAL

CUSTOMER TRAINING & TECHNICAL SUPPORT

Tempo Europe Limited Unit 3, Maesglas Industrial Estate, Newport, NP20 2NN
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TS90 TelScout™
User Guide

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Features, Application & Description

Features

♦ Easy to Use - Anyone Can Use It

♦ Large, High-resolution, Backlit Display

♦ Splash, Dust and Shock Resistant Packaging

♦ Rechargeable Battery Pack

♦ One Button Expand/Full-view Function

♦ Dual line test via two standard-size banana jacks (trace comparison)

♦ Intermittent Fault Location

♦ Context-sensitive Help (Help Screens Available for All Functions)

♦ Small, Portable, Lightweight Package (2.2 lbs.)

♦ Accurate (±3 ft. up to 3km, 1% beyond)

♦ 15km Fault-location Capability

♦ Choose Cable Types from selected list for Fast, Accurate Testing

Applications

♦ Find Distance to Fault on Cable Lengths

♦ Find Impedance Mismatches

♦ Determine Length of Cable

Description

Designed specifically for Twisted Pair Cable Network applications, the TS90 applies the newest technology to provide both ease of use and coaxial cable testing performance not found in any other TDR.

Simply select the cable type to be tested and the TS90 does the rest.

Pulse width, V_P, gain and vertical position are automatically selected and adjusted as you scan the cable.

Move the cursor to the fault and use the one-button zoom (expand) function to pinpoint its location. The TS90 uses a 5 ns pulse width for close-in resolution. Faults as near as 1 metre from the testing end are located with ease.

Optimized pulsing and sampling, coupled with advanced filtering and signal-processing techniques provide a clean waveform for easy event identification.

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Front Panel and Controls

Front Panel

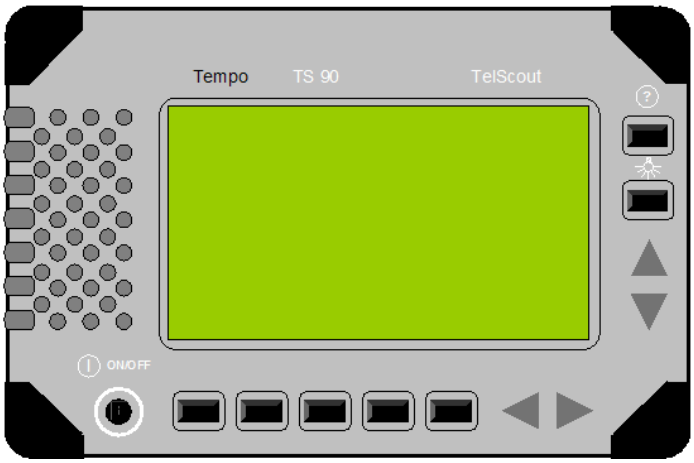

figure 1

Controls

ON/OFF	Power: This button turns the instrument on and off. It does not turn off the battery power to the memory used for saving setups and measurements.
?	Help: Press HELP to display detailed information on the current display and the operation of the controls. Press HELP a second time to remove the help display. In selected menus, Lesson softkeys are available that provide tutorials about using the Unit.
	Backlight: Press this button to switch the display backlight on and off. The instrument default is OFF, and when the user turns on the instrument, the backlight is always OFF. The backlight button can only be turned ON by pressing this button.
	5 Softkeys: Located across the bottom of the LCD. These are called softkeys because their labels are displayed on the LCD. Their functions vary according to the instrument function. Softkeys let you - 1) change functions or modes, 2) select a menu item, and 3) turn functions on and off.
	Left, right, up, and down arrow buttons serve the functions of moving the cursor left and right across the displayed waveform, changing values and raising or lowering gain, or scrolling through a menu.
TEST REFERENCE	TEST: This connector consists of two standard-size banana jacks for connecting to the test pair of the cable under test. REFERENCE: This connector consists of two standard-size banana jacks for connecting to the reference pair of the cable under test.

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Powering Up the TS90

Connect the Cable
Connect the TS90 to the line under test using the supplied test leads.
For single line testing connect TS90 to line under test via TEST PAIR.
To compare two waveforms connect TS90 to lines under test via TEST PAIR and REFERENCE PAIR.

TS90 Main Display Screen
Press the Power button to turn on the instrument and reach the Initial power up Display screen. See figure 2.
First choose if you want U.S. units e.g. distance in feet, as opposed to the metric km, American Wire Gauge (AWG) or metric, diameter of cable in mm.

Once you've chosen U.S. or Metric you have two choices:
Test will take you straight to a graphical representation of the cable under test, it allows the user to "see" up to 15km of cable. Use **More** or **Less cable** buttons to view cable length. Gain (

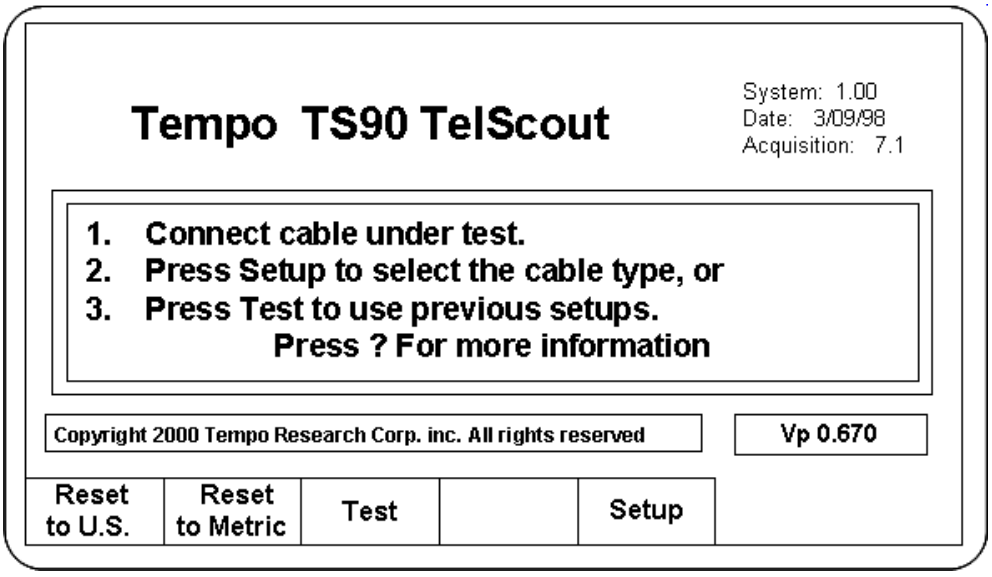

figure 2. **TS90 Opening Display**

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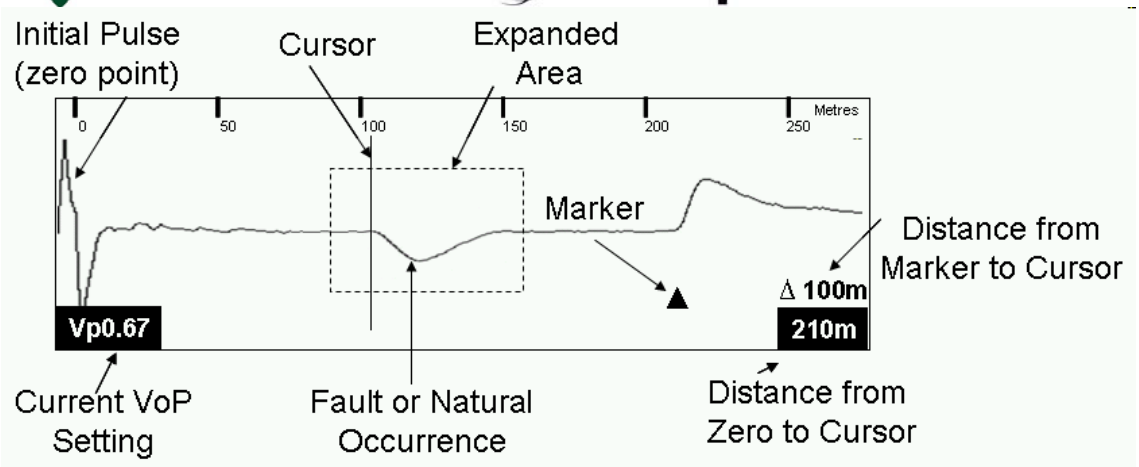

Figure 3. **Typical trace showing impedance mismatches and display icons Available.**

The instrument powers up with the same settings in place as when it was last powered off. Press **Setup** or **Test** and the TS90 does the rest –

♦ **Press Setup to select the cable type:**

Choose with ▲▼	Type	Diameter	Vp
Air-cored Poly (PEUT)	Air PIC	0.90mm	0.700
Air-cored Poly (PEUT)	Air PIC	0.64mm	0.650
Air-cored Poly (PEUT)	Air PIC	0.50mm	0.670
Air-cored Poly (PEUT)	Air PIC	0.40mm	0.660
Filled Poly (CPFUT)	Gel PIC	0.90mm	0.700
Filled Poly (CPFUT)	Gel PIC	0.64mm	0.630
Filled Poly (CPFUT)	Gel PIC	0.50mm	0.640
Filled Poly (CPFUT)	Gel PIC	0.40mm	0.650
Paper (P/UT)	Pulp/paper	0.90mm	0.700
Paper (P/UT)	Pulp/paper	0.64mm	0.735
Paper (P/UT)	Pulp/paper	0.50mm	0.680
Paper (P/UT)	Pulp/paper	0.40mm	0.670
Temp. Cable Settings			
Empty			

Cable type defines the velocity of propagation (Vp) for the cable under test.
Press ▲▼ to select the cable type to be tested. If your cable doesn't appear in the list of selected cables, you can define your own custom cable allowing the user to select the name, type of cable e.g. PEUT, diameter of cable e.g. 0.5mm and the Vp e.g. 0.67. See page 11.

Press Exit to go to Test Mode. This will take you to figure 5.

♦ **Press Test to use the previous cable setup.**

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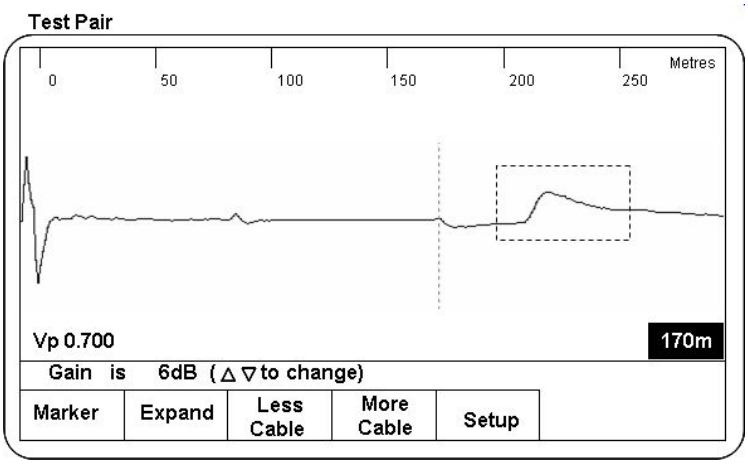
Testing a Cable

Pulse width, gain and vertical position are automatically adjusted as you scan the cable –

Move the cursor to the fault and use the one-button expand function to pinpoint its location -
♦ Use the ◀▶ to position the cursor on the left edge of the event.
♦ The distance to the event is displayed in the box in the lower right corner of the display.



The following softkeys are available:

MARKER:	Sets and clears the event marker (▲). When set, the cursor readout shows both distance from zero to the cursor and distance from the marker to the cursor. When set, marker is always located and remains at the current position of the cursor.
EXPAND:	Toggles between Expand and Full View. Expands the waveform around the cursor. When invoked the softkey re-labels to FULL VIEW: This returns the waveform to normal view and the softkey re-labels back to EXPAND.
LESS CABLE MORE CABLE:	Press LESS CABLE or MORE CABLE to look further in or further out along the cable. Less Cable and More Cable decrease and increase the waveform distance view one range setting for each press of the softkey.
SETUP:	The Setup menu allows you to select the Cable Type to be tested and is the gateway to all other setup menus.

The following additional softkey functions are available when the **SETUP** softkey is pressed:

Test Type	**Define Cable**	**More Setups**		**Exit**

♦ **TEST TYPE:** Enables you to select from the following menu:

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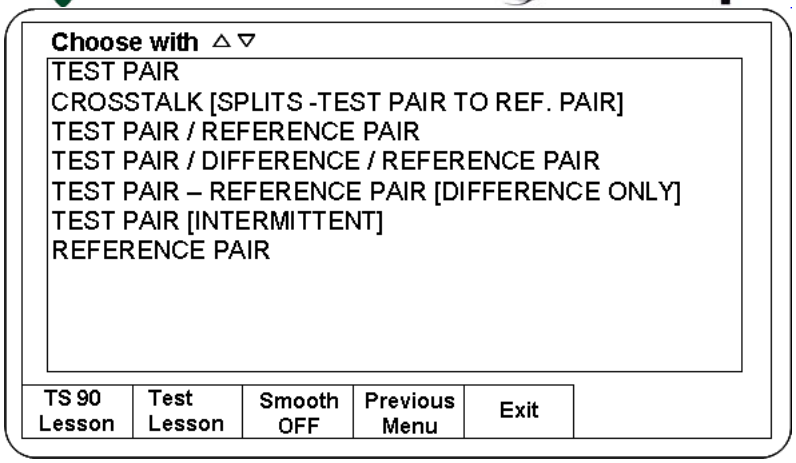

TEST PAIR
Graphical representation of line connected to TEST port. This is the most commonly used function for engineers to connect their faulty line to TS90 and scan the cable to see the fault, then move the cursor to the fault and read the distance to fault.

CROSSTALK
Measures distance to where jointer has split pairs along cable route. Can also locate where pairs have been re-split (to tap out straight).Splits must be taken out where they occur.

TEST PAIR / REFERENCE PAIR
Displays both traces connected to the terminals. Can be used for comparison.

TEST PAIR / DIFFERENCE / REFERENCE PAIR
Displays three traces: the two connected to TS90, plus the difference between them.

TEST PAIR – REFERENCE PAIR [DIFFERENCE ONLY]
Displays the algebraic difference between the Test and Reference traces

TEST PAIR [INTERMITTENT]
Captures changes that occur along cable route. Very good for intermittent faults that occur randomly.
TS90 can be left to monitor line, changes in line condition are shown on the display screen as a thin line.

REFERENCE PAIR
Graphical representation of line connected to REFERENCE port.

Note the softkeys have changed:

TS90 Lesson. On line help to tell you what the instrument can do.

Test Lesson. On line help to tell you how to do it.

Smoothing. Allows you to select smoothing levels 1-7 or Off. Higher levels reduce noise on the waveform, but also increase time between waveform updates.

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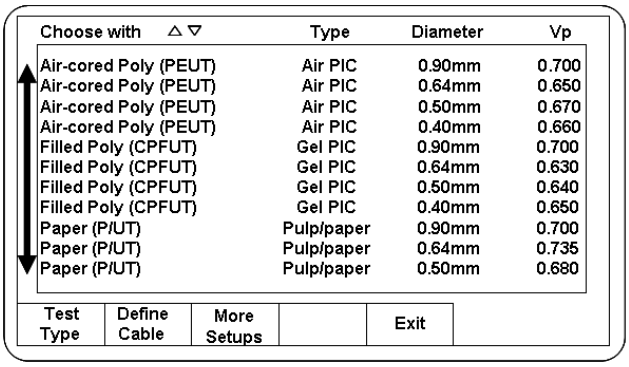
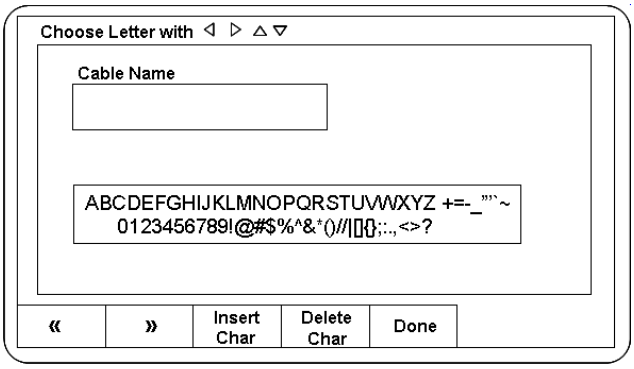
DEFINE CABLES: Allows you to select a cable type from a built in menu, or create or change custom cable types.

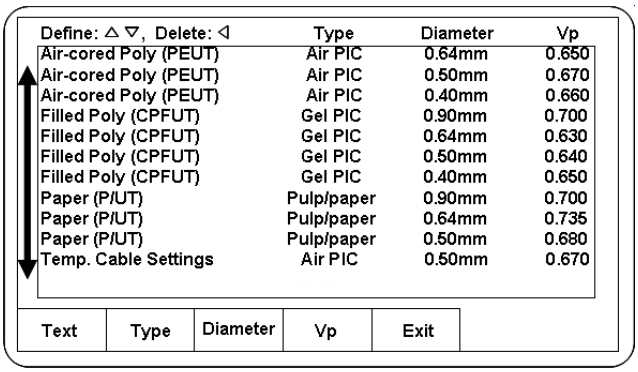


To input your own cable name, Scroll down list to Temp Cable Settings. Find one of twenty empty memory locations below, then press **Text**.



Text: Brings up an alphanumeric keyboard on screen to enter details.

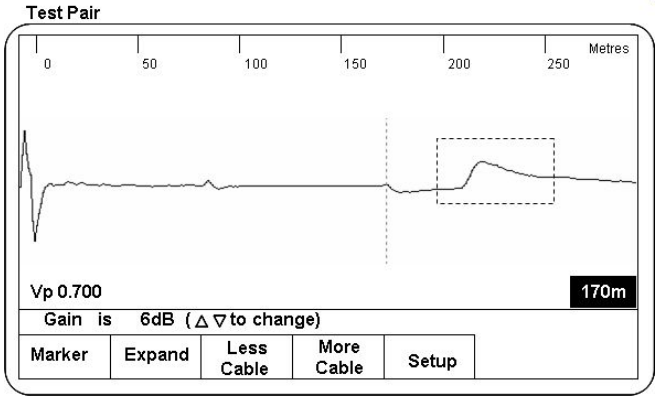
Use softkeys to enter Cable Name then press **Done**.



To select Cable Type, press **Type**.

Use ▲▼to select appropriate cable, Air PIC, GEL PIC, Pulp/Paper.
When Cable Type has been chosen, press Diameter, use ▲▼to select 0.4mm, 0.5mm, 0.664mm or 0.9mm.

When Diameter has been selected, press **Vp**, use ▲▼to select Vp between 45 and 150m/µS.



When this is completed, press **Exit**, this will take you back to Test screen displaying the trace with your new cable settings.

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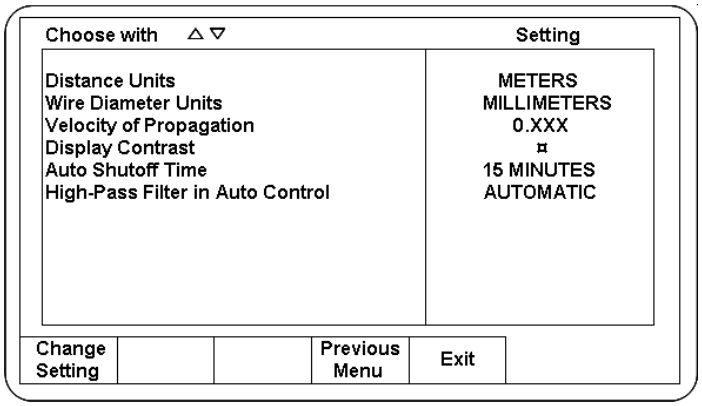
MORE SETUPS: Allows you to change the following settings for the TS90.



Feet, Nanoseconds or Metres
Millimetres or AWG
0.XXX, FT/ µS, m µS
Adjusts display contrast for viewing.
5-30 mins, or Disable - when not used.
Off, On, or Automatic. Reduces AC noise for a cleaner waveform

As the screen help says, choose with ▲▼.
Highlight the setting you wish to change, press **change setting** softkey, the setting on the right hand side will be highlighted, use ▲▼ to choose the option you want. Press **Exit** to take you back to Test screen.

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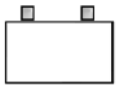
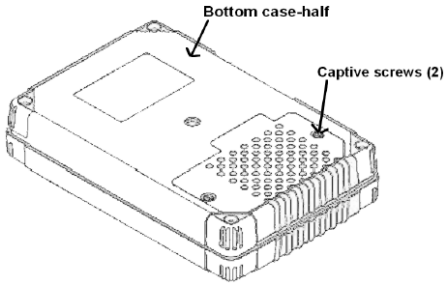
Battery Removal & Replacement

Replacing the Battery

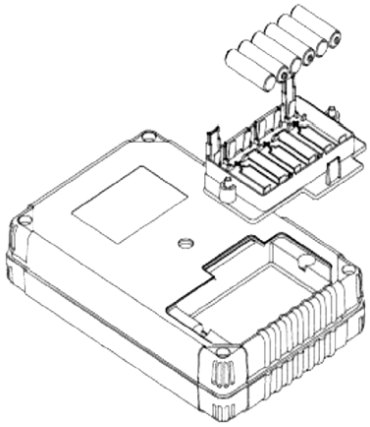


Replace the Batteries when the Low-Battery icon appears -

A Low-Battery/Power Off message is displayed when the battery level is too low to continue operation of the unit.



Use a flat blade screwdriver to loosen the two captive screws attaching the battery door holder to the unit.



Always replace all six cells at the same time.

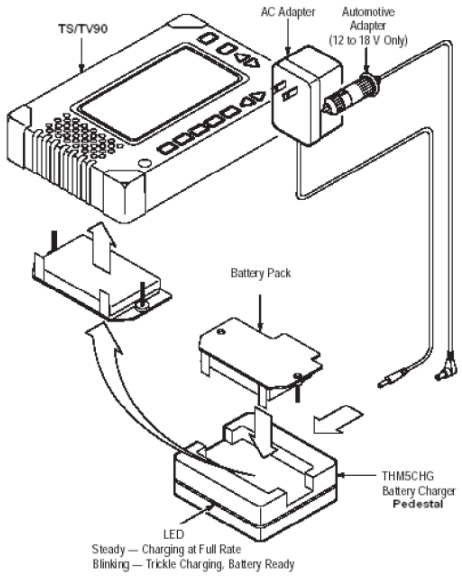
Never mix new and old cells.

Never mix cell types (alkaline and non-alkaline).

Insert cells as shown in the battery holder (reversed cells may leak and damage the instrument).

NiCad Battery Charger

Charging Information



Charge in a dry location, not to exceed 113° F / 45°C.

The Battery Charger will not overcharge the battery pack.

To maintain peak performance of NiCad batteries, it is recommended to fully discharge them before recharging.

Safety

Only charge battery packs in the Battery Charger. Do not charge non-rechargeable batteries. This may cause explosion. Do not lay the battery pack with its terminals against a conductive surface. NiCad batteries must be recycled or disposed of properly.

Charge Time

A fully discharged battery pack is recharged in one hour. A partially discharged battery pack recharges in less time.

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Cleaning & Safety

Cleaning the Unit

Remove dust from the outside of the instrument by wiping with a lint-free cloth or small brush. Use the brush to remove dust from the connectors.
Clean the remaining dirt with a lint-free cloth dampened with a mild detergent and water solution. Do not use abrasive cleaners or harsh chemicals. (e.g. alcohol or acetone) as damage to the enclosure might result

Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Measuring Terminals – This instrument is not intended to be connected to voltages above 30VAC or 60VDC (referenced to earth).

To avoid injury or fire hazard, do not operate this unit in an explosive atmosphere.

Batteries – The unit is powered by either a NiCad Battery Pack or 6 “AA” alkaline batteries (9V total). Dispose of depleted batteries in accordance with Local, State and Federal Laws.

Fuse – The unit contains a 1.5 Amp fast acting fuse, This fuse is not user replaceable.

Recharge Batteries Properly – Recharge batteries for the recommended charge cycle only.

Do Not Operate Without Covers – Do not operate this product with covers or panels removed.

Do Not Operate With Suspected Failures – If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Operate in an Explosive Atmosphere.

Conformity & Warranty

EC Declaration of Conformity

Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility and Low Voltage Directive 73/23/EEC for Product Safety. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:
EMC Directive 89/336/EEC:
EN 55011 Class A Radiated Emissions
EN 50082-1 Immunity:
IEC 1000-4-2 Electrostatic Discharge Immunity
IEC 801-3 RF Electromagnetic Field

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Warranty

Tempo warrants this product against defects in materials & workmanship for a period of one year from the date of shipment to the original purchaser. All units returned to Tempo (delivery charges pre-paid), which are deemed defective under this warranty, will be replaced or repaired at Tempo's option. This warranty shall not apply to any defect, failure, or damage caused by improper use or inadequate maintenance. This warranty does not apply to worn or damaged accessories such as test leads, batteries and soft cases.

EXCEPT AS PROVIDED IN THIS SUMMARY, TEMPO MAKES NO WARRANTY OF ANY KIND, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION; THE IMPLIED WARRANTY OF MERCHANTBILITY AND FITNESS FOR A PARTICULAR USE. IN NO EVENT SHALL TEMPO BE LIABLE FOR INDIRECT, SPECIAL OR CONSEQUENCTIAL DAMAGES.

Warranty on Repaired Products: All repaired products are covered by a 90-day warranty against defects in materials and workmanship. **Non-Warranty Repairs:** Tempo will charge for materials and labor for all product repairs that are not under warranty. **Replacement Parts:** Replacement Parts are available through Tempo authorized repair centers only.

Accessories: Accessories are available through the Tempo sales department. Contact the sales department for a list of available accessories.

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Characteristics

♦ **Test Signal Output** - 1/2 sine balanced.

♦ **Amplitude**: ≤6V into 105Ω.

♦ **Pulse Widths** – 5nS to 2500ns. (automatic)

♦ **Input Protection -** +/-200 VDC + peak AC to a maximum of 440Hz.

♦ **Display Ranges** - Eleven automatic display ranges plus single button expand window.

♦ **Gain** - 0 to 63 dB.

♦ **Filter** - High pass, cut-off frequency 150 kHz, user selectable.

♦ **Distance Accuracy** – 0.01% +/-300pS +/-Vp uncertainty +/- cursor resolution.

♦ **Display**: 5.25 inches. high contrast, high resolution, backlit LCD, 520 x 200 pixels.

♦ **Distance Measurements** - Meters, feet, nanoseconds.

♦ **Auto Shutoff Time** - Operator selectable: 5 to 30 minutes.

♦ **Temperature Range** - Operating: 0°C to +45°C / +32°F to +113°F.
Non-operating: -20°C to +60°C / - 4°F to +140°F.

♦ **Humidity**: 95% RH, non-condensing at +30°C to +40°C / +86°F to +104°F

♦ **Field Usage** - Shock, splash and dust resistant.

♦ **EMI Emissions** - EN55011, Class A.
EN60555-2

Standard & Optional Accessories

Standard Accessories:

♦ Test leads (two pair), - 012154500
♦ Soft Carrying Case, - 016164301
♦ Users Manual, - TS90-3000
♦ Six AA Alkaline Batteries, - 0010-0030

Optional Accessories:

♦ Strand Hook (D-Ring) - 354074500
♦ Heavy Duty Transport Case – THM5HCA
♦ Hands Free Pouch – THM5SCA
♦ Rechargeable NiCad Battery Pack - THM5BAT.
♦ External Charger for NiCad Battery Pack - THM5CHG.

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Includes: DC Adapter, Charger, Pedestal and one of the following wall transformers (specify when ordering):
Standard - 110 V US.
Opt. A1 - 220 V Universal Europe.
Opt. A2 - 240 V UK.
Opt. A6 - 110 V Japan.

TS90 CableScout Reference Guide

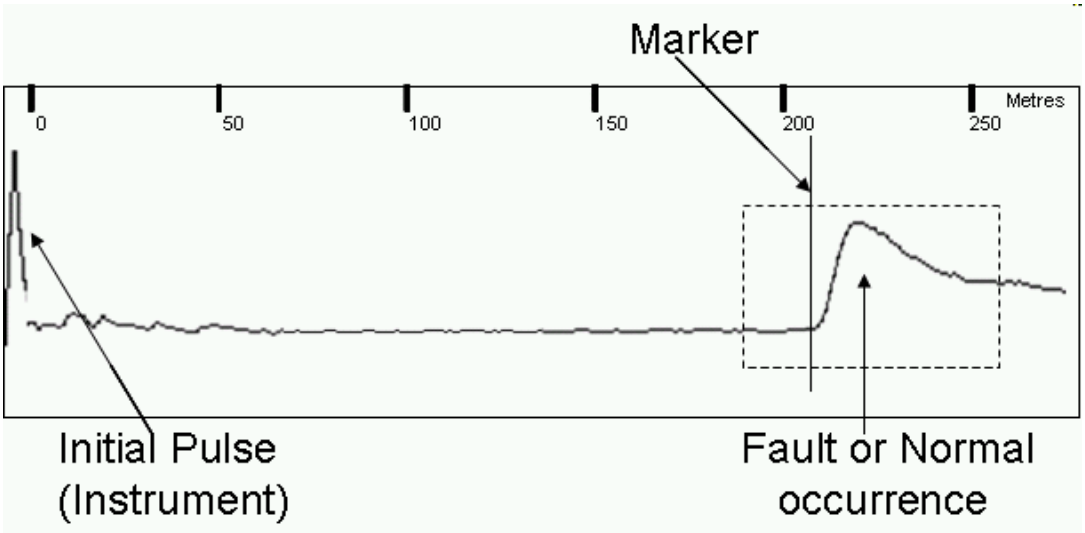
Time Domain Reflectometer Principles

A Time Domain Reflectometer – TDR, is a device using a principle similar to radar to measure time and distance over a length of cable. A TDR sends out a pulse of energy and measures the reflections to events along the length of the cable. The TDR measures the time taken for the reflections to return and converts this into distance along the cable. The results are shown on the screen.

The events that a TDR can as accurately pinpoint trouble such as Earth faults, Contacts, High Resistive faults (HRs), Splits, Rectified Splits, Load Coils, Low Insulation faults, Disconnects (either one or both legs Dis). Basically any event on the line which creates an impedance mismatch can be located by the TS90.

A TDR can also provide a rough estimate of the total amount of cable that is wet, and the exact location of the wet section.

The TDR displays a graph of the tested cable with distance (time to reflection) on the horizontal axis. The on screen cursor helps by displaying feet or meters to a point on the cable. The vertical axis on the TDR display, shows the type and severity of fault. Several kinds of problems, as well as normal occurrences will be demonstrated in the next sections.



Typical TDR Display

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Time Domain Reflectometer Concepts

There are several basic concepts that will help you to accurately locate and interpret the waveforms you will see on the TDR. You can use these concepts to help identify the waveforms you are analyzing –

Vp - Velocity of Propogation:

A cable's Velocity of Propagation (VoP or V_p) specification is simply a measure of how fast a signal travels in the cable. It is typically expressed as a percentage of the speed of light. For example, a cable with a Vp value of 0.85 indicates that the signal is travelling down the cable at 85% of the speed of light. Since a Time Domain Reflectometer (TDR) is really making measurements in the time domain, the distance accuracy of the TDR is dependent upon having the correct Vp value.

♦ Pulses travel at different velocities on different cables just as an object travels at different speeds through different thickness of liquids.

♦ Vp varies between cable types, sizes and manufacturers, and the type of insulation and cross sectional geometry of a cable will affect the velocity of a pulse.

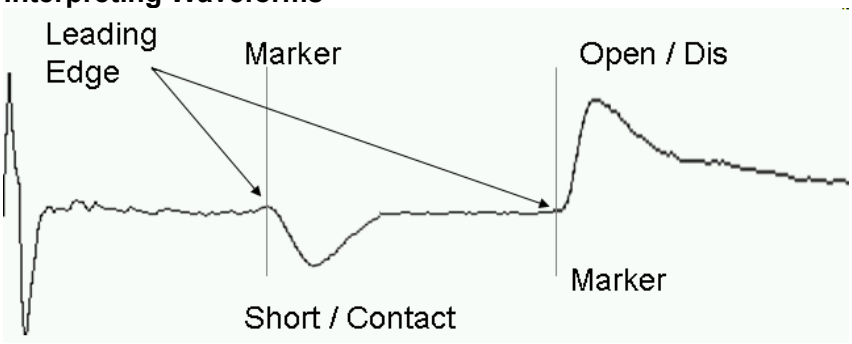
♦ Identifying the correct Vp for the cable being tested is imperative to have accurate distance measurements.

Cable Impedance

Cable impedance is made up of resistance, inductance and capacitance inherent in a cable. Reflected pulses are caused by impedance changes.

♦ TDRs can measure reflections caused by series impedances from several hundred Ohms down to a few Ohms
♦ TDRs can also measure reflections caused by shunt impedances up to several hundred Ohms

Interpreting Waveforms



♦ OPEN: (Capacitive Fault) - Will cause the waveform display to break above the plane of the pulse reference line.
♦ SHORT: (Resistive Fault) - Will cause the waveform to dip below the plane of the pulse reference line.
♦ LEADING EDGE: Indicates where the event is located. The leading edge is the precise point where the waveform breaks the plane above or below the pulse reference line.

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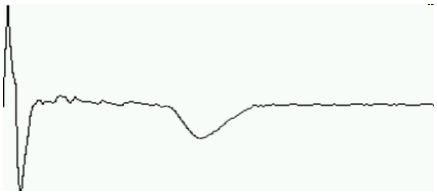
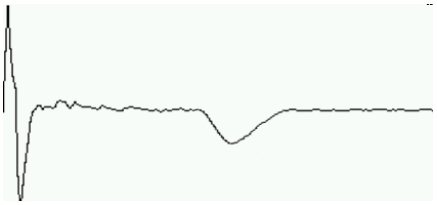
♦ MARKER: A Cursor or Marker can be set at the Leading Edge of the pulse break so that distances can be read on the TDR.
Markers may be moved anywhere on the screen to mark distance from the left hand zero reference point.
♦ GAIN: Acts like an amplifier control. Adjusts the vertical amplitude (height) of the waveform displayed. However, amplitudes that are too high may produce distorted waveforms.

Sample Waveforms

Earth Fault		Low impedance fault gives negative reflection. Magnitude of reflection depends on value of fault. Bigger value fault reflects more pulse energy back to TDR.
Contact / Short		Another low impedance fault. Contacts / Shorts reflect 100% of the pulse energy giving large reflection. Size of reflected pulse depends on distance, pulse width, cable diameter etc.
Open / Disconnect		High impedance fault. Opens reflect 100% of the pulse energy giving large reflection. Size of reflected pulse depends on distance, pulse width, cable diameter etc.
Split		A capacitive fault that can be detected using TDR. Splits can give either positive or negative reflections depending on how you connect the 4 wires.
Rectified Split		As above. This time the reflection of the re-split can be seen behind the original split. Splits must be taken out where they occur.
High Resistance (HR)		High impedance fault positive reflection. Possibly the hardest faults to find. HRs up to 20Ω give small reflections. Use plenty of Gain.
Low Insulation		Low impedance fault always gives negative reflection. Size of the reflected pulse depends on the value of the fault. If the insulation breaks down to the extent that contact occurs, 100% pulse energy returned

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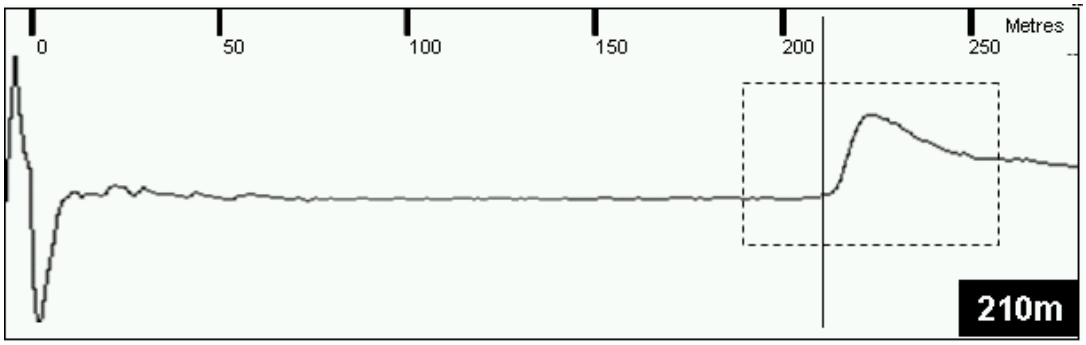
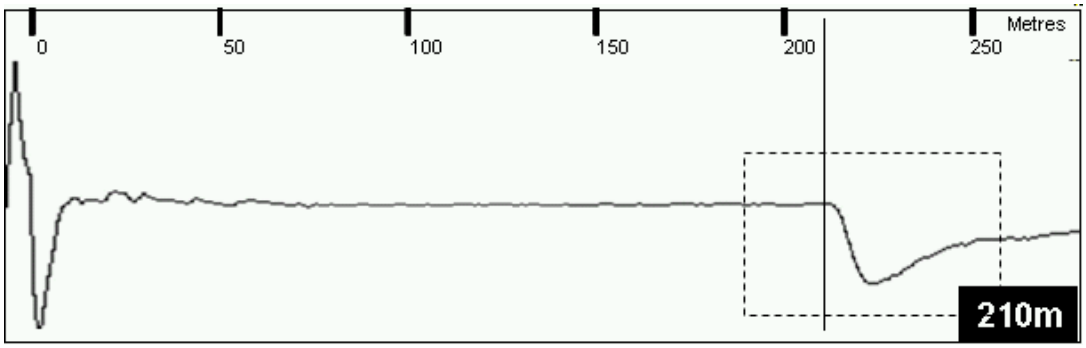
TS90 Quick Reference

Distance/Open/Short

1. Press RESET TO METRIC or RESET TO US (not necessary if previously set).
2. Press SETUP.
3. Use ▲▼ to select the cable type to be tested.
4. Connect the test leads to the cable under test.
5. Press TEST TYPE.
6. Use ▲▼ to select TEST PAIR.
7. Press EXIT.
8. Press MORE CABLE until the reflection is seen.
9. Use ▲▼ to adjust the waveform height.
10. Press ◄►to move the cursor to the leading edge of the reflection.



Typical Open -



Typical Short -

Load Coils

1. Press RESET TO METRIC or RESET TO US (not necessary if previously set).
2. Press SETUP.
3. Use ▲▼to select the cable type to be tested.
4. Connect the test leads to the cable under test.
5. Press TEST TYPE.
6. Use ▲▼to select TEST PAIR.
7. Press EXIT.
8. Press MORE CABLE until the reflection is seen.

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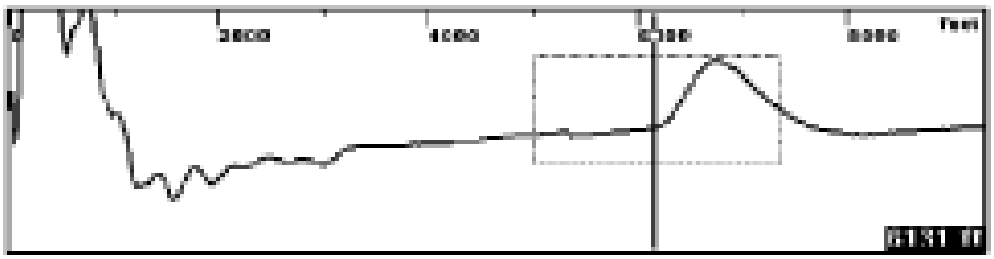
9. Use ▲▼to adjust the waveform height.
10. Press ◄►to move the cursor to the leading edge of the load coil.



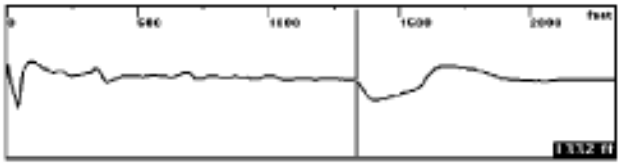
Typical Load Coil

NOTE: Load coil waveforms look very similar to an Open waveform. Typically, the load coil will be located at its appropriate spacing, depending on the loading scheme being used.

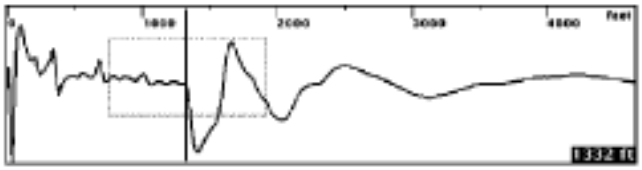
Bridged Taps and Laterals

1. Press RESET TO METRIC or RESET TO US (not necessary if previously set).
2. Press SETUP.
3. Use ▲▼to select the cable type to be tested.
4. Connect the test leads to the cable under test.
5. Press TEST TYPE.
6. Use ▲▼to select TEST PAIR.
7. Press EXIT.
8. Press MORE CABLE until the reflection is seen.
9. Use ▲▼to adjust the waveform height.
10. Press ◄►to move the cursor to the leading edge of the bridged tap.

Single Bridged Tap



Multiple Bridged Taps



NOTE: If there is more than one bridged tap on the pair, the additional lateral might be sufficient to obscure the end of the cable. If necessary, remove the first bridged tap and retest the cable to locate the next tap.

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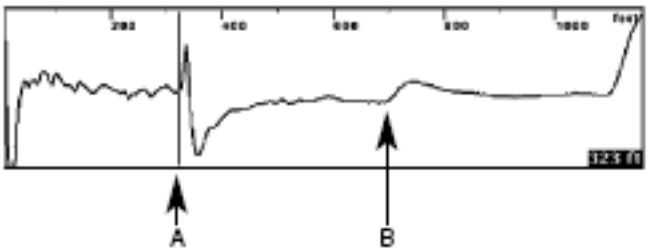
Water

1. Press RESET TO METRIC or RESET TO US (not necessary if previously set).
2. Press SETUP.
3. Use ▲▼to select the cable type to be tested.
4. Connect the test leads to the cable under test.
5. Press TEST TYPE.
6. Use ▲▼to select TEST PAIR.
7. Press EXIT.
8. Press MORE CABLE until the reflection is seen.
9. Use ▲▼to adjust the waveform height.
10. Press ◄►to move the cursor to the beginning of the wet section (see A below). This is the distance to the water.
11. Press ◄►to move the cursor to the end of the wet section (see B below).
12. A to B is the wet section.

Typical Water Waveform



NOTE: The distance from the front panel to the water (A) is correct. The wet section distance (A to B) is not correct due to the Vp being changed by the water. Subtract the dry section distance from the cable map to obtain the wet distance, or measure from both ends of the cable to the wet section.

Split Pair

1. Press RESET TO METRIC or RESET TO US (not necessary if previously set).
2. Press SETUP.
3. Use ▲▼to select the cable type to be tested.
4. Connect the TEST leads to the first split pair.
5. Connect the REFERENCE leads to the second split pair.
6. Press TEST TYPE.
7. Use ▲▼to select SPLITS OR CROSSTALK.
8. Press EXIT.
9. Press MORE CABLE until the reflection is seen.
10. Use ▲▼to adjust the waveform height.
11. Press ◄►to move the cursor to the split.

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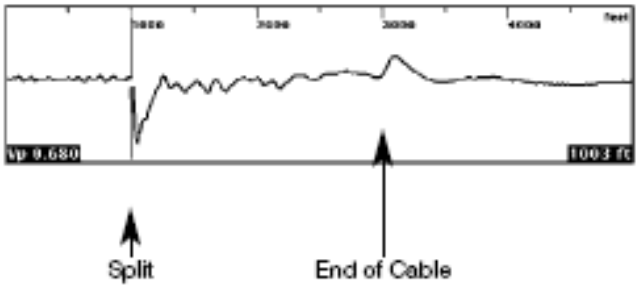
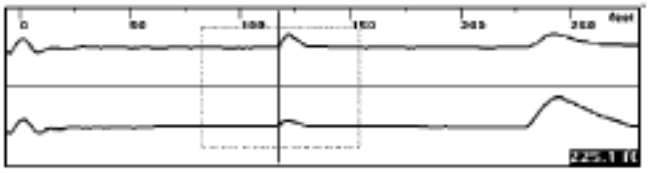
Typical Split (Crosstalk Mode)



Comparing Two Pairs

1. Press RESET TO METRIC or RESET TO US (not necessary if previously set).
2. Press SETUP.
3. Use ▲▼to select the cable type to be tested.
4. Connect the TEST leads to the first pair.
5. Connect the REFERENCE leads to the second split pair.
6. Press TEST TYPE.
7. Use ▲▼to select TEST PAIR / REFERENCE PAIR.
8. Press EXIT. Both the test pair waveform and the reference pair waveform are displayed (test pair waveform I on top).
9. Press MORE CABLE until the reflection is seen.
10. Use ▲▼to adjust the waveform height.
11. Press ◄►to move the cursor to the leading edge of the event.

Comparing Two Waveforms



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