

Warranty

The Radiodetection RD6000DSL is warranted to be free from defects in material and workmanship that develop under normal use in accordance with Radiodetection Operating Instructions for a period of one (1) year from the date of shipment from the Radiodetection Factory or its designated distributor.

Items returned for repair or replacement shall be shipped with a copy of the dated invoice, freight charges prepaid, to:

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This warranty will be void if products are modified by the purchaser during the period of warranty without the manufacturer's written consent. This warranty is expressly made in lieu of all other warranties expressed or implied, including merchantability, whether arising by law, custom or conduct. The rights or remedies provided herein are exclusive and in lieu of any other rights or remedies unless specifically stated in the purchase order for this equipment. This warranty covers repair or replacement of the purchased item only and does not cover any subsidiary damages to associated customer equipment. If the extended warranty is purchased, it does not apply to the battery pack.

250-0040-02

RD6000DSL

Multi-Function Cable Test Instrument



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Appendix B: VOP Table

Telephone Cable	AWG	MM	VOP
PIC	19	.912	.72
	22	.643	.67
	24	.511	.66
	26	.404	.64
Jelly/Filled	19	.912	.68
	22	.643	.62
	24	.511	.60
	26	.404	.58
Pulp	22	.643	.67
	24	.511	.68
	26	.404	.66

**Appendix A:
Serial I/O Printer Port Connection**

Citizen PN60 Pocket Printer:

The RD6000DSL interfaces to the Citizen PN60 Pocket Printer

Printer Set-up Parameters:

Language:	English
Font:	Roman
Font Lock:	Off
Line Spacing:	6LP1
Character Set:	Italics
Code Page:	USA
Space Skip:	Enable
Stylewriter:	Auto
Protocol:	DTR
Emulation:	Epson
Pitch:	10CPI
Compress:	Off
Form Length:	11 Letters
Slash Zero:	On
Internal Char Set:	USA
Auto LF:	Off
Power Off:	3 Minutes
Baud Rate:	9600

Seiko DPU-411/414 Printer:

The RD6000DSL can be used with the Seiko DPU-411 Thermal Printer and uses the Seiko DPU-411 command set. Serial communication parameters are: no parity, two-stop bit and 9600 Baud

Printer Set-up Parameters:

Input Method:	Serial
CR Function:	Carriage Return
Print Mode:	Normal Printing
Character Set:	Ordinary Character
Zero Font:	Slash Zero
Internal Char. Set:	USA
Data Bit Len:	Eight Bits
Parity Permission:	Without
Parity Condition:	Odd
Baud Rate:	9600

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Section 1: Safety Information



WARNING - Failure to follow the procedure or process correctly may result in death or serious personal injury.



CAUTION - Failure to follow the procedure or process correctly may result in equipment damage or data loss.



HAZARDOUS VOLTAGE - The hazardous voltage symbol indicates the high voltage source on the RD6000DSL is active or there is a hazardous voltage present on the cable under test.



WARNING - Before using, review all safety precautions. Note and follow all safety information on equipment and in documentation.

Do not operate this instrument near flammable gases or fumes.

Do not modify any part or accessory of this instrument.

If the unit is damaged, do not use and secure the product from use by others.

Read and follow the Operator's Manual. Failure to do so could compromise the safety of the operator.

When the hazardous voltage warning appears, stop the test immediately and remove the voltage source, failure to do so may compromise the safety of the operator.

This instrument is intended for connection to telephone networks only.

Always keep the instrument in its protective bag with the rear compartment zipped closed while testing.

Retain these instructions for future reference.



CAUTION - Store your RD6000DSL indoors during extreme hot or cold weather. If the RD6000DSL is stored in a vehicle overnight, ensure the instrument is brought to the specified operating temperatures before use.

Do not expose to extreme temperatures.

Compliance

Europe: Complies with 89/336/EEC and 73/23/EEC

USA: Complies with Part 15 of the FCC Rules

Ingress Protection

IP54

Maximum Range (live): 19,400.0m at 99.0% VOP
11,700.0m at 60.0% VOP
Range varies with VOP, Maximum testable cable length varies with pulse width and cable type

Maximum Range (stored): 3,600.0m at 99.0% VOP
2,200.0m at 60.0% VOP
Range varies with VOP, pulse width and cable type

Input Protection: 400V from DC to 60Hz

Velocity of Propagation:
Unloaded Cable Range: VOP(%) ranging from 30.0% to 99.0%
Loaded Cable Range: VOP(%) ranging from 0.8% to 20.0%
Unloaded Cable Range: V/2 ranging from 45.0 to 148.4 m/μs
Loaded Cable Range: V/2 ranging from 1.2 to 30.0 m/μs

Super-Store Storage: 32 TDR waveform records with 6144 16-bit samples each
8 Auto - Test records
8 RFL Records
8 Power Spectral Density Records
8 Open/Cap Meter Records

Software Noise Filters: 4x, 8x, 16x, 32x, 64x, 128x, 50/60 Hz, High-pass filter

Resistance Fault Locator (RFL)

Location Range: 0 to 45 km
Resistance Fault Range: 0 to 20 MΩ
Accuracy (3-wire): +/- 0.25% of DTS plus +/- 0.4 Ω
Accuracy (4-wire): +/- 0.25% of DTS plus +/- 0.25 Ω
Accuracy (Kupfmuller): +/- 1.0% of DTS plus +/- 1 Ω

Remote Device

Communications for:
Short Pair
Open Pair
Connect through to exchange
Send tones for Insertion Loss and Crosstalk tests
Set Terminations
Tone for pair identification

Compliance Statement:

Europe: Complies with 89/336/EEC and 73/23/EEC.
Emissions tested for Class A equipment.

USA: NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.



CAUTION - DO NOT perform any service or repair of the RD6000DSL. Attempting to do so could result in electric shock and/or void the manufacturers warranty.

CAUTION - The RD6000DSL contains NO user serviceable parts.

Section 2: Introduction

The RD6000DSL is a multi-function cable test instrument, specifically designed for use on telephone networks, combining diagnostic and fault location facilities in a single instrument.

Telephone networks rely on cables to transfer data from one point to another. This data is conveyed in the form of electrical signals, therefore the electrical characteristics of the cable itself greatly affect the integrity of the signal being transmitted.

Cable test instruments are used to ensure that cables can conduct signals correctly, test for interference along a cable run, verify if it's properly installed and also troubleshoot faulty cables.

The RD6000DSL includes a full function Time Domain Reflectometer (TDR) which provides a visual indication of cable faults along with a means of locating them.

Other Features:

- Multi-Meter
- Insulation Resistance Tester
- Pair Balance and Noise Measurements
- POTS and Wideband Transmission Test
- Open/Cap Meter
- Resistance Fault Locator (RFL)

Range: 100m to 999m
Resolution: 1m
Accuracy: 3%

Range: 1,000m to 9,990m
Resolution: 10 m
Accuracy: 5%

Range: 10,000m to 49,900m
Resolution: 100 m
Accuracy: 8%

Range: 0 nF to 9.99 nF
Resolution: 0.01 nF
Accuracy: 2% +/- 0.06 nF

Range: 10.0 nF to 99.9 nF
Resolution: 0.1 nF
Accuracy: +/- 3%

Range: 100 nF to 999 nF
Resolution: 1 nF
Accuracy: +/- 5%

Range: 1,000 nF to 2,000 nF
Resolution: 1 nF
Accuracy: +/- 8%

Time Domain Reflectometer (PET)

Range: 0 to 610 m
Resolution: < 0.07 m at 99% VOP, < 0.02 m at 30%

Range: 610 m and greater
Resolution: 0.1 m at any VOP

Distance Accuracy: +/- 0.15 m plus +/- 0.01% of reading
Vertical Resolution: 14 bits with 137 dots displayed
Vertical Sensitivity: Greater than 65 dB
Output Signal: Pulse widths of 2ns, 25ns, 100ns, 500ns, 1µs, 4.4µs and 330µs
Output Balance: Variable from 80Ω to 120Ω

V.90 Insertion Loss

Range: 63 dB Loss to 10 dB Gain
Test Frequencies: 600, 1200, 1600, 2000, 2400, 2600, 2900, 3100, 3200, 3300, 3350, 3400, 3500, 3550, 3600, 3650, 3700, 3750, 3800Hz
Output Level: -10 dBm
Impedance: 600Ω , 900Ω and TN12

POTS Crosstalk

Range: -20 to -40 dB
Freq. Range: 300 to 6000 Hz
Resolution: 0.1 dB
Output Level: -10 dBm
Impedance: 600Ω , 900 Ω, TN12

Pair Quality (Wideband)

Power Spectral Density

Vertical Range: -20 to -140 dBm/Hz
Vertical Resolution: 1 dB
Frequency Range: 20 kHz to 2020 kHz
Resolution Bandwidth: 10 kHz
Impedance: 100 Ω, 120 Ω, 135 Ω

Wideband Crosstalk

Range: -20 to -40 dB
Resolution: 1 dB
Frequency Range: 20 kHz to 2020 kHz
Output Level: 0 dBm
Impedance: 100Ω , 120Ω , 135Ω

Wideband Insertion Loss

Range: 63 dB Loss to 10 dB Gain
Resolution: 1 dB
Output Level: 0 dBm
Impedance: 100Ω , 120Ω , 135Ω

Fault Location:

Open/Capacitance Meter

Range: 0 to 99.9 m
Resolution: 0.1 m
Accuracy: 2% +/-1 m

Range: 100m to 999m
Resolution: 1m
Accuracy: 3%

Section 3: Controls and Connections

3.1 Controls



1. Power: Switches the RD6000DSL ON and OFF
2. Backlight: Switches the backlight ON and OFF. This improves viewing under certain ambient light conditions
3. Contrast: Increases and decreases screen contrast
4. Help: Accesses the on board help system
5. Auto Test: Starts an automatic fault diagnosis and location process
6. End/Back: Stops a test or takes you up one level within the selected menu
7. Softkeys: Control on screen features dependant on the selected operating mode and or menu system
8. Waveform Keys: Adjust the waveform display
9. Mode: Changes between various live and stored waveform modes, when using the RD6000DSL
10. Range: Allows the display range to be increased and decreased when using the RD6000DSL. Pulse width and vertical gain are automatically adjusted with range
11. Cursors: Move the on-screen cursor when using the RD6000DSL
12. Charging LED: Green LED lights when the RD6000DSL battery charger or an external DC source is connected
13. Headset Jack: Can be used on this instrument
14. 12V DC Input Jack: Used to connect the external battery charger or optional adapter to charge from a 12V vehicle cigarette lighter
WARNING: Only use an approved adapter of the specified rating

3.1.1 Waveform Keys

These keys are to manipulate the displayed waveform when using the RD6000DSL.



Horizontal Zoom: Used to expand the waveform, allowing it to be examined in more detail.



Vertical Gain: Used to control the vertical size of the waveform.



Scroll Controls: Used to move waveforms left and right on the display.



Shift Controls: Used to move waveforms up and down on the display.

3.1.2 Telephone Keys

These keys perform normal telephone key functions when using the RD6000DSL telephone features.

You have numbers 1-9 and the *, 0, and # keys as shown below.



IR (Insulation Resistance) Continued

Range: 10.0M Ω to 99.9M Ω
 Resolution: 0.1M Ω
 Accuracy: 4%

Range: 100M Ω to 999M Ω
 Resolution: 1M Ω
 Accuracy: 10%

Pair Quality (POTS)

Loop Current

Range: 0.0 to 120.0mA
 Resolution: 0.1mA
 Accuracy: 1% +/- 0.2mA
 Load: 500 Ohms

Noise Metallic (Transverse Noise) - Continuous and Peak

Range: 0 to 50 dBmC (-90 to -40 dBmp)
 Resolution: 1 dB
 Accuracy: +/-2 dB
 Filter: User selectable P/C weighted or flat (3kHz)

Power Influence (Longitudinal Noise)

Range: 40 to 100 dBmC (-50 to 100 dBmp)
 Resolution: 1 dB
 Accuracy: +/-2 dB
 Filter: User selectable P/C weighted or flat (3kHz)

Longitudinal Balance

Range: 40 to 62 dB
 Resolution: 1 dB
 Accuracy: +/-2 dB
 Frequency: 1004 Hz

POTS Insertion Loss

Range: 63 dB Loss to 10 dB Gain
 Freq. Range: 300 to 6,000 Hz
 Resolution: 0.1 dB
 Output Level: -10 dBm
 Impedance: 600 Ω , 900 Ω and TN12

Display:

320 x 240 dot-matrix liquid crystal display with CCFL backlighting.

Basic Telephone Talk Set (when used with headset)

Serial Number/Bar Code to the EAN 128 Standard. Shipping cartons will also contain instrument serial number/bar code

Multi-Meter:*DC Voltmeter*

Range: 0.0 to 400.0V
 Resolution: 0.1V
 Accuracy: 1% +/- 0.1V
 Impedance: 1 M Ω

AC Voltmeter

Range: 0.0 to 400.0V
 Resolution: 0.1V
 Accuracy: 2% +/- 0.1V
 Impedance: 1 M Ω

Foreign Battery

Range: 2.0 to 400.0V
 Resolution: 0.1V
 Accuracy: 1% +/- 0.1V
 Impedance: 1 M Ω

Resistance

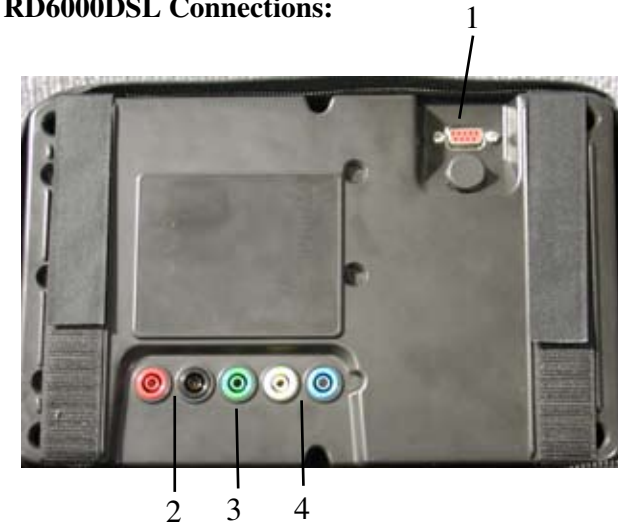
Range: 0.0 to 1999.9 Ω
 Resolution: 0.1 Ω
 Accuracy: 0.2% +/- 0.2 Ω

Range: 2,000 Ω to 10,000 Ω
 Resolution: 1 Ω
 Accuracy: 0.2% +/- 1 Ω

IR (Insulation Resistance)

Voltages: 50V, 100V, 250V, 500V

Range: 0.00M Ω to 9.99M Ω
 Resolution: 0.01M Ω
 Accuracy: 2% +/- 0.01M Ω

3.2 RD6000DSL Connections:

1. Serial Port: For connection to a PC to transfer waveforms to the Radiodetection Wave-View software, or for direct connection to an external printer.
WARNING: Do not connect to serial port while Line 1 or Line 2 are connected to the telephone network.



2. Line 1 Banana Jacks: For connecting Red and Black Radiodetection test leads. Connect these to the pair under test.

3. Earth Banana Jack: For connecting the Green Radiodetection earth lead. Connect this to the network earth.



- WARNING:** This is a functional earth only, NOT a protective earth. Never connect to anything other than earth.

4. Line 2 Banana Jack: For connecting Yellow and Blue Radiodetection test leads. Connect these to the pair under test. (Line 2 is only used for line testing in TDR mode and the 4-wire RFL test).



CAUTION: Only use Radiodetection test leads. Using other test leads may damage the RD6000DSL and/or void the manufacturers warranty.

Section 4: Power Sources

The RD6000DSL is powered by an internal 7.2V Nickel metal Hydride (NiMH) rechargeable battery pack, or an appropriate Riser Bond/Radiodetection external DC power supply, such as the supplied DC adapter.

4.1 External DC Supply

An appropriate Radiodetection external DC power supply can be connected via the DC input jack (charger socket) on the front of the unit. This can be either the supplied DC charger or the optional Riser Bond vehicle cigarette lighter adapter.

DC power source specifications:

- Center positive
- 12V
- 1.3A

When a DC source is connected the Green charger LED on the front of the unit will be illuminated.

4.2 Battery Charging

To charge the RD6000DSL connect an appropriate DC power source to the DC input jack (charger socket) on the front of the unit. This can be either the supplied DC charger or the optional Radiodetection vehicle cigarette lighter adapter.

Charging will take 16 hours and will provide approximately 6 hours use without use of the backlight. The RD6000DSL can be used while charging.

While charging, the green LED is lit continuously. Once charging is complete the green LED will go out.

The LED will flash if the battery is outside the operating temperature limits, i.e., if the battery is too hot or cold to be safely charged.

It's always a good idea to refer to plant maps whenever possible to help minimize confusion or errors when testing plant cable, especially when testing through bridged taps.

Remember, a TDR will test through a bridged tap displaying a waveform interpretation of the cable under test, including any bridged taps and their corresponding laterals. A lot of information is displayed in the waveform, therefore, thorough study and correct cursor placement becomes very important.

Section 17: Technical Specifications

Physical (main instrument):

Without carrying case & accessories	With carrying case & accessories
Height: 6.93 inches; 176 mm	Height: 7.80 inches; 198 mm
Width: 10.71 inches; 272 mm	Width: 11.18 inches; 284 mm
Depth: 3.15 inches; 80 mm	Depth: 7.00 inches; 178 mm
Weight: 4.84 lbs; 2.2 kg	Weight: 7.92 lbs; 3.6 kg

Physical (remote device):

Height: 216 mm
Width: 100 mm
Depth: 40 mm
Weight: 0.4 kg

Environmental:

Operating Temp:	0°C to 50°C
Storage Temp:	-20°C to 60°C
Humidity:	95% maximum relative, non-condensing, IEC 68-2-3
Vibration:	IEC 68-2-6
Shock (bump):	IEC 68-2-29, 40g, 6ms, 1000 shocks in each axis
Drop:	IEC 68-2-27, 1 meter free fall, packaged in carry case
Moisture Rating:	IP 54

Hazardous Voltage Warning:

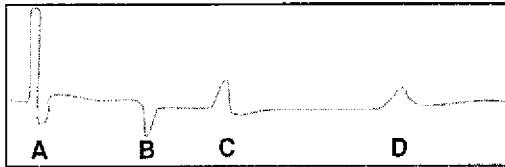
Audible/visual warning when 42.4 V peak (30 V_{RMS}) is present. User selectable low impedance 50 kΩ threshold 25 V_{RMS} Instrument tests for Hazardous Voltage at startup and each main test screen (Multi-Meter/Pair Quality/Fault Location) and will automatically monitor the cable once per minute when unit is in an "idle" state.

Power:

Internal: Rechargeable 7.2V nickel metal hydride battery pack.
External: 12 VDC, 1.3A power supply
Operating Time: Greater than 5 hours without backlight

16.6 Locating Bridged Taps

A bridged tap is not a section of cable, therefore, we will refer to the point of connection of the lateral to the main cable as the bridged tap. The cable extending from the bridged tap to the subscriber will be referred to as the lateral.



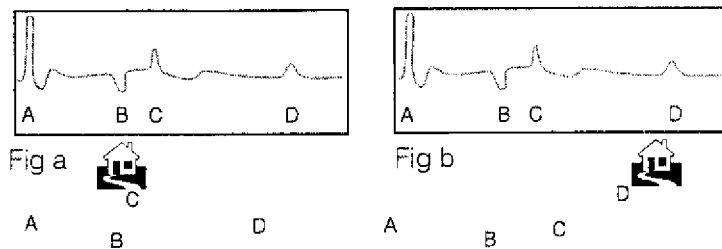
Above is a common waveform which results from testing a section of cable containing a bridged tap from which a lateral extends to the subscriber.

You might assume the following:

- Point A: The TDR pulse from the point of connection
- Point B: The point of a bridged tap on the main cable
- Point C: The end of the lateral
- Point D: The end of the main cable circuit

However, this could be the result of a somewhat different cable layout as explained below. A common mistake when testing through bridged taps is to misidentify the end of the lateral for the end of the main cable circuit.

Below are two slightly different cable plant layouts yet the resulting waveforms are identical.



In Figure a - the length of the lateral is shorter than the end of the main cable circuit.

In Figure b - the length of the lateral is longer than the main cable circuit.

NOTE: Do not assume the first upward reflection after a bridged tap is always then end of the lateral; it may be the end of the cable.

4.3 Maximizing Battery Life

To maximize the RD6000DSL battery life:

- Do not recharge until the battery low warning is displayed.
- Stay within the recommended temperature limits.

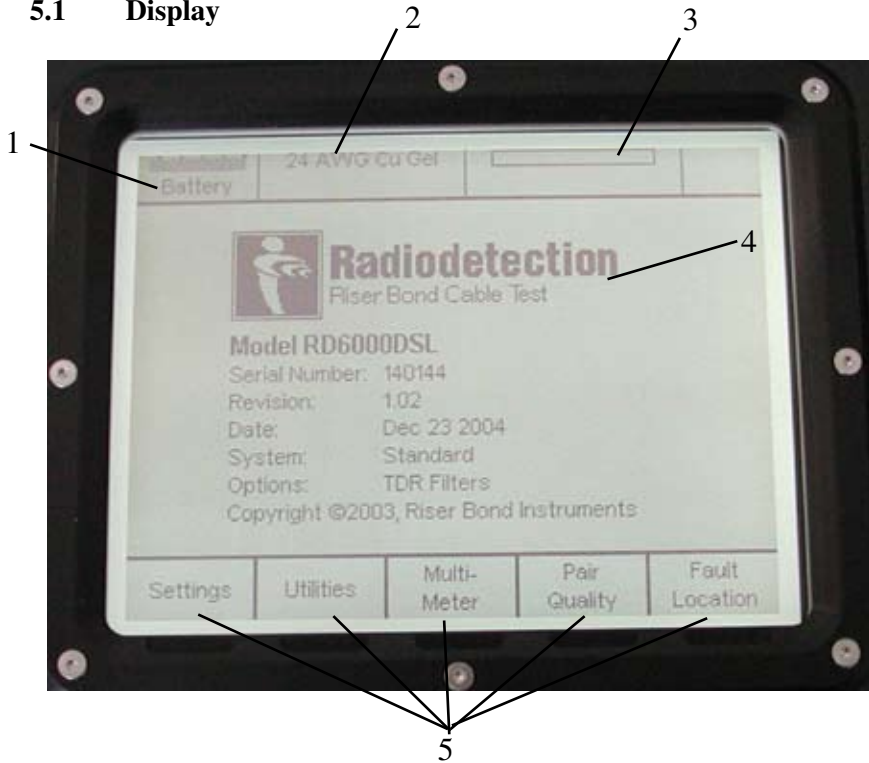
Operating Temperature: 0 to 50°C
32 to 122°F

Storage Temperature: -20 to 60°C
-4 to 140°F

Humidity: 95% maximum relative, non-condensing

Section 5: RD6000DSL User Interface

5.1 Display



1. Battery Level: Shows the level of charge and warns you when the battery charge is low
2. Cable Type: Displays the selected cable type
3. Progress Bar: Indicates progress when saving waveforms, and performing tests, calculations or calibrations
4. Main Display Area: This section of the screen displays waveforms, test results and available options, dependent on the operating mode selected. (the start up screen is shown above).
5. Softkey Menu: This area of the screen displays the available menu options for the selected operating mode. Each menu option corresponds to the softkey below it.

Sometimes it's not always practical to disconnect the far end of the cable. However, it's still possible to test a cable that is terminated. If the cable is damaged, the signal will reflect back at the damaged point prior to being absorbed by a termination. If a reflection is created at the point of termination, it's possible the TDR has found a faulty terminator.

In some cases, for example, when testing hard-line coax cable, we want to terminate the cable to eliminate ghosts and study the waveforms. It's always best to test using both methods. In order to minimize confusion and eliminate guesswork, it's best if all other equipment or hardware is disconnected from the cable under test.

16.5 Moisture in a Twisted Pair

The greatest percentage of twisted pair problems are caused by moisture in the cable. How to locate the problem, why one pair may be affected but not another, and how much of the cable is affected, are all problems that need to be addressed.

A TDR will find water in the cable. It shows up as a lowering of the cable impedance, however, it's not always possible to accurately tell how wide the water problem is. With filled cable it's always a point problem as moisture cannot move inside the cable. In air-core or pulp cable, moisture can travel anywhere along the cable run.

By testing from both ends and recording the distance to fault in all pairs, it's possible to determine approximately how wide the problem is.

When testing through water, measurements up to the water are very accurate. After the water, distance readings may be incorrect due to a change in the associated change in VOP. Even though the moisture may be 20 or 30 feet wide, each pair usually becomes impregnated at a different point. The range of these points will indicate the length of the problem.

The location and width of the water damage is now known. But it's still necessary to locate where the water actually entered the cable. A break in the sheath will not necessarily be within the span of where the water is found and will not necessarily show up. If the break in the cable sheath is not fixed, similar problems will show up in the future.

If the hole in the sheath happens to be at a high point in the cable, the water will enter through the hole then migrate to a lower point. If the water entry point is not found, it may be necessary to visually inspect the cable. It's also necessary to check the integrity of the sheath.

Dielectric Constant (Relative permittivity) of the insulation material is known:

$$VOP = 1/\sqrt{\epsilon_r}$$

Where: ϵ_r = The dielectric constant (relative permittivity) of the cable insulation material.

For Example: Polyethylene $\epsilon_r = 2.25$

$$\begin{aligned}\text{Therefore VOP:} &= 1/\sqrt{2.25} \\ &= 0.667\end{aligned}$$

A short length of the same type of cable is available:

- Measure the physical length of the sample
- Obtain a reading for the apparent length of the cable using an estimated VOP value
- Adjust the VOP value until the distance reading indicated is the same as the measured length

The VOP of a cable can vary with temperature, age and humidity. It can change approximately 1% for every ten degrees centigrade change from room temperature. It can also vary from one manufacturing run to another, every new cable can vary as much as +/-3%.

With this change in the dielectric constant, the VOP changes and therefore the apparent length of the cable also changes. When using a known length of cable to determine VOP, be certain to use at least 100 feet (33m). The longer the test cable the better.

Fortunately, there are ways to minimize error. When trying to pinpoint a fault, the most common technique used to reduce VOP error is to test the faulty cable from both ends. It is then possible to take the actual cable length and divide by the sum of the two TDR readings obtained by the tests from each end. This produces an adjustment factor, which the TDR readings can be multiplied by to give the corrected length readings.

16.4 Termination

When testing cables it's best if the cable is not terminated. A termination can absorb the pulse and therefore no signal will return to the instrument. The TDR's transmitted pulse must be reflected back to the instrument by a fault or the end of the cable in order to indicate a distance. It's best if all equipment and components are disconnected from the cable under test.

5.2 Menu System

The RD6000DSL menu system provides access to various system settings and calculation tools as well as the various cable test and fault location features.

The menu system is navigated using the Softkeys and the **End/Back** key.

The function of each softkey is displayed above it in the softkey menu area of the display, and changes from screen to screen.

The **End/Back** key is used to exit a menu and will always take you up one level in the menu system.

5.2.1 Adjusting On-screen Parameters

On screen parameters are adjusted using **Select** (usually Softkeys 2 & 3) and **Adjust** (usually Softkeys 4 & 5).

To adjust on screen parameters:

- Press **Select** until the parameter you wish to adjust is highlighted on the screen.
- Press **Adjust** until the desired selection is displayed.
- Press **Select** to select another parameter or press **End/Back** to exit the menu and return to the settings screen.
- The changes will be stored and remain until they are manually reset.

All menus within the RD6000DSL menu system work in the same way.

Section 6: System Setup



WARNING: The RD6000DSL performs a Hazardous Voltage Test each time it's switched on, or when certain tests are selected. If an AC voltage greater than 30VAC is detected, the Hazardous Voltage Warning will be displayed.



WARNING: The cable under test may have a fault that results in all test leads (including earth) floating at a hazardous potential above earth. It's not possible for the instrument to indicate this without a good earth.



WARNING: When this warning is displayed, stop testing immediately and remove the voltage source.

From the start-up screen (shown page 9), press softkey 1 to enter the Settings Screen. From here you can adjust various system settings and user preferences.

6.1 General Settings

Press Softkey 1 to enter the General Settings Screen.



The system default settings are shown above

From here you can adjust basic system settings:

Measurement Units:	Metric/US (Imperial)
Backlight at Startup:	ON/OFF
Serial Printer:	Seiko DPU411/DPU414/Citizen PN60
Auto Off:	Disabled/ 3, 5, 10, 15 or 20 minutes
Active Remote:	None/Osc

16.3 Velocity of Propagation

A TDR is an extremely accurate instrument, however, variables in the cable itself can cause errors in the distance measurements. One way to minimize errors is to use the correct pulse velocity for the cable under test.

To calculate and display the distance to a point of reflection, the velocity of the pulse in the test cable is used to convert the measured time into a distance.

The Velocity of Propagation (VOP) is a specification of the speed at which a signal travels through the cable. Different cables have different VOP's and knowing the VOP of a cable is the most important factor when using a TDR for fault finding. By entering the correct VOP, the instrument is calibrated to that particular cable. Typically, the VOP of the cable under test will be listed in the cable manufacturer's catalog or specification sheet.

The cable pulse velocity is normally expressed as either:

- The ratio of the cable pulse velocity to the velocity of light in a vacuum (Velocity of Propagation - VOP)
- Cable pulse velocity divided by two (V/2)

For Example:

$$\begin{aligned} \text{VOP} &= 66.7\% \\ \text{Actual propagation velocity} &= 66.7\% * c \end{aligned}$$

$$c = \text{velocity of light in a vacuum} = 300 \text{ m}/\mu\text{s}$$

$$\begin{aligned} \text{Actual propagation velocity} &= 66.7\% * 300 \text{ m}/\mu\text{s} \\ &= 200 \text{ m}/\mu\text{s} \end{aligned}$$

In order to gain accurate measurements it's essential that the correct VOP value is used. The correct VOP value for a particular cable may not always be known or available, it's therefore necessary to be able to calculate it.

There are three methods of calculating the VOP of a cable, each based on the availability of different information about the cable under test.

The velocity of propagation for the cable is known:

$$\text{VOP} = V/c$$

$$\text{Where: } V = \text{velocity of propagation for the cable} \quad c = 300 \text{ m}/\mu\text{s}$$

16.2 Blind Spots

The pulse generated by a TDR takes a certain amount of time and distance to launch. This distance is known as the blind spot, and varies depending on pulse width. The larger the pulse width, the larger the blind spot.

It is more difficult to locate a fault contained within the blind spot. If a fault is suspected within the first few feet of cable, it is advisable to add a length of cable between the TDR and the cable being tested. Any faults that may have been hidden in the blind spot can now easily be located.

When adding cable to eliminate the blind spot, remember the TDR will also measure the length of this jumper cable. The length of the jumper must be considered in the distance reading. Using the RD6000DSL dual cursors, the length of the jumper can be subtracted by placing the first cursor at the point of connection with the jumper.

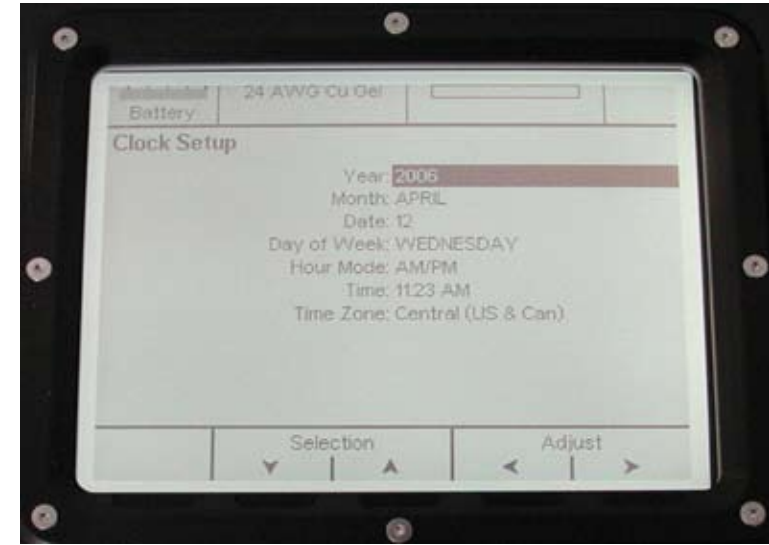
Although not critical, it's best if the jumper cable is the same impedance as the cable under test. The quality of the connection is the most important factor regardless of the type of jumper being used. It's important to remember to subtract the length of the jumper from the cable when measuring from the point connection because the TDR is also reading the length of this jumper. The distances below are based on one cable type, and results will vary.

Pulse Width	Blind Spot Length			
	Twisted Pair		Coaxial	
2 ns	6 ft.	2m	6 ft.	2m
25 ns	18 ft.	5m	20 ft.	6m
100 ns	50 ft.	16m	55 ft.	17m
500 ns	225 ft.	68m	243 ft.	73m
1.5 μ s	515 ft.	156m	650 ft.	197m
4.4 μ s	1350 ft.	410m	1750 ft.	530m
330 μ s	N/A	N/A	N/A	N/A

6.2 Clock

From the Settings screen, press Softkey 2 to enter Clock setup.

From here you can adjust time, date and time zone settings.



6.3 Calibration

The RD6000DSL should be calibrated regularly to ensure that the Multi-Meter and Resistance Fault Locator (RFL) features operate correctly. It is also advisable to perform a calibration if the RD6000DSL has been subjected to extreme temperatures.

To perform a calibration:

- From the RD6000DSL Settings screen, press **Calibration** (Softkey 3)
- The display will change, giving you instructions on how to perform the calibration.
- Follow the on-screen instructions.

NOTE: You will need to access and make various connections between the RD6000DSL test leads.

- Once the calibration is complete, the results will be displayed on-screen.
- Press **End/Back** to return to the Settings screen.

6.4 Setting the Cable Type

NOTE: It is important to select the correct cable type before performing any tests. Failure to do so will result in inaccurate test results.

The current cable type is shown at the top of the RD6000DSL display next to the battery level (shown on page 9).

6.4.1 To Set the Cable Type

- From the RD6000DSL Settings screen, press **Cable** (softkey 5)
- The display will change, giving you a list of preset cable types. The current cable type will be highlighted in the list with a small arrow to the left of it
- Use the **Select** keys (softkeys 3 & 4) to move up and down the list until the appropriate cable type is highlighted
- Once your chosen cable type is highlighted, press **Set** (softkey 5)
- The small arrow will move to the newly selected cable type and the current cable type display at the top of the display will be updated
- Press **End/Back** twice to return to the Settings screen
- The changes will be stored and remain until they are manually reset

There are 10 entries in the cable type list shown as **<empty>**, these allow user defined cable parameters to be input and stored for future use.

Entries 13-22 are reserved for user defined cable types to be stored.

6.4.2 To set a user defined cable type

- From the RD6000DSL Settings screen, press **Cable** (softkey 5)
- The display will change, giving you a list of preset cable types. The current cable type will be highlighted in the list with a small arrow to the left of it
- Use the **Select** keys (softkeys 3 & 4) to move up and down the list until the first available **<empty>** entry is highlighted
- Press **Create/Edit** (softkey 1)
- the display will change to give you a series of cable type parameters to set (see display screen)
- use **Select** (softkeys 2 & 3) and **Adjust** (softkeys 4 & 5) to set each of the parameters
- Press **End/Back** when you have set a parameter, this will save your entry and allow you to move on to the next parameter
- **Clear** will erase settings for the selected parameter
- Press **End/Back** twice to return to the Settings screen
- The Cable Type will be stored and remain available for selection until manually edited or erased

Section 16: Hints and Tips

This section gives some hints and tips on specific TDR features and cable test problems.

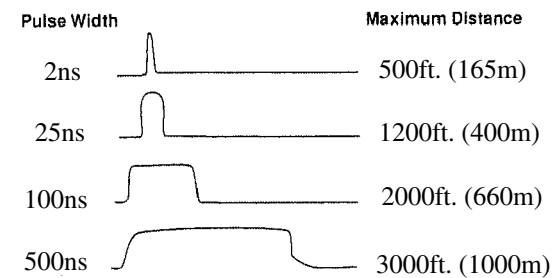
16.1 Pulse Widths

The amount of energy sent down a cable can be controlled by the operator, as many TDR's have selectable pulse width settings.

The pulse width control allows the TDR signal to be adjusted to travel different distances along the cable and with different energy levels. The wider the pulse width, the more energy transmitted, and therefore, the further the signal will travel down the cable.

NOTE: Even when testing very long lengths of cable, always start the fault finding procedure with the shortest pulse width available, as the fault may be only a short distance away.

Use the zoom and gain controls to help locate the fault. If the fault is not located, switch to the next larger pulse width and retest. Keep switching to the next larger pulse until the fault is located. All reflections will be the same width as that of the output (incident) pulse.



Sometimes, larger pulse widths are helpful even for locating faults that are relatively close. If the fault is very small, the signal strength of a small pulse may not be enough to travel down the cable, "see" the fault, and travel back. The attenuation of the cable combined with the small reflection of a partial fault can make it difficult to detect. A larger pulse width would transmit more energy down the cable, making it easier to see a small fault.

Section 15: Maintenance

This section gives basic information on how to look after your RD6000DSL and ensure optimum performance over its life.

15.1 Cleaning

Use a lint-free cloth or small soft brush to remove dust from the RD6000DSL display screen and connectors.

Use a damp cloth with mild soap and water to clean the case, front panel and outside of the instrument.



CAUTION: Do not get water in the instrument as it may affect its operation

CAUTION: Do not use harsh chemicals or abrasive cleaners as they may damage the case and front panel.

15.2 Periodic Inspection

Inspect the RD6000DSL and its accessories regularly. If the unit is used in harsh, dusty or wet environments, it should be inspected after each use.

If repairs are necessary, return the instrument to Radiodetection.

Check List:

- Check for damaged, worn or missing parts
- Check for any deformation of the enclosure
- Inspect the back panel connectors for dirt, broken or deformed insulation and contacts
- Inspect cable accessories for damaged insulation, bent or broken clips - replace damaged parts immediately

15.3 Service

For all servicing and repairs, return the instrument to Radiodetection.



CAUTION: DO NOT perform any service or repair of the RD6000DSL. Attempting to do so could result in electric shock and/or void of the manufacturers warranty

CAUTION: The RD6000DSL contains NO user serviceable parts.



6.4.3 To create a new cable type based on an existing one

- From the RD6000DSL Settings screen, press **Cable** (softkey 5)
- The display will change, giving you a list of preset cable types. The current cable type will be highlighted in the list with a small arrow to the left of it
- Use the **Select** keys (softkeys 3 & 4) to move up and down the list until the cable type you wish to base your new one on is highlighted
- Press **Copy** (softkey 1)
- The cable type details will be copied to the first available <empty> slot and will be named “cable_type” **copy**
- Use the **Select** keys (softkeys 3 & 4) to highlight the copied cable type
- Press **Create/Edit** (softkey 1)
- The display will change to give you a series of cable type parameters
- Use **Select** (softkeys 2 & 3) and **Adjust** (softkeys 4 & 5) to adjust the parameters as necessary
- Press **End/Back** when you have set a parameter, this will save your entry and allow you to move on to the next parameter
- **Clear** will erase settings for the selected parameter
- Press **End/Back** twice to return to the Settings screen
- The Cable Type will be stored and remain available for selection until manually edited or erased

6.5 Connecting to the Cable Under Test

The RD6000DSL uses the same connection for most tests.



WARNING: The cable under test could have a fault resulting in hazardous live conditions. Do NOT touch exposed connections.

WARNING: Before connecting to a telecom network:

- a) Disconnect any cables that are connected to the charger socket (other than the DC charger adapter), serial port or headset jack.
- b) The green terminal should only be connected to good protective earth (ground) or alternatively to good earth (ground) via a ground stake for example. Always verify the integrity of the earth before connecting the instrument.
- c) Test leads should not be connected to primary AC mains supply circuits other than a protective earth terminal.

6.5.1 To Make a Typical Connection

This is used for most tests and measurements

- Connect the **RED** test lead to the **A Leg (Ring)** of the pair
- Connect the **BLACK** test lead to the **B Leg (Tip)** of the pair
- Connect the **GREEN** test lead to the **Earth (Ground)**

6.5.2 To Make a Two-Pair Connection

This is used to compare two pairs when using TDR and RFL functions.

- Connect the **RED** test lead to the **A Leg (Ring)** of the pair
- Connect the **BLACK** test lead to the **B Leg (Tip)** of the pair
- Connect the **GREEN** test lead to the **Earth (Ground)**
- Connect the **BLUE** test lead to the **A Leg (Ring)** of the second pair
- Connect the **YELLOW** test lead to the **B Leg (Tip)** of the second pair



WARNING: While connected to a telecom network:

- a) Keep the unit in its bag with the rear compartment zipped shut
- b) DO NOT touch exposed metal parts on the rear panel
- c) DO NOT connect anything to the serial port or Line 3 phone jack
- d) DO NOT use a headset
- e) Always assume the network is at a hazardous voltage, even if the hazardous voltage warning is not shown

14.4 Controlling the Remote Device

- Connect to the pair using the typical connection outlined in Section 6.5.1
- From the RD6000DSL start screen, press **Utilities** (softkey 2)
- Ensure that the RD6000DSL Remote Device is connected to the pair
- Press **Remote Device** (softkey 4)
- The RD6000DSL will automatically test the pair for any remotes

If no device is found an error will be displayed. To re-test the pair for a remote device press **Seek Remotes** (softkey 1).

- When a remote device has been detected and communications established, a control menu will be displayed
- The Remote Device Setup screen allows the user to remotely alter Remote Device settings using the **Mode** (softkey 4) and **Set Mode** (softkey 5) keys
- Once your Remote has been set, press **End/Back** to exit the screen

14.5 Multiple Remotes

Up to three remotes may be used on a single pair, this can help to save time when testing a very long cable.

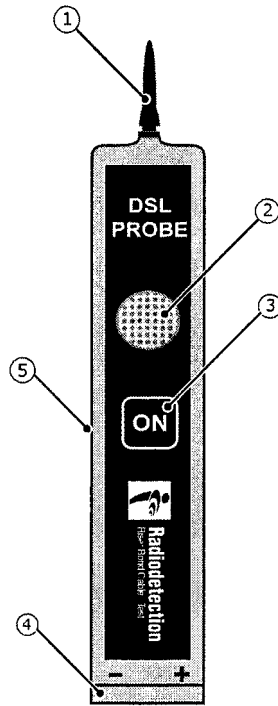
For Example: A remote could be installed at a cross connection to test the pair between the cross connect and the customer. Another remote with a different ID setting could be placed at the Central Office so the complete length of the pair may also be tested.

- If multiple remotes are detected, the Setup Remotes screen will display this.
- Use the **Remote** (softkey 2) and **Set** (softkey 5) keys to select and set the appropriate remote as active.
- Once set as active, the remote can be controlled using the **Mode** (softkey 4) and **Set Mode** (softkey 5) keys.

NOTE: When using remotes in series, ensure that the first remote in the series is set to Through, otherwise you will not be able to access the other remotes along the cable.

14.3 RD6000DSL Probe

The RD6000DSL probe detects identification tones (warble tones) placed onto a cable by the RD6000DSL Remote Device. This is used for identifying a particular cable in a crowded duct.



1. **Probe Point:** Detects the identification tone (warble tone)
2. **Speaker:** Sounds, when an identification tone (warble tone) is detected
3. **On Button:** When pressed, allows the probe to detect the identification tone
4. **Battery Compartment:** Houses a single 9V battery
5. **Headphone Socket:** Jack for connection of headphones, for use in noisy environment

Section 7: Utilities

The utilities section provides access to useful tools and features to help with the cable test process

7.1 Records List

This provides a listing of all saved records in the RD6000DSL memory, with options to upload, delete or recall.

- From the RD6000DSL Start screen, press **Utilities** (softkey 2)
- The display will change, press **Records List** (softkey 3)
- Use **Select** (softkeys 2 & 3) to move up and down the list
- Once you have selected the record you can upload, delete or recall the record using the other softkey options displayed

7.2 Remote Device

This allows you to select and configure any remote devices you may wish to use.

See Section 14 for more information on the RD6000DSL Remote Device.

7.3 Telephone

This allows you to use the RD6000DSL as a telephone. Use the number keypad to enter a number and press **Call** (softkey 1) to make the call. You also have options to Clear the number. Mute and adjust the Volume.

Memory (softkey 5) allows you to enter, select and recall stored phone numbers.

To connect the RD6000DSL in order to use the telephone feature use the typical connection outlined in Section 6.5.1.

Section 8: Multi-Meter Functions

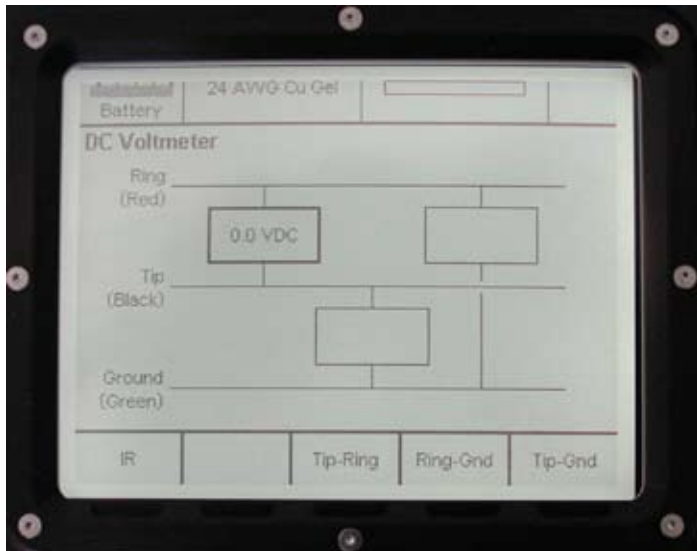
The RD6000DSL multi-meter is used to make various electrical measurements on the cables under test.

8.1 To Measure DC or AC Volts

This is used to check the magnitude of any voltages present on the network. A telephone system usually works at 48V or 60V DC, so this should be present when connected. When disconnected from the exchange the DC voltage should be zero.

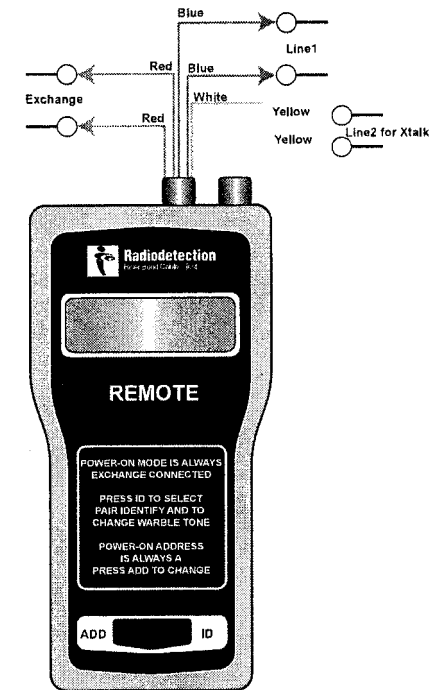
No AC voltage should be present, however a small voltage may be detected. If this is below 2V, there is no real cause for concern

- Connect to the pair using the typical connection outlined in Section 6.5.1
- From the RD6000DSL Start screen, press **Multi-Meter** (softkey 3)
- The display will change, press either **DC Voltmeter** (softkey 1) or **AC Voltmeter** (softkey 2)
- You will be presented with the following Voltmeter Screen:



- Press the relevant softkey for the measurement you want to take:
 - Softkey 3: Ring to Tip
 - Softkey 4: Ring to Ground
 - Softkey 5: Tip to Ground

The reading will be displayed in the relevant box on the screen



- The Remote is powered up as soon as a test lead is connected. The display will switch off after 5 seconds to conserve battery life, however, the Remote will remain switched on until the test leads are removed.

NOTE: When operating the Remote Device from within the Central Office or Exchange, use the Power Lead accessory to power the unit.

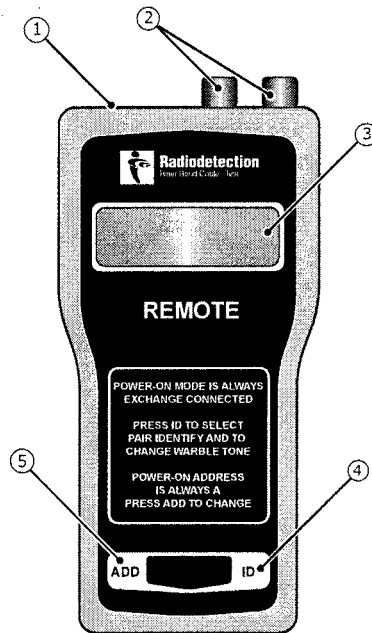
- Press **ADD** to scroll through and select the desired address.

Up to three RD6000DSL Remote Devices can be connected to the pair under test with each individually controlled by the RD6000DSL.

- Press **ID** to activate the identification (warble) tone, if you need to identify a particular line using the RD6000DSL probe.

Further control of the Remote Device is done via the RD6000DSL Remote Device Setup Screen.

14.1 Remote Device Controls & Connections



1. **Power Socket:** For connection of the power lead
2. **Test Lead Sockets:** For connection of Line 1 and Line 2 test leads
3. **Display:** LCD display
4. **ID Key:** Activates the identification (warble) tone
5. **Add Key:** Changes the remote's address (A, B or C)

14.2 Remote Device Setup

- Connect to the test leads as shown on next page:

The standard one meter test lead has two red and two blue leads with alligator clips.

Remove the jumper between the central office and the subscribers line.

Connect the red leads to the Central Office side of the pair and the blue leads to the subscriber line side of the pair.

NOTE: The RD6000DSL Remote Device is connected in series with the pair. Polarity is NOT critical.

8.2 To Measure Foreign Battery or DC Influence

When disconnected from the exchange, this will detect any voltage that may have crept onto the network through joints, etc.

- Connect to the pair using the typical connection (see Section 6.5.1)
 - From the RD6000DSL Start screen press **Multi-Meter** (softkey 3)
 - The display will change, press **Foreign Battery** (softkey 3)
 - You will be presented with the Voltmeter screen
 - Press the relevant softkey for the measurement you want to take:
 - Softkey 4: Ring to Ground
 - Softkey 5: Tip to Ground
- The reading will be displayed in the relevant box on the screen

8.3 To Measure Insulation Resistance (IR)

This will measure the resistance between each conductor and ground. There should be a resistance of tens of MΩ present, if not, there is a problem somewhere along the line.

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Multi-Meter** (softkey 3)
- The display will change, press **IR** (softkey 4)
- You will be presented with the Insulation Resistance-meter screen
- Press Test Voltage (softkey 1) to adjust the Voltage at which you are working. This is displayed in the top right of the screen



CAUTION: Set the Test Voltage to 50V for the initial IR Test. Using a higher voltage may damage equipment still connected to the network. If a full test is required, ensure that the pair is isolated, the exchange battery is disconnected and all other equipment is off the pair.

- Press the relevant softkey for the measurement you want to take:
 - Softkey 3: Ring to Tip
 - Softkey 4: Ring to Ground
 - Softkey 5: Tip to Ground
- The reading will be displayed in the relevant box on the screen

8.4 To Measure Resistance (less than 10kΩ)

With an open circuit this test will measure the resistance between the two wires of a pair. This should be in the region of 10kΩ

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Multi-Meter** (softkey 3)
- The display will change, press **Resistance** (softkey 5)
- You will be presented with the Resistance screen
- Press **Resistance** (softkey 5)
- You will be presented with the Resistance-meter screen
- Press the relevant softkey for the measurement you want to take:
 - Softkey 3: Ring to Tip
 - Softkey 4: Ring to Ground
 - Softkey 5: Tip to Ground

The reading will be displayed in the relevant box on the screen

8.5 To Measure Loop Resistance

When disconnected from the exchange, this test will check the resistance of the copper wires that make up the pair, this will vary with length and cable type but should typically be around 1200Ω. This resistance will be very high if there are breaks in the wire or problems at any joints.

- Connect a Remote Device or Strap to the far end of the pair
- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Multi-Meter** (softkey 3)
- The display will change, press **Resistance** (softkey 4)
- You will be presented with the Resistance screen
- Press **Loop Resistance** (softkey 4)
- You will be presented with the Resistance-meter screen
- The reading will be taken and displayed on the screen automatically

8.6 To Measure Resistive Difference

This will measure the resistive difference in ohms between Tip & Ground and Ring & Ground.

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Multi-Meter** (softkey 3)
- The display will change, press **Resistance** (softkey 4)
- You will be presented with the Resistance screen
- Press **Resistive Difference** (softkey 3)
- You will be presented with the Resistance-meter screen
- The reading will be taken and displayed on the screen automatically

TDR Start: Select whether the TDR will start at the shortest possible range and pulse width or by automatically running a search for major faults.

Stress Voltage: Disables or sets the voltage threshold for the Stress TDR function.

Stress Starts IFD: Selects whether the Stress TDR will automatically start the Intermittent Fault Detection (IFD) feature.

Stress Polarity: Select whether the Stress Polarity is Plus, Minus or Toggled.

Smoothing Filter Sweeps: Select the Smoothing Filter value between 1 and 64.

13.4 TDR Use

- Connect to the pair using the typical connection (section 6.5.1)
- Select the appropriate mode for the tests you wish to perform
- Select the shortest range and pulse width, to examine the cable close to the instrument
- Slowly increase the range to test more of the cable
- Look for any features (reflections) along the waveform

Remember you can overlay example waveforms using the **Loaded Sample** and **Unloaded Sample** options in the TDR menu

- Be sure to scan all the way to the end of the cable section you are testing.

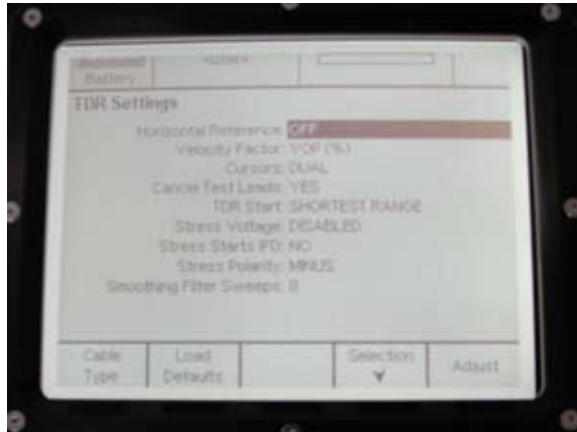
Section 14: RD6000DSL Remote Device

The RD6000DSL Remote Device provides the signal source for Insertion Loss and Crosstalk tests and can also be used to remotely control the far end of the cable under test.

The Remote Device can open, short (strap) and connect the pair through the Central Office. It also provides a warble tone to help identify the pair.

13.3 TDR Setup

- From the RD6000DSL start screen press Fault Location (softkey 5)
- The display will change, press **TDR** (softkey 4)
- The display will change, press **Control** (softkey 3), until Settings is displayed
- Press **Settings** (softkey 1), you will be presented with the TDR settings screen
- Adjust the on screen setup parameters using the **Select** and **Adjust** keys
- The RD6000DSL default settings are shown below. You can always return to these by pressing **Load All Defaults** (softkey 2)
- Press **End/Back** to return to the TDR screen



13.3.1 TDR Setup Parameters

Horizontal Reference: Selects whether a horizontal (x-axis) reference line is displayed.

Velocity Factor: Selects how the velocity of propagation is displayed, as either VOP (%) - a percentage of the speed of light, or $V/2$ (m/ μ s) - meters per micro-second, divided by two.

Cursors: Select single or dual cursors

NOTE: If dual cursors are selected, an extra option will appear in the TDR menu to control the second cursor. Press Control (softkey 3) until cursor is displayed. The distance displayed is the distance between the two cursors.

Cancel Test Leads: Selecting YES, will subtract the length of the test leads from the distance between the cursors.

Section 9: POTS Pair Quality Tests

The RD6000DSL pair quality functions are used to make various electrical measurements on the cables under test to determine their quality and integrity. These tests are split into two sections, POTS and Wideband.

9.1 To Measure Loop Current

When connected to the exchange, a current of 20mA should be present. If this cannot be detected then there is a problem somewhere along the line.

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Pair Quality** (softkey 4)
- The display will change, press **POTS** (softkey 4)
- The display will change, press **Loop Current** (softkey 2)
- You will be presented with the Meter screen
- The reading will be taken and displayed on the screen automatically

9.2 To Measure Signal to Noise Ratio

NOTE: An RD6000DSL Remote Device should be used for this test. See Section 14 (page 40) for connection and operation details.

This test will provide you with a ratio of the amount of signal compared to the amount of noise on the line

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Pair Quality** (softkey 4)
- The display will change, press **POTS** (softkey 4)
- The display will change, press **Loop Current** (softkey 2)
- You will be presented with the Meter screen
- Use the Select and Adjust keys to set your test parameters
- Press **Start** to begin the test

Test Parameters:	Ω
Noise Filter:	Psophometric / 3kHz Flat
Frequency:	CCITT / ITU-T / USA
Near End:	600 Term / 900 Ω Term / TN 12 Term
Far End:	600 Ω Term / 900 Ω Term / TN 12 Term

9.3 To Measure Noise Metallic

NOTE: An RD6000DSL Remote Device should be used for this test. See Section 14 (page 40) for connection and operation details.

This test will provide a reading to give an idea of the amount of general noise on the circuit. Acceptable limits are usually set by the network operator. See Section 9.8.

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Pair Quality** (softkey 4)
- The display will change, press **POTS** (softkey 4)
- The display will change, press **Noise** (softkey 4)
- You will be presented with the Noise screen
- Press **Select Filter** (softkey 1) to select the desired noise filter
- Press **Noise Metallic** (softkey 4)
- An average and a peak reading will be displayed on the screen

Noise Filter Options:

Noise Filter: Psophometric / C-weighted / 3kHz Flat

9.4 To Measure Power Influence

NOTE: An RD6000DSL Remote Device should be used for this test. See Section 14 (page 40) for connection and operation details.

This test will provide a reading to give an idea of the amount of induced voltage, etc., on the line. Acceptable limits are usually set by the network operator. See Section 9.8.

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Pair Quality** (softkey 4)
- The display will change, press **POTS** (softkey 4)
- The display will change, press **Noise** (softkey 4)
- You will be presented with the Noise screen
- Press **Select Filter** (softkey 1) to select the desired noise filter
- Press **Power Influence** (softkey 6)
- Readings for Power Influence and Calculated Balance will be displayed on the screen

Noise Filter Options:

Noise Filter: Psophometric / C-weighted / 3kHz Flat

Unloaded Sample (softkey 4), Loaded Sample (softkey 5)

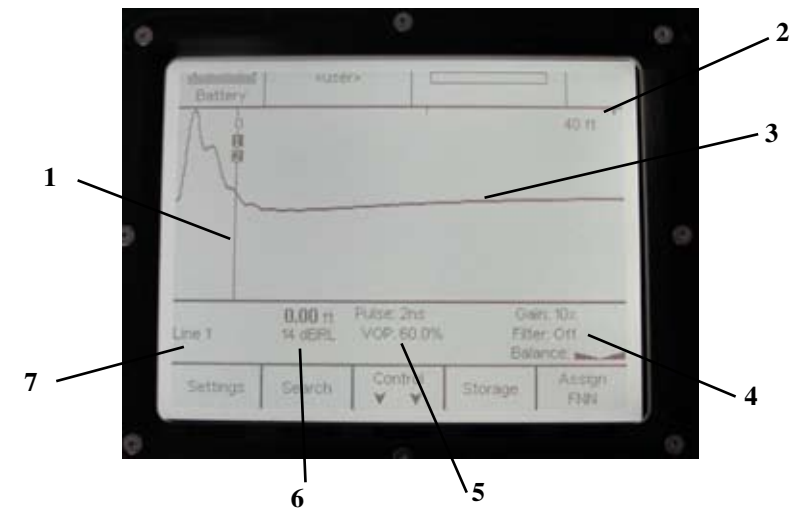
Press **Control** (softkey 3) until the softkey menu displays Unloaded Sample and Loaded Sample. This provides access to a series of sample waveforms.

Highpass On/Highpass Off (softkey 1)

Press **Control** (softkey 3) until the softkey menu displays Highpass On or Highpass Off. This toggles the high pass filter on and off.

13.2 TDR Display

The keys on the right hand side of the RD6000DSL are used to perform the main waveform analysis functions as described in section 3.1.



1. **Cursor:** On-screen cursor, for making significant points along a waveform
2. **Scale:** Indicates the current scale
3. **Waveform:** Waveform displayed indicating features along the cable under test.
4. **Gain, Filter & Balance:** Indicates the selected Gain, Filter and Balance values.
5. **Pulse and VOP:** Indicates the selected Pulse Width and Velocity of Propagation (VOP) values.
6. **Cursor position:** Indicates the cursor position in terms of the distance along the cable under test.
7. **Mode:** Indicates the selected mode of operation.

Pulse Width (softkeys 4 & 5)

Press **Control** (softkey 3) until the softkey menu displays Pulse Width. These keys can be used to increase and decrease the pulse width of the output TDR signal.

Balance (softkeys 1 & 2)

Press **Control** (softkey 3) until the softkey menu displays Balance. These keys can be used to adjust the output balance circuit.

Filter (softkeys 4 & 5)

Press **Control** (softkey 3) until the softkey menu displays Filter. These keys can be used to scroll through the available software filters.

Filters available:

Off; 4 x Ave; 8 x Ave; 16 x Ave; 32 x Ave; 64 x Ave; 128 x Ave;
50/60Hz

Settings (softkey 1)

Press **Control** (softkey 3) until the softkey menu displays Settings. From here you can set various TDR preferences.

Search (softkey 2)

Press **Control** (softkey 3) until the softkey menu displays Search. This will automatically search the cable for major faults.

Storage (softkey 4)

Press **Control** (softkey 3) until the softkey menu displays Storage. This gives access to the TDR waveform memory store.

Assign FNN (softkey 5)

Press **Control** (softkey 3) until the softkey menu displays Assign FNN. This allows you to assign an FNN or Work Order number.

Short Osc/Open Osc (softkey 1)

Press **Control** (softkey 3) until the softkey menu displays Short Osc or Open Osc. This controls the RD6000DSL Remote Device to open or short the circuit.

Hold to Stress (softkey 2)

Press **Control** (softkey 3) until the softkey menu displays Hold To. If the Stress TDR is enabled under the TDR Settings, this will apply a voltage (50V or 100V) to the line to locate high-resistance faults, such as water ingress.

9.5 To Measure Longitudinal Balance

This test is concerned with the balance of signal on the two wires forming a pair. If the signals are not balanced then signal leakage can occur (especially at the ends of the pair). It may also affect the cancelling of unwanted signals usually eliminated by the twisting. Acceptable limits are usually set by the network operator.

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Pair Quality** (softkey 4)
- The display will change, press **POTS** (softkey 4)
- The display will change, press **Balance** (softkey 5)
- You will be presented with the Meter screen
- The reading will be taken and displayed on the screen automatically

9.6 To Measure POTS Insertion Loss

NOTE: An RD6000DSL Remote Device should be used for this test. See Section 14 (page 40) for connection and operation details.

This test is used to measure the insertion loss of a pair at a specific frequency and give an idea of its transmission characteristics. The RD6000DSL Remote Device is required to provide test tones and must be connected to the end of the pair as it will act as both the signal source and termination.

V.90: Provides a sweep across the V.90 test frequencies

Sweep: Provides a sweep across entire voice band

Slope: Measures insertion loss and slope across the standard three POTS test frequencies; ITU-T, CCITT & USA

Single: Measures insertion loss at a single POTS frequency

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Pair Quality** (softkey 4)
- The display will change, press **POTS** (softkey 4)
- The display will change, press **Control** (softkey 1), to display more test options
- Press **Insertion Loss** (softkey 4)
- Select the type of test you wish to perform by pressing the relevant softkey
- You will be presented with the meter screen, adjust the on screen test parameters and press **Start** (softkey 5)
- The readings will be taken and the results displayed on screen

Termination impedances can be selected for all insertion loss tests for both the Remote Device and the RD6000DSL.

Terminations available:

Near End: 600Ω Term / 900Ω Term / TN 12 Term
 Far End: 600Ω Term / 900Ω Term / TN 12 Term

9.7 To Measure POTS Crosstalk

NOTE: An RD6000DSL Remote Device should be used for this test. See Section 14 (page 40) for connection and operation details.

This test is used to measure the near (NEXT) and far (FEXT) end crosstalk characteristics of a pair. The RD6000DSL Remote Device is required to provide test tones and must be connected to the end of the pair as it will act as both the signal source and termination.

There are two different types of measurement available for both near (NEXT) and far (FEXT) end crosstalk:

Sweep: Provides a sweep across entire voice band

Single: Measures insertion loss at a single POTS frequency

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Pair Quality** (softkey 4)
- The display will change, press **POTS** (softkey 4)
- The display will change, press **Control** (softkey 1), to display more test options
- Press **Crosstalk** (softkey 4)
- Select the type of test you wish to perform by pressing the relevant softkey
- You will be presented with the meter screen, adjust the on screen test parameters and press **Start** (softkey 5)
- The readings will be taken and the results displayed on screen

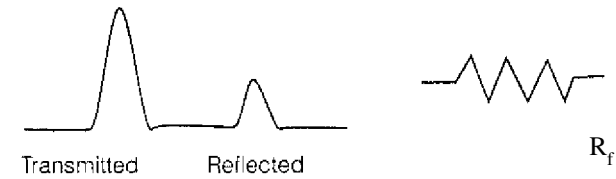
Termination impedances can be selected for all insertion loss tests for both the Remote Device and the RD6000DSL.

Terminations available:

Near End: 600Ω Term / 900Ω Term / TN 12 Term
 Far End: 600Ω Term / 900Ω Term / TN 12 Term

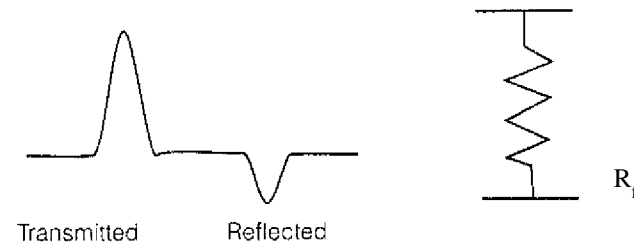
Sample Waveforms:

- An open circuit, or high series impedance fault



NOTE: The reflection is positive, or in phase with the transmitted pulse, therefore the higher R_f , the bigger the reflection.

- A short circuit or low shunt impedance fault



NOTE: The reflection is negative or out of phase with the transmitted pulse, therefore the higher R_f , the smaller the reflection.

13.1 TDR Controls

The keys on the right hand side of the RD6000DSL are used to perform the main waveform analysis functions as described in section 3.1.

When in TDR mode the softkeys perform a number of tasks dependent on which section of the TDR menu you are in.

However, throughout the TDR softkey menu, system **Softkey 3** acts as the **Control** to scroll through the menu options.

Softkey Menu Options:

VOP (softkeys 1 & 2)

Press **Control** (softkey 3) until the softkey menu displays VOP. These keys can be used to increase and decrease the Velocity of Propagation (VOP) for the cable.

NOTE: On the TDR screen the “F” cursor indicates the distance to the fault and the “S” cursor indicates the distance to the strap.

- Relocate (softkey 3): Runs the same RFL test again
- New Pair (softkey 4): Allows you to select a new RFL test
- Short/Open Remote Device (softkey 5): Shorts or opens the RD6000DSL Remote Device (if connected) to determine the end of the cable

Section 13: TDR Operation

The RD6000DSL includes a full function Time Domain Reflectometer (TDR), which provides a visual indication of cable faults along with a means of locating them.

When two insulated conductors are placed close together they form a transmission line with a characteristic impedance. A TDR looks for a change in this impedance, which can be caused by a number of things including: cable damage, water ingress, a change in cable type and improper installation or even manufacturing flaws.

Pulses are transmitted along a cable via two metallic elements such as a pair of conductors or a single conductor and the metallic cable sheath. Any imperfections and impedance mismatches in the cable will reflect a proportion of the pulse energy, dependent on the imperfection or mismatch. The distance to the fault can then be calculated, as it is proportional to the time taken for the pulse to travel along the cable to the fault and reflect back.

The RD6000DSL displays both the transmitted and reflected pulse, with the distance to the fault displayed when the cursor is positioned at the beginning of the reflected pulse. The type of fault can then be determined by analysis of the displayed waveform.

NOTE: In order for this process to work the cable must contain at least two conductors, or one conductor and a metallic sheath.

9.8 Pair Quality Guide Readings

The following table provides a guide for acceptable and unacceptable readings. The information contained in this table is not definitive and is intended as a guide only.

Acceptable limits are usually set by the network operator.

	Good	Fair	Bad
Noise Metallic	<= 20 dBnC <= -70 dBmp	21 to 30 dBnC -69 to -60 dBmp	> 30 dBnC > -60 dBmp
Power Influence	<= 80 dBnC <= -10 dBmp	81 to 90 dBnC -9 to 0 dBmp	> 90 dBnC > 0 dBmp
Long. Balance	> 69 dB	50 to 60 dB	< 50 dB

Section 10: Wideband Pair Quality Tests

The RD6000DSL pair quality functions are used to make various electrical measurements on the cables under test to determine their quality and integrity. These tests are split into two sections, POTS and Wideband.

10.1 To Measure IR Factor

NOTE: An RD6000DSL Remote Device should be used for this test. See Section 14 (page 40) for connection and operation details.

This test is used to determine the quality of the insulation of the cable by performing a capacitance check and then checking the Insulation Resistance of the pair by performing an IR test. The result is shown for A-B, A-Earth and B-Earth as a number and GOOD or BAD

- Connect the pair using the typical connection (section 6.5.1)
- From the RD6000DSL start screen press **Pair Quality** (softkey 4)
- The display will change, press **Wideband** (softkey 5)
- Press **IR Factor** (softkey 1)
- Press **Start**
- The readings will be taken and the results displayed on the screen

10.2 To Measure Wideband Insertion Loss

NOTE: An RD6000DSL Remote Device should be used for this test. See Section 14 (page 40) for connections and operation details.

This test is used to measure the insertion loss of a pair at a specific frequency and give an idea of its transmission characteristics. The RD6000DSL Remote Device is required to provide test tones and must be connected to the end of the pair as it will act as both the signal source and termination.

There are two different types of insertion loss measurement available

Sweep: Provides a sweep across entire voice band
Single: Measures insertion loss at a single POTS frequency

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Pair Quality** (softkey 4)
- The display will change, press **Wideband** (softkey 5)
- Press **Insertion Loss** (softkey 2)
- Select the type of test you wish to perform by pressing the relevant softkey
- You will be presented with the meter screen, adjust the on screen test para-

If the distance to the strap point is not known:

- Press **Settings** (softkey 1)
- Press **Cable Type** (softkey 1)
- Use the Select and Adjust keys to ensure that the correct cable type is selected
- Press **End/Back** twice to return to the RFL Test screen
- Once back at the RFL Test screen, press **Test** (softkey 5)

NOTE: The RD6000DSL will tell you when the strap should be connected.

- The RD6000DSL will measure the fault value, then check that the pair is shorted (strapped) at the end. The distance to the strap and to the fault will then be calculated.

NOTE: To ensure accurate results:

The fault ratio between the conductors must be at least 2 to 1. For example, if the “good” wire has a fault of $2M\Omega$ the fault on the bad wire must be less than $1M\Omega$.

The loop resistance must be 100 times smaller than the sum of the two faults. For example, if one fault is $10k\Omega$ and the other is $90k\Omega$ ($10+90=100k\Omega$), then the loop resistance must be 1000Ω or less.

12.2.4 Multiple Gauge Cables

If a cable has multiple sections of different gauge cables and cable types, you can use the DTS Setup screens to fully define each section of the cable run up to a maximum of 10 segments.

- From the RD6000DSL **RFL Test Screen**, press **Setup DTS** (softkey 4)
- Use the Select and Adjust keys to enter the distance and cable type for each section of cable before the strap point.
- Press **End/Back** to return to the RFL Test screen
- Once back at the RFL Test screen, press **Test** (softkey 5)

12.2.5 After the RFL Test

When an RFL test result has been obtained, the softkey functions will change to give you the following options:

- Print (softkey 1): Allows you to print directly to a serial printer if connected.
- Transfer to TDR (softkey 2): Transfers the RFL test result to the integral TDR.

12.2.2 Performing a 3-Wire/4-Wire RFL Test

NOTE: For the 4-Wire test you need two good wires, attach the yellow and black leads to the good wires.

- Connect to the pair using the typical connection (section 6.5.1)
- Connect the strap to the end of the cable

If the distance to the strap point is known:

- Press **Setup DTS** (softkey 4)
- Use the Select and Adjust keys to enter the distance and cable type for each section of cable before the strap point
- Press **End/Back** to return to the RFL Test screen

If the distance to the strap point is not known:

- Press **Settings** (softkey 1)
- Press **Cable Type** (softkey 1)
- Use the Select and Adjust keys to ensure that the correct cable type is selected
- Press **End/Back** twice to return to the RFL Test screen

- Once back at the RFL Test screen, press **Test** (softkey 5)
- The RD6000DSL will measure the fault value, then check that the pair is shorted (strapped) at the end. The distance to the strap and to the fault will then be calculated

NOTE: If a fault is not detected or the strap not detected a warning message will be displayed.

NOTE: The opposite ends of the pair must be strapped together, at a point past the fault, normally at the end of the cable span (A yellow strapping clip is supplied). If the RD6000DSL Remote Device is used, the RD6000DSL will automatically control it to provide strapping functions during RFL tests.

12.2.3 Performing a Kupfmuller RFL Test

- Connect to the pair using the typical connection (section 6.5.1)

If the distance to the strap point is known:

- Press **Setup DTS** (softkey 4)
- Use the Select and Adjust keys to enter the distance and cable type for each section of cable before the strap point
- Press **End/Back** to return to the RFL Test screen

meters and press **Start** (softkey 5)

- The readings will be taken and the results displayed on screen

Termination impedances can be selected for all insertion loss tests for both the Remote Device and the RD6000DSL.

Terminations available:

Near End:	100Ω Term / 120 Ω Term / 135 ΩTerm
Far End:	100Ω Term / 120 Ω Term / 135 ΩTerm

10.3 To Measure Wideband Crosstalk

NOTE: An RD6000DSL Remote Device should be used for this test. See Section 14 (page 40) for connections and operation details.

This test is used to measure the near (NEXT) and far (FEXT) end crosstalk characteristics of a pair. The RD6000DSL Remote Device is required to provide test tones and must be connected to the end of the pair as it will act as both the signal source and termination.

There are two different types of insertion loss measurement available for both near (NEXT) and far (FEXT) end crosstalk:

Sweep: Provides a sweep across entire voice band
Single: Measures insertion loss at a single POTS frequency

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Pair Quality** (softkey 4)
- The display will change, press **Wideband** (softkey 5)
- Press **Crosstalk** (softkey 3)
- Select the type of test you wish to perform by pressing the relevant softkey
- You will be presented with the meter screen, adjust the on screen test parameters and press **Start** (softkey 5)
- The readings will be taken and the results displayed on screen

Termination impedances can be selected for all insertion loss tests for both the Remote Device and the RD6000DSL.

Terminations available:

Near End:	100Ω Term / 120 Ω Term / 135 ΩTerm
Far End:	100Ω Term / 120 Ω Term / 135 ΩTerm

10.4 To Measure Power Spectral Density

This will monitor the power output versus frequency of a digital service or help to check an inactive/faulty pair for signals that may be corrupting a digital service.

There are two different types of PSD measurement available.

Inactive: For when the line is disconnected from the exchange, either via the RD6000DSL Remote or directly. This measures the inactive PSD using the user selected termination.

Active: For when the line is disconnected to the exchange, either via the RD6000DSL Remote or directly. This measures the active PSD using a high impedance termination, without disrupting data services.

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL Start screen, press **Pair Quality** (softkey 4)
- The display will change, press **Wideband** (softkey 5)
- Select either **PSD (Inactive)** (softkey 4), or **PSD (Active)** (softkey 5)
- Select the type of test you wish to perform by pressing the relevant softkey
- You will be presented with the meter screen
- Press **Telco Service** (softkey 1) and use the Select and Set Keys to set the type of service you are testing
- Press **End/Back** to save your selection and return to the PSD screen
- The readings will be taken and the results displayed on the screen automatically

Other options within the PSD screens include:

Assign FNN (softkey 2): Allows you to assign an FNN or work number and save results against it

Print (softkey 3): Allows the PSD results to be printed directly to a printer if connected

Cursor on/off (softkey 4): Toggles the on-screen cursors on and off

Mask on/off (softkey 5): Toggles the on-screen mask on and off

Section 11: Auto Test

The RD6000DSL also has an Auto Test feature which allows you to perform a comprehensive diagnostic test of the pair at the press of a single button.

- Press the relevant softkey for the measurement you want to take:

Softkey 3: Ring to Tip

Softkey 4: Ring to Ground

Softkey 5: Tip to Ground

The reading will be displayed in the relevant box on the screen

- **Transfer to TDR** (softkey 2): Transfers the Cap/Open meter test result to the integral TDR.

NOTE: On the TDR screen the “C” cursor indicates the position of the fault

12.2 Resistive Fault Locator (RFL)

This provides three test modes to locate resistance faults on a pair or a single conductor.

3-Wire: Used when only one leg of a pair is faulty

4-Wire: Used when one leg of a faulty pair is affected and a second good wire is available

Kupfmuller: Used when a good wire cannot be found

There are on-screen diagrams for each test to indicate correct connection and test procedure.

12.2.1 RFL Setup

- From the RD6000DSL start screen press **Fault Location** (softkey 5)
- The display will change, press **RFL** (softkey 5)
- You will be presented with the RFL Test screen
- Press **Settings** (softkey 1)
- You will be presented with the RFL Setup screen

NOTE: The RFL must be configured properly for accurate fault location.

- Use the Select and Adjust keys to set the on-screen parameters

NOTE: Enter the actual cable temperature, NOT the ambient temperature.

- Press **Cable Type** (softkey 1) and use the select and set keys to set the correct cable type
- Press **End/Back** twice to return to the RFL Test screen

Section 12: Fault Location

Having used the Multi-meter, Pair Quality and Auto Test features to determine whether there may be a fault present, the following tools will help you to actually locate that fault.

Type of Fault	Excellent	Good	Fair
Open Circuit	TDR	Open/Cap Meter	
Short Circuit	TDR/RFL		
High Resistance Joint	TDR		
Split Pairs	TDR		
Crosstalk		TDR	
Low Insulation Resistance	RFL		TDR
Low Insulation Resistance to Ground	RFL		TDR
Contact Fault	RFL	TDR	
Earth Fault	RFL	TDR	
Water in Cable		TDR	
Locate Load Coil	TDR		Open/Cap Meter

12.1 Open/Cap Meter

This allows you to measure capacitance to the end of the pair or locate and measure the distance to faults caused by open circuits.

- Connect to the pair using the typical connection (see Section 6.5.1)
- From the RD6000DSL start screen press **Fault Location** (softkey 5)
- The display will change, press **Open/Cap Meter** (softkey 3)
- You will be presented with the Open/Cap Meter screen
- Press **Cable Type** (softkey 1) and use the Select and Set controls to select the appropriate cable type
- Press **End/Back** to return to the Open/Cap Meter screen

The Auto Test Includes:

- DC Volts
- AC Volts
- Loop Current
- Loop Resistance
- Resistance to Distance
- Open DC Volts
- Open AC Volts
- Insulation Resistance
- Capacitance
- Capacitance to Distance
- Longitudinal Balance
- Transverse Noise
- Longitudinal Noise
- Calculated Balance

11.1 To Perform an Auto Test

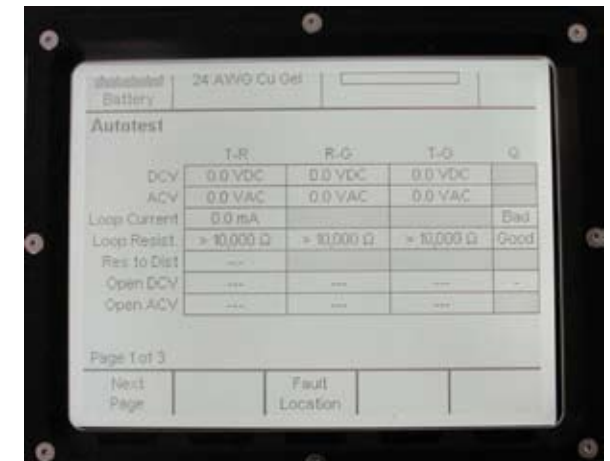
- Connect to the pair using the typical connection (see Section 6.5.1)
- Press **Auto Test** on the left hand side of the RD6000DSL front panel
- You will be presented with the Auto Test Screen, press **Standard** (softkey 5)
- Select whether you will be using the RD6000DSL Remote Device (softkey 4) or No Remote (softkey 5)
- You will be asked to enter an FNN or Work Order Number

NOTE: Use Last FNN (softkey 1) to recall the last FNN or Work Order Number

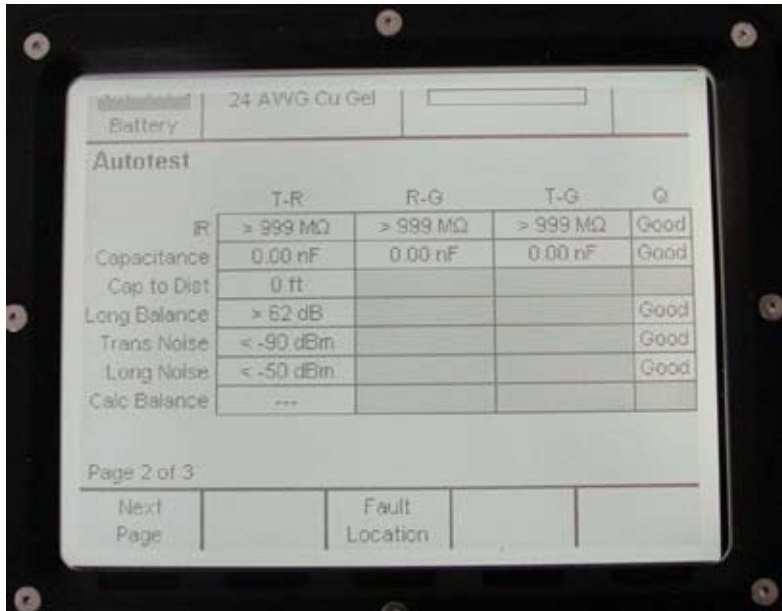
- Press **Start** (softkey 5) to perform a full Auto Test
- Readings will be taken automatically and the results displayed in a table on the screen
- Three screens are required to display all of the Auto Test results. Once the test is complete you can use **Next Page** (softkey 1) to switch between the screens
- The Auto Test results will be stored automatically

The Auto Test results screens are shown below:

Auto Test Screen 1:



Auto Test Screen 2:



Auto Test screen provides a fault report based on the Auto Test results

11.2 Recalling Stored Auto Test Results

- From the RD6000DSL start up screen, press **Auto Test** on the left hand side of the RD6000DSL front panel
- Press **Records List** (softkey 3)
- The screen will change to show a series of memory banks



- Use the **Selection** keys (softkeys 2 & 3) to highlight the memory bank, containing the results you wish to view
- Press **Recall** (softkey 5) to display the Auto Test results

11.3 Deleting Stored Auto Test Results

- From the Auto Test Storage screen, use the **Selection** keys (softkey 2 & 3) to highlight the memory bank, containing the results you wish to view
- Press **Erase** (softkey 4)
- You will be asked to confirm that you wish to delete the selected record
- Press **Yes** (softkey 3) to confirm