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OPERATION MANUAL

T631 TDR

HIGH SPECIFICATION COAXIAL CABLE FAULT LOCATOR

90/00901209-10 ISSUE 10 10/2013

REFER TO PREFACE AND SAFETY INSTRUCTIONS BEFORE OPERATING

Radiodetection®

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1. PREFACE & SAFETY

1.1 HEALTH AND SAFETY AT WORK ACT 1974 SECTION 6.1 (C)

This product is tested and supplied in accordance with published specifications and, when used in normal or prescribed applications and within the parameters specified, it will not cause danger or hazard to health or safety.

All usage of the product must be in accordance with the Operating Manual for this equipment and any work on the electrical components housed within the machine must be undertaken by qualified personnel.

1.2 SAFETY PRECAUTIONS

For connection to live cables up to 600 V RMS use the Bicotest T631F Blocking Filter.

Only fit 3 Ah NiMh cells.

Do not charge the batteries when the ambient temperature is below 0°C.

AC adaptor and its carry pouch are not waterproof.

AC adaptor is for indoor use only.

The main unit is safe and conforms to IEC 1010. The AC adaptor conforms to the manufacturers safety standards.

1.3 BATTERIES

The T631 is provided with a set of 3 Ah rechargeable NiMh cells. These are supplied in the discharged state and must be charged for 24 hours before use. Charge the batteries as described in section 4. Note that full rated capacity may not be achieved for the first three cycles of use.

2. INTRODUCTION

The Model T631 is a pulse reflection (TDR) Cable Test Set, for locating cable faults and evaluating changes in impedance caused by connectors, taps, terminations etc. Pulses transmitted into a cable are reflected by cable imperfections. The transmitted pulse and the reflected pulse(s) are shown on the display. The time taken by the pulse to travel to the fault and return is a measure of the distance to the fault. Distance to fault is displayed on the screen after the cursor is positioned to coincide with the start of the fault pulse. The type of fault can be determined by analysis of the displayed waveform.

Although designed principally for 50, 75 and 93 Ω coaxial cables it is equally effective on other cable types as a fault locator.

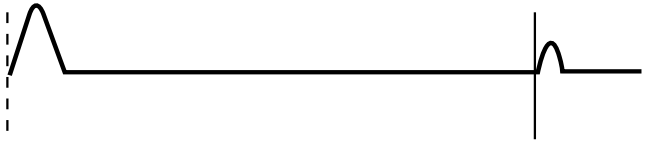
Impedance mismatches can be measured in terms of Return Loss (dBRL) with the location displayed in feet, metres or time.

Principle features include a 15 location memory for trace storage with ability to transfer to a printer or PC, and dual cursors for point to point measurements.

2.1 SAMPLE TRACES

1. Open circuit/high impedance series faults

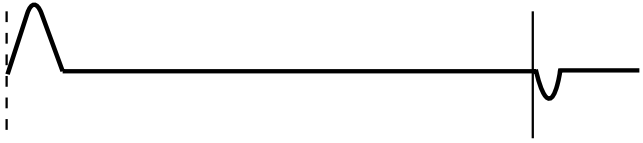
Note: Positive (upward) reflection



Transmit Pulse **Reflected Pulse**

2. Short circuit/low impedance shunt faults

Note: Negative (downward) reflection



Transmit Pulse **Reflected Pulse**

The T631 will display:

a) A “live” trace.

b) A stored trace recalled from the memory.

c) A live and stored trace together for comparison.

d) The difference between a live and stored trace.

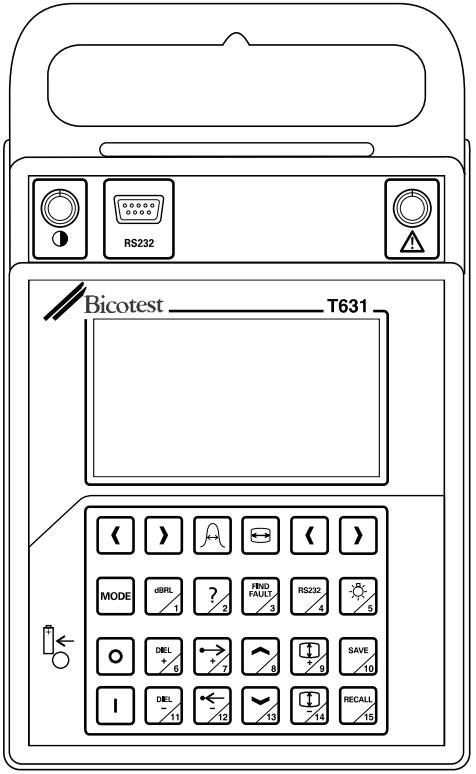
2.2 POWER SOURCE

The T631 is powered by 8 rechargeable cells in a compartment accessible from the rear of the T631, or from an external DC power source via the DC jack.

When operated from batteries, the T631 will automatically switch off before the batteries are completely discharged.

2.3 MAIN FEATURES

Figure 1 shows the front panel of T631.

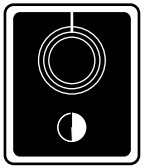


3. FRONT PANEL

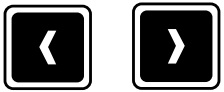
3.1 CONTROLS

Switches the unit ON. To conserve battery life the unit will switch off 5 mins after the last key operation. If automatically switched off all measurement parameters will be restored when switched on again.

Switches the unit OFF. This will reset the instrument to the 6 m range, (or equivalent in feet or time), Gain A1, 2 ns pulse and LINE mode. PVF, units and impedance will remain as they were before switch off.



Rotary control to adjust the contrast of the screen display. It is recommended that it is set to the mid position on switch on to obtain a display.



CURSORS – two independent cursors
Adjusts the position of the appropriate cursor. Cursors move left or right as indicated. If held down the cursor initially moves slowly and will then accelerate. The cursor being moved is displayed as a solid line, the passive cursor is a broken line.

PULSE WIDTHS

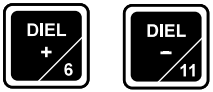
Enables the various pulse widths available on each range to be selected. The pulse widths are either automatically selected (AUTO) or set to a specific value (MANUAL) via the HELP menu.

HORIZONTAL EXPANSION (ZOOM)

Enables the trace about the solid cursor to be expanded by factors of 2, 4 and 8, depending on range selected (see Section 7.7 and Section 12, Specification for further details).

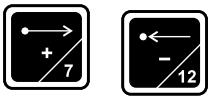
OPERATION

Selects the operating mode (see Section 6 for further details).



DIELECTRIC

Used to set the appropriate velocity factor for the cable dielectric. The value will increment or decrement. If held down the value changes slowly at first and then quickens. Also act as numbers 6 and 11.



RANGE

Selects the displayed range. The range will increase or decrease and if held down will step through the available ranges. Also act as numbers 7 and 12.

SHIFT
Adjusts the vertical position of the live trace. If held down the trace shifts – slowly at first and then quickens. Also act as numbers 8 and 13.

AMPLITUDE
Adjusts the vertical amplitude of the trace. If held down the unit will step through the available gain stages. Also act as numbers 9 and 14.

MEMORY
Enables a live trace to be stored into any of 15 memory locations. Also acts as number 10.

Enables any of 15 stored traces to be recalled. Also acts as number 15.

BACKLIGHT
Switches the display backlight ON and OFF. The backlight will switch off automatically after 5 minutes. Also acts as number 5.

INTERFACE
Calls up a menu from which the displayed trace and data may be transferred to a printer, or memorised waveforms may be transferred to a PC, or reloaded from a PC. Also acts as number 4.

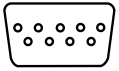
AUTO FAULT FIND
Causes the unit to search for the next significant reflection, starting from the right hand cursor position (see Section 7.8). Also acts as number 3.

HELP MENU
Accesses a “Help” menu for setting machine parameters (see Section 10). Also acts as number 2.

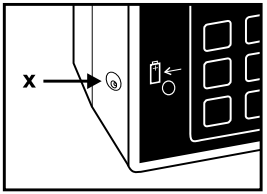
RETURN LOSS
Enables the return loss between the transmitted pulse and a selected reflected pulse to be determined. Also acts as number 1.

3.2 CONNECTORS
Input/Output

BNC socket to connect to the cable under test.

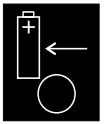


9 way D connector to interface with a printer or PC.



DC jack to supply 12 – 20 V external DC.
Note centre is positive.

3.3 CHARGE INDICATOR
Battery Charging



Charge Indicator illuminates when the internal battery is being charged.

4. POWER SOURCES

4.1 INTERNAL BATTERY

4.1.1 RECHARGING

The cells may be recharged by connecting the AC adaptor to the DC power jack and leaving the equipment switched off. The charge indicator will illuminate while the batteries are being charged. Full charge is achieved in 14 hours. A fully charged battery will give approximately 8 hours operation if the backlight is not used. (see Section 12 'Power Source' for details of charging voltages).

Note: When fitting new cells the initial charge period should be 24 hours and 14 hours thereafter.

4.1.2 MAXIMISING BATTERY LIFE

Do not recharge until the Battery Low warning is displayed.

Do not charge for more than 24 hours.

Stay within the RECOMMENDED temperature limits shown in the specification (Section 12).

4.1.3 REPLACEMENT

Figure 2 shows the rear view of the unit.

Cells are accessed by removing the back cover which is secured by 2 fasteners.

See specification (Section 12) for cell type.

It is recommended that cells are replaced as a set of 8.

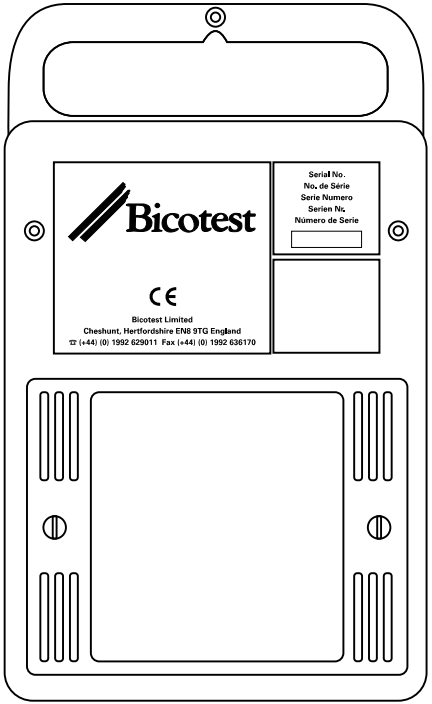


Figure 2 – Battery Access

4.2 EXTERNAL DC

The unit will run from an external 12 – 20 V DC power source via the DC jack. This may be either the AC adaptor or any other DC supply that meets the specification. Centre is positive.

Note that the batteries are charged when external 15 – 20V DC power is applied and the unit is switched off – DO NOT FIT NON-RECHARGEABLE BATTERIES.

4.3 MEMORY BACK UP BATTERY

The memory back up battery is a lithium manganese cell which is part of the main PCB assembly.

The life expectancy is typically four years and replacement is recommended every two years during a routine service to avoid possible loss of stored traces.

5. DISPLAY

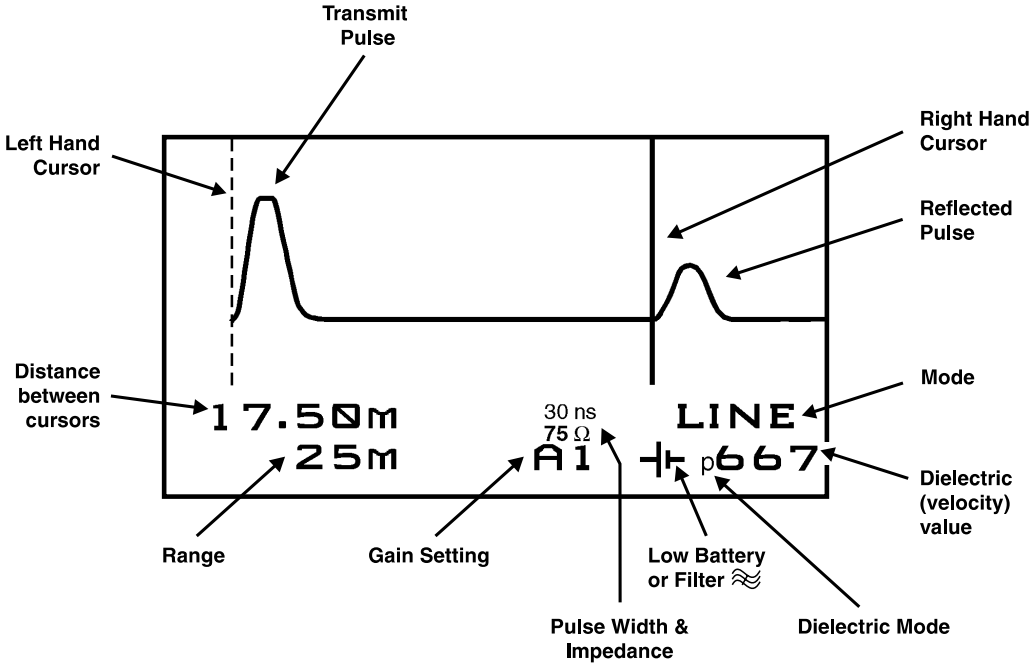


Figure 3 – T631 Display

6. OPERATING MODES

The unit has 4 display modes.

1. **Line (L)** the trace obtained from the cable connected to the BNC socket is displayed.

2. **Memory (M)** the trace from a selected memory is displayed.

3. **Dual (L & M)** the trace obtained from the cable connected to the BNC socket and a selected trace recalled from the memory are displayed simultaneously.

4. **DIFF (L – M)** the trace displayed is the difference between the trace of the cable connected to the BNC socket and a selected trace from the memory.

7. OPERATING INSTRUCTIONS

7.1 GENERAL

For correct operation the cable under test should be taken out of service with all sources of supply removed. If this is not possible and the cable is energised or likely to become energised then the blocking filter accessory should be used.

RF signals present on telecommunications cables may corrupt the display.

7.2 SWITCH-ON

Power the unit from previously charged internal batteries or from the AC adaptor, or external DC source.

Press the on button and the display should appear.

Rotate the contrast control if necessary to obtain a well defined trace.

On receipt from the factory the unit will power up in the LIVE cable mode, on the 6 m range, with the distance read out in metres, a propagation velocity factor (PVF) of 0.667 and impedance 75 Ω.

The left hand cursor, (dotted), will be at the start of the transmitted pulse (0 m). The right hand cursor, (solid), will be approximately one third of the way across the display.

The distance units, impedance and the Propagation Velocity Factor Mode (i.e. PVF, V, or $\frac{V}{2}$) can be re-programmed via the HELP menu and once programmed will be set automatically on switch on thereafter.

Should the unit switch off automatically, the last established machine settings are restored when the unit is switched on.

7.3 PROGRAMMING FROM THE HELP MENU

7.3.1 DISTANCE UNITS

Press HELP key  to obtain the Menu.

Selects UNITS by pressing the key indicated.

Select Feet, Metres or Time by pressing the appropriate key.

7.3.2 DIELECTRIC PARAMETERS

Press HELP key to obtain the Menu.

Select DIELECTRIC by pressing the key indicated.

Select PVF, V, or $\frac{V}{2}$ by pressing the appropriate key.

7.3.3 IMPEDANCE

Press HELP  key to obtain the Menu.

Select IMPEDANCE by pressing the key indicated.

Select 50, 75 or 93 Ω by pressing the appropriate key.

7.3.4 PULSE SELECTION

A fixed pulse width may be selected by pressing HELP, PULSE WIDTH and then choosing the required pulse. This pulse width will then apply to all ranges and the pulse width control will not function until auto is restored, or the unit is switched off.

Auto pulse selection allows the instrument to select a pulse appropriate to the selected range. This mode is selected by pressing HELP and then selecting PULSE WIDTH and AUTO.

7.4 SETTING DIELECTRIC (PVF)

7.4.1 FROM CABLE TYPE

The unit can be directly programmed from the list of cable types contained in the HELP Menu.

To access the Menu, press HELP, press the key appropriate to CABLE TYPE. From the list of options select the appropriate category and then the particular cable type. The available cable types are shown in the following table.

On returning to normal operation the display will confirm the selected PVF value.

Note: The PVF values are nominal values and variations may be encountered. The DIEL keys are then used to set the specific value.

The PVF (DIEL) can also be set using the DIEL controls to the value appropriate to the cable under test.

OPTION	MAIN TYPE	SUB TYPE	DIELECTRIC SETTING	M/μs	
			(PVF)	V	V/2
1	TELEPHONE	POLY PE	0.667	200	100
		JELLY FILLED	0.64	192	96
		PAPER (0.83 uF)	0.72	216	108
		PAPER (0.72 uF)	0.88	264	132
2	POWER	PILC 25 kV	0.54	162	81
		XLPE	0.52	156	78
		MIC	0.41	123	62
3	CATV	QR PARA III	0.88	264	132
		PARA I	0.82	246	123
		T, TR	0.87	261	131
		TX, TX10	0.89	267	134
		RG6, RG11, RG59	0.82	246	123

OPTION	MAIN TYPE	SUB TYPE	DIELECTRIC SETTING	M/μs	
			PVF	V	V/2
4	IBM	TYPE 1	0.78	234	117
		TYPE 2	0.78	234	117
		TYPE 3	0.62	186	93
		TYPE 6	0.78	234	117
		TYPE 9	0.69	207	104
5	DATA	RG58	0.78	234	117
		RG58U	0.66	198	99
		THICK ETHERNET	0.78	234	117
		THIN ETHERNET	0.67	201	101
		RG11, RG6	0.82	246	123

For conversion 1 metre = 3.28 feet.

If the value of the PVF or the cable type is not known then the PVF can be determined as follows.

7.4.2 DIELECTRIC CONSTANT (PERMITTIVITY) KNOWN

$$PVF = \frac{1}{\sqrt{\varepsilon}}$$

Example: For polyethylene ε = 2.25

$$PVF = \frac{1}{\sqrt{2.25}} = 0.667$$

7.4.3 SHORT LENGTH OF SAME TYPE OF CABLE

1. Measure physical length of the sample.
2. Obtain a reading for the apparent length of the cable using any PVF value.
3. Adjust the PVF value until the distance reading indicated is the same as the measured length.

7.5 CONNECTING TO CABLE UNDER TEST

Connect the cable under test directly to the BNC socket or via the test lead supplied.

Unless the LH cursor is moved to coincide with the end of the test lead, the distance read out will include the length of the test lead which must be subtracted from the reading obtained.

7.6 LOCATING A CABLE FAULT

Set the DIEL appropriate to the cable type (see Section 7.4). Select a RANGE to cover the full cable length. Use “AUTO” Pulse Width selection unless a specific pulse width is preferred.

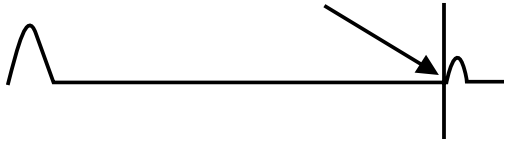
Adjust the AMP controls until the fault reflection is observed.

If the fault reflection is less than halfway across the screen select a shorter range and a narrower pulse width for optimum results.

If there is no fault reflection there are two possibilities.

1. The cable length is longer than its recorded length. In this case increase the range until a reflection is seen.
2. The fault is very close to the position at which the instrument is connected. In this case reduce the range until a reflection is seen. In both cases, use may be made of the auto fault find facility (see Section 7.8).

Adjust the Right Hand cursor controls to bring the RH cursor to the point at which the start of the reflected pulse just leaves the horizontal as shown.



The distance to the fault is as indicated on the LCD.

For closer examination, press ZOOM  to expand the trace and reposition the cursor more precisely.

Remember to subtract the length of the test lead if used.

7.7 USE OF THE LEFT HAND CURSOR

The left hand cursor can be moved to:

1. Eliminate the length of the test lead.

2. Measure between any two features on the trace.

3. When moved the LH cursor becomes the live cursor and changes to a solid line, with the RH cursor becoming a broken line.

7.7.1 ELIMINATING THE LENGTH OF THE TEST LEAD

Connect the test lead to the unit. Select 3 m or 6 m range.

Adjust the controls so that the reflection from the end of the test lead is obtained.

Using the LH cursor controls move the LH cursor to the start of the reflection.

Connect the test lead to the cable under test and locate the fault as described in Section 7.6.

NB: The distance to fault is now that from the end of the test lead.

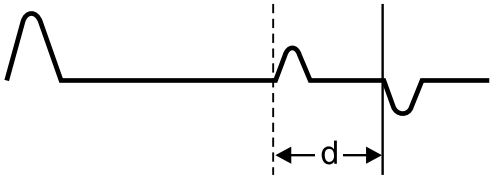
7.7.2 MEASURING BETWEEN TWO FEATURES

Using the LH cursor controls set the LH cursor to the start of the feature on the LH side.

Using the RH cursor controls set the RH cursor to the start of the feature on the RH side.

The RH cursor is then live and becomes a solid line with the LH cursor a broken line.

The distance read out is the distance between the two cursors as shown.



In the ZOOM mode, if a cursor is not on the screen it cannot be moved. Therefore if a measurement

between two features is to be made in ZOOM mode, position cursors at the relevant positions, then ZOOM and make any fine adjustments as necessary. The readout is always the distance between the cursors, even if one is not on the screen. Since expansion takes place around the live (solid) cursor, the ZOOM facility can be activated by either the left or right cursor by moving the relevant cursor and thereby making it solid.

7.7.3 RESETTING THE LH CURSOR

The LH cursor may be reset to `0' for normal measurements by switching the unit off and on.

Note that the instrument is calibrated such that cable lengths are measured from the co-ax socket. Due to the internal wiring of the instrument, this may result in the left hand cursor being set a short distance into the displayed transmit pulse, especially on the short pulses. This is correct and ensures accurate cable length measurements.

7.8 FIND FAULT – ENSURE RANGE SETTING IS FULL AND NOT EXPANDED (ZOOM)

The “FIND FAULT” function is a means whereby the unit will automatically scan a cable and locate the nearest significant feature and configure the parameters of the unit to optimally display the feature.

Pressing the key a second or subsequent time locates the next significant feature along the cable.

It is essential that the PVF is set to the value appropriate to the cable type in order that distance measurements are accurate (see Section 7.4).

Having obtained the display the parameters may then be altered if required.

This feature is intended for use on coaxial cables where the reflection from a fault may be quite small, so the sensitivity used is quite high. On a power cable or twisted pair telephone cable, mismatches due to joints, or change of cable type may give rise to many reflections which the instrument will detect even though they are not faults.

7.8.1 OPERATION

The FIND FAULT function starts at the location of the RH cursor and searches to the right. Therefore for a full search the RH cursor should first be placed just to the right of the transmit pulse.

Pressing the FIND FAULT key will start the search. This may take several seconds. While searching, “AFF” is displayed in place of the usual mode display.

Searching is carried out on all ranges from the one appropriate to the starting cursor position (6 m range if the cursor starts on zero) to 12 Km. Gain and Pulse Widths appropriate to the range are used.

When a fault is found, the unit will beep twice and place the RH cursor just before the fault. If no fault is found the unit will beep 4 times, and return to the original conditions.

Pressing FIND FAULT again will cause the next fault to be found. Note that “FIND FAULT” may change the machine settings.

7.9 RETURN LOSS (dBRL) MEASUREMENTS

The T631 has two principles of operation.

1. Simple fault location.

2. Qualitative measurement and location.

In the Simple Fault Location mode the pulse width is automatically selected with each range to one best suited to provide a strong reflection from the fault, in order to easily identify and locate it. No significant conclusion can be drawn from the amplitude of the reflected pulse although its polarity is indicative of the type of fault.

i.e. Upwards – positive – high series impedance

Downwards – negative – low shunt impedance

In order to gain a measure of the significance of the reflection it is necessary to compare the amplitude of the reflected pulse with that of the transmitted pulse.

The amplitude of the reflection resulting from an impedance change, relative to that of the transmitted pulse is a measure of the impedance mismatch at that point and the ratio is referred to as the reflection coefficient.

Reflection coefficient $\rho = \frac{Ar}{At}$ where

Ar = amplitude of reflected pulse

At = amplitude of transmitted pulse

The amplitude of the reflected pulse cannot normally exceed that of the transmitted pulse and therefore the reflection co-efficient cannot exceed unity. It is usual therefore to express the reflection in percentage terms or millirhos (mρ) where:

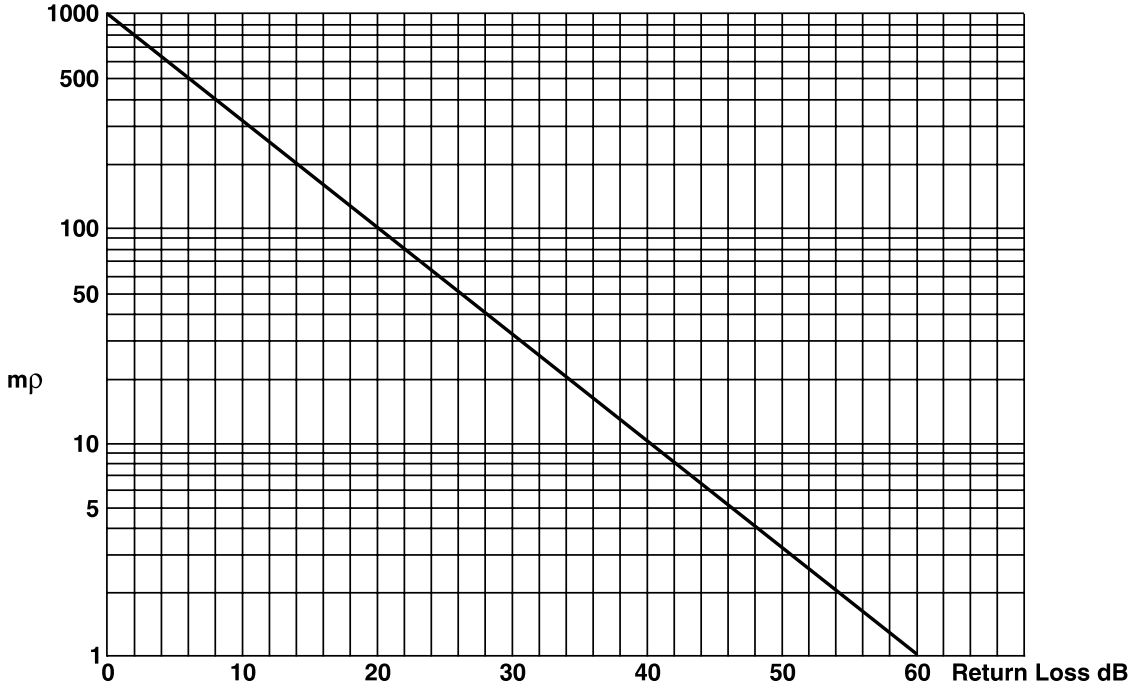
1000 mρ = 1 rho = 100 % reflection

Impedance mismatches can also be expressed logarithmically in terms of Return Loss where:

Return Loss = $20 \log_{10} \frac{At}{Ar}$ dB

or Return Loss = $20 \log_{10} \frac{1}{\rho}$ dB

A conversion chart is given below:



Reflection Coefficient/Return Loss Conversion Chart

The foregoing assumes an ideal “lossless" cable. In practice, measurements obtained include the effect of pulse attenuation due to cable loss and requires correction in order to obtain true return loss.

i.e. True Return Loss = Measured Return Loss – Pulse Attenuation

Since the amplitude of the reflection varies with the pulse width it is essential when determining Return Loss to use the SAME PULSE WIDTH for all measurements.

This is facilitated by the HELP Menu. Press HELP  and then the appropriate key for PULSE WIDTH. From the list of options select the pulse appropriate to the measurement. On returning to the trace the selected pulse width will be confirmed on the display, and the PULSE key will be inoperative.

The output impedance of the T631 must be set to match the impedance of the cable under test.

7.9.1 MEASUREMENT OF RETURN LOSS (dBRL)

Through the HELP Menu select the IMPEDANCE to match the cable under test.

Similarly select the PULSE WIDTH appropriate to the measurement.

To minimise any possible mismatches the cable under test should be connected directly to the unit using matched connectors.

Select the appropriate RANGE & PVF.

Set the AMP to A1 (0 db) on the LCD.

Ensure that the LH cursor is set to the start of the transmitted pulse or a particular pulse if an interfeature measurement is required.

Increase the AMP control until the desired reflection is obtained.

Move the RH cursor to coincide with the start of the reflected pulse.

Check the distance reading to confirm the location - note the distance.

Press dBRL and the Return Loss in dB will be calculated and displayed on the LCD together with the corresponding reflection co-efficient.

The result is “Measured Return Loss” which requires correction for Pulse Attenuation.

Press RS232 key to print results. **Note:** this option is not displayed on screen but is available. Ensure printer lead is plugged into the instrument and printer and that the printer is ready to print (see section 9).

Press key 8 to return to normal operation.

Notes

a) Note that a positive dB value (or mrho value <1000) indicates a return loss (i.e. the reflection is smaller than the transmit pulse). Under certain conditions it is possible for the reflection to have a greater voltage amplitude than the transmit pulse. In this case the dB value will be shown as negative and the mrho figure will be greater than 1000.

b) If the return loss is outside the range of the instrument then XXX dB and XXX mρ will be displayed.

c) The position of the cursor prior to pressing dBRL is important as the signal level at that point is used as the zero reference. Be sure to place the cursor on the flat section of the trace just before the pulse.

d) When measuring very small reflections switching the filter in can improve the performance of the return loss function.

7.9.2 MEASUREMENT OF PULSE ATTENUATION

This should be determined using a sample length of the same type of cable as that under test.

Connect the cable directly to the T631 with the end shorted or open.

Measure the Return Loss and the length. Since the cable ends provides a 100% (0dB) reflection, the loss measured is entirely due to the pulse attenuation.

Divide the loss obtained by the cable length and obtain the pulse attenuation loss in dB per metre or per foot.

Multiply by the distance reading for the cable length noted in the Return Loss measurement to obtain the appropriate pulse attenuation.

Obtain the TRUE RETURN LOSS from:

True Return Loss = Measured Return Loss – Pulse Attenuation.

Note: Pulse Attenuation (Cable Loss) is frequency dependent and will be higher for narrow pulse widths than wider pulse widths. The pulse width used for measuring pulse attenuation MUST be the same as that used to measure the Return Loss.

A library of Pulse Attenuation (Cable Loss) for different cable types for different pulse widths can be compiled using the procedure detailed in “Measurement of Pulse Attenuation”.

7.10 FILTER

A low pass filter is available from the Help menu. It is used to reduce noise, especially on high gain settings. It should not be used with the 2 ns and 10 ns pulses.

8. USE OF THE MEMORY

8.1 STORING A TRACE

Obtain the desired LIVE trace using the method previously described in Section 7.

Press the SAVE key and then select the desired Memory location by pressing the appropriate key.

The live trace is now stored in the selected memory location, together with the associated machine settings.

Any trace present in the memory will be overwritten and lost.

8.2 RECALLING A STORED TRACE

Press the RECALL key and then select the desired memory location.

The stored trace will then be displayed on the LCD and memory location confirmed.

The machine parameters are set in accordance with the stored trace, and cannot be altered.

8.3 COMPARING A LIVE AND STORED TRACE

Press the MODE key and select L & M. The displayed memory waveform will be the last one that was accessed by either SAVE or RECALL.

Recall the appropriate stored trace from memory as described earlier.

The machine parameters are set in accordance with the stored trace.

If not already connected to the cable under test, connect to the cable and observe that both the live trace and the recalled trace are overlaid.

The SHIFT control may be used to separate the traces for easier identification and comparison. The live trace moves relative to the stored trace.

8.4 DIFFERENCE BETWEEN A LIVE AND STORED TRACE

Press the MODE key and then select L – M.

Recall the appropriate stored trace from memory as described earlier. The machine parameters are set in accordance with the stored trace.

If not already connected to the cable under test, connect to the cable and observe the trace which is the difference between the live and recalled trace.

To view the LIVE trace and recalled trace separately use the MODE key and then select LIVE (L) OR MEMORY (M) as required.

8.5 HELP MENU

When in the MEMORY mode, if the HELP menu is accessed, those keys that affect set parameters are disabled.

9. RS232 – PRINTING AND PC INTERFACE

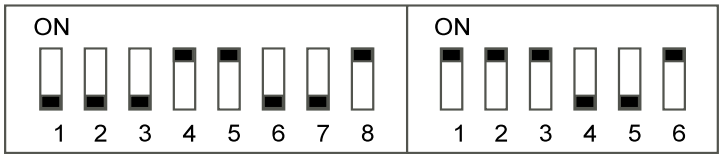
Screen information and Memory contents can be transferred to a printer or PC via the RS232 interface.

9.1 PRINTING

A suitable printer is the Seiko DPU 411 – 21B available in 220 V 50 Hz or 120 V 60 Hz versions. Other printers may require a different interface cable and printer set-up and details of the RS232 interface is given in the specification Section 12.

9.2 PRINTER SET-UP SEIKO DPU 411-21B

The DIP switch on the printer must be set as shown below.



Connect the interface cable supplied with the printer between the printer and the RS232 port.

Obtain the required display on the screen, either a live trace, a recalled memory trace, or an L & M or L – M trace.

Depress the RS232 key and select menu option 1 “PRINTER”. The display will then display “PRINTING” as the data is transferred to the printer.

9.3 PC TRANSFER

A PC software kit, X600 TRACEability™ is available. This enables a cable database to be established. Data from all memories can be transmitted to, and received from, a PC. See the manual supplied with the software for full instructions.

10. HELP MENU MACHINE SET UP

1. Impedance	
93Ω	1
75Ω	2
50Ω	3
Help Menu	7
Operation	8

2. Filter	
Filter ON/OFF	

3. Units	
Feet	1
Metres	2
Time	3
Help Menu	7
Operation	8

4. Dielectric	
PVF	1
V	2
V/2	3
Help Menu	7
Operation	8

5. Cable Type	
Telephone	1
Power	2
CATV	4
IBM	4
Data	5
Help Menu	7
Operation	8

6. Pulse Width	
2 ns	1
10 ns	2
30 ns	3
100 ns	4
300 ns	5
1200 ns	6
Auto	7
Operation	8

7. Help Text	
Explanation	1
	2
	3
	4
	6
	7
	8

8. Operation

11. ERROR MESSAGES

When switched on the T631 performs a self test. If it fails the following message is displayed:

INTERNAL MALFUNCTION ERROR XX

PLEASE REFER TO MANUAL

Please contact your supplier and report the error number.

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12. SPECIFICATION

All specifications in this section assume a PVF of 0.667.
1 metre is equivalent to 3.28 feet or 10 nanoseconds.

RANGES AND RESOLUTION:

Maximum Displayed Range Nominal	Horizontal Expansion (Zoom)	Resolution at Max Zoom
3 m	x1	13 mm
6 m	x1	26 mm
12 m	x1, x2	26 mm
25 m	x1, x2, x4	26 mm
50 m	x1, x2, x4, x8	26 mm
100 m	x1, x2, x4, x8	52 mm
200 m	x1, x2, x4, x8	0.1 m
400 m	x1, x2, x4, x8	0.2 m
800 m	x1, x2, x4, x8	0.4 m
1600 m	x1, x2, x4, x8	0.8 m
3200 m	x1, x2, x4, x8	1.6 m
6400 m	x1, x2, x4, x8	3.2 m
12800 m	x1, x2, x4, x8	6.4 m

Accuracy	Typically <0.5% (48 m range and above)
Dielectric	PVF 0.300 - 0.999 V 90 - 300 m/μs V/2 45 - 150 m/μs
Cursors	2
Pulse Characteristics:	
Waveform	Sine Squared
Amplitude	Nominally 2.5 V into selected impedance
Pulse Widths	2, 10, 30, 100, 300, 1200 ns half height nominal
Source Impedance	50, 75 or 93 Ω
Connector	BNC Female
Protection	250 V RMS, 0-60 Hz
Mode Selection	Auto or Manual
Filter	16 Mhz Low Pass Filter

VERTICAL DEFLECTION:

SENSITIVITY

Gain Setting	Signal for Full Scale Deflection
A1	16 V
A2	8 V
A3	4 V
A4	2 V
A5	960 mV
A6	480 mV
A7	240 mV
A8	120 mV
A9	60 mV
Aa	30 mV
Ab	15 mV

AUTO MODE PULSE SELECTION

Nominal Range (@PVF = 0.667)	Default Pulse (ns)	Available Pulses (ns)
3 m	2	2, 10
6 m	2	2, 10
12 m	10	2, 10, 30
24 m	10	2, 10, 30
48 m	30	2, 10, 30, 100
96 m	100	2, 10, 30, 100
192 m	100	2, 10, 30, 100, 300
384 m	300	2, 10, 30, 100, 300, 1200
800 m	300	2, 10, 30, 100, 300, 1200
1600 m & above	1200	2, 10, 30, 100, 300, 1200

Return Loss Measurement	Range: 0 dB to > 30 dB		
Display Modes	Line (L) Memory (M) Comparison (L & M) Difference (L-M)		
Memories	15 - Stores trace displayed in Mode L.		
Interface	RS232 to printer or PC. Connector 9 pin D Male. Configuration 4800 baud, no parity, 8 bits, 1 stop bit.		
	PIN	**FUNCTION**	**DIRECTION**
	2	Received Data (RXD)	Input
	3	Transmit Data (TXD)	Output
	5	Ground	
	6	Data Set Ready (DSR)	Input
	7	Request To Send (RTS)	Output
Display	240 x 128 pixel LCD 240 x 100 pixel waveform area		

Backlight	LED with auto switch off (5 mins)
Keyboard	Sealed membrane
Power Sources	Battery - internal rechargeable NiMh provides 8 hours operation (excluding backlight). Cells - 8 x R14 **External DC:** Operating 12 to 20 V 0.25 A Charging 15 to 20 V 0.25 A Connector 2.1 x 5.5 x 9.5 mm plug centre positive (reverse polarity protection).
Dimensions	300 x 183 x 75 mm
Weight	2.5 kg (including batteries & carry bag)
Accessories	Carry bag - soft weatherproof bag with shoulder strap and accessory pouch. AC Adaptors - 120 V or 230 V 50/60 Hz (see separate specification). Test Lead - 3 metre 75 Ω BNC/BNC + BNC/Crocodile clip + BNC/F Adaptor Operating Manual
Safety	IEC 1010-1

AC Adaptors	UK 230 V ±10% 50 Hz 90 mA Output 15 V DC 400 mA North America 120 V ±10% 60 Hz 180 mA Output 15 V DC 400 mA Europe 230 V ±10% 50 Hz 90 mA Output 15 V DC 400 mA
Environmental & Safety (Main Unit)	
Safety	BS EN 61010-1 : 1993 and IEC 1010-1 : 1990 and Amendment 1 : 1992
Maximum permissible voltage on input connector for safe operation	30 V RMS

Temperature	Operating temperature: Including batteries: 0°C to +50°C Excluding batteries: -5°C to +50°C Storage temperature: Including batteries: -20°C to +50°C Excluding batteries: -20°C to +65°C
Recommended temperature limits to maximise battery life	Charging: +10°C to +35°C Discharging: -5°C to +45°C Storage: 0°C to +45°C
Damp Heat, Steady State	BS 2011, part 2.1 Ca : 1977 (IEC 68-2-3 : 1969) 40°C, 93% RH, 4 days
Damp Heat, Cyclic	BS 2011, part 2.1 Db : 1981 (IEC 68-2-30 : 1980) 25°C, 95% RH, 12 hr 55°C, 93% RH, 12 hr 6 cycles
Low Air Pressure	BS 2011 part 2.1 M : 1984 (IEC 68-2-13 : 1983) Non operational: 150 mb 16 hours Operational: 533 mb 30 minutes

Random Vibration	BS 2011 part 2.1 Fdb : 1973 5 to 150 Hz, 0.005g^2/Hz 2 hours in each of 3 planes (in soft carry case)
Shock	BS EN 60068-2-27 : 1993 part 2, test Ea (IEC 68-2-27 : 1987) 50g, 11ms (in soft carry case)
Bump	BS EN 60068-2-29 : 1993 part 2, test Eb (IEC 68-2-29 : 1987) 40g, 6ms, 1000 bumps in each of 3 axes (in soft carry case)
Free Fall	BS EN 60068-2-32 : 1993 part 2, test Ed (IEC 68-2-32 : 1975) 1m (in soft carry case)
Water and dust Protection	BS EN 60529 (IEC 529 : 1989) To IP54

13. PRODUCT SAFETY DATA

The T631 is a Pulse Echo Test Set that provides visual indication of cable faults. The T631 is tested and supplied in accordance with our published specifications, and when used in normal or prescribed applications within the parameters specified for electrical and mechanical performance, will not present any danger or hazard to health or safety, provided normal engineering and safety practices are observed.

Doubt relating to any aspect of usage of this instrument must be referred to Radiodetection Limited.

13.1 POWER SUPPLY

a) The instrument is fitted with eight rechargeable NiMh batteries with capacity of 3 Ah. The batteries should only be replaced with equivalent cells with the same capacity. A quick blow fuse that is not accessible to the operator is fitted to protect the battery circuit.

b) The instrument can also be powered with an external 12 to 20 V DC source 0.25 A as outlined in specification (section 12). A quick blow fuse that is not accessible to the operator is fitted to offer protection.

c) The instrument can also be powered with an optional AC Adaptor (for further details see specification, section 12).

13.2 ROUTINE SERVICING

It is recommended that the instrument is returned to Radiodetection Limited annually for service and calibration checks. The instrument is fitted with eight rechargeable NiMh batteries with capacity of 3 Ah. Replacement batteries must be of a similar type.

13.3 COMPOSITION/TOXIC HAZARDS

Under normal conditions of use, storage and handling, the T631 presents no toxic hazards, however, in certain circumstances the following could apply:

a) Incineration

The instrument houses NiMh batteries and these **must not be incinerated**. Additionally some of the electronic components included in the assembly are constructed with resins and other chemicals which produce toxic fumes during incineration. It is required that the instrument is submitted to the correct authority for disposal in accordance with local by-laws.

b) Acidic or Caustic Compounds

Some of the electronic components included in the assembly, particularly the electrolytic capacitors contain acidic compounds. In the event of any damaged items coming into contact with the skin, the affected area should be washed with clean, cold water. In the event of eye contamination, thoroughly irrigate with recognised eyewash and seek urgent medical assistance.

c) Physical Damage

Some of the components used in the assembly may contain very small quantities of toxic materials. There exists a remote possibility that physically damaged components may present a toxic hazard. As a general precaution avoid unnecessary contact with damaged electronic components and arrange for disposal in accordance with local legislation that may currently be in force.

13.4 TRANSPORT AND HANDLING

The instrument is supplied in a soft carry bag which offers adequate protection under normal working conditions. For transportation over long distances the instrument should be suitably packed in a box filled with shock absorbing material such as bubblepack or corrugated cardboard.

13.5 STORAGE

The instrument should be stored in a dry, clean environment. The NiMh battery will self discharge over a period of up to 1 year so it may be necessary to fully charge and discharge the battery several times, using the recommended adaptor, before full capacity is restored.

No hazard is anticipated during storage.

13.6 DISPOSAL

When disposing of electrical and electronic equipment or packaging materials, exercise precautions that are required by local legislation. If in doubt, contact the local authority.

13.7 SAFE USE

The T631 is designed to be used by suitably trained personnel following the procedures and instructions described in this operating manual. Additionally, the following points should be noted:

a) Personal Protection/Protective Clothing

Not necessary for operating the T631, providing that normal safe working practice is observed.

b) Working Environment

No special precautions are needed for operating the T631. Appropriate precautions must be observed for potentially hazardous, working environments such as construction site installations, electricity substations, explosive atmospheres, etc.

Other products available from Bicotest:

LEXXI™ T810
A universal hand-held TDR for use on all types of metallic cable, including live AC when used with the blocking filter lead

T600 Series TDRs
World class, user-friendly cable fault locators which feature interface with PCs via X600 TRACEability™ software

T631F, T600FS and T600FD Blocking Filters
Single and dual input LV mains blocking filters for use with T600 series TDRs

T272 High Resistance Cable Fault Locator
For location of high resistance insulation faults of up to 200 megohms

Please contact our sales Office for further information on the above systems.

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