Polar CITS880s Series Controlled Impedance Test System

User Guide

CITS880s

Polar Instruments Ltd

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PRODUCT REGISTRATION

Registering your product ensures you can be kept up to date when upgrades or enhancements become available.

Please register using the form below.

To: Polar Instruments Ltd.
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Email: polarcare@polarinstruments.com

Instrument	**CITS880s**

Serial Number	
Software version	
Name	
Company	
Job Title	
Address	
Post/ZIP Code	
Country	
Telephone	
Fax	
E-mail	

CITS880s OPERATOR MANUAL

POLAR INSTRUMENTS LTD. HARDWARE WARRANTY

1. Product Warranty. Product hardware is warranted to be free from defects in material and workmanship during the Warranty Period (as defined below). Product hardware is warranted to conform substantially to Polar's then current (as of the date of Polar's product shipment) published user documentation during the Warranty Period. The Warranty Period is twelve (12) months. Product support beyond these periods may be available at additional cost – consult Polar for details

   TDR Head and Input Relay warranty
   This product is an extremely sensitive measuring instrument. To prevent damage it is essential to observe static precautions at all times. The TDR head and/or input relay will be damaged if any voltage (e.g. from static) is applied to the probes.
   The warranty period for the TDR head is six (6) months or until one failure, whichever occurs sooner.

   The warranty period for the relay is one year or 1 million operations, whichever occurs sooner.

   Reliability statistics indicate that if the TDR head and/or the relay's input resistor have been damaged, it is likely to have arisen from misuse (e.g. static damage or similar) and as these circumstances are outside Polar Instruments' control, any further failures will not be covered by warranty.

2. Warranty Claims. Polar shall incur no liability under this warranty if the end user fails to provide Polar with notice of the alleged defect during the applicable Warranty Period and within seven (7) days of delivery to end user or, if the defect would not have been reasonably apparent on inspection, within seven (7) days of its discovery by end user. After receiving such notice, Polar will notify the purchaser of its designation of one of the following problem resolution methods:
   Return to Factory: The allegedly defective goods must be returned to Polar within seven days of Polar's notice and in accordance with Polar's instructions advised at the time.
   Other: Polar will use commercially reasonable efforts to repair, correct or work around the problem by means of telephone support or other means reasonably determined by Polar.
   Polar shall incur no liability under this warranty if Polar's tests disclose that the alleged defect is due to causes not within Polar's reasonable control, including alteration or abuse of the goods. Under the *Return to Factory* alternative, if a Product is determined not to be defective or to have a defect due to causes not within Polar's reasonable control, Polar reserves the right to apply a processing charge.

3. Damage in Transit. End user must notify Polar and the carrier of any claim for damage in transit within two (2) days of receipt of the damaged merchandise. Failure to do so may result in the carrier and/or Polar refusing to accept liability in which case end user must pay the purchase price as if the hardware had been delivered without damage.

4. Polar's Liability Polar's liability, and end user's sole and exclusive remedy, shall be limited to the express remedies set forth in this Polar Hardware Warranty.

5. Disclaimer of Warranties. **POLAR MAKES NO OTHER WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, REGARDING PRODUCTS. ALL OTHER WARRANTIES AS TO THE QUALITY, CONDITION, MERCHANTABILLITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT ARE EXPRESSLY DISCLAIMED.**

6. Limitation of Liability. **POLAR SHALL NOT BE RESPONSIBLE FOR DIRECT DAMAGES IN EXCESS OF THE PURCHASE PRICE PAID BY THE END USER OR FOR ANY SPECIAL, CONSEQUENTIAL, INCIDENTAL, OR PUNITIVE DAMAGE, INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFITS OR DAMAGES TO BUSINESS OR BUSINESS RELATIONS, WHETHER OR NOT ADVISED IN ADVANCE OF THE POSSIBILITY OF SUCH DAMAGES, THE FOREGOING LIMITATIONS SHALL APPLY, NOTWITHSTANDING THE FAILURE OF ANY EXCLUSIVE REMEDIES.**

DECLARATIONS

EUROPEAN COMMUNITY DIRECTIVE CONFORMANCE STATEMENT

Product: CITS880, CITS880s

This product conforms to all applicable EC Council Directives, including:

EC Council Directive **2014/30/EU** (commonly referred to as “the EMC Directive”) on the approximation of the laws of the Member States relating to electromagnetic compatibility.

EC Council Directive **2014/35/EU** (commonly referred to as the LVD Directive”) on the harmonisation of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits.

EC Council Directive **EC 1907/2006** as amended by **2015/863/EU** (commonly referred to as “the RoHS 3 Directive”) on the Registration, Evaluation, Authorisation and Restriction of Chemicals (**REACH**) as regards skin corrosion/irritation, serious eye damage/eye irritation and acute toxicity

EC Council Directive **2012/19/EU** (commonly referred to as “the WEEE Directive”) on waste electrical and electronic equipment.

Harmonised standards applied in order to verify compliance with these Directives:

EN 61326:1998
EN 61010-1:2010

The CE-mark was first applied to this product in 2014.

The manufacturer of this product takes full responsibility for this declaration of conformity:

Polar Instruments Ltd
Garenne Park
St Sampsons
Guernsey
GY2 4AF

Signed for Polar Instruments Ltd:

Nigel A. Mann (Director)

This declaration issued 07/04/2021.

SAFETY

WARNING

The LIVE and NEUTRAL lines on this unit are BOTH fused.

This unit contains no user-serviceable parts. When the unit is connected to its supply, the opening of covers or removal of panels is likely to expose dangerous voltages. To maintain operator safety, do not operate the unit unless the enclosure is complete and securely assembled.

GROUNDING

This unit must be earthed (grounded); do not operate the instrument with the safety earth disconnected. Ensure the instrument is connected to an outlet with an effective protective conductor terminal (earth). Do not negate this protective action by using an extension cord without a protective conductor.

Note: This instrument is fitted with 3-wire grounding type plug designed to fit only into a grounding type power outlet. If a special local plug must be fitted to the power cord ensure this operation is performed by a skilled electronics technician and that the protective ground connection is maintained. The plug that is cut off from the power cord must be safely disposed of.

Power cord color codes are as follows:

Europe

brown	live
blue	neutral
green/yellow	earth (ground)

United States

black	live
white	neutral
green	ground

POWER SUPPLY

Check that the indicated line voltage corresponds with the local mains power supply. See the rear panel for line voltage range and frequency.

CITS880s OPERATION

This manual contains instructions and warnings that must be observed by the user to ensure safe operation. Operating this instrument in ways other than detailed in this manual may impair the protection provided by the instrument and may result in the instrument becoming unsafe. Retain these instructions for later use.

Use only the precision cables supplied by Polar Instruments; the CITS880s is calibrated using the supplied Polar cables. Use of any other cables or exchanging cables between channels may invalidate the calibration of the unit.

The instrument is designed for use indoors in an electrical workshop environment at a stable workstation comprising a bench or similar work surface. Use only the accessories (e.g. test probes and cables) provided by Polar Instruments. The unit must be maintained and repaired by a skilled electronics technician in accordance with the manufacturer's instructions.

The instrument should not be installed in such a way as to inhibit access to the mains switch on the rear panel. This switch or the removal of the power connector are the prime means of disconnection from the supply in an emergency.

If it is likely that the protection has been impaired the unit must be made inoperative, secured against unintended operation and referred to qualified service personnel. Protection may be impaired if, for example, the instrument:

Shows signs of physical damage

Fails to operate normally when the operating instructions are followed

Has been stored for prolonged periods under unfavourable conditions

Has been subjected to excessive transport stresses

Has been exposed to rain or water or been subject to liquid spills

CAUTION

Electrical Isolation

Always disconnect the board under test from the local mains supply (including ground) before using this instrument. The CITS880s applies test voltages to the item under test. Make sure that the item under test is isolated from all other sources of electrical power. External power could damage the tester.

Static sensitive devices

This unit contains static sensitive devices. Observe static precautions at all times.

SPECIFICATIONS

Test parameters

Controlled Impedance Measurement Range	20 – 150Ω (single-ended) 40 – 200Ω (differential) 70 – 130Ω (groundless differential)
Measurement Accuracy (single-ended) *Calibrated against traceable airline standards at 28Ω, 50Ω, 75Ω and 100Ω*	± 1.5% at 28Ω ± 1% at 50Ω ± 1.25% at 75Ω ± 1.5% at 100Ω
Measurement Accuracy (differential, typical) *Typical values for even mode Z_{oe} < 100Ω.* *For 100Ω < Z_{oe}< 150Ω add 1%.* *For 150Ω < Z_{oe}< 180Ω add 1.5%.*	± 2.5% at 56Ω ± 2% at 100Ω ± 2.5% at 150Ω ± 3% at 200Ω
Measurement Accuracy (groundless differential)	± 3% at 100Ω ± 4% at 70Ω/130Ω
Impedance Tolerance Range	0.1% – 99.99%
Vertical Display Ranges (Ω)	1, 2, 5, 10, 20, 50Ω/division
Vertical Display Ranges (mRho)	10, 20, 50, 100, 200, 500 mRho/division
Horizontal Display Ranges	Automatically set by software
Testable Trace Lengths Optimum Minimum (using non-matched probe) Minimum (using matched probe) Maximum	 0.15 meters 0.09 meters 0.05 meters 2 meters
Horizontal Distance Units	Inches, feet, meters, millimeters
Horizontal Time Units	Nanoseconds, picoseconds
Test Method	Time Domain Reflectometer (TDR measurement using PC software control)
Reflected Pulse Risetime	≤ 200ps
System Bandwidth	>1.75 GHz (derived from maximum risetime)
Output Impedance	50Ω (± 2%)
Pulse Amplitude	Nominal 300mV into 50Ω load
Calibration Method	Ratiometric measurement to calibrated precision internal 50Ω reference
Vp Compensation	0.33 – 0.99
Relay Life	1 x 10^6 operations/channel (typical)
Channels	4

ENVIRONMENTAL OPERATING CONDITIONS

The instrument is designed for indoor use only under the following environmental conditions:

Altitude	Up to 2000m
Temperature	+10°C to +30°C ambient
Relative humidity	RH 80% maximum at 31°C — derate linearly to 50% at 40°C Non condensing.
Mains borne transients	As defined by Installation Category II (Overvoltage Category II) in IEC60364–4–443
Pollution Degree	2

POWER REQUIREMENTS

85 – 250V at 50/60Hz (0.1 – 0.06A)

Line Fuse values

Time Delay 1.6A T

PHYSICAL CHARACTERISTICS (EXCLUDING ACCESSORIES)

Temperature

Operating	10°C to 30°C
Storage	0°C to +50°C

Dimensions

Width	446 mm (17.6 in.)
Height	132 mm (5.2 in.)
Depth	300 mm (11.81 in.)
Weight	6.9kg (15.2 lb.)

SYMBOLS

CAUTION

No external voltage should be applied to the front panel SMA connector terminals. Read Section 2 — *SETTING UP THE CITS880s SYSTEM* for information on how to use these connectors.

On the rear panel the USB connector should be used to link to the controlling PC using the cable provided.
See installation sheet.

The Status port D connector should be used in accordance with the instructions in Appendix C.

CAUTION

Static sensitive devices — observe electrostatic discharge precautions. A wrist strap is provided with the CITS880s (connect the wrist strap to one of the sockets on the CITS880s front panel).

Note: The CITS880s contains static sensitive devices — observe electrostatic discharge precautions at all times.

PERSONAL COMPUTER REQUIREMENTS

Computer	IBM PC or compatible
Processor	Pentium 1.6GHz or better
Operating system	Windows 10 or later
System memory required	2 GB recommended
Hard disk space required	20 MB (min.)
Video standard	FHD (1920 x 1080 min.)
Communication ports	2 available USB 2.0 ports required

ACCESSORIES

Standard Accessories

Probe Cable	WMA360
IPS-50 Microstrip Probe (50Ω)	CPB001
IPDS-100 Differential Probe (100Ω)	CPB274
Sample Test Coupon	MPCD1325
Operator manual	MAN207
USB 2.0 cable	ACC371
Foot Switch	ACC383
Antistatic wristband	ACC175
Wrist band ground cord	ACC185
50 ohm reference impedance	WMA328
Torque wrench	ACC313
SMA Adaptor	MQX428

Optional Accessories

Instrument carrying case	ACC125
Datalog Report Generator (DRG Pro)	ACC230

GUIDE TO THE MANUAL

INTRODUCTION	An overview of the Polar CITS880s. A description of the principles of operation and explanation of basic TDR principles and controlled impedance.
INSTALLATION/SET UP	Connecting the instrument to a power supply, installation of software and preparation for use. Specifying the PC communication ports, calibration type and passwords.
GETTING STARTED	Introduction to basic CITS880s operation using the supplied sample test coupons. Using the Setup Wizard (first time users.)
OPERATION	Operation of the CITS880s. Information about the different ways in which the facilities of the CITS880s can be used and how to test boards.
THE TEST FILE EDITOR	Description of test parameters – creating, writing and saving test files.
MAINTENANCE	Details of maintenance and cleaning procedures.
APPENDIX A	Notes on Characteristic Impedance.
APPENDIX B	Notes on static sensitive devices and preventing damage to the CITS.
APPENDIX C	Status output connector details

OPERATING THE CITS880s

The CITS880s software is designed for use within the Microsoft Windows® environment. Familiarity with the Microsoft Windows 10® or later environments is assumed. For more information on Microsoft Windows® operation consult the appropriate Microsoft Windows® User Guide.

CITS880s functions are controlled by selecting the associated commands from pull-down menus or clicking the “short-cut” buttons with the mouse.

Selecting commands

Using the keyboard:

Activate the CITS880s menu bar by pressing the Alt key on the keyboard. Use the arrow keys to navigate to the commands. Press <Enter> or <CR> to accept or the <Esc> key to cancel.

Using the mouse:

To display a command list, point to the menu name and click the left mouse button.

Point to the command name and click the left mouse button.

Selecting a command name which is followed by ellipses (...) displays a dialog box containing options which qualify the command.

Clicking the **OK** button corresponds to pressing the <CR> or <Enter> key on the keyboard.

Clicking the **Cancel** button corresponds to pressing the <Esc> key on the keyboard.

CONTENTS

SECTION 1 — INTRODUCTION

CONTROLLED IMPEDANCE TESTING

1-1 The CITS880s system

The CITS880s Controlled Impedance Test System is designed to provide low cost automated measurements of the characteristic impedance of printed circuit boards and test coupons. The system is shown in the diagram below. *It should only be used on un-powered PCB samples in accordance with the instructions in this manual.*

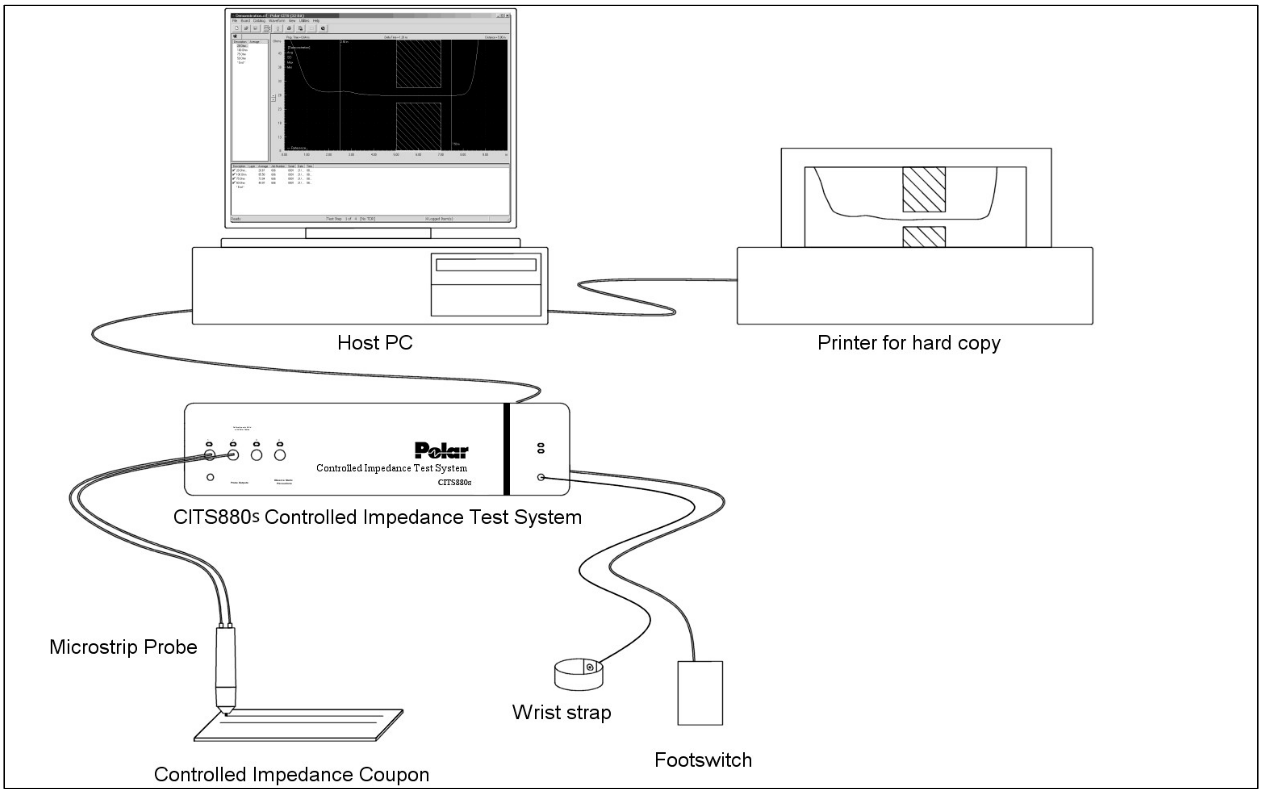


Figure 1-1 CITS880s Controlled Impedance Test System

The Polar Instruments Controlled Impedance Test System comprises a measurement system controlled by software running within the Microsoft Windows® environment on an IBM PC-compatible computer.

The CITS880s is designed to facilitate rapid and convenient testing of single-ended and differential controlled impedance printed circuit board traces and test coupons.

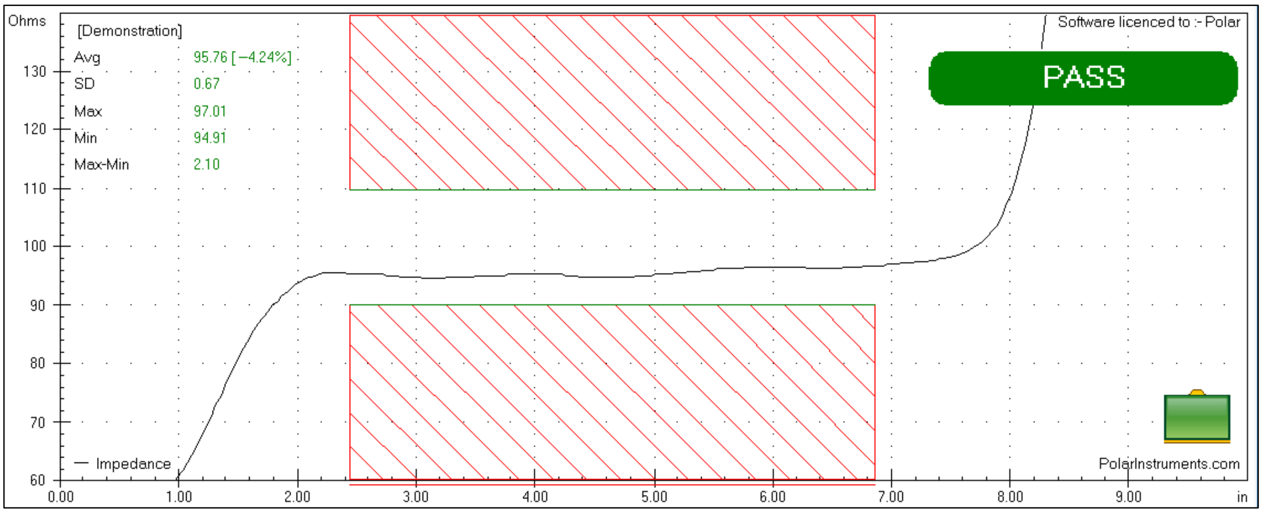


Figure 1-2 CITS880s Waveform Display Window

Connection between the CITS880s and boards under test is achieved using the special Polar supplied microstrip probes and probe cables.

CITS880s probes

Polar produces a comprehensive range of test probes with a wide choice of footprints, Test probe types include:

- single ended – IPS
- differential – IPDS
- groundless differential – GDPS probes

and are precision molded from ESD dissipative materials and include internal ESD grounding. For maximum protection against ESD damage Polar also recommends operators use a wrist strap connected to an appropriate ESD ground point.

CITS880s software

The CITS880s software is written to run within the Microsoft Windows® environment, so test result waveforms may be printed out using the currently installed printer.

The CITS880s system may be controlled from the PC keyboard or by simple point-and-click operations with a Microsoft-compatible mouse. Use of a mouse is recommended for maximum ease of use.

A plug-in foot-switch is included with the CITS880s to allow the operator to perform hands-off testing.

1-2 Test files

All the information necessary for performing a controlled impedance measurement on a circuit board is stored in a *test file*. An operator only needs to select the appropriate test file from a list and the system is ready for testing.

Test files are easily created and modified via the integrated test file editor — most files will be created with just a few key-strokes and mouse clicks. Test files provide a convenient mechanism for automated testing of boards with a number of different controlled impedance traces.

Test files in may be imported in XML format to support Industry 4 automation and data exchange.

1-3 Data analysis

Test results are displayed as a graph of impedance against distance or time along a PCB track. PASS, INTERMEDIATE or FAIL results are returned according to whether or not the impedance of the trace remains within tolerance over the full length of the tested region, using a range of test methods. The average, standard deviation, minimum and maximum impedance values over the tested region are displayed on screen along with the measured waveform; differential test results include readings for odd and even mode impedances, crosstalk and unbalance.

The CITS880s supports launch point extrapolation (LPE) which uses line fitting to the TDR trace. LPE can better reflect the impedance that the signal sees as it launches into the trace.

All test results are displayed on the PC screen in waveform and statistical form for rapid analysis. Waveforms may also be stored to disk for later inspection.

Test data may be logged for subsequent statistical analysis. The stored data may be printed out or imported into a spreadsheet or the Datalog Report Generator (available as an optional accessory.)

The CITS880s also generates data in delimited format (suitable for importing into a spreadsheet or database) for statistical process control (SPC) analysis.

Test results (with user-selectable data columns) may be exported in Microsoft Excel® format.

1-4 CITS880s features

The CITS880s system is designed to make the complex process of impedance testing as simple as possible. The CITS880s includes the following features:

Board testing

Four channel testing.

Average, absolute and envelope test methods support measurement of a comprehensive range of impedance values, including average, standard deviation, minimum, maximum and (maximum – minimum) readings for single-ended, differential and groundless differential testing, odd and even modes, crosstalk and unbalanced lines.

Imbalance between lines is measured and logged in differential tests. A warning is issued when the imbalance exceeds operator-specified level.

Wide range of Polar Instruments manufactured microstrip probes for easy connection to the board under test. The IPS, IPDS and GDPS probes are precision molded from ESD dissipative materials and include internal ESD grounding

Automatic instrument set up

Setup Wizard for first time users

Integrated test file editing

Group testing for verification of impedance spread

Data logging

Rapid data logging of test results

Statistical analysis for process control

Automatic storage of waveforms/test results

Automatic storage of file snapshots

Hard copy of test & stored results

Display

Linear display of impedance against distance (in U.S. or metric measurements) or time.

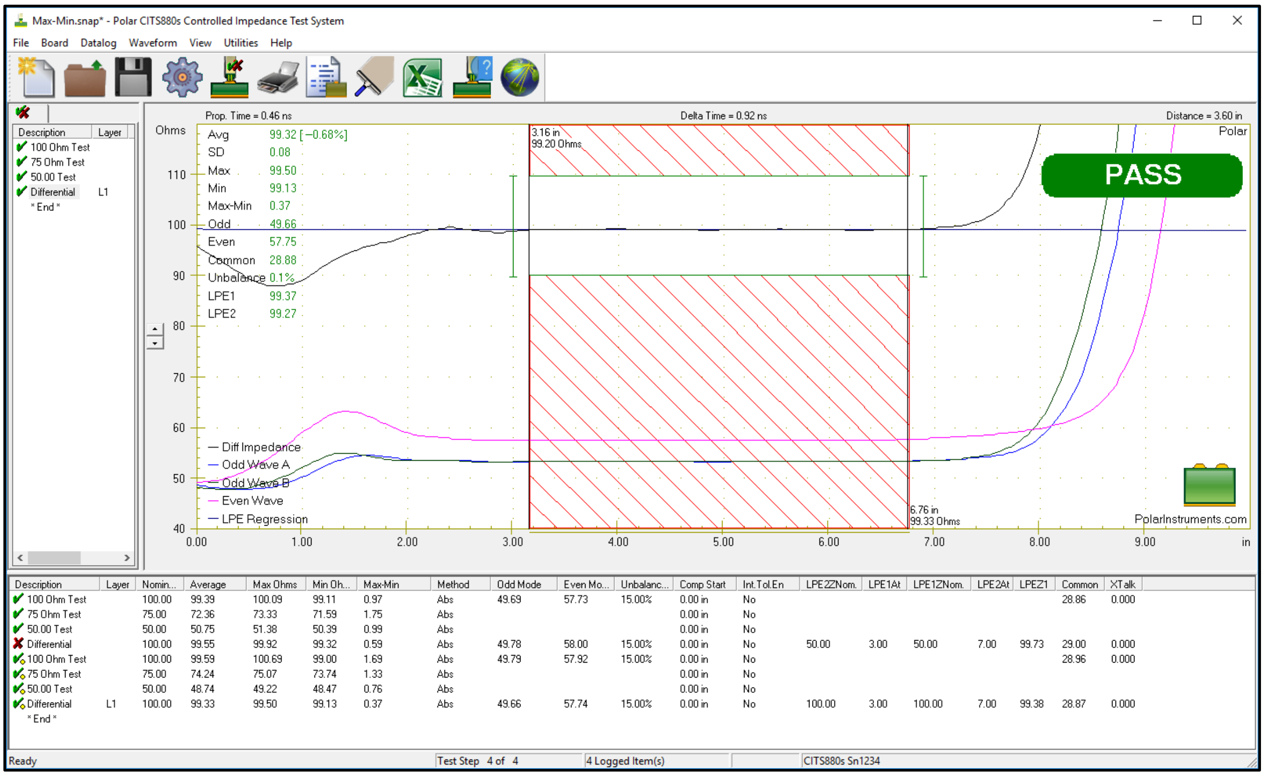


Figure 1-3 CITS880s Main screen

Impedance display in Ohms or mRho

Differential impedance measurements incorporate optional on-screen single-ended and odd and even mode impedance waveforms for engineering analysis

On-screen cursors for easy distance measurement

On-screen display of waveform statistical analysis

Clear Pass/Intermediate/Fail PCB track test results displayed in waveform window

Waveform overlay for rapid comparison of results

Impedance measurement using absolute, average or envelope test methods

User definable colour schemes

Status Outputs

The CITS880s includes opto-isolated, open-collector Status Outputs (located on the rear of the CITS) to provide a hardware indication of the results of a test. See Appendix C for connector details.

Statistical Process Control

The CITS880s provides the facility to log continuously all data to an external file. The file is in delimited text format so can be easily imported into and edited by a spreadsheet or database and includes fields that can be used by statistical process control systems.

1-5 Characteristic impedance

As the speed of electronic devices increases the electrical properties of the circuits carrying signals between them become more important.

At the high frequencies and clock rates of modern digital circuitry, cables and PCB tracks cannot be regarded as simple connections but should be considered by the PCB designer as transmission lines to ensure that signals are not degraded as they route around the PCB.

In the case of PCB tracks the series resistance and parallel conductance of the transmission lines are largely negligible. The most significant circuit parameters governing PCB trace performance are the distributed series inductance and parallel capacitance of the conductors; the impedance of a PCB trace will be determined by its inductive and capacitive reactance.

These parameters give rise to the characteristic impedance, Z_0,

$$Z_0 = \sqrt{\frac{L}{C}}$$

where L is in henrys per unit length, C is in farads per unit length and Z_0 is in ohms. Trace impedance will depend on the physical dimensions of the trace (e.g. trace width and thickness) and the dielectric constant of the PCB substrate material and dielectric thickness. PCB impedances will typically range from 25 to 120 ohms.

Consider an electrical signal travelling through a conductor such as a PCB track.When the signal encounters a change of impedance (Z_0) arising from a change in material or geometry, part of the signal will be reflected and part transmitted. These reflections are likely to cause aberrations on the signal that may degrade circuit performance.

To optimise performance of high-speed circuits it is desirable to match the input and output impedances of devices with the characteristic impedance of the interconnections.

See Appendix A for a more detailed discussion of characteristic impedance.

1-6 TDR fundamentals

The CITS880s Controlled Impedance Test System makes measurements using *time domain reflectometry* (TDR).

Time domain reflectometry

A time domain reflectometer is a special kind of oscilloscope.

A "normal" oscilloscope measures changes in voltage over a period of time and displays this as a graph. A TDR performs a similar function but incorporates additional circuitry to output a voltage and monitor changes in that voltage level over a period of time.

Time domain reflectometry is similar in principle to radar or sonar in that a signal is transmitted and the reflections or echoes of that signal are monitored. In the case of TDR the signal is a voltage transmitted along a cable or PCB track.

Reflections of the signal occur when there is a change in the characteristic impedance of the conductor. The time taken for the reflections to return to the TDR can be used to measure the distance to any change in impedance.

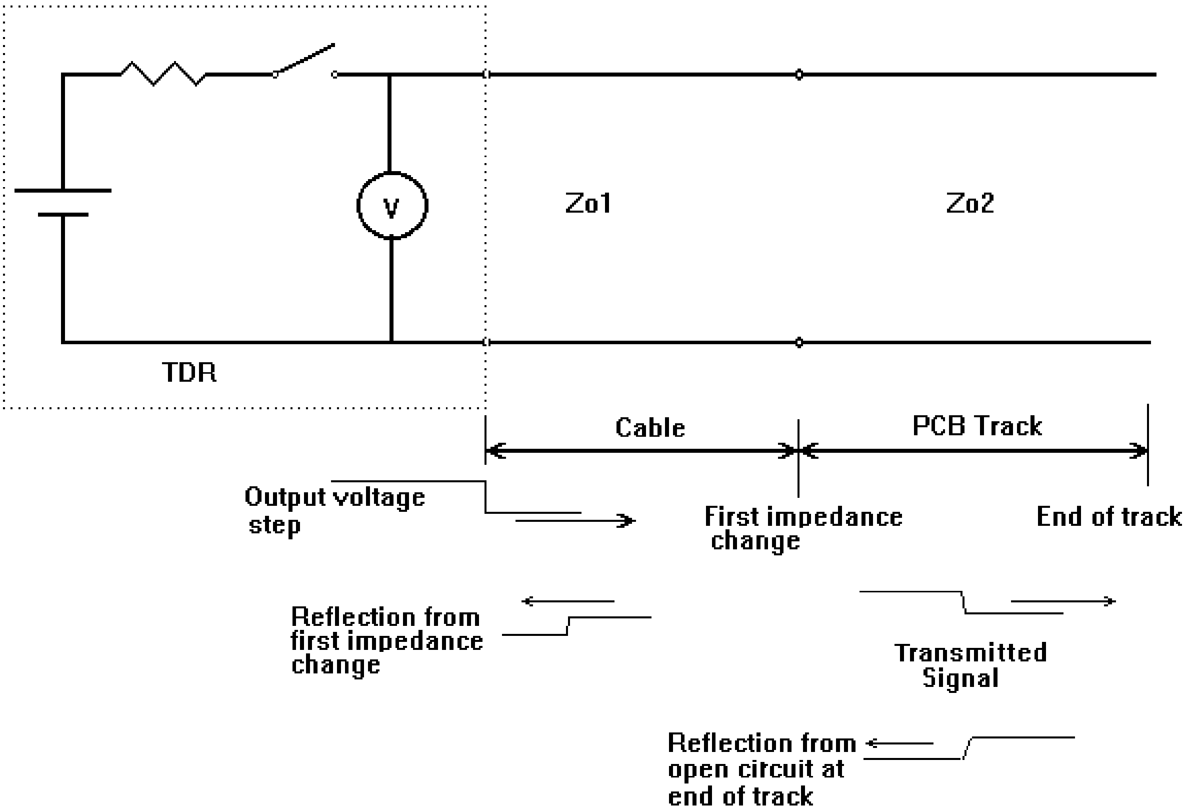


Figure 1-4 Simplified TDR-cable system equivalent circuit

The diagram below shows a typical TDR waveform.

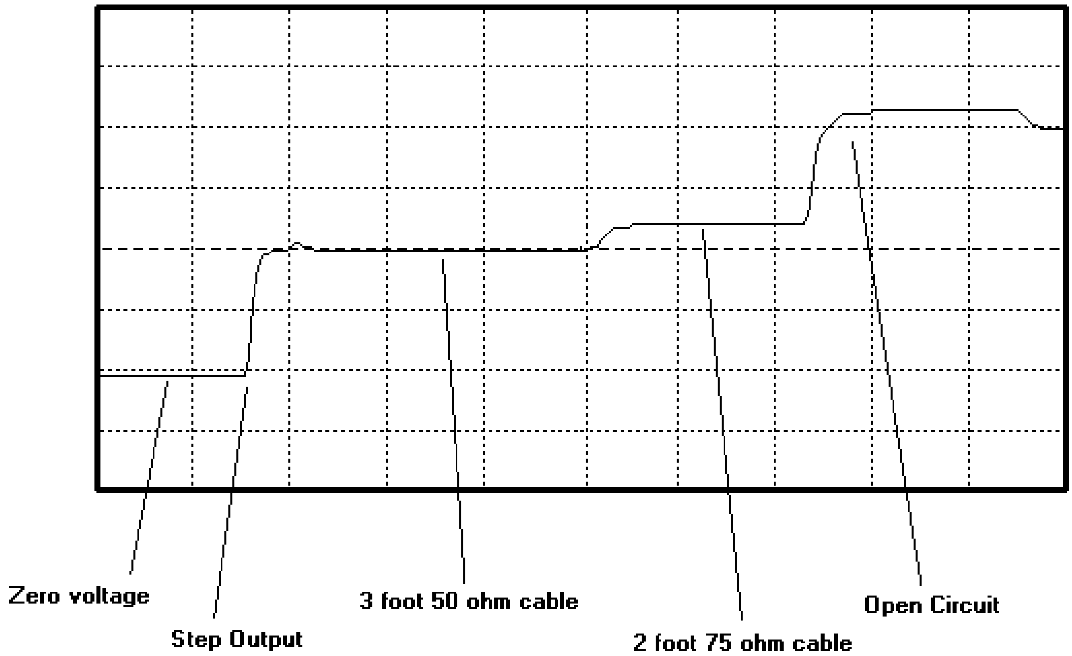


Figure 1-5 TDR trace showing voltage steps at impedance discontinuities

As a step wave propagates down a cable any increase in characteristic impedance causes a reflected voltage which adds to the initial step.

This is shown, for example, in the previous diagram by the step up from the 50Ω to 75Ω cable.

A decrease in impedance would cause a reflection in the opposite sense which would show as a downward step in the TDR trace. As long as the characteristic impedance remains constant the trace remains level.

An open circuit at the end of the cable reflects 100% of the voltage in a large upward step.

If the end of the cable were to be short circuited a 100% reflection in the opposite direction would occur, returning the trace to the zero voltage level.

1-7 CITS880s measurements

The CITS880s displays a graph of the characteristic impedance of a specified length of PCB trace.

This is achieved by calculating the impedance along the length of the cable or PCB based on the size of the reflections measured using time domain reflectometry.

Single ended impedance testing

Normal controlled impedance structures comprise a single signal conductor and a ground plane or planes. Impedance measurements made between the signal and ground are sometimes referred to as *single-ended*.

The single-ended transmission line is probably the commonest way to connect two devices. In this case a single conductor connects the source of one device to the load of another device.

The circuit below is an example of a single-ended transmission line.

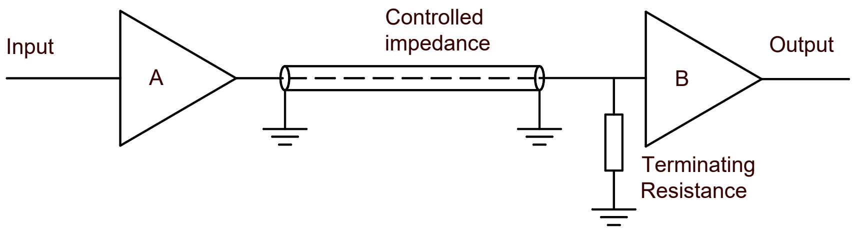


Figure 1-6 Single ended transmission line

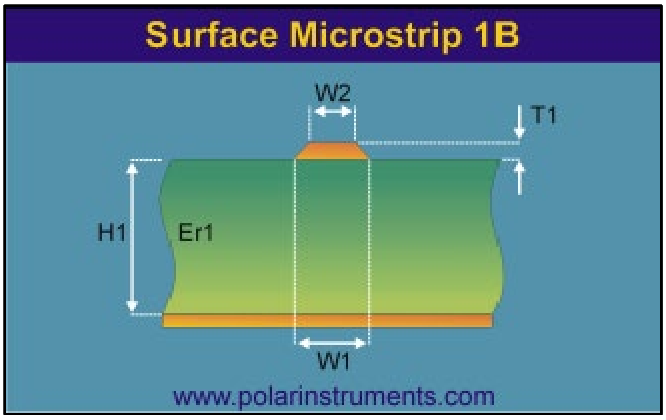
The reference (ground) plane provides the signal return path. This is an example of an unbalanced line. The signal and return lines differ in geometry — the cross-section of the signal conductor is different from that of the return ground plane conductor.

The impedance of a PCB trace will be determined by its inductive and capacitive reactance, resistance and conductance. These will be a function of the physical dimensions of the trace (e.g. trace width and thickness) and the dielectric constant of the PCB substrate material and dielectric thickness. PCB impedances will typically range from 25 to 120 ohms.

Single-ended transmission lines on PCBs

In practice, a single-ended PCB transmission line typically consists of a line conductor trace, one or more reference planes and a dielectric substrate comprising one or more layers of dielectric material. Two configurations are commonly used, *microstrip* and *stripline*.

Surface Microstrip



Surface microstrip with single dielectric below the trace

The simplest configuration, the surface (or *exposed*) microstrip, shown in the diagram above, consists of a signal line, the top and sides exposed to air, on the surface of a board of dielectric constant Er1 and referenced to a power or ground plane.

The surface microstrip structure can be implemented by etching one surface of double-sided PCB material. The diagram illustrates the typical (cross-section) layout of the surface microstrip structure (using a single dielectric layer) and shows the characteristic microstrip impedance attributes:

- the microstrip impedance references a single plane
- the impedance trace is often on an outer layer

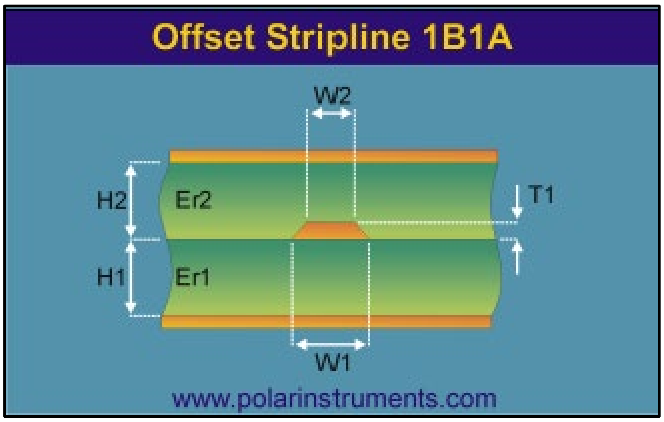
The trace and plane(s) form the controlled impedance. The PCB will frequently be multi-layer in fabrication and the controlled impedance can be constructed in several ways.

However, whichever method is used the value of the impedance will be determined by its physical construction and electrical characteristics of the dielectric material:

- the width W1, W2 and thickness T1 of the signal trace
- the height H1 of core or pre-preg material either side of the trace
- the configuration of trace and planes
- the dielectric constant Er1 of the core and pre-preg material

Offset stripline

The stripline (shown in profile below) typically consists of a line conductor trace sandwiched between two reference planes and a dielectric material (shown as two layers).



Offset stripline with one layer of dielectric above and below the trace

In this configuration the signal trace is sandwiched between two planes and may or may not be equally spaced between the two planes. This construction is often referred to as *dual stripline*.

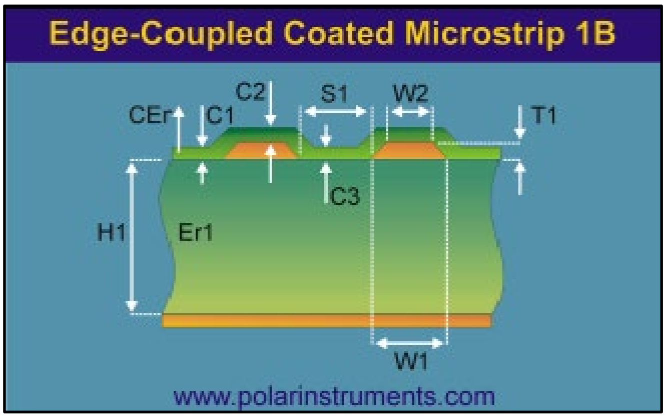
A second mirror trace will be positioned down from the top ground plane. These two signal layers will be routed orthogonally (crossing at right angles so as to minimise the crossing area).

The transmission line, i.e. the trace and planes, form the controlled impedance. The value of the impedance will be determined by its physical construction and electrical characteristics of the dielectric material:

- the width and thickness of the signal trace
- the dielectric constant and height of the core or pre-preg material either side of the trace
- the configuration of trace and planes

Electromagnetic waves in a vacuum travel at the speed of light. The propagation velocity in a material is primarily dependent on the Er of the material and is roughly inversely proportional to the square root of the dielectric constant of the material. Assuming a value of about 4 for dielectric constant for G-10 or FR-4 (the actual value will depend on frequency and the glass to resin ratio) the propagation velocity will approximate to half the speed of light.

Coated microstrip



Coated microstrip with single dielectric layer below the trace

As in the case of the surface microstrip this construction is simple to fabricate, but the extra process of adding solder mask coating can cause impedance variations. The operator must specify the thickness of the coating outside, above and between the traces to allow for variations in the board fabricating process.

This construction is particularly sensitive to solder mask flooding with LPI (Liquid Photo Imageable) solder mask. (In differential structures this causes the dielectric constant in the edge-coupling region to vary, depending on flood depth.)

Differential impedance testing

A more complex type of controlled impedance structure is that of a differential pair of signal conductors. The lines are driven as a pair with one line transmitting a signal waveform of the opposite polarity to the other. At the receiving end one signal is subtracted from the other so noise induced in both lines is cancelled out. This method is commonly employed to achieve high noise immunity in high speed digital and analog systems.

The characteristic impedance of a differential pair is affected not only by the impedance of each line of the pair to ground but also by the interaction of the signal lines with each other.

The differential configuration (often referred to as a balanced line) is used when better noise immunity and improved timing are required. In differential mode the signal and its logical complement are applied to the load.

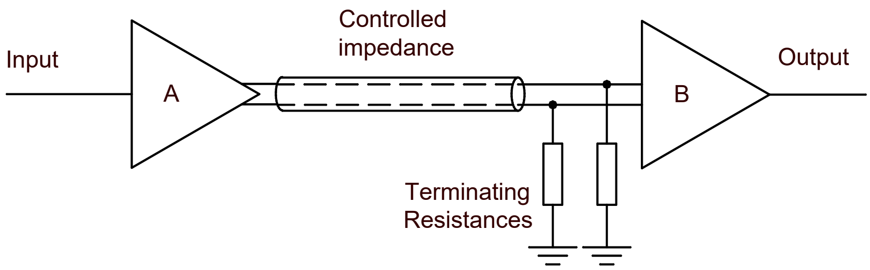


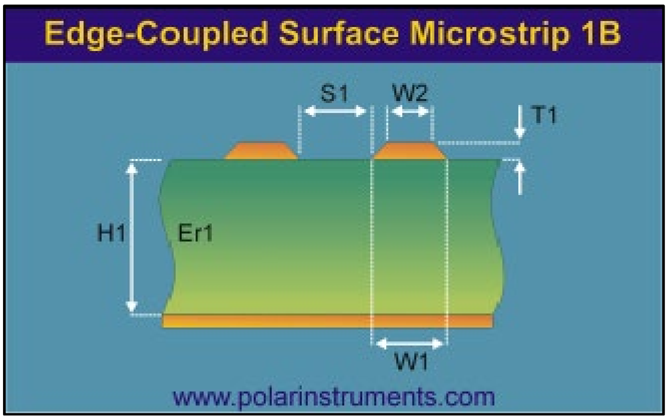
Figure 1-7 Differential configuration – balanced line

The balanced line thus has two signal conductors and an associated reference plane or planes as in the equivalent single-ended (unbalanced) case. Fields generated in the balanced line will tend to cancel each other, so EMI and RFI will be lower than with the unbalanced line. External noise will be "common-moded out" as it will be equally sensed by both signal lines.

Differential transmission lines on PCBs

A typical differential configuration, the edge-coupled surface microstrip is shown below.

Edge-coupled surface microstrip

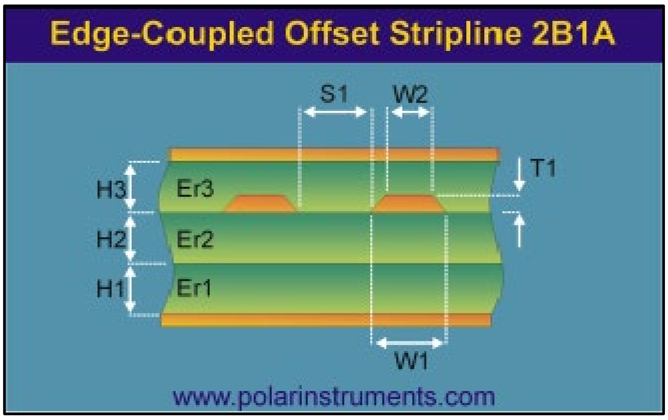


Edge-coupled surface microstrip with one layer below the traces

In this construction the gap S1 between the traces defines the coupling factor and hence the differential impedance. The etch factor, plating density and undercut will make this construction simple to manufacture, but with a wider tolerance due to the extra processing required on external layers.

The stripline construction is also used in differential pair configurations. A typical construction, the edge-coupled offset stripline is shown below.

Edge-coupled offset stripline



Edge-coupled offset stripline with one dielectric layer above the traces and two below

The reduced processing of internal layers makes this construction easier to fabricate with more consistent results than the equivalent surface trace structure. During the manufacturing process resin will be forced in between the traces resulting in a resin-rich region (shown as REr in the model) between the two traces. This region will consist of a dielectric with Er different from the rest of the structure.

The Differential Test

Controlled impedance structures often comprise a single signal conductor and a ground plane or reference plane. Impedance measurements made between the signal and ground are then sometimes referred to as *single-ended*.

Where higher performance (e.g. greater noise immunity and better EMC performance) is required a more complex type of controlled impedance structure is employed — that of a *differential pair* of signal conductors. The signal lines are driven as a pair with one line transmitting a waveform of opposite polarity to the other.

At the receiving end one signal is subtracted from the other so any noise induced in both lines is cancelled out. This is a technique commonly used to increase noise immunity (and reduce signal skew in bus circuitry) in high speed digital and analog systems.

The characteristic impedance of a differential pair, therefore, is affected not only by the impedance of each line of the pair to ground but also by the interaction of the signal lines with each other.

The CITS880s differential tests include results for odd and even mode and unbalance between lines.

Test coupons

The impedance of a PCB trace depends on a number of factors, including the dimensions of the trace (i.e. trace width and thickness) and the thickness and dielectric constant of the laminate and prepreg material. It's common practice for board manufacturers to check controlled impedance build integrity initially by building engineering lots to verify copper weight, line widths and dielectric thickness and constant before beginning volume production. Even in production manufacturers perform 100% controlled impedance testing on controlled impedance boards.

However, it is not uncommon for the actual PCB traces to be inaccessible for testing. In addition, traces may be too short for accurate measurement and will probably include branches and vias which would also make exact impedance measurements difficult. Adding extra pads and vias for test purposes would almost certainly adversely affect the performance of a controlled impedance trace as well as occupying valuable board space. PCB testing is therefore normally performed, not on the PCB itself, but on one or two test coupons integrated into the PCB panel. The coupon will be of the same layer and trace construction as the main PCB and will include traces with precisely the same impedance as those on the PCB, so testing the coupon will give a high degree of confidence that the board impedances will be correct.

The CITS880s is supplied with a sample coupon with single ended and differential traces, typical of those used in manufacturing, with the associated test files so that users may familiarise themselves with the operation of the instrument.

SECTION 2 — INSTALLATION AND SET UP

SETTING UP THE CITS880s SYSTEM

Siting the CITS880s

The CITS880s should be installed indoors on a stable, level bench or workstation in an environment as described in the SPECIFICATIONS section.

The host PC should be sited adjacent to the CITS880s and its monitor and keyboard positioned at heights suitable for comfortable operation.

When assigning a work area for the testing of PCBs and positioning equipment, consideration should be given to the probe cables and how they flex. See Figure 1-1 for typical workstation layout.

System requirements

The CITS880s software is designed to run on a personal computer meeting the following specifications:

Computer	IBM PC or compatible
Processor	Pentium 1.6GHz or faster
Operating system	Microsoft Windows 7 or later
System memory required	1GB (32- bit) 2GB (64-bit)
Hard disk space required	20 MB
Video standard	FHD (1920 x 1080) or higher recommended
Communication ports	2 USB 2.0 ports required

2-1 Unpacking

The instrument is shipped in a sturdy transit pack.

Open the pack carefully and remove the instrument and its accessories. If the instrument is damaged in any way contact the local distributor or supplier.

Retain the pack for possible future use.

Note: Always obtain a Return Number before returning an instrument to Polar Instruments.

The package should contain:

Installation sheet

CITS880s

50Ω probe cables (x4)

IPS50 Microstrip probe

IPDS100 Differential Probe

Sample test coupon

Power cord

USB 2.0 interface cable

Foot switch

Accessory pouch

Program installation disk / Operator Manual

Anti-static wrist band and cord

Note: If the instrument has been shipped or stored in a cold environment, allow the instrument to reach the temperature of its new location before applying power.

2-2 Controls and connectors

SMA connectors

The Front Panel SMA connectors should be connected to Polar Instruments microstrip probes only.

Caution: Tighten with care. Use a torque wrench set to 5 lbf inches ±0.3 lbf inches (0.565 Nm ±0.034Nm).

USB interface to the PC

Important! Install the CITS880s and USB driver software prior to connecting the CITS880s to the host computer via the supplied USB 2.0 cable.

Status

Connections to the 9-pin D Status output are to be made as instructed by trained and qualified technicians in accordance with the information in the Service Manual. See Appendix C for Status connection details.

Footswitch

Connect to a free USB port on the PC.

Microstrip probes

The IPS single ended probes, IPDS differential probes and GDPS groundless differential probes are precision moulded from ESD dissipative materials and include internal ESD grounding. (For maximum protection against ESD damage Polar also recommends that operators use a wrist strap connected to an appropriate ESD ground point.)

Wrist strap/Ground

The wrist strap socket provides a connection to the machine's enclosure; it is connected directly to the protective conductor of the supply cord. This connector should only be used for antistatic wrist straps.

Connecting to a power supply

WARNING! Do not locate the instrument in such a way as to prevent access to the power switch.

Refer to the voltage label on the rear panel of the instrument and make sure that the marked voltage range is suitable for the local mains power supply.

Note: If a special local plug must be fitted to the power cord ensure this operation is performed by a skilled electronics technician and that the protective ground connection is maintained. The plug that is cut off from the power cord must be safely disposed of.

Power cord colour codes are as follows:

Europe

brown	live
blue	neutral
green/yellow	earth (ground)

United States

black	live
white	neutral
green	ground

Connect the power cord to the instrument and to the power source.

2-3 Installing the CITS880s software

Installing the program

Important!

Install the CITS880s and USB driver software prior to connecting the CITS880s to the host computer via the supplied USB 2.0 cable. The USB driver will be installed when the CITS880s is powered up connected to the host computer.

Close all other programs.

Log on to the computer as an administrator.

Navigate to the Polar software release page supplied (contact polarcare@polainstruments.com for the latest version.)

*After downloading the software, unpack the software into a suitable folder and run **Setup.exe** from there. Follow the instructions on screen.*

Choosing the install folder

The CITS880s Installation program proposes the destination location — the drive and folder of the hard disk onto which the CITS880s program is to be installed, by default:

C:\Program Files\Polar\CITS880s on a 32-bit system,
C:\Program Files (x86)\Polar\CITS880s on a 64-bit system.

*Press <**Continue**> to accept the proposed destination drive and folder or type the name of an alternative drive and folder.*

To choose an existing drive and folder (directory) press the Choose Directory button — the Choose Directory dialog box is displayed.

*Navigate to the destination directory from the Choose Directory box and press **OK.** Press <**Continue**>.*

The Installation program will prompt for a name for the CITS880s program group. The CITS880s program icons will be created in the specified program group.

*Press <**Enter**> to accept the proposed name, or type in a different name in the name box or select an existing group (press the drop-down list box arrow to display the current group list).*

The installation program will create the CITS880s directory and file structure, copy the CITS880s files onto the hard disk and create a program group and the CITS880s program item.

*When Setup is complete, click **Close** to close the Add or Remove Programs window.*

Installing the USB driver

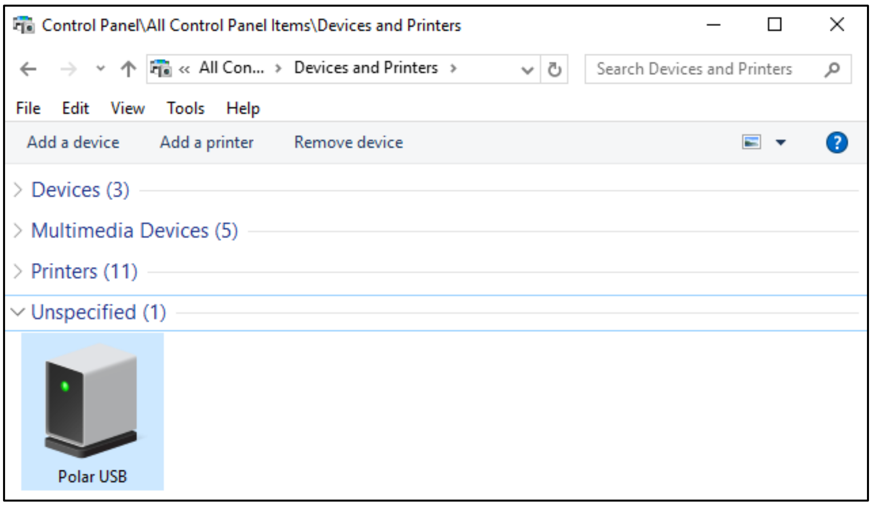
Installing the USB driver on Windows 7

Log on to the computer as an administrator.

*Once you have downloaded the software from the Polar web site, unzip the installer into a suitable folder and run **Setup.exe** from there. Choose the install folder as described above; note the location of the install folder – it will be necessary to navigate to this folder to install the USB driver.*

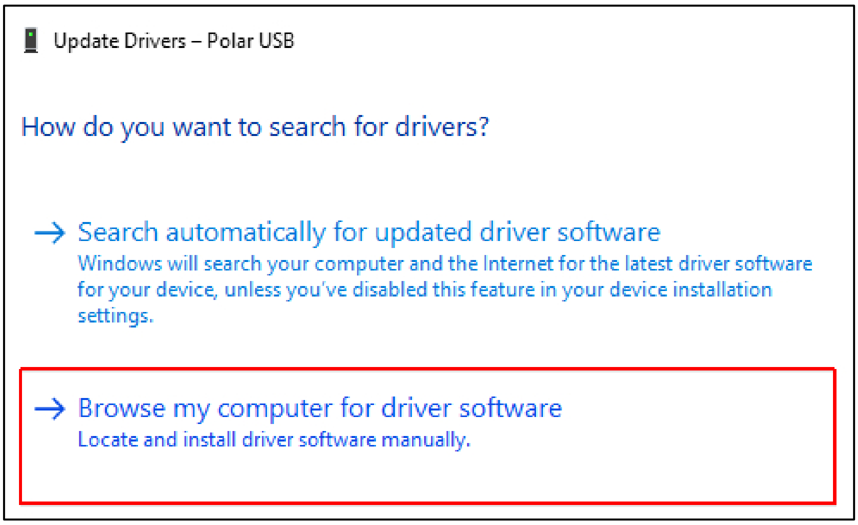
When the host PC senses the presence of the CITS880s (see Connecting the CITS880s to the USB communication port) it will attempt to install the device automatically.

*Alternatively, choose **Control Panel|Devices and Printers** – you should see the Polar USB device listed.*



*Right click the icon, choose the **Hardware** tab and click **Properties**:*

*From the Properties dialog select the **Driver** tab, then click **Update driver…** (It may be necessary to click the **Change Settings** button and then choose **Update Driver…**)*



*Choose **Browse my computer for driver software** and navigate to the CITS880s install folder*

Specify the CITS880s install folder, by default:

C:\Program Files\Polar\CITS880s on a 32-bit system,
C:\Program Files (x86)\Polar\CITS880s on a 64-bit system.

*The install folder should contain the driver; click **Next**.*

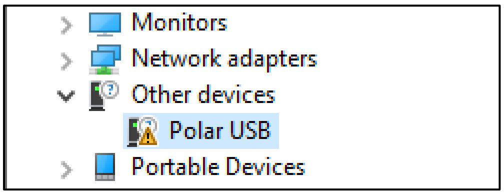
Windows confirms the successful installation of the Polar WinUSB Device.

Installing the USB driver on Windows 8/10

With the software installed connect the CITS880s to the PC via the supplied USB 2.0 cable and apply power. When the host PC senses the CITS880s (see the User Guide Connecting the CITS880s to the USB communication port) it will attempt to install the device automatically.

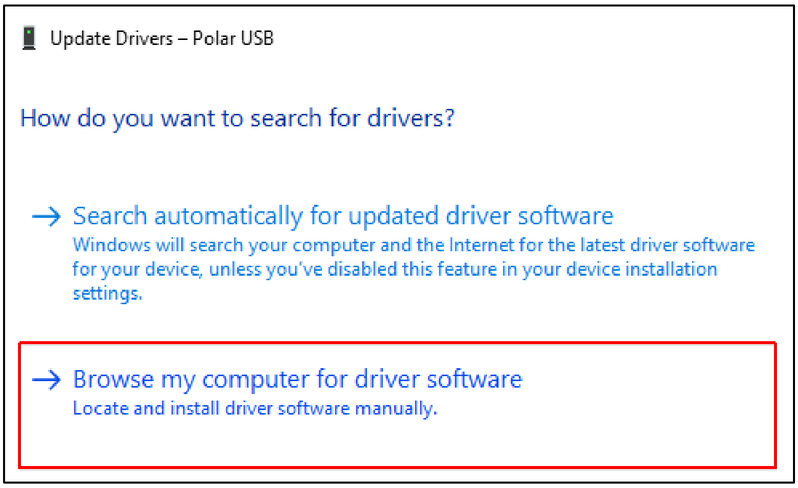
*If unsuccessful, choose **Control Panel**. (Press the Windows key, click the All Apps downward pointing arrow and scroll to the Windows System group and choose Control Panel. Alternatively, move the mouse to the lower right corner of the screen to display the Charms bar (Windows 8) or click the Start button (Windows 10) then click the Settings icon. From the Settings panel choose Control Panel.)*

*In **Devices Manager** – you should see the Polar USB device listed indicating a driver update is required.*

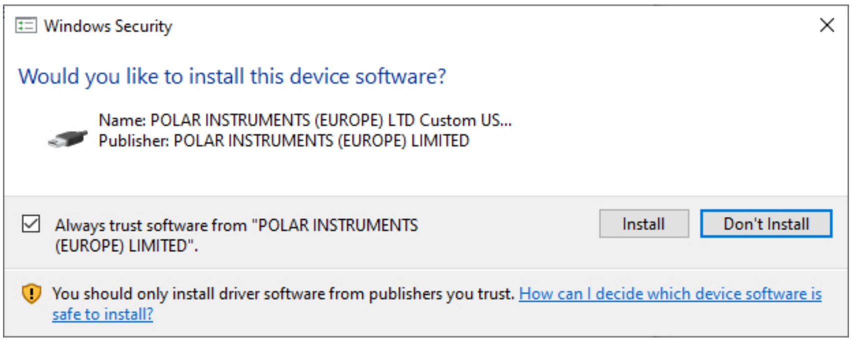


*Alternatively, in **Devices and Printers** – you should see the Polar USB device listed. Right click the icon, choose the **Hardware** tab and click **Properties**. From the Properties dialog select the **Driver** tab, then click **Update driver…***

Windows displays the driver search dialog.

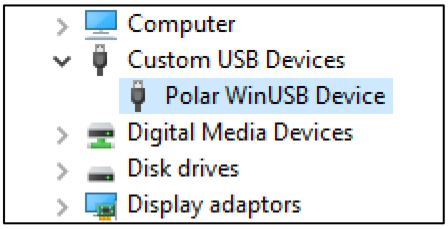


*Choose **Browse my computer for driver software** and navigate to the CITS880s install folder. Windows locates the driver file and requests confirmation of the driver installation:*



Click Install – Windows confirms successful driver installation.

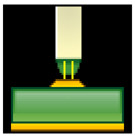
The driver appears in Device Manager



The CITS880s is ready for use

Installing the CITS880s licence

CITS880s operation is enabled via the CITS880s Polarcare licensing system. Contact Polarcare at Polar Instruments for license installation and support.



CITS880s icon

Hint: The CITS880s program may be started each time Windows is started — hold the <**Ctrl**> key depressed and drag the CITS880s icon with the mouse to copy it to the **Startup** group.

In Windows 10 right click the Start button and choose Run. Type **shell:startup** to open the Startup folder; copy the CITS880s icon to the Startup folder

2-4 Connecting the computer to the CITS

CITS880s commands and data are transferred between the CITS880s and the host computer via a USB 2.0 communication link.

Connecting the CITS880s to the USB communication port

Connect the supplied USB 2.0 cable between the USB port of the host computer and the USB connector on the CITS.

Connecting the CITS880s peripherals

Plug the Foot Switch D connector into its socket on the rear of the CITS. Plug in the 4mm anti-static wrist strap.

Connect the Barcode Reader (if used) between the keyboard and the computer — unplug the keyboard from the computer, plug the Barcode Reader into the keyboard socket on the computer and plug the keyboard into the Barcode Reader.

Connecting the cables

The CITS880s is calibrated before shipment using cables labelled with the channel number and CITS880s serial number.
If a cable is replaced the instrument should be re-calibrated and the cable relabelled with the channel number and the instrument serial number.

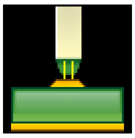
For single-ended testing connect a probe cable to its corresponding SMA front panel connector of the CITS880s and connect the Polar microstrip IPS probe to the probe cable.

The CITS880s channels are arranged in pairs for differential testing; connect the differential probe (e.g. the Polar IPDS100 probe) to Channels 1 and 2 or 3 and 4 SMA connectors using the supplied cables.

Power up the CITS880s and the host computer. The green BUSY LED should light for approximately 5 seconds and then turn off, indicating that the system is operating normally.

If applicable, connect a 9-pin D-connector to the **Status** output. Connection details and a description of the function of each pin for the Status output are contained in Appendix C.

2-5 Running the program



To start the program, double click the CITS880s icon with the mouse or highlight the icon and press <**Enter**>. After a few seconds the main CITS880s display will appear. Prior to testing, allow the instrument to warm up

Note: If the program is being run for the first time, the System Configuration dialog box is displayed. Options can be changed at any time during normal operation by choosing **Config** from the Utilities menu..

2-6 System configuration

The system configuration (**Config..**) dialog allows the operator to specify the CITS880s operating environment.

The environment includes

system security and editing permissions

datalogging options

default paths to test, waveform and snapshot files

system prompts, colours and languages

test file import options

probe test interval options

From the **Options** menu select **Config...** to display the **Config** dialog box. Select the **General** tab:

To exit any of the **System Configuration** menus without saving changes press <**Esc**> or click the **Cancel** button.

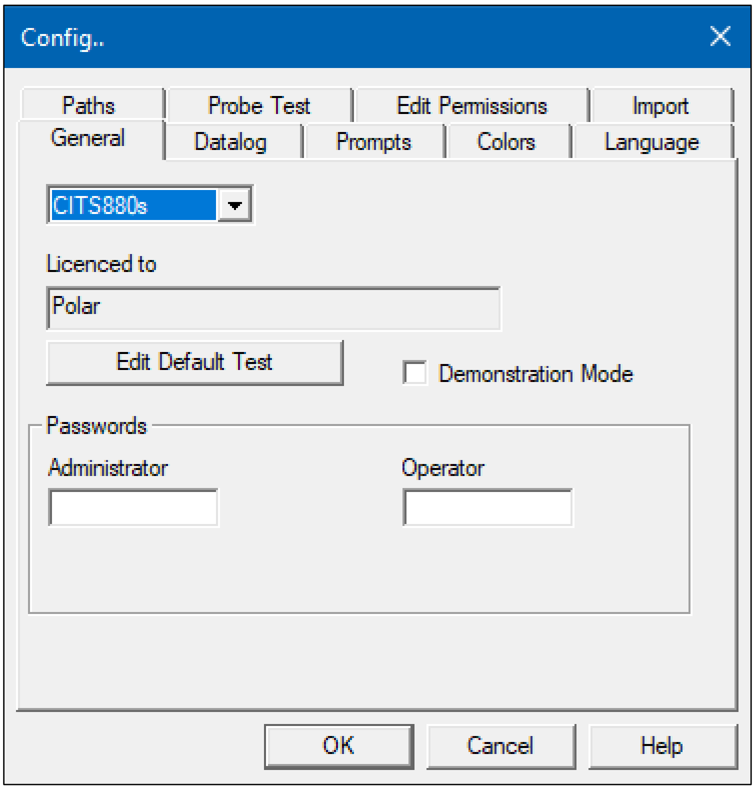


Figure 2-1 The System Configuration menu

General options

Demonstration Mode

Demonstration mode is provided to allow the CITS880s program to be operated without an instrument connected. In this mode when the Test function is selected the CITS880s allows the operator to select a stored waveform for display.

Editing the default test parameter settings

Use the Edit Default Test function to define the test parameters and settings in the Test Editor when a new test is added to the test list.

System security

The CITS880s incorporates two levels of security, **Administrator** and **Operator**. The **Passwords** options enable the Administrator to specify password protection for critical system and test file information. The system administrator is able to control operator access to each field in the Test Setup Editor via the Test Permissions page

Specifying a password

Specifying a password is optional; if an **Administrator** password is specified, unauthorised users will be prevented from modifying the system configuration, editing test files (files containing test parameters) or deleting logged records.

If a password is set it will be requested before these operations are permitted.

If an **Operator** password is set it will be required if an operator attempts to alter test parameters. All system changes will require the Administrator password.

To specify a password, activate the **Password** box and type the password — up to 8 characters may be used. For security, characters typed will be displayed as asterisks. If no password is required leave the field blank.

Confirmation

If a password is entered the CITS880s displays a confirmation box. Re-type the password in the confirmation box to verify the original.

Activate on Exit

If a password has been specified, exiting this screen with this box checked enables password protection immediately; otherwise the password protection is not enabled until the software is next run.

Controlling test file editing permissions

With an Administrator password specified the CITS880s will require the Administrator password to access the Test File Editor to alter test parameters for a test or group of tests.

If an operator password has been specified the Administrator is able to grant controlled operator access to the Test File Editor. Use the **Edit Permissions** page to control which test parameter fields, if any, may be modified by the operator.

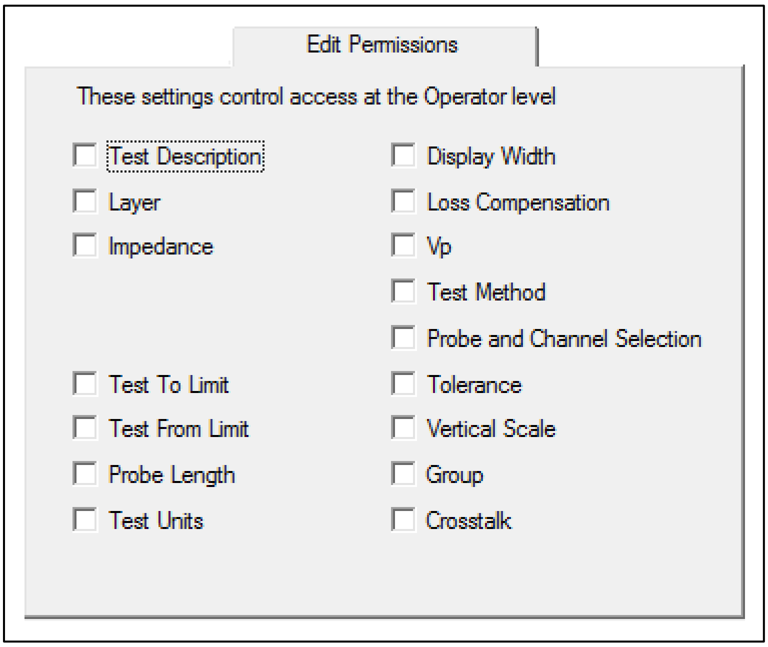


Figure 2-2 Edit Permissions

Click each checkbox to enable the associated field as required.

When the operator attempts to modify test parameters the system will request a password. Supplying the Administrator password will open the Test Setup Editor with full access to all test parameters, if the Operator password is entered the Test Setup Editor opens with only the parameters checked in the Edit Permissions page enabled. Press **OK** to confirm and close the dialog.

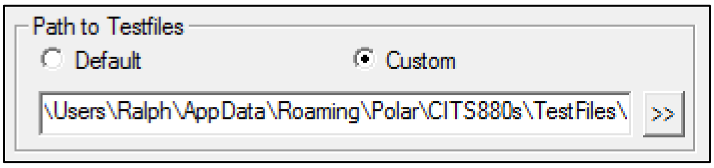
Logging off the current user

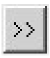
To switch between Administrator and Operator (without exiting the program) choose the **Utilities|Logoff current user** command. At the next attempt to modify test parameters the system will request a password. Enter the Administrator or Operator password as required.

Setting default file locations

Setting the Path to Testfiles options

Click the **Paths** tab and use **Path to Testfiles** to specify the location for test parameter files.



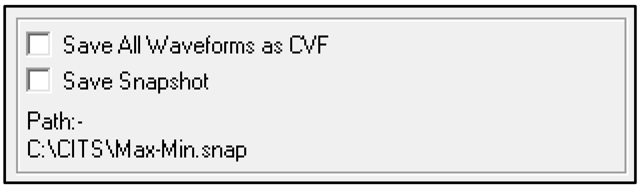


Select Testfile Target Folder…button

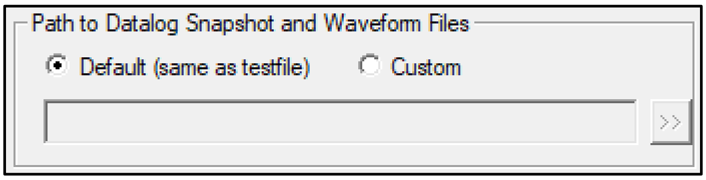
Test files are stored by default in the C:\Users*username*\AppData\Roaming\Polar\CITS880s\TestFiles\ folder; to choose another folder click the **Custom** option button and use the **Select Testfile Target folder…**button to navigate to the target folder.

Setting the path to waveform / snapshots files options

During data logging, users can allow waveform and snapshot files to be saved automatically at the datalog point.



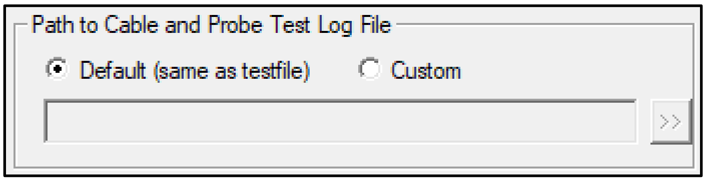
During data logging waveform and snapshot files are saved and named using the board serial number and test name.



Waveform and snapshots files are stored by default in the same folder that contains the test file; choose another folder via the **Custom** option.

Setting the path to the cable and probe test log file

By default, the results of cable and probe tests are stored in the same folder as test files.



To choose another folder click the **Custom** option button and use the **Select Target folder…**button to navigate to the new target folder.

Setting the Datalog options

The **Datalog** dialog allows the operator to specify data logging options.

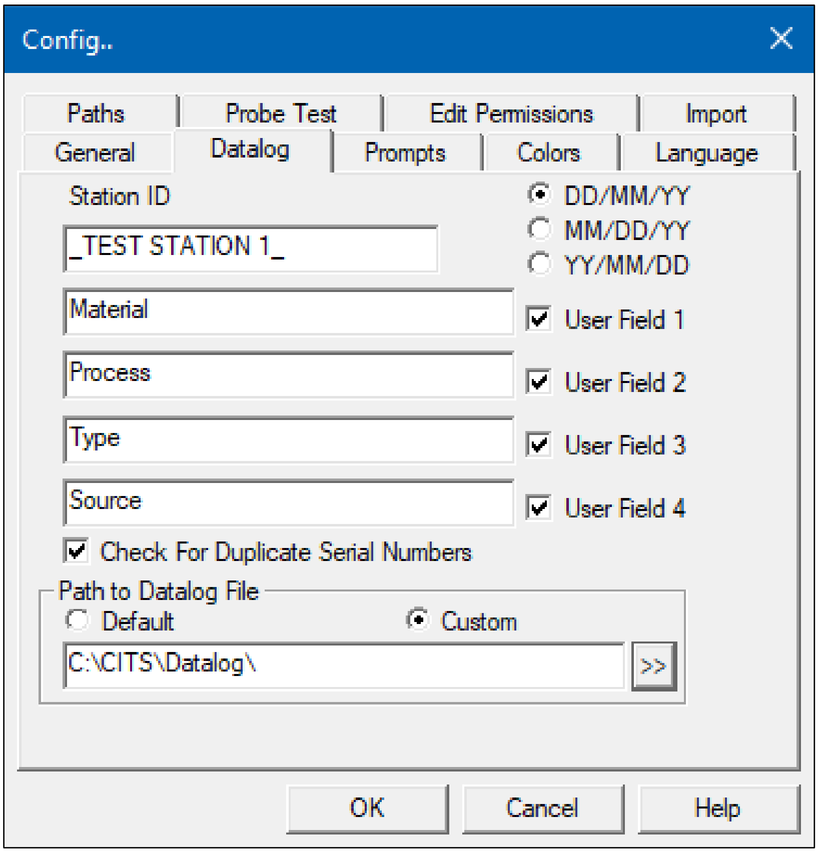


Figure 2-3 The Datalog dialog tab

Specifying a Station ID

Click into the Station ID field and type the name of the test station. This is used when multiple CITS880s stations are data logging to a common log file

Specifying the date format

The CITS880s data logging can record the date in one of three common formats. Choose from DD/MM/YY or MM/DD/YY or YY/MM/DD formats.

Defining custom information fields

Specify user fields to provide additional board information (e.g., batch ID, material, process, etc.). User fields can be completed during the datalog process.

Check for Duplicate Serial Numbers

Specify optional checking of serial numbers for duplicates during data logging

Change the destination folder for logged data.

Activate each field via its check box then type the name of the field into the associated text box.

Checking for duplicate serial numbers

If this option is set, the CITS880s will check for unique serial number entry during data logging.

Specifying the Datalog folder

Datalog files are located by default in the C:\Users\username\AppData\Roaming\Polar\CITS880s\TestFiles folder (assuming a default installation). To specify a different folder, click the ***Custom*** *option button.*

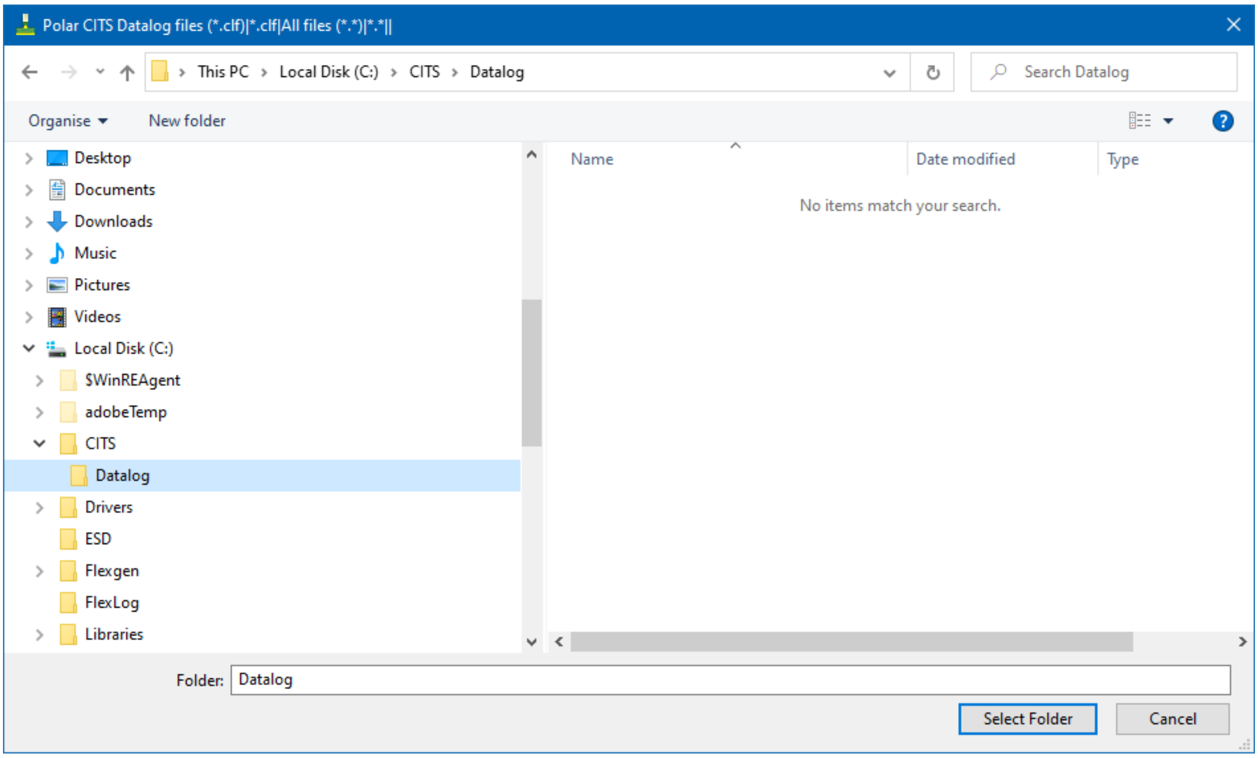


Figure 2-4 Select Datalog Target folder dialog box

Navigate to the data logging folder and press **Open**.

Note: if necessary, create the folder by right clicking a blank area within the **Select Datalog Target Folder…** dialog box and choosing **New** then **Folder** from the shortcut menus.

See the Windows User Guide for details.

Changing the system prompts

The CITS880s incorporates facilities automatically to display confirmation or information dialog boxes as test files are created, loaded or deleted. Click on the Prompts tab to specify the system prompt options:

- Display a Confirm Delete message to prevent accidental deletion of a test file
- Automatically display the Board Details dialog box each time a new test file is generated
- Show the Board Notes (a text box containing notes, instructions, etc. for a board under test) as a test file is loaded
- Display a Confirm message to clear the board waveforms currently in the Test Window
- During data logging tests may be cycled through in sequence automatically (if **Auto Advance** from the **Datalog** menu is selected).

- The operator can specify a brief view of each waveform as the CITS880s advances through the tests. Click Delay before Auto Advance and specify a time in seconds; the system will pause for the specified time before advancing to the next step.
- CITS880s displays a warning that the relays are approaching end of usable life – this setting allows the user to specify when the warning is triggered.
- CITS880s displays a warning at switch on when a recalibration is due in order to maintain its full specified performance – choose the number of days before the calibration due date that the warning will be displayed.
- Sound an audible warning when a board passes or fails the test process. Customize the audible warning If Beep on Pass or Beep on Fail are checked by navigating to a suitable audio file (in .wav format.)

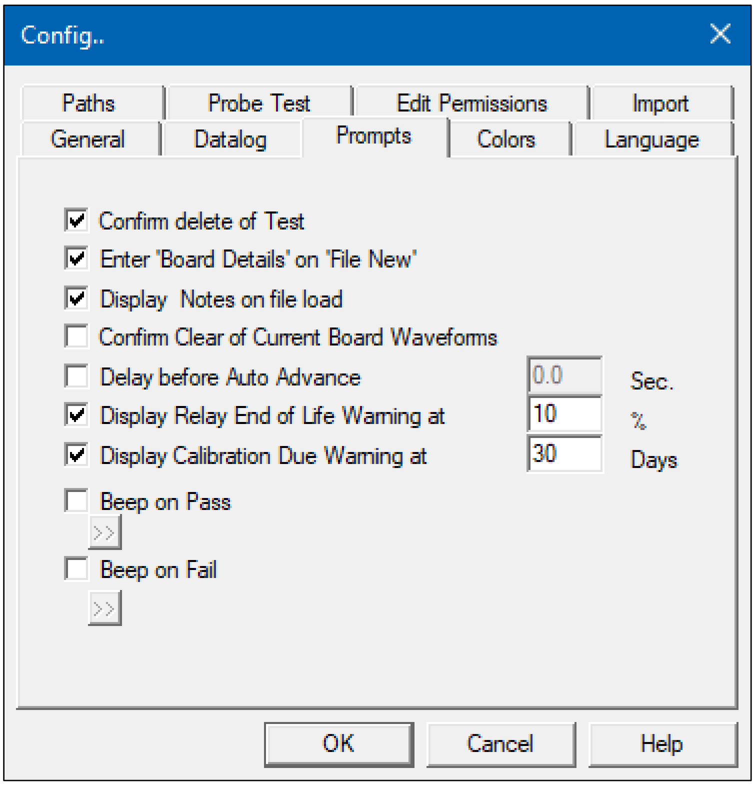


Figure 2-5 Prompts dialog

Click the associated check box to select each option.

File Import horizontal fine adjustment

The CITS880s can import files from earlier versions of the CITS; if necessary use the File import Horizontal Fine Adjustment setting to provide horizontal offset in inches or millimetres.

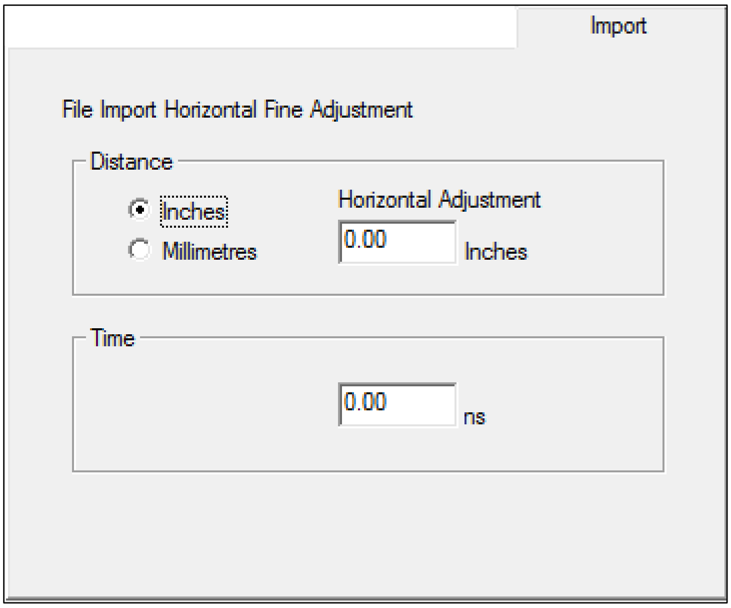


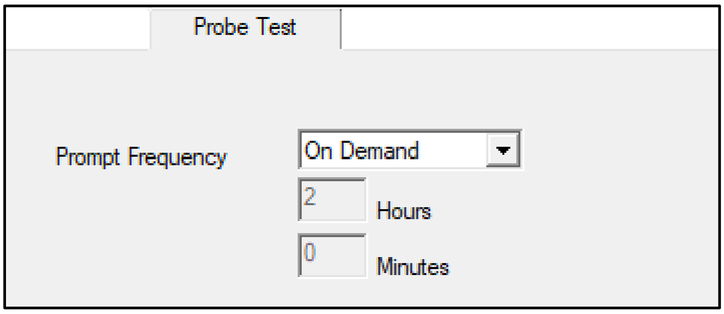
Figure 2-6 File Import horizontal fine adjustment

Choose the Distance units and specify the horizontal offset in the selected units.

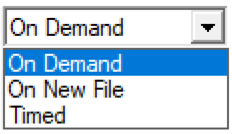
Set the Time adjustment in nanoseconds.

Probe Test

Use the Probe Test options to specify the frequency of prompts for Probe Verification testing.



Specify the frequency from the Prompt Frequency dropdown



Probe verification can be manually requested, when a new file is created and the first test run or at a user-specified interval.

Changing the CITS880s display colors

Click the Colors tab to change the colors of objects (waveforms, cursors, graticules, axes, etc.) in the display window.

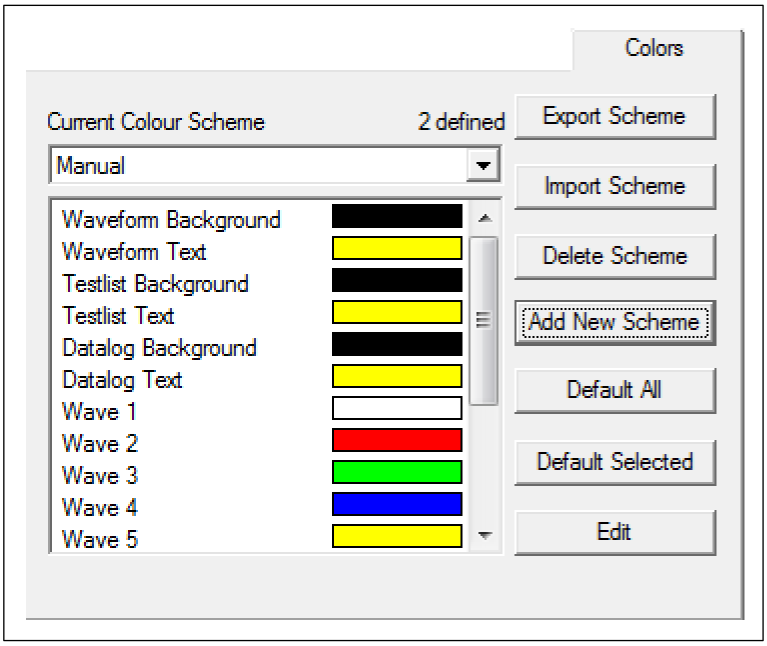


Figure 2-7 Display Colors dialog

Click on the object name/color then click the **Edit** button to display the color palette. If necessary click **Define Custom Colors** to choose from a wider range of available colors (the actual range will depend on the graphics card installed on the machine).

Color choices are grouped into Schemes. Click **Add New Scheme** and supply a descriptive name to create a new scheme.

Click **Default Selected** to set the current scheme object color to its default value.

Click **Default All** to reset all object colors in the scheme to the default values.

Importing/exporting schemes

Schemes may be transferred between CITS880s installations. Click **Export Scheme** to save the scheme under a descriptive name. Click **Import Scheme** to load a previously exported scheme.

SECTION 3 — GETTING STARTED

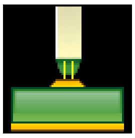
FIRST TIME CITS880s OPERATION

IMPORTANT Observe antistatic discharge precautions at all times

The CITS880s is a sensitive measuring instrument. To prevent damage to the CITS, always observe antistatic precautions. Polar IPS and IPDS probes are precision moulded from ESD dissipative materials and include internal ESD grounding. For maximum protection against ESD damage Polar recommends operators use a wrist strap connected to an appropriate ESD ground point. See Appendix B for more information

This section discusses the basic operation of the CITS880s program using the sample test coupons included with the CITS.

First time operators are encouraged to work through this section using the coupons and test files provided to verify the correct operation of the CITS880s and quickly gain familiarity with the impedance testing procedure.



CITS880s icon

Power up the CITS880s, double-click the CITS880s icon on the desktop to start the CITS880s program. The CITS880s main screen is shown in Figure 3-1. Allow the instrument to warm up to achieve calibrated status for critical measurements.

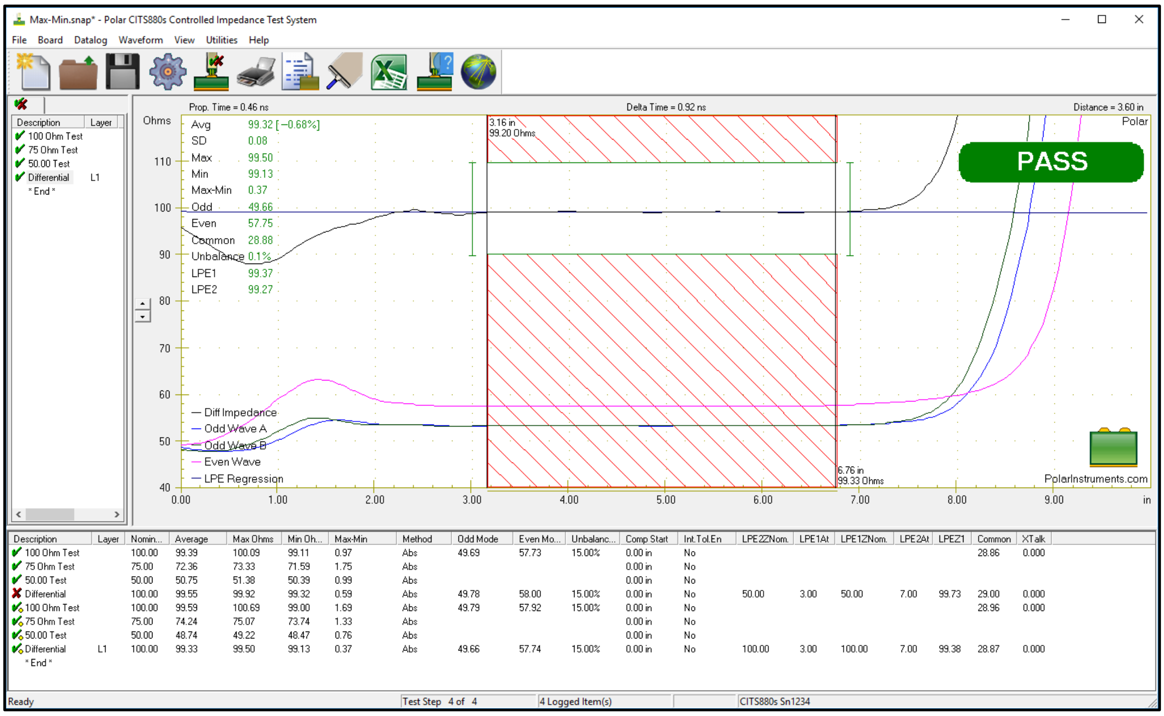


Figure 3-1 The CITS880s main screen

Note: the colours of the screen displays may be changed at the option of the user — the screen views used in this manual may differ from the system in use.

The CITS880s screen

The CITS880s screen window is split into three window panes and comprises six sections:

The Test List window pane which lists the tests within the active test file.

The Waveform Display window pane which displays the impedance waveform and test results.

The Datalog Results window pane which displays logged test results (e.g. for a batch of boards using the active test file).

The menu bar containing all the CITS880s commands.

The tool bar, which provides short cut access to the most commonly used commands.

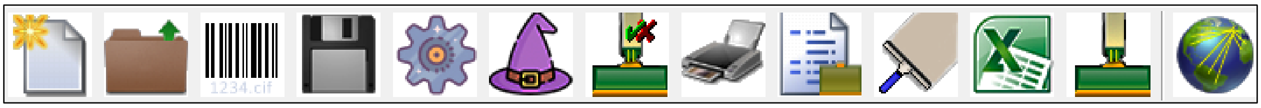
The status bar, which displays descriptions of the tool bar buttons as the mouse is moved over each button and test and data logging information.

The CITS880s window may be increased or decreased in size by dragging the window borders with the mouse.

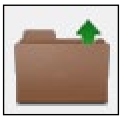
If necessary, press the Maximise button to increase the display size to full screen.

The CITS880s main tool bar

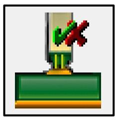
The CITS880s main toolbar (described in detail in the next section) contains buttons that provide quick mouse access to the most frequently used CITS880s commands:



(This section discusses only the **File Open** and **Execute Test** buttons.)



The **File Open** button displays the **Open** dialog box and allows the user to choose a test file. Each test file contains one or more tests for the board under test.



The **Execute Test** button performs a test using the selected test list item.

3-1 Testing the sample coupon traces

When testing, wear a wrist strap connected to a suitable earth point. A wrist strap is provided with the CITS; connect the wrist strap to the wrist strap stud on the CITS880s front panel.

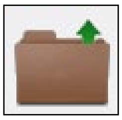
The CITS880s includes a sample coupon to allow users to familiarise themselves with the operation of the instrument. The coupon includes three single-ended PCB traces of nominal impedance, 50Ω, 75Ω and 100Ω and one differential trace of nominal impedance 100Ω. The CITS880s software includes a test file incorporating the 50Ω, 75Ω and 100Ω tests associated with the coupon.

Note: the sample coupon includes impedances of nominal value only and should not be used for calibration purposes.

To test any PCB trace it is necessary to select the correct test file for the board trace under test. This file includes the nominal trace impedance to be tested for, the test channel, the test tolerance and the distance over which to test. In this section test the sample coupon supplied with the CITS880s.

Note: the CITS880s should be allowed to warm up prior to use in measurement – calibration will be invalid until the warm up period has completed (approximately 20 minutes.)

Selecting a test file



*File **Open...***

From the **File** menu select **Open...** or press the **Open...** button on the tool bar with the mouse — the **Open** dialog box appears with the test files listed. See Figure 3-2.

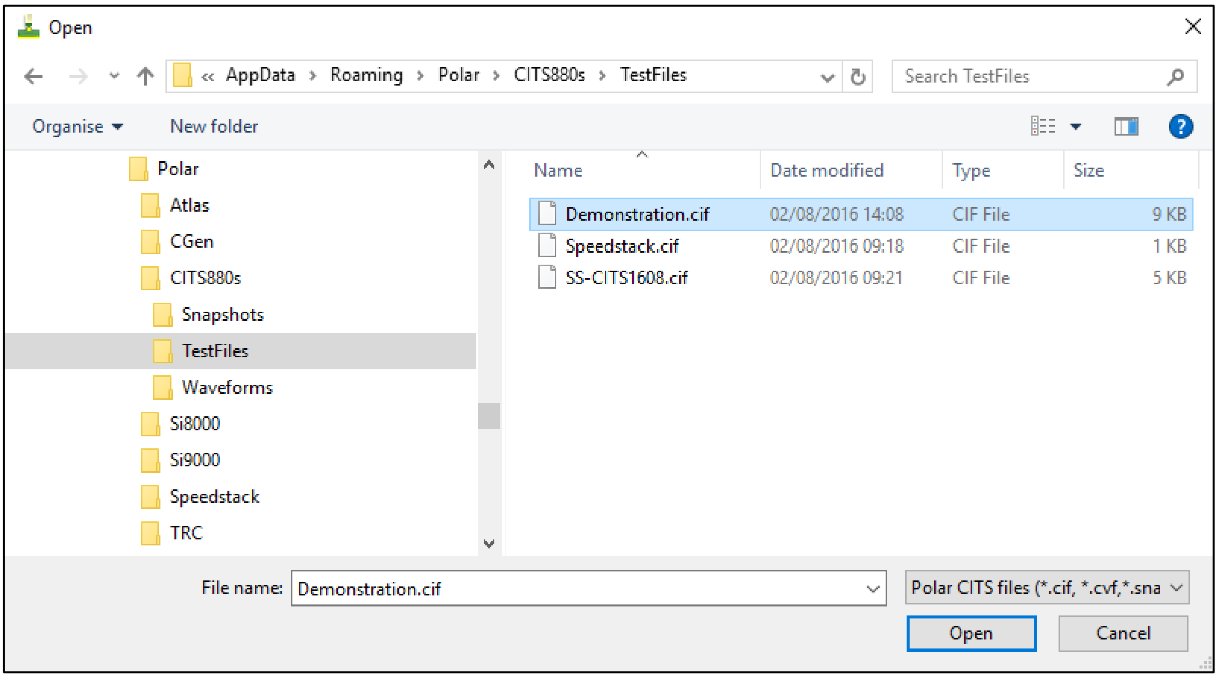


Figure 3-2 The Open Test File dialog

Note: file locations may vary dependent on installation.

The Demonstration file contains the tests associated with the sample coupon. This example will test the coupon's 50Ω trace using the 50 Ohm Single test in the Demonstration file.

Select the Demonstration file and click **OK**. The CITS880s loads the selected test file and displays the list of trace tests for the coupon in the Test List window pane. See Figure 3-3 below.

The CITS880s provides the option of selecting test files from the list using the mouse or keyboard arrow keys or using the CITS880s foot pedal to advance through the list and perform each test in the sequence without the use of mouse or keyboard. If a barcode reader is used this is entered at the start of a cycle.

Click on the 50 Ohm Single test — the Waveform Display pane reflects the impedance and distance scales for the test and cross hatched areas indicating the distance or time region over which impedance will be tested.

The impedance scale indicates the nominal impedance and the PASS and FAIL impedance ranges. An INTERMEDIATE (i.e. guard-band) range (shown below) may optionally be added between the PASS and FAIL ranges.

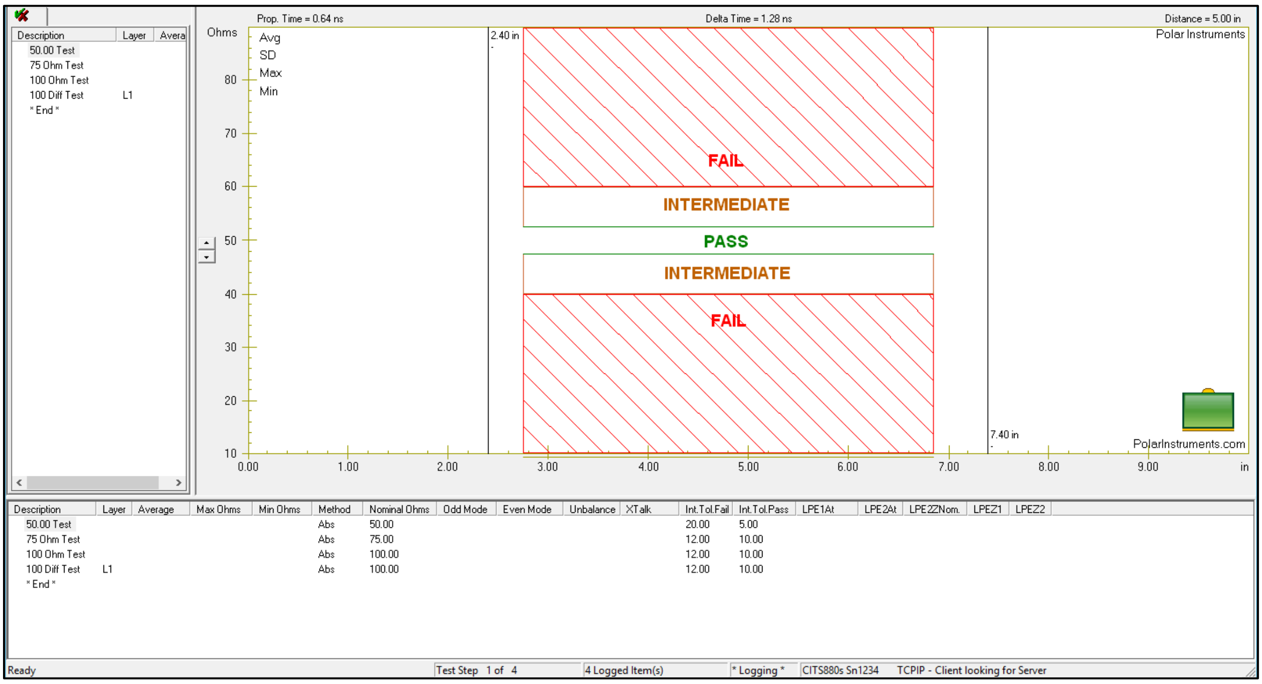


Figure 3-3 The CITS880s Test Window with the Demonstration file loaded (50 Ohm Single test selected)

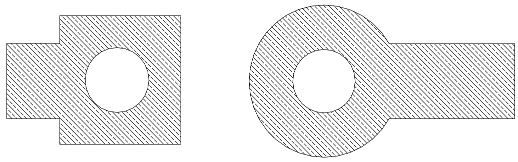
Note: these are sample settings that may be changed by the user so may differ between systems.

Click on the 75 Ohm and 100 Ohm tests and note the changes in the Waveform display window.

For the test shown in Figure 3-3 the nominal impedance has been specified in the test file as 50Ω ±5% so the acceptable range of impedance values for a PASS result is from 47.5 – 52.5Ω. The FAIL threshold is set at ±20% so the range of impedance values for a FAIL result is less than 40 ohms or greater than 60 ohms. Between the PASS and FAIL values the CITS800s returns an INTERMEDIATE result. The test is performed on a 50Ω coupon trace (from 2.75” to 6.75”).

Performing the single-ended tests

When executing the test ensure the Microstrip probe signal pin is connected to the signal pad and the probe ground pin to coupon ground pad. Typically, ground connections have square pads to distinguish them from signal pads. Probe pin spacing (pitch) should match the spacing between signal and ground pad holes. The probe tips should be of appropriate diameter and profile with suitably sharp edges so as to provide accurate and repeatable contact with the pads.



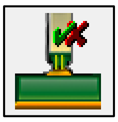
Minimising aberrations

It is important to use high quality test connections (e.g. use Polar supplied microstrip probes) to minimise aberrations. Polar IPS and IPDS probes are precision moulded from ESD dissipative materials and include internal ESD grounding.

Probe connections should be tightened with the Polar supplied torque wrench to ensure a good connection.

For maximum protection against ESD damage Polar also recommends operators use a wrist strap connected to an appropriate ESD ground point.

Choose the **Datalog** menu and ensure the **Autolog** command is off (un-ticked).


CITS880s ***Test***

To test the coupon, connect the microstrip probe across the 50Ω test impedance and press the foot switch or click the **Test** button. Take care not to touch the track on the coupon during testing.

The system will set up the instrument for testing and then graph the impedance of the 50Ω trace.

The CITS880s displays the trace's impedance against the test program limits. See Figure 3-4.

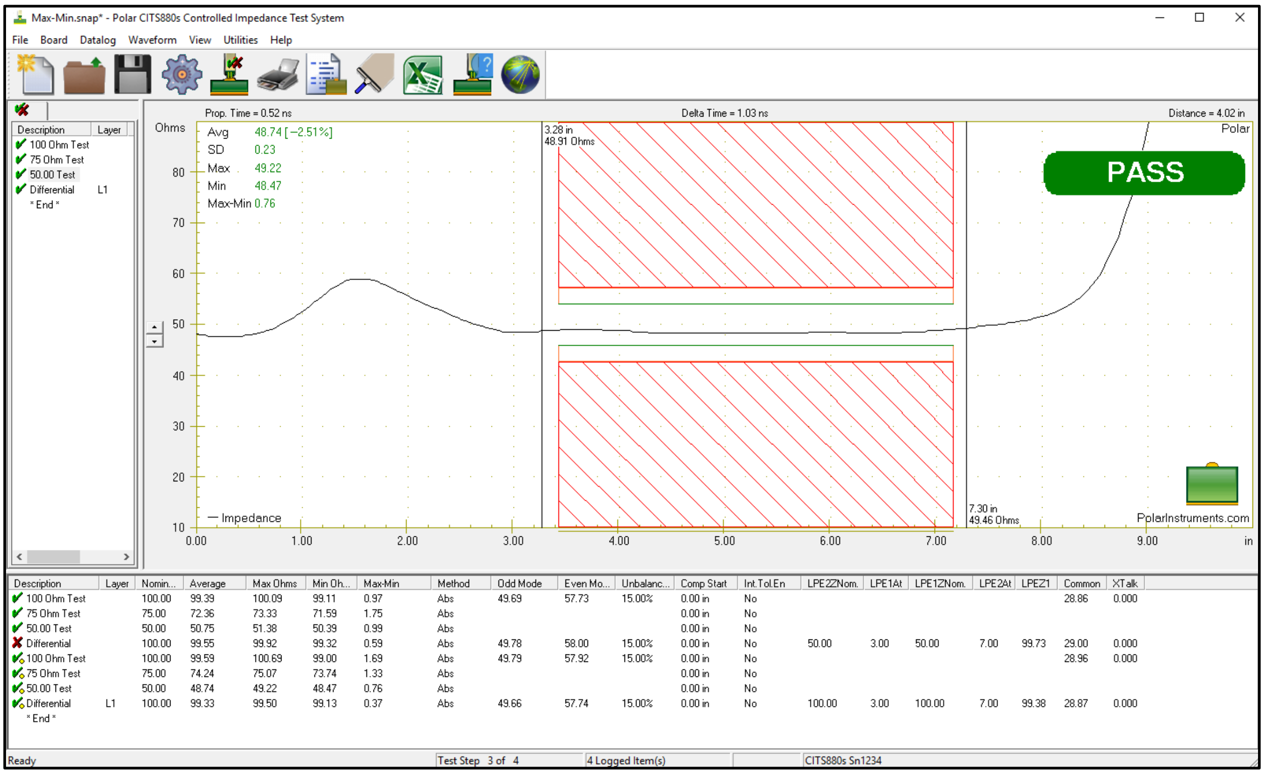


Figure 3-4 Graph of 50Ω impedance within limits

If the waveform remains between the PASS limits over the whole of the tested region the CITS880s records a **PASS**.

If necessary, use the up and down arrows to move the display vertically to view portions of the trace.

Displaying the impedance statistics

The CITS880s displays the PASS, INTERMEDIATE or FAIL result for the test and displays the impedance statistics over the tested area:

- average impedance
- standard deviation
- maximum impedance
- minimum impedance
- maximum – minimum impedance (optionally)

The tested area is usually the flattest portion of the coupon waveform and is usually referred to as the *undisturbed interval* (ignore test connection aberrations and open circuit termination effects).

Values are presented in the associated boxes on screen along with the impedance waveform. If the displayed waveform extends into the INTERMEDIATE region the CITS880s records an **INTERMEDIATE** result; if any part of the waveform traverses into the crosshatched area the CITS880s records a **FAIL**. (See also the Test Editor for the Average and Envelope test methods.)

(If the CITS880s records an **INTERMEDIATE** or **FAIL** on the sample coupon, check for correct probe/coupon polarity and good contact between the microstrip probe and the trace on the coupon and try again.) Repeat the procedure for the 75Ω and 100Ω nominal impedance traces on the sample coupon using the 75 Ohm Test and 100 Ohm Test respectively.

See below for the 100 Ohm Differential test using the IPDS100 Differential probe.

As each test is completed a result symbol is displayed alongside the test in the Test List window pane to indicate a PASS, INTERMEDIATE or FAIL result (see table below) for the trace along with the Average value of impedance for each test (see Section 4.6 — *Adding columns to the Test List* to display other values.)

PASS	✓	Green tick
INTERMEDIATE	↻	Yellow clockwise open arrow
FAIL	✗	Red cross

Test results for all tests performed on the coupon are also recorded in the Datalog window pane. Yellow circles alongside test results indicate that the logged results have not been saved to disk.

The Status Bar indicates which test is currently displayed.

When all tests are complete, step through and review each test result (waveform and statistical results) by clicking the test name in the Test List window pane.

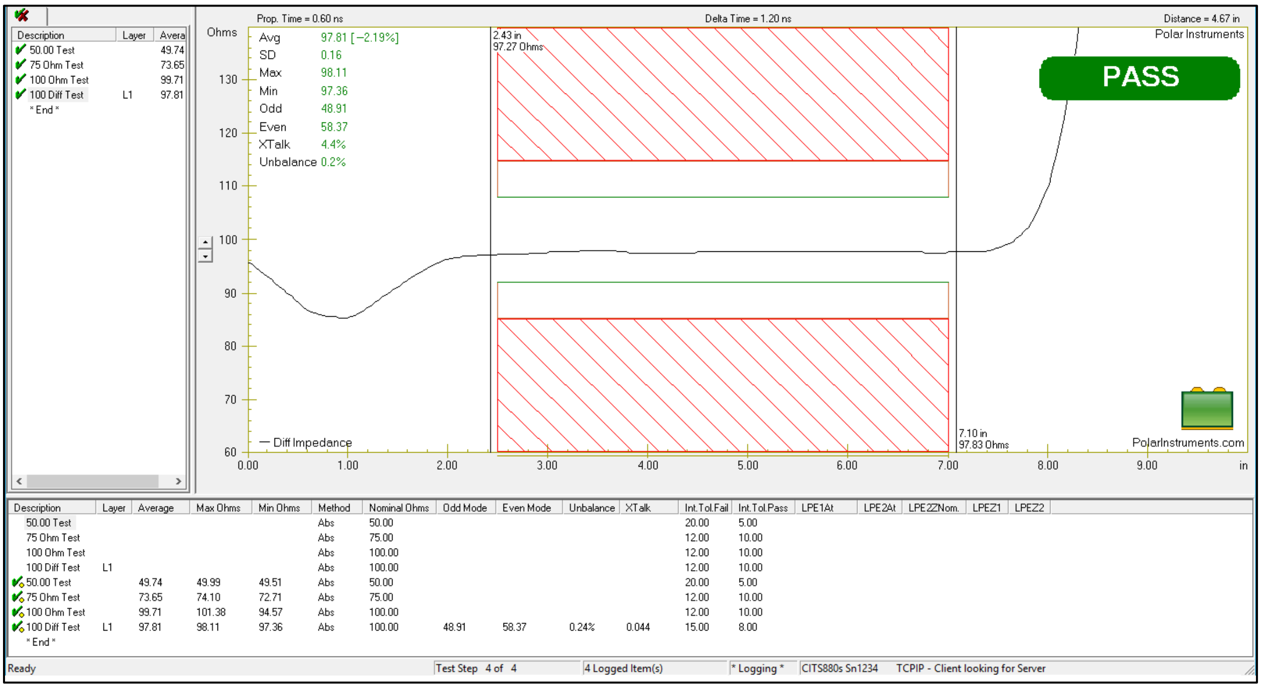


Fig 3-5 Completed set of Coupon Test results

Using the measurement cursors

The CITS880s incorporates on-screen measurement cursors to display absolute values of propagation delay time, distance and impedance along the displayed waveform. Use cursors for critical time measurements — click onto each cursor and drag it with the mouse to the point of interest on the waveform. Each cursor displays the distance along the trace and impedance where the cursor crosses the waveform. The distance between the cursors (propagation delay time, delta time and distance between the cursors) are displayed above the Waveform Display window pane. Delta time (or real time) is the “out and back” time of the TDR signal. Propagation time, the “out only” time is calculated as half that value.

Testing the Differential coupon

The sample coupon includes a 100Ω differential pair.

Connect the IPDS100 Differential Probe to the Channels 1 and 2 SMA connectors on the CITS880s front panel.

Select the Differential 100Ω Ohm Diff Test. Locate the IPDS100 Probe across the 100Ω impedance and press the Test button.

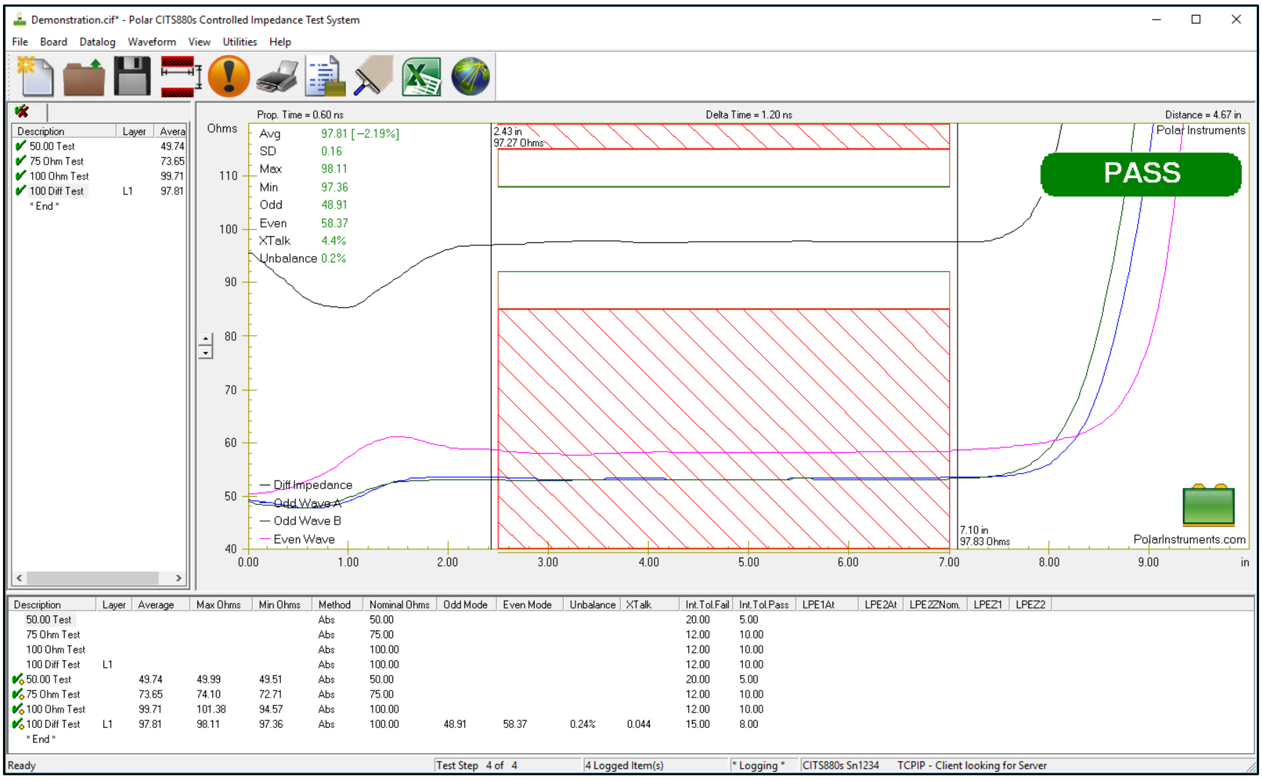


Figure 3-6 Differential Coupon Test PASS result

The differential pair returns results as for the single-ended case but can also include values for crosstalk, odd and even mode impedance and unbalance between the lines.

Odd mode impedance is defined as the impedance of either of the conductors in a differential pair when both drives are driven differentially (i.e. with signals of equal and opposite polarity) so odd mode impedance is equal to half the value for differential impedance in a balanced system.

Even mode impedance is the impedance of either of the conductors in a differential pair when both drives are driven in common mode (i.e. with identical signals of the same polarity.)

Adding a test with the Setup wizard


Setup Wizard

First time users may find it helpful to use the Board|Setup Wizard… which provides a guide through the steps required to create a test for a board trace.

Connect the cables and appropriate probe.

The Wizard includes steps to specify the test parameters (test type, test channel(s) and impedance value) and locate the open circuit at the end of the probe. With the probe at the trace launch point; the Wizard selects a suitable horizontal range to display the trace waveform and the test region for the trace, choosing the Test From and Test To distances.

From the Board menu, choose Setup Wizard…

Locating the open circuit at the end of the probe

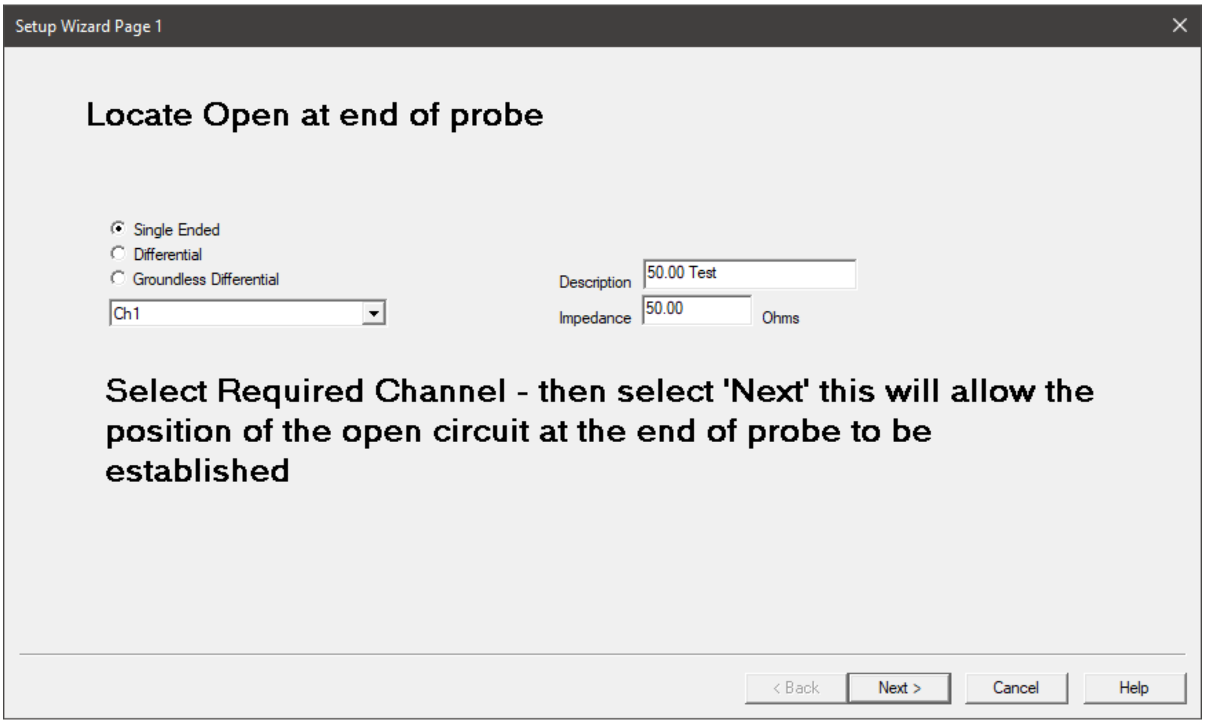


Figure 3-7 Locate open circuit at end of probe

Choose the test type (Single ended, Differential or Groundless Differential) and channel or channel pair and add the description and impedance value. The Wizard locates the open circuit at the end of the probe. Click Next.

Calculating the horizontal range and test region

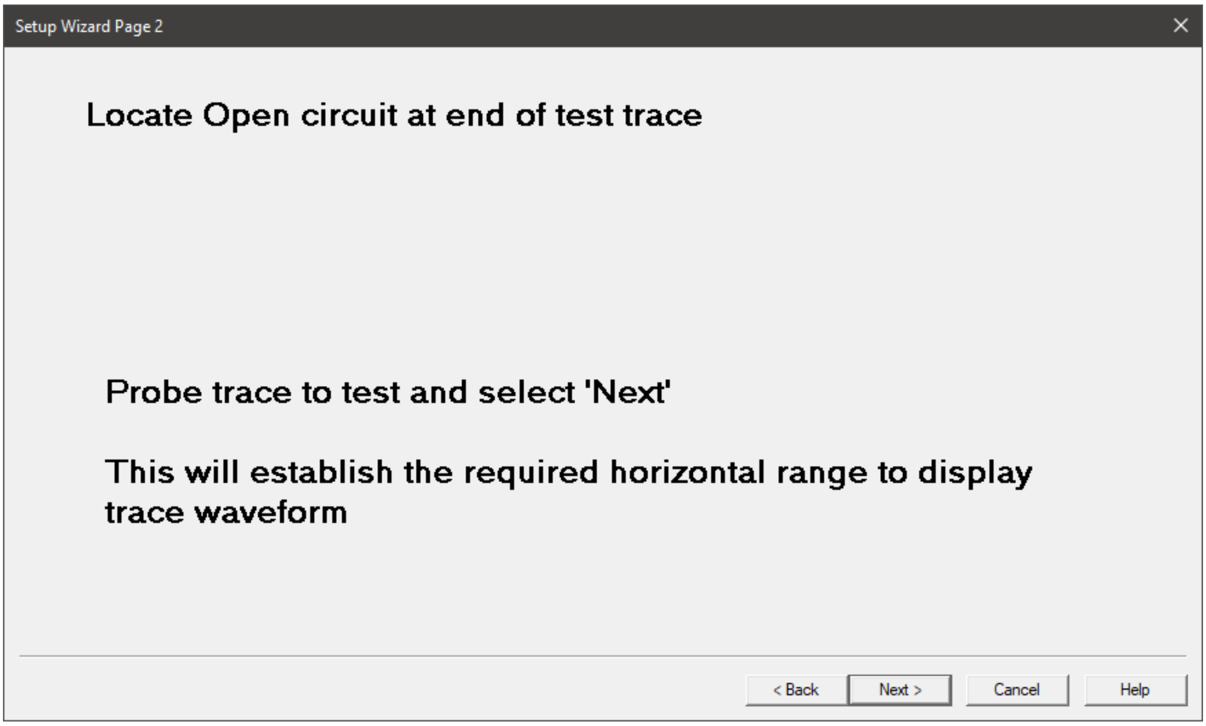


Figure 3-8 Locate open circuit at end of test trace

Locate the probe at the trace launch point and click Next.

The Wizard will propose the most appropriate test region (the Test From and Test To horizontal values)

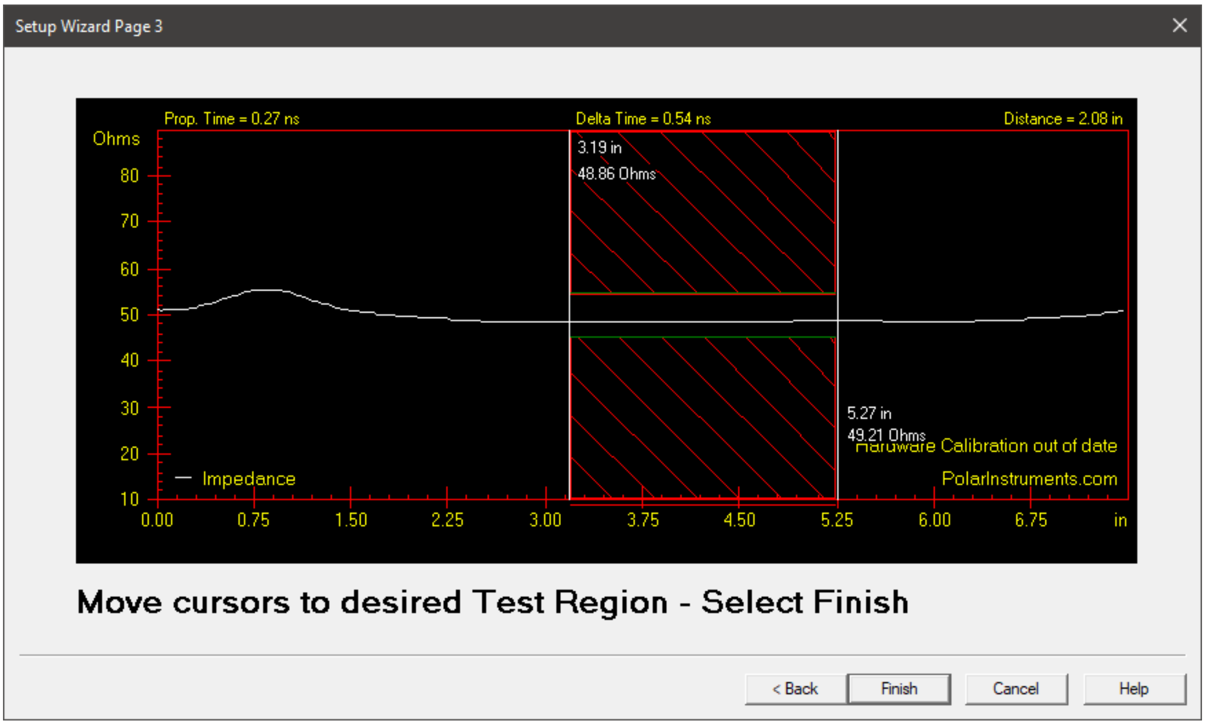


Figure 3-8 Wizard proposed test region

If necessary, move the cursors to a more suitable part of the waveform – usually the flattest portion of the waveform – see the example graphic below.

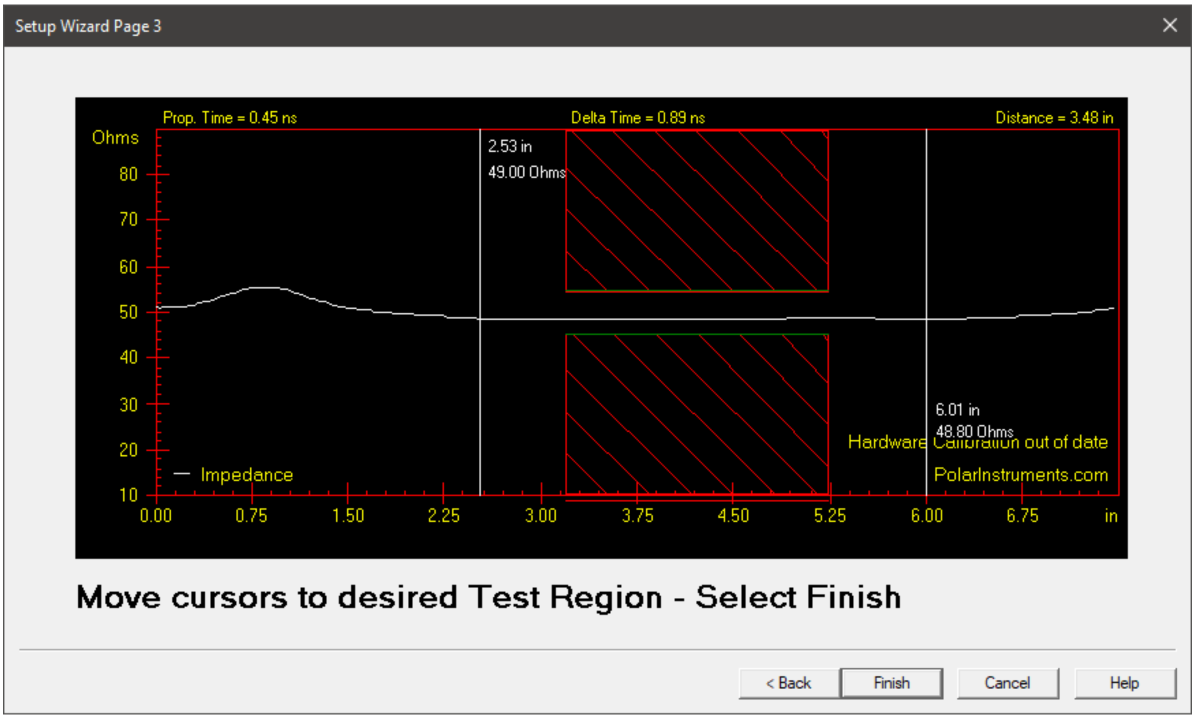


Figure 3-9 Move cursors to define test region

Click Finish – the Wizard reflects the chosen test region.

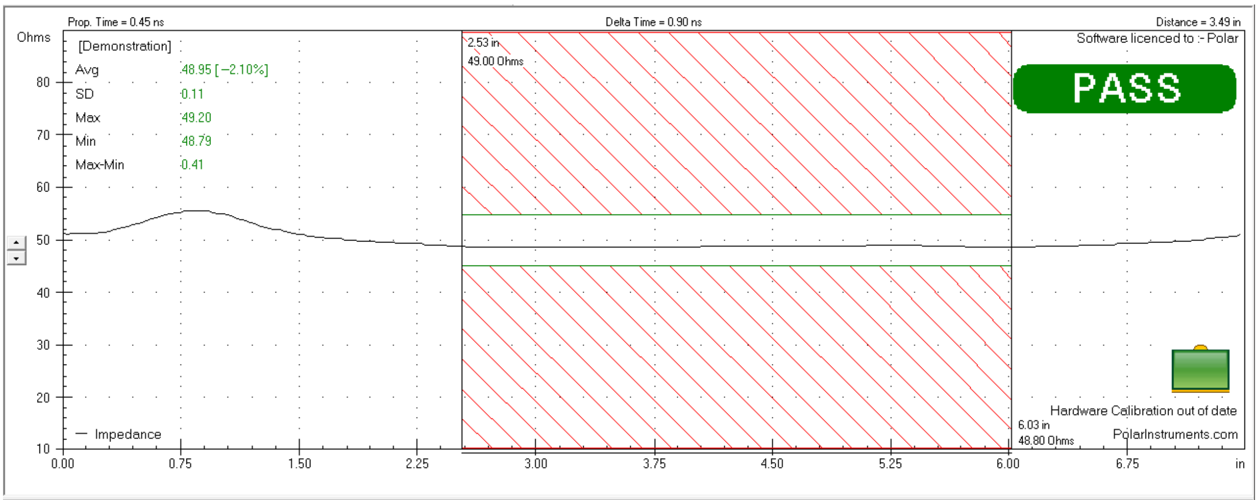


Figure 3-10 Cursor defined test region

Use the Test Editor to specify other test parameters.

Saving snapshots

When all tests have been completed the test file with all its tests and associated waveforms and results can be saved for later recall as a *snapshot* (see next section *System Operation – The File Menu*.)

3-2 Exiting the program

Select **Exit** from the **File** menu or press **Alt+F4** to leave the program and return to the Windows Program Manager.

SECTION 4 — SYSTEM OPERATION

USING THE CITS

IMPORTANT The CITS880s is an extremely sensitive measuring instrument. To prevent damage to the CITS880s observe static precautions at all times. Polar IPS and IPDS probes are precision moulded from ESD dissipative materials and include internal ESD grounding. For maximum protection against ESD damage Polar recommends operators use a wrist strap connected to an appropriate ESD ground point. See Appendix B for information.

STARTING THE CITS

Note: The CITS880s should be allowed to warm up prior to use in measurement – calibration will be invalid until the warm up period has completed (approximately 20 minutes.)

Double clicking the CITS880s icon starts the program. When the CITS880s program runs, the main CITS880s screen is displayed loaded with the last test file used – Figure 4-1.

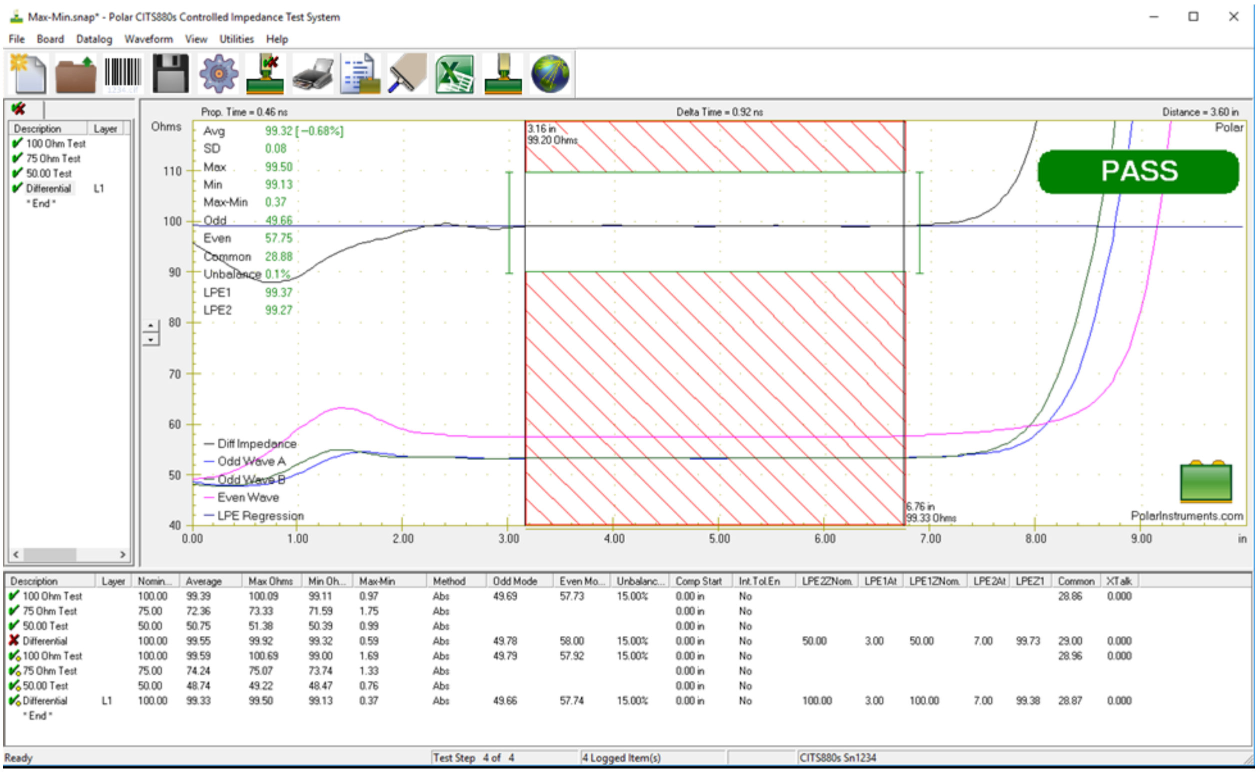


Figure 4-1 The CITS880s main screen

4-1 The CITS880s screen

The CITS880s window is split into three main areas:

The Test List window pane contains each named test within the currently selected test file.

Description	Layer	Average
✔ 50.00 Test	L1	50.08
✔ 75 Ohm Test	L1	73.78
✔ 100 Ohm Test	L1	97.53
✔ 100 Ohm Diff	L1	98.34
* End *		

The Waveform Display window displays the impedance waveform and statistical results for the selected test.

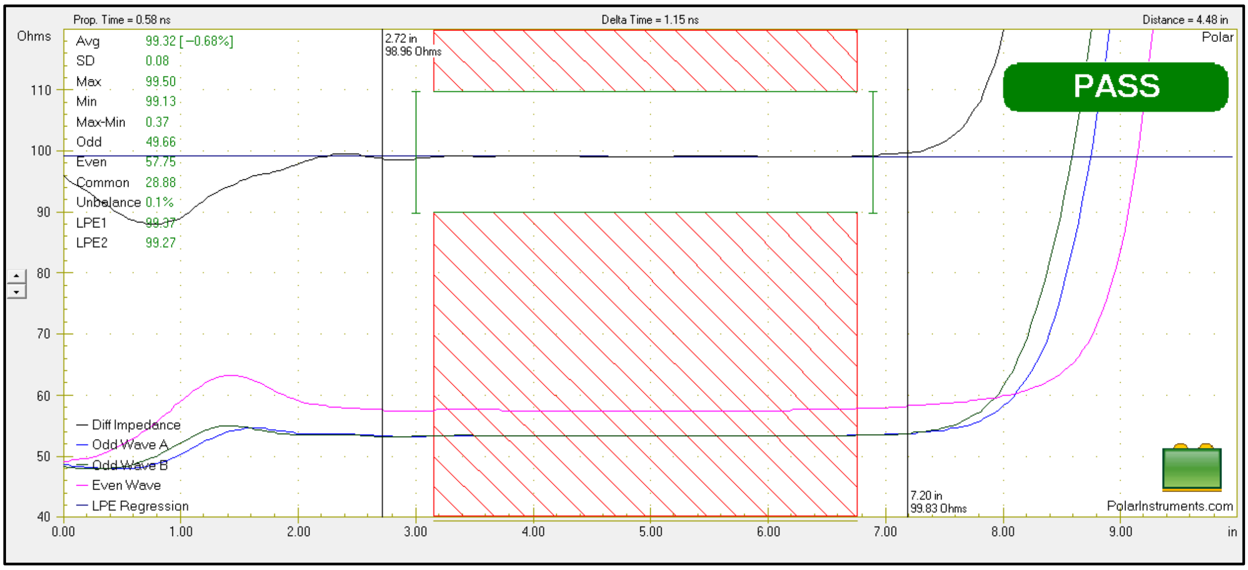


Figure 4.2 CITS880s Waveform Display Window

The Datalog Results window pane displays the logged results for one or more boards using the current test file.

Description	Layer	Average	Job Number	Board Serial	Date	Nominal Ohms	SD	Even Mode	Odd Mode	XTa
✔ 50.00 Test	L1	50.08	Phen 0012	SN-0074	19/08/14	50.00	0.15			
✔ 75 Ohm Test	L1	73.78	Phen 0012	SN-0074	19/08/14	75.00	0.17			
✔ 100 Ohm Test	L1	97.53	Phen 0012	SN-0074	19/08/14	100.00	0.52			
✔ 100 Ohm Diff	L1	98.34	Phen 0012	SN-0074	19/08/14	100.00	0.28	59.62	49.17	0.0
* End *										

The CITS880s includes two control sections:

The menu bar containing all the CITS880s commands

The tool bar which provides short cut access to the most commonly used commands.

The status bar displays descriptions of the tool bar buttons as the mouse is moved over each button and test and data logging information.

The CITS880s window may be increased or decreased in size by dragging the window borders with the mouse.

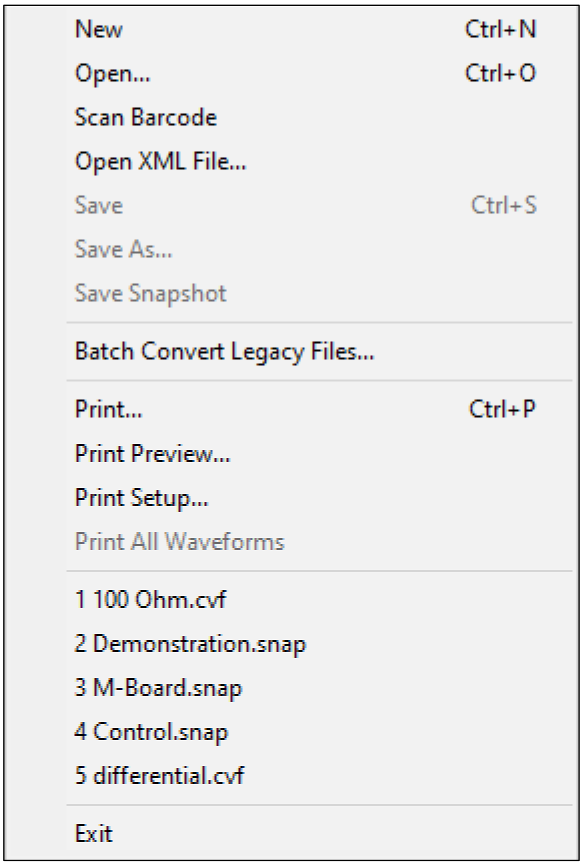
The main screen window can be maximised to full screen view if desired — click the **Maximise** button (or double-click the CITS880s Title Bar or press **Alt+Spacebar** then **X** on the keyboard.)

4-2 The CITS880s menu bar

All CITS880s commands are available from pull-down menus; commands can be accessed via the keyboard or mouse (see OPERATING THE CITS880s.)

The File menu

Use the **File** menu to process CITS880s test files.



Employ these menu commands to:

Create new test files

Open existing files (including files in XML format)

Scan

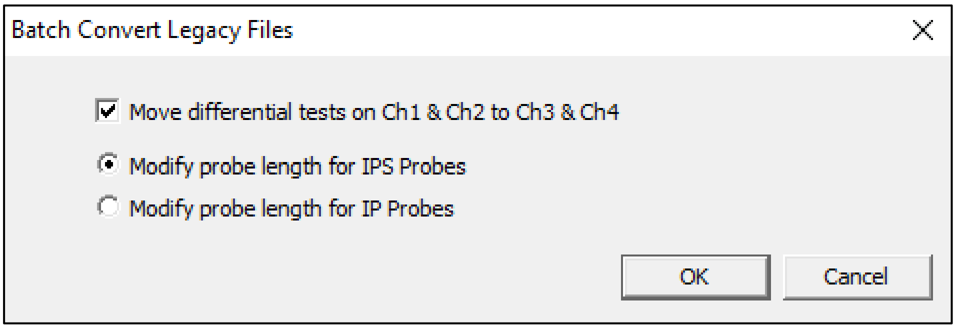
Save existing files

Convert legacy format files

Save and open snapshots

A snapshot is a test file with one or more completed tests along with their associated waveforms and test results.

If it is necessary to open files in a legacy format (for example files using earlier style probes) or move differential tests to different channels choose the Batch Convert Legacy Files command and select the appropriate options. Press OK and follow the steps to choose and save files.



Choose a CITS880s test file via a barcode reader

The CITS880s Scan Barcode dialog can be utilised to scan the barcode for the item to be tested (for example, a controlled impedance test coupon) and load the associated CITS test file from the CITS880s test files folder. Both CITS native .CIF and XML test files can be loaded via the barcode reader.

Choose and set up printers for hard copy

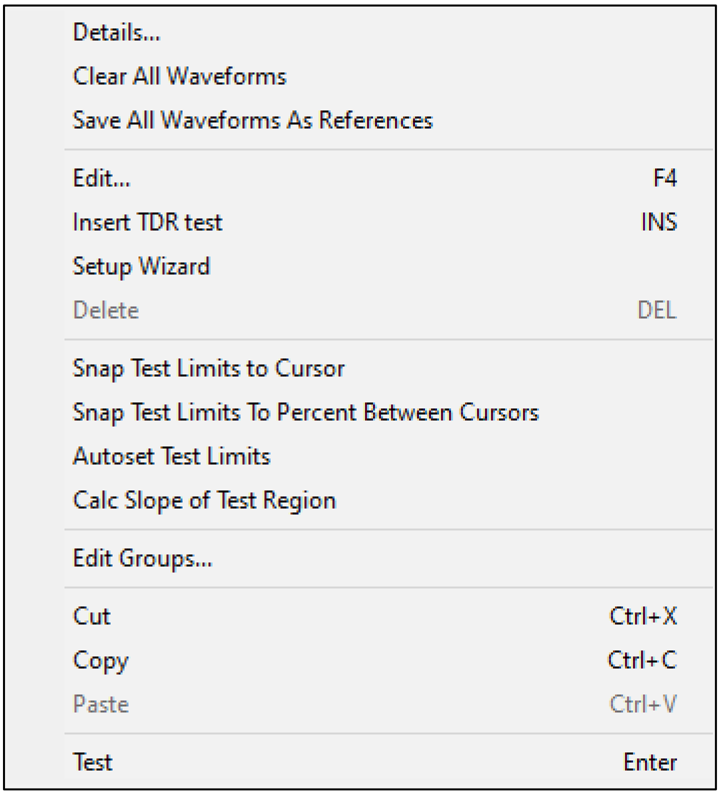
Preview and print the displayed waveform, datalog results or test file list

Exit from the CITS880s program

When the **File** menu appears the last five test files opened are listed in reverse order.

The Board menu

The Board menu contains the commands to insert new tests and modify existing board test parameters within the current test file.



Board information

Typically, each board will have an associated test file containing all the tests for the controlled impedance traces on the board. Each board test file will include board setup information **Details…** (e.g. customer name, board type and part number) along with notes for the board (comments, special instructions, etc.) Board notes will be displayed as the test file is loaded.

Use the **Clear All Waveform** commands to remove all test result waveforms from the test window; the **Save all Waveforms As Reference** allows the on screen waveforms to be stored as reference for future tests.

Creating and editing board tests

Use the **Insert TDR test…** command to add a controlled impedance trace test to a board test file: the Test Editor is displayed to allow test parameters to be specified for the new test (see *Test Editor* for a discussion of test parameters.)

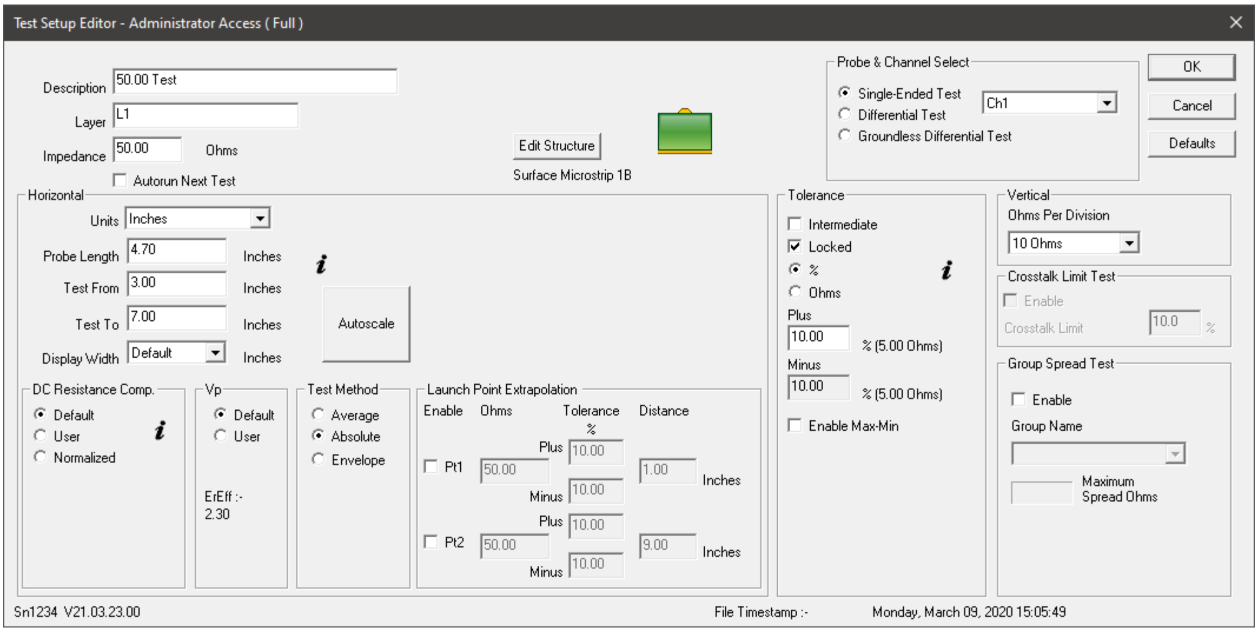


Figure 4.3 CITS880s Test Editor

Supply a descriptive name for the test and layer name and trace impedance.

Choose the test type, single ended, differential or groundless differential and select the CITS880s channel or channel pair.

Specify the horizontal units (distance or time) and the probe length and test region (normally to test the flattest portion of the trace waveform.)

Choose the Test Method (the default method is the Absolute Method.)

Specify the tolerance (the tolerance about the nominal impedance to which the track will be tested.) See the screen graphic below.

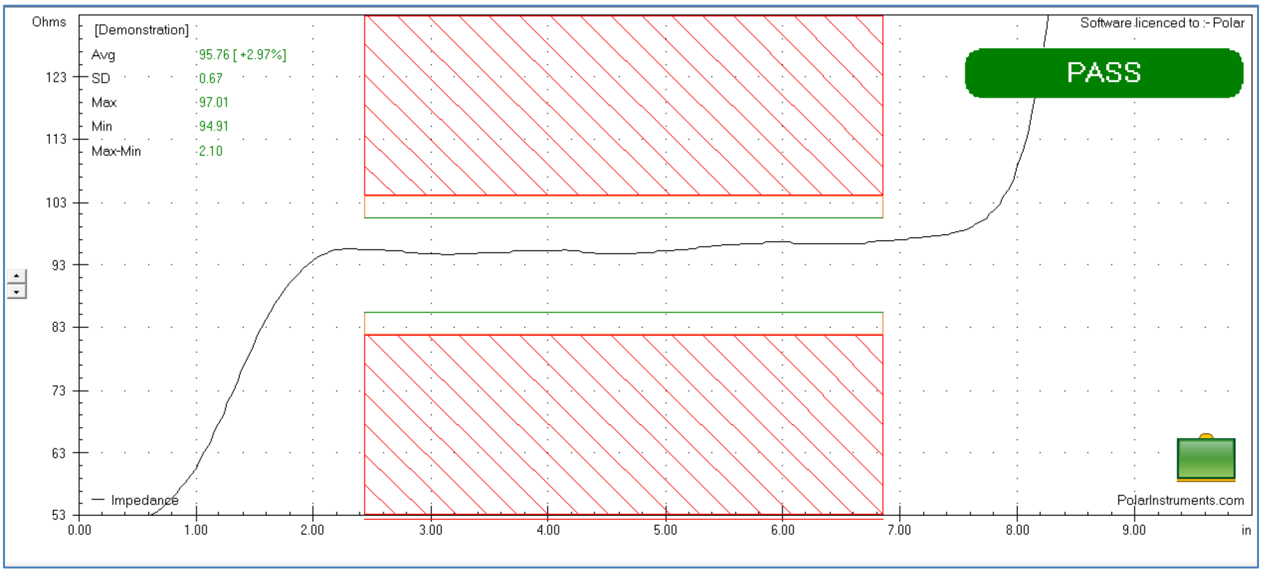


Figure 4.4 CITS880s Waveform Display Window – Pass Result

The Waveform Display pane reflects the impedance and distance scales for the test. The graphic above shows upper and lower red cross hatched (FAIL) areas, upper and lower green (INTERMEDIATE) areas and the clear (PASS) area between them, indicating the region over which impedance will be tested.

The impedance scale indicates the nominal impedance and PASS, INTERMEDIATE and FAIL impedance ranges.

PASS, INTERMEDIATE and FAIL test limits

The CITS880s test file accepts PASS and FAIL impedance limits or, using the Intermediate option shown in the dialog below, PASS, INTERMEDIATE and FAIL impedance limits. The INTERMEDIATE test results provide a guard band between PASS and FAIL.

In the example above, the test indicates a PASS if the impedance value remains within the clear area, i.e. falls within ±10% of the nominal impedance over the test area.

A reading of between 10% and 15%, defined as the INTERMEDIATE limits, indicates the test should be run again or the result referred for consultation.

A reading of greater than ±15% from the nominal impedance is recorded as a FAIL.

An INTERMEDIATE result is shown below.

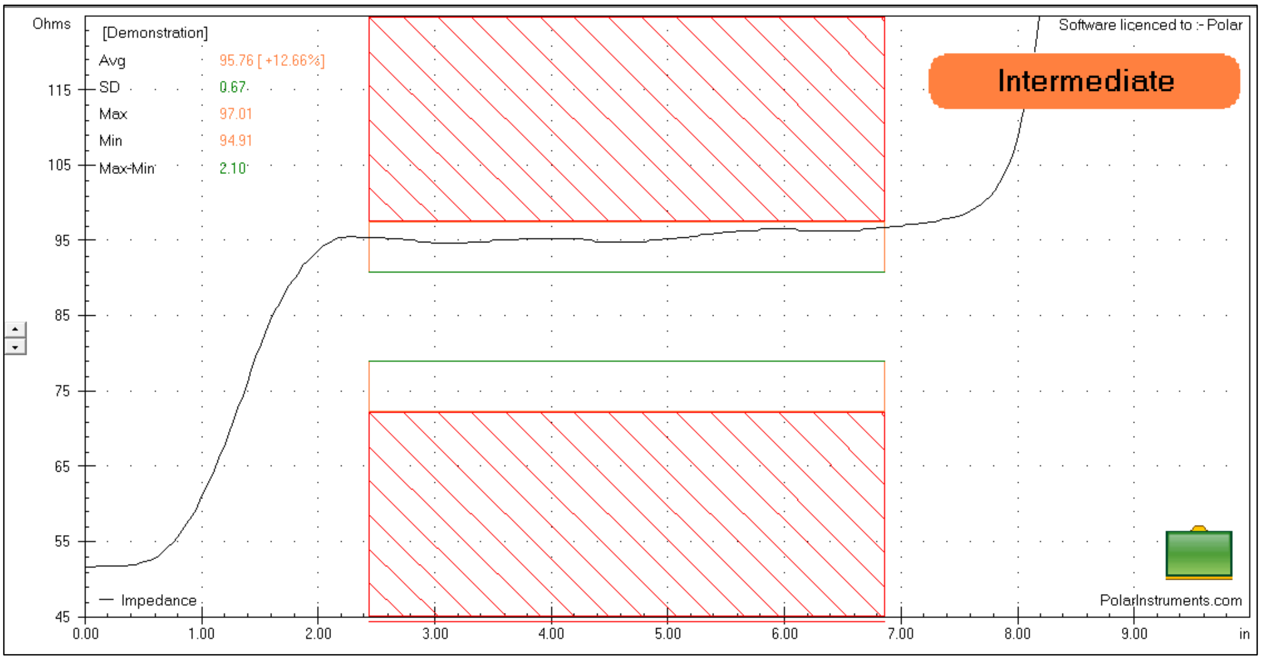
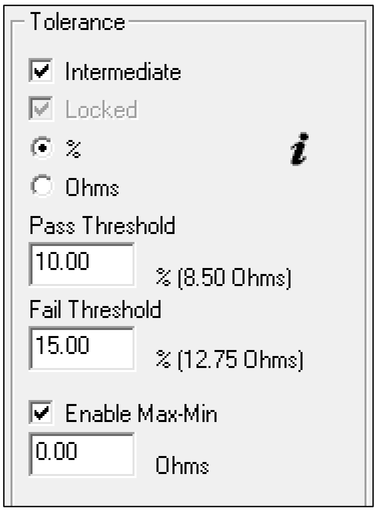


Figure 4.5 CITS880s Waveform Display Window – Intermediate Result

Setting tolerance values

Tolerance values are set within the Tolerance section of the Test Editor dialog box.



Using locked tolerance values

If the Intermediate option is not required, the Plus and Minus tolerances may be locked; i.e. the Plus and Minus settings have the same value, or unlocked, where the Plus and Minus tolerance value is set independently.

Uncheck the Intermediate box, click the Locked check box to lock or unlock the tolerance and enter the limit values. Values may be specified as a percentage or in Ohms.

If the Intermediate check box is ticked tolerances are locked and the Locked option is disabled.

The tolerance must be set to a value in the range 0.10% to 99.99% in 0.01% steps; alternatively, it may be set directly in Ohms. Click the % or Ohms option buttons to select.

Editing a test

The **Edit…** command allows changes to be made to existing tests.

The **Delete** command removes the test from the test list; choose **Test** to run the test on the trace.

Using the time/distance cursors

Propagation delay times may be measured by positioning the cursors at the beginning and end of the test specimen.

The screen displays the distance and impedance where each cursor crosses the impedance waveform.

The **Snap Test Limits to Cursor** command allows the user to change the distance over which the trace is tested to the distance indicated by the cursor positions.

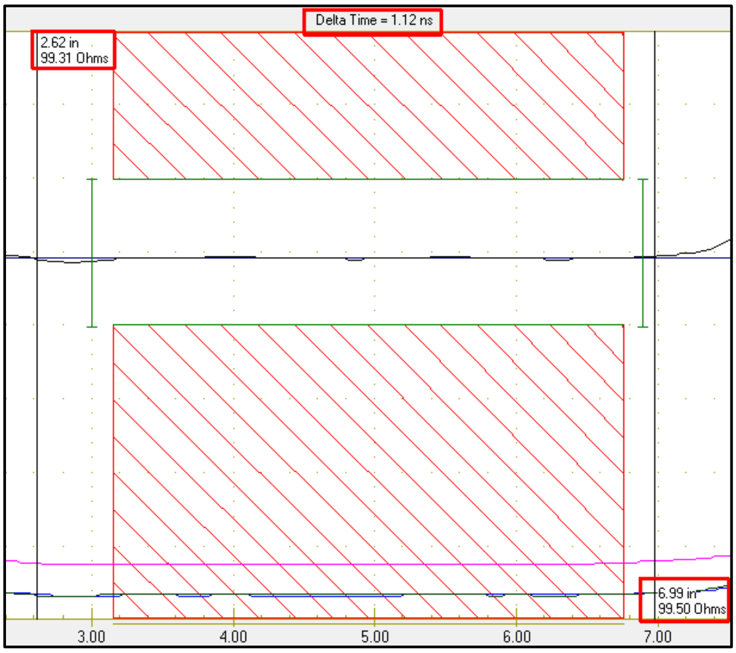


Figure 4.6 Snap Test Limits to Cursor

Use the **Snap Test Limits to Percent between Cursors** command to change the horizontal **Test From** and **Test To** limits to percentage values of the current lower and upper cursor time positions.

The **Autoset Test Limits** sets the horizontal **Test From** and **Test To** limits to encompass the flattest portion of the waveform.

The **Calc Slope of Test Region** command returns the first cursor position and slope of the measured signal within the horizontal **Test From** and **Test To** limits.

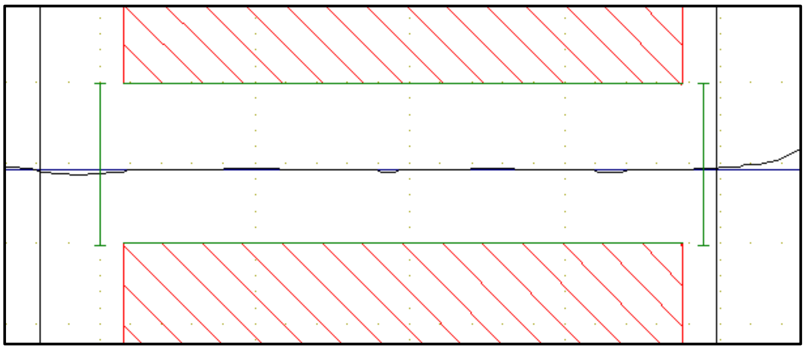
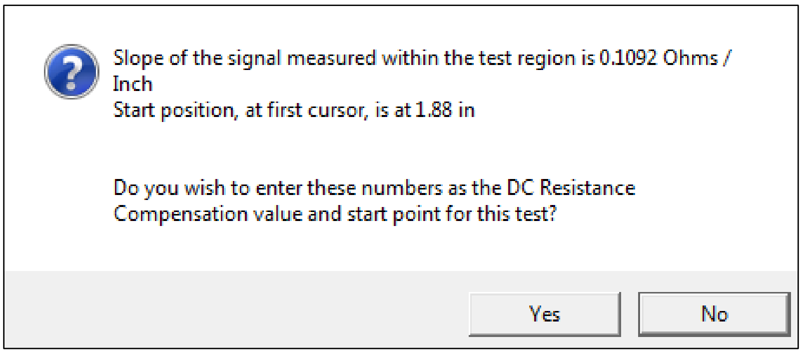


Figure 4.7 Calc slope of test region

The values may be applied to the current waveform and to the DC Resistance Compensation settings of the test for future measurements.

Note that if the calculated value is negative the slope of the waveform cannot be due to trace resistance.



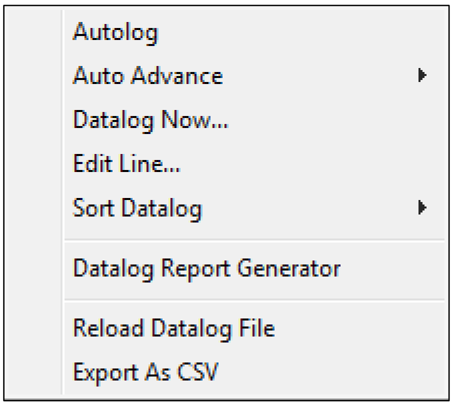
The Board menu includes the **Setup Wizard…** command that will guide the user through the steps required to create a test for a board trace.

Editing groups

Individual trace tests may be designated as members of a named group and tested for impedance spread across the group.

The Datalog menu

The **Datalog** menu allows the user to control the CITS880s data logging facilities. Data logging enables test data to be automatically recorded to a text file for archiving and subsequent analysis. The log file can be printed out or imported into a spreadsheet for analysis or the optional Datalog Report Generator.



Ordering the datalog

The data log can be sorted by record creation order or by board serial number.

Automatic data logging

Automatic data logging can be toggled on or off via the **Autolog** command. **Autolog** is ON by default and its status is saved between sessions.

Auto advancing through tests

Tests may be cycled through in sequence automatically or manually selected. If **Auto Advance** is selected the CITS880s steps through the test list from the top depending on the Auto Advance option specified (**Off**, **On Pass**, **After Test**).

If the **Delay Before Auto Advance** option has been selected (see the Config|Prompts dialog in the Utilities menu) the test waveform is displayed briefly before **Auto Advance** moves to the next test.

Saving waveforms and snapshots on datalog

If the **Save all Waveforms as CVF** (.cvf) files) and **Save Snapshot** check boxes (see the **Datalog - Board Information** dialog) have been checked, waveform files and snapshots will be saved automatically at the datalog point.

During the data logging process waveform files will be saved and named using the board serial number and test name (for example, SN123_Test50Ohm.cvf).

Starting the Datalog Report Generator

The **Datalog Report Generator** command starts the optional Datalog Report Generator.

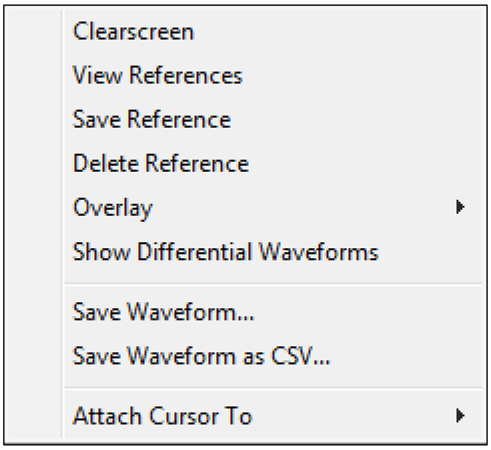
Reloading the datalog file

The **Reload Datalog File** command allows CITS880s users logging data to a common datalog file on a network server to refresh the local copy of the datalog file with the updated data from the server.

Exporting the datalog file

The **Export as CSV** command saves the datalog in comma delimited format; the contents and order of the exported file are the selected columns shown in the datalog window.

The Waveform menu



The **Waveform** menu allows the operator to:

*Save the current waveform as the reference waveform for a test file via the **Save Reference** command — this reference waveform is then displayed in green (default color) whenever the test file is selected. Reference waveforms are retained even when the screen is cleared. **View Reference** toggles the reference display on and off. The reference waveform is removed via the **Delete Reference** command.*

Reference waveforms will be removed from the test file when the associated test parameters are changed.

***Overlay** multiple waveforms — allowing comparison of a sequence of test results.*

Record (save) the current waveform to disk for later viewing.

View recorded waveforms.

In differential tests, view the single ended and even-mode impedance waveforms for engineering analysis.

In differential tests, assign the measurement cursors to the differential, single ended or even mode waveforms.

The View menu

The View menu allows the user to control the display of CITS880s screen items (readout, cursors, graticule, toolbar, etc.). Results can be optionally displayed in mRho

This menu also allows the user to select for display statistical information in the Test List and Datalog window panes.

The Utilities menu

The **Utilities** menu allows users to:

Change operating conditions during normal CITS880s operation

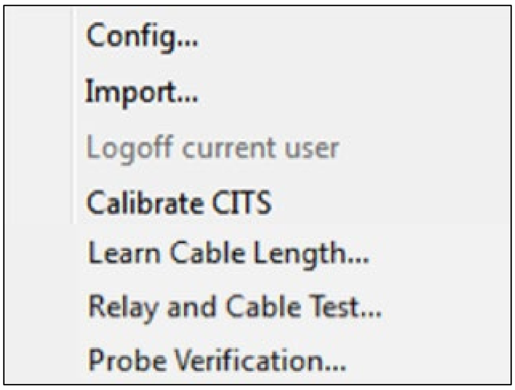
Import test files from earlier CITS880s versions

Calibrate the CITS880s (using the appropriate license)

Learn the cable lengths of one or more of the four channel test cables

Add relay and cable tests to a test file.

Verify the test probes



Config…

Use the **Config** command to change System Configuration options (see SYSTEM CONFIGURATION for more details).

Import…

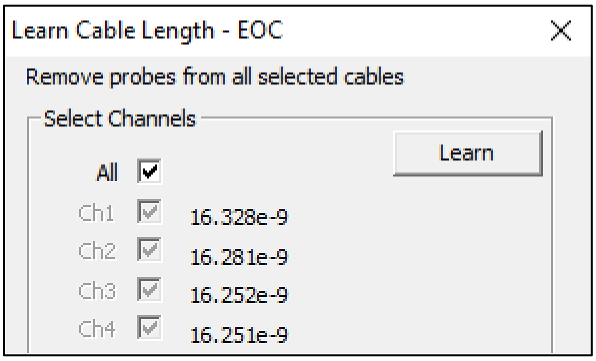
Use the **Import** command to open CITS880s test files produced using earlier versions of the product. Use the dialog to open files with .mrf or .tst extensions.

Calibrate CITS

Contact your local Polar office for calibration and licensing.

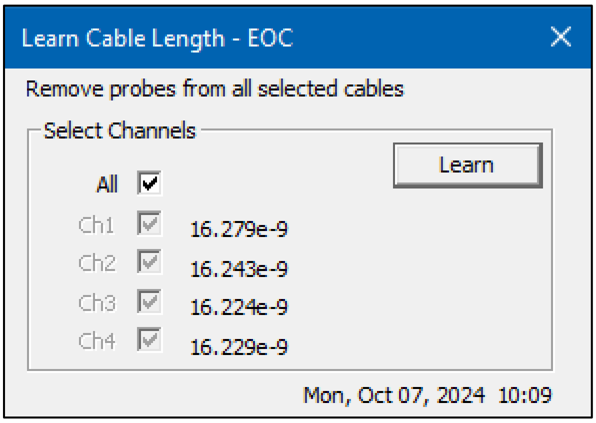
Learn Cable Length

*Use the **Learn Cable Length** command to measure the lengths of the cables (without the probes) attached to the four channels.*



Ensure all probes have been removed from all the selected cables and click the check box for each channel to be tested or All for all four channels.

Click Learn – the CITS880s will learn and display the new results in the Learn Cable Length dialog.



Relay and Cable Test…

The Relay and Cable Test… provides predefined test programs for each channel to verify the operation and integrity of the cables and relays.

A relay and cable test for each channel will be added to the end of the current test file; it is suggested that a new test file be created to run these tests. *Delete these tests from the test file after use – they are specific to the hardware state ONLY at the time of testing.*

With the tests added to the test file, ensure all probes are removed from their cables and the End of Probe calibration has been completed then select and run the test for each channel in turn; the impedance value and waveform is displayed for each channel. See the graphic below.

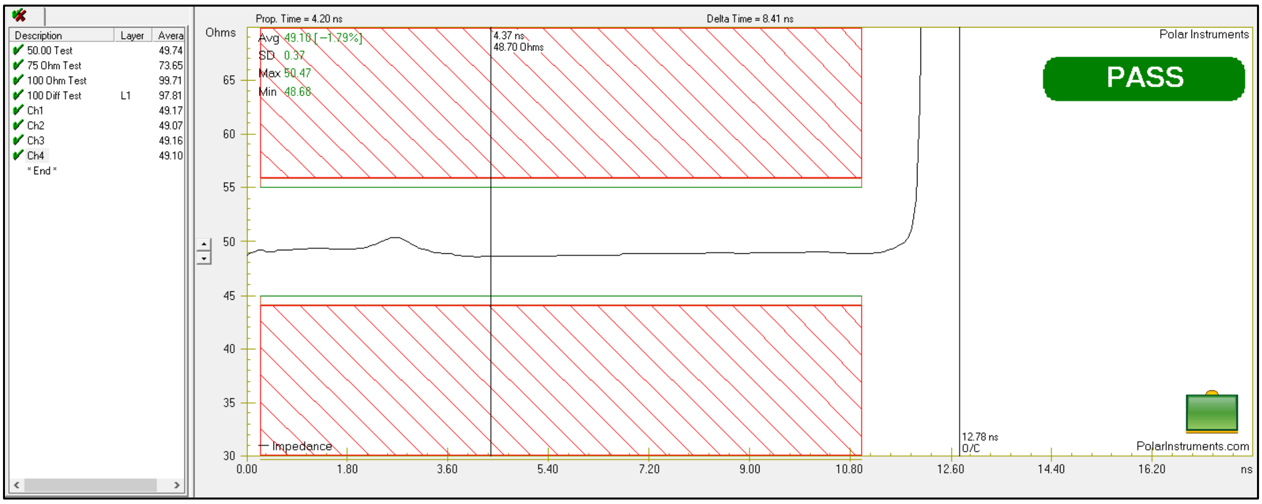
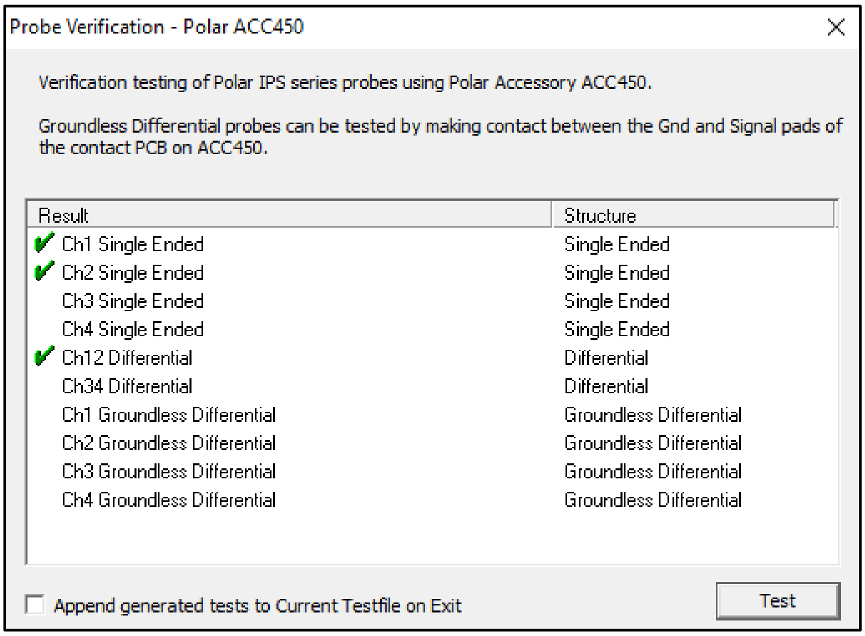


Figure 4-8 Relay and Cable Test

Verifying the test probes

Use the Probe test accessory ACC450 to verify the basic operation of the test probes.

Connect the probe(s) to their respective CITS880s channels. Locate the probe pins on the Ground and Signal pads on ACC450, highlight each channel / probe structure and click Test. The probe test may optionally be added to the test list.



The Help menu

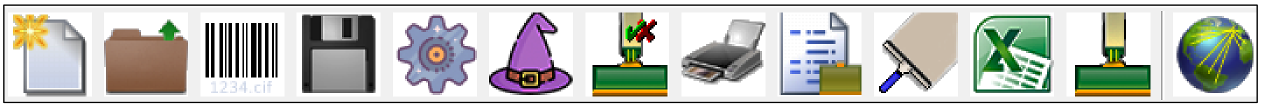
The Help menu Help Topics provides online access to the CITS880s User Guide — press the F1 function key to access the on-line help from anywhere in the program.

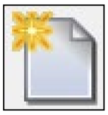
If a an Internet connection is available, select **Visit Polar website** to access the Polar Instruments web site for product and application information or **Check for Updates** to request updates to the software.

Select **About CITS**… for system information (calibration due date, remaining relay life and software and firmware versions,)

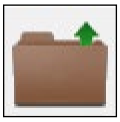
4-3 The CITS880s main tool bar

The CITS880s main toolbar contains buttons that provide quick access to the most frequently used commands:



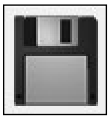


Press the **File New** button to create a new test file.

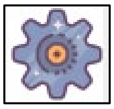


File Open... — press this button to display the **Select Test File** dialog box and choose a test file. Each test file contains one or more tests for the board under test.

Scan Barcode — Open the **Scan Barcode** dialog to scan the barcode for the item to be tested (for example a test coupon) and load the associated CITS test file

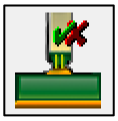


File Save — save the current test file.



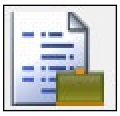
Board Edit — start the Test File Editor

Setup Wizard — add a guided test with the Setup Wizard

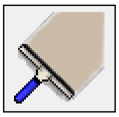


Execute Test — perform a test using the selected test file.

Print waveform — send current waveform to printer for hard copy.

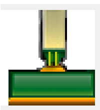


Datalog Report Generator — start the (optional) Datalog Report Generator.



Clear Screen — clears the waveform display window.

Export to Microsoft Excel — save the contents and order of the datalog in CSV format



Verify Probe — verification testing of IPS probes

Visit Polar Website — Access the Polar Instruments Internet Web site for updates and application information.

4-4 The Waveform Display window pane

When a test is executed the CITS880s displays the resulting impedance waveform along with the test limits (the PASS, INTERMEDIATE (guard-band) and FAIL hatched areas), and the results of the test in the Waveform Display window pane.

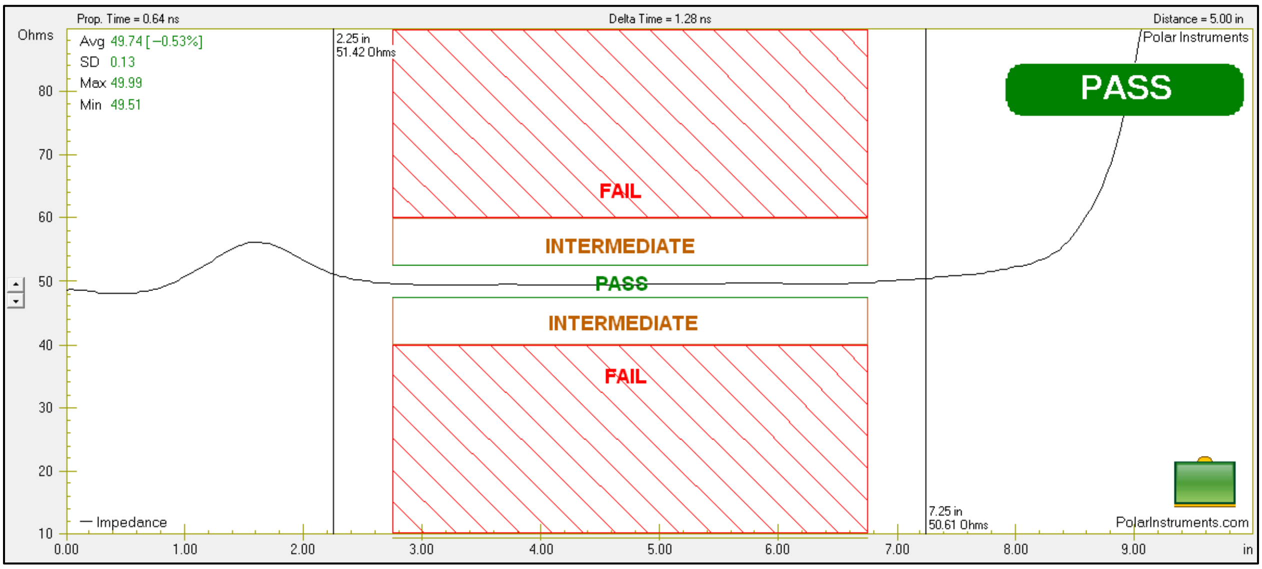


Fig 4-9 Waveform Display window pane

The PASS/INTERMEDIATE/FAIL result is displayed along with the statistical data for the tested region of the displayed waveform included in the statistics/results area — the upper left corner of the Waveform Display window pane. The tested region is commonly referred to as the *undisturbed interval* (or flattest portion) of the waveform and delimited by the width of the test limits (the intermediate and crosshatched areas — shown in orange and red by default).

On completion of a test the resulting test waveform is displayed, a PASS, INTERMEDIATE or FAIL result is reported and displayed statistical data are updated.

For single ended measurements four values are displayed:

Average impedance

Standard deviation

Minimum impedance

Maximum impedance

Other values such as the range between maximum and minimum impedance may also be added for display.

Note: If the test limits are correctly set the average impedance is the measured characteristic impedance for the trace under test.

When differential impedance measurements are specified in the test (i.e. when testing a differential pair of traces) additional values are displayed:

Odd mode impedance

Even mode impedance

Crosstalk (optional license)

Unbalance (shown as a percentage) between the lines

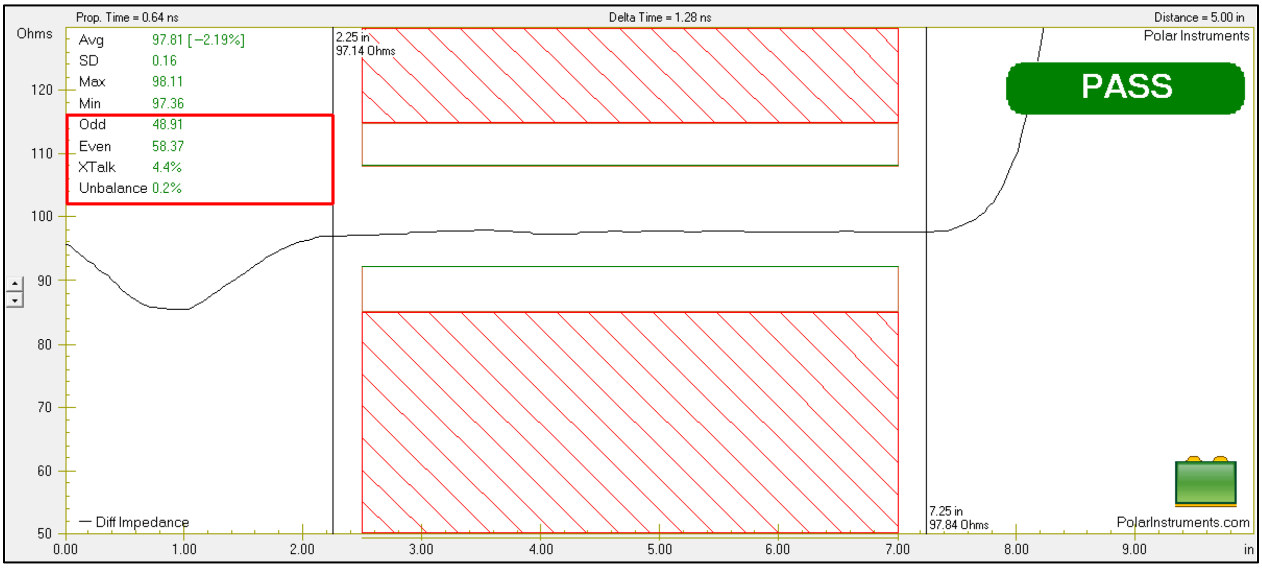


Fig 4-1 Waveform Display window pane – differential measurements

During differential testing the CITS880s records the differential impedance of the pair of traces, the single-ended impedance of each line to ground and the differential even mode impedance of the pair. To view the single-ended and even mode waveforms right-click the waveform window and select **Show Differential Waveforms**.

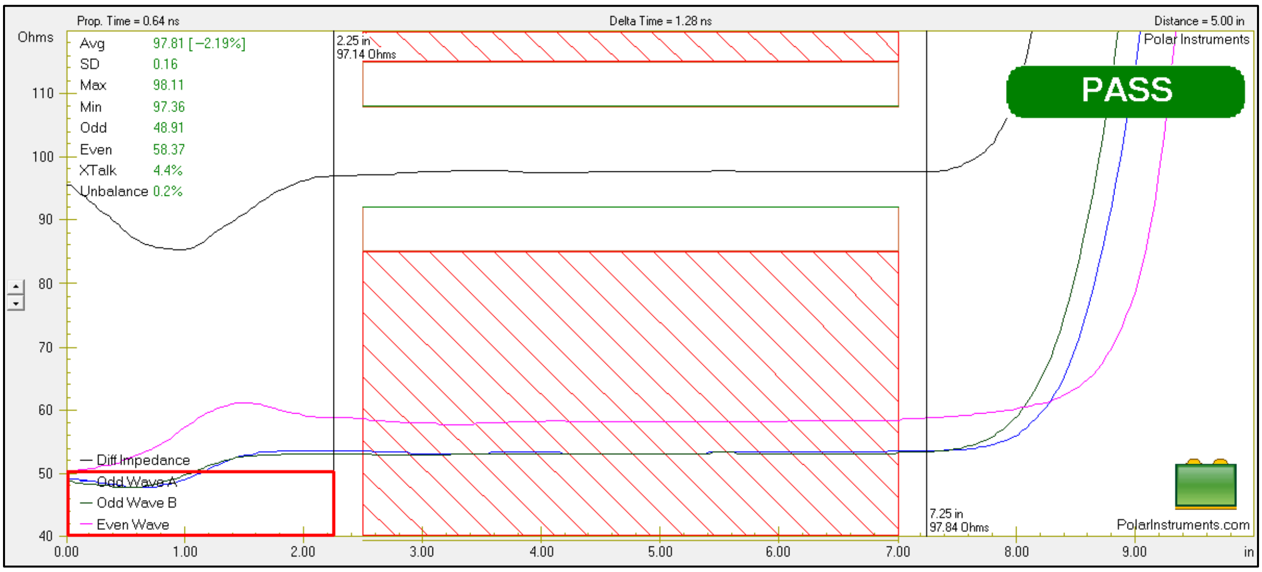
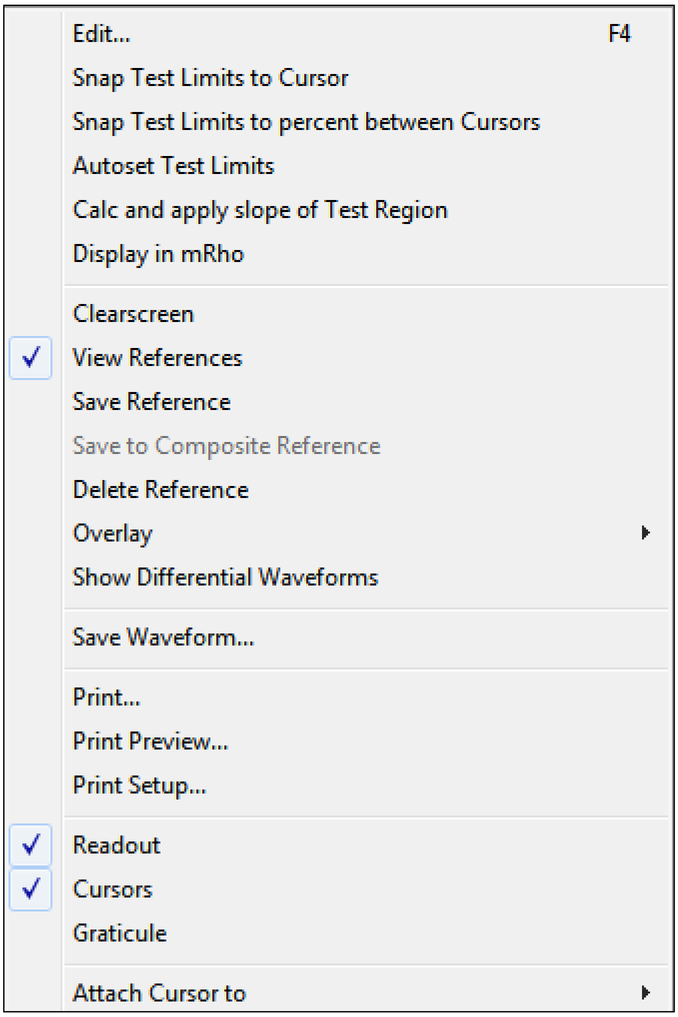


Fig 4-11 Showing Differential Waveforms

The Waveform Display shortcut menu

Right-clicking into the Waveform Display window pane displays the Waveform Display shortcut menu:

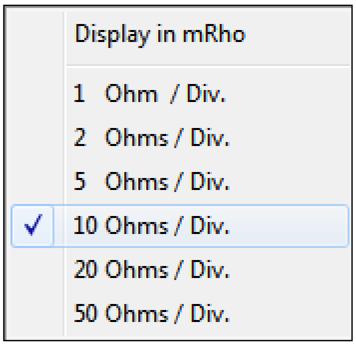


The shortcut menu contains the most commonly used functions previously described for waveform display.

Vertical and horizontal axes

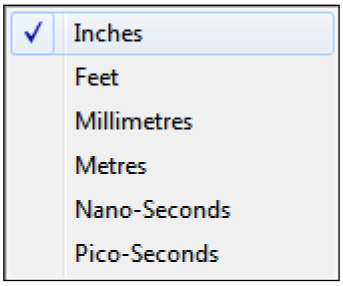
The vertical axis is graduated in Ohms/div by default. The vertical deflection factors (Ohms/div) for each test are derived from the settings in the test file (see Section 5 — EDITING TEST FILES).

The deflection factor can be changed on screen by right-clicking the mouse on the vertical scale and selecting a new deflection factor from the short cut menu:



The vertical axis can also be graduated in mRho. Select **Display in mRho** from the shortcut or the **View** menu. The CITS880s converts the current Ohms/div setting to mRho.

The horizontal axis is graduated in units of distance or time. When measuring distance (i.e. along the controlled impedance trace) the units of measurement can be selected by right clicking the horizontal scale:



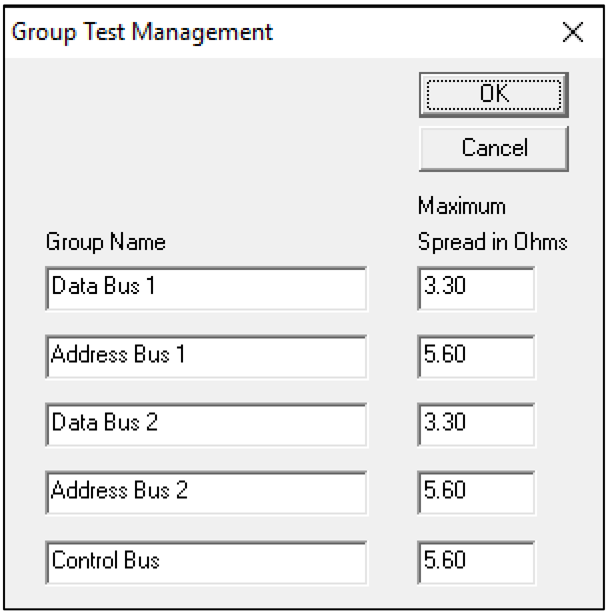
Horizontal units are graduated in inches, feet, millimetres, metres, nanoseconds or picoseconds.

Changing the vertical and horizontal deflection factors via the shortcut menus method will not invalidate the results of a test.

Group testing

Individual trace tests may be designated as members of a named group and tested for impedance spread across the group.

From the **Board** menu choose the **Edit Groups…** command — the **Group Test Management** dialog is displayed.



Enter a group name and maximum impedance spread for each group; up to five groups may be specified. Use the Test List Editor to designate a test as a member of a group; see *EDITING TEST FILES*.

When grouped tests are run the display reflects the result of the test along with its results within the group. The test list displays a combination of ticks, retest arrows and crosses and the spread results are included in the statistical display (Zs) on screen.

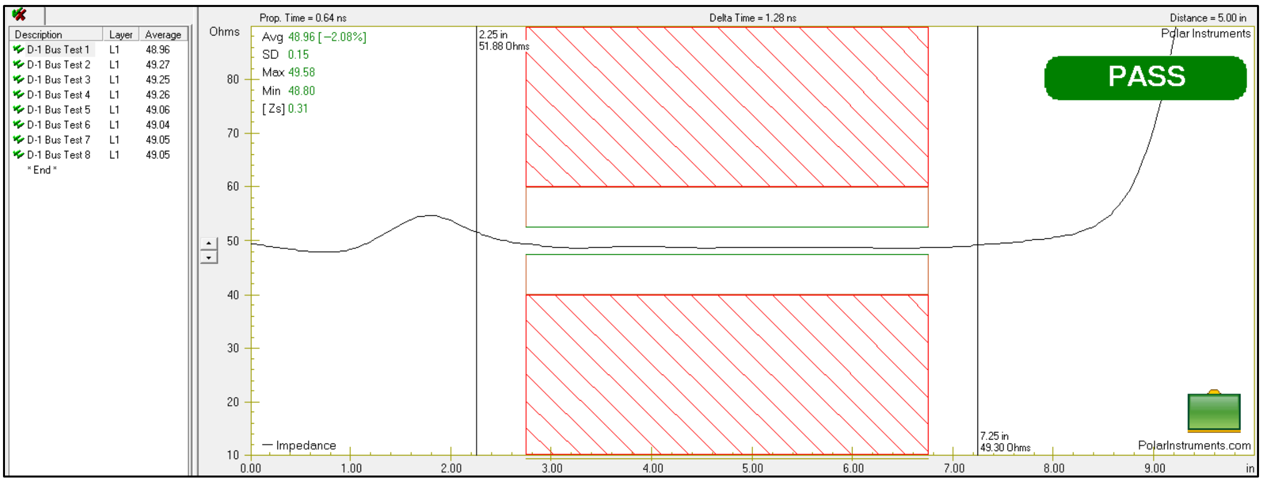


Fig 4-12 Waveform Display window pane – Group Test Results

4-5 The Test List

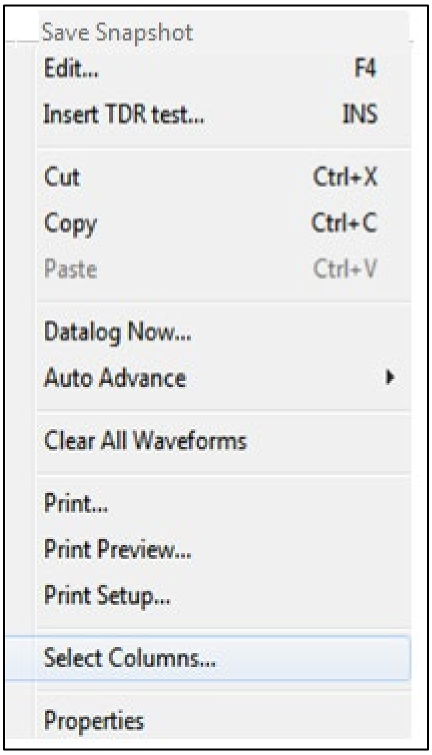
The Test List is displayed in the Test List window pane.

The List contains one or more columns, or *fields*, displaying information (for example, the description, test parameters or test results, if any) for each test in the active test file. Descriptive and parameter information is derived from the entries and settings in the Test Setup Editor window. By default the Description (i.e. the test name) and the Average impedance result are displayed.

Test results include a PASS / INTERMEDIATE / FAIL result along with statistical information for the test. The Description field displays the PASS result (green tick), INTERMEDIATE (orange retest arrow) or FAIL (red cross) for both absolute and group spread values.

Adding columns to the Test List

To add fields to the Test List right click into the Test List window pane — the Test List short cut menu is displayed:



Choose the **Select Columns…** command to display the Select Test List Display Columns dialog box.

The Select Test List Display Columns dialog box comprises two list boxes — the box on the left lists the fields which are still available for inclusion in the Test List pane, the box on the right lists the currently displayed fields.

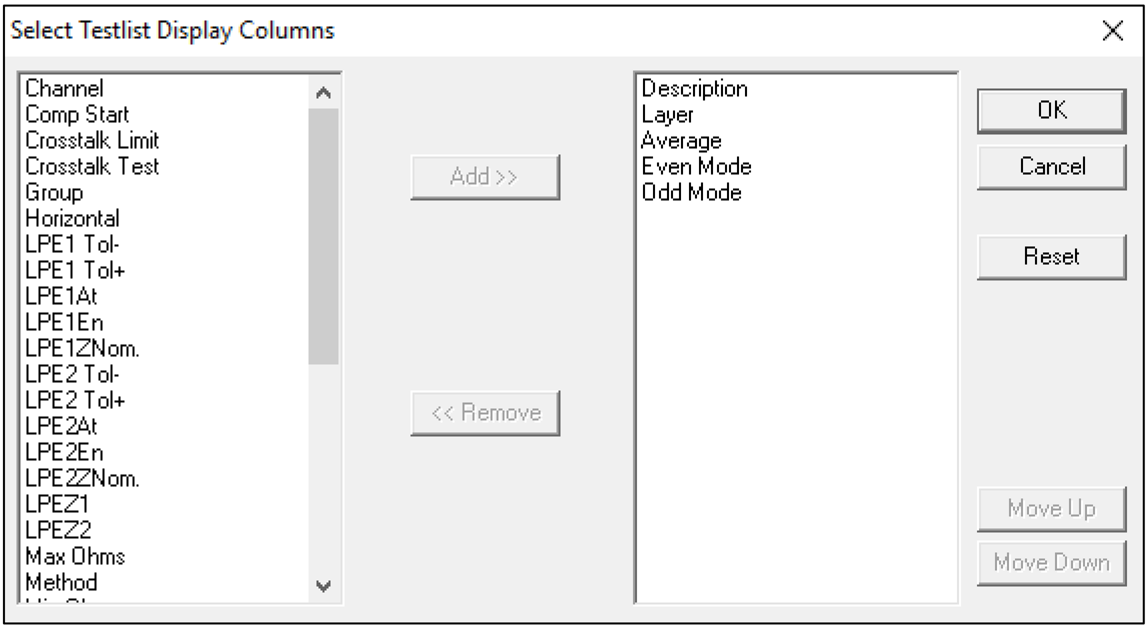


Fig 4-13 Adding and removing fields with the Select Testlist Display Columns dialog box

To add a column, select the field from the list of available fields and click the Add button; to remove a column, select the field from the list of displayed fields and click the Remove button.

To select a group of adjacent fields drag the mouse over the range of fields; to select non-adjacent fields, hold the Ctrl key down while clicking on the fields of interest — press OK to confirm the selection.

Pressing the Reset button restores the displayed fields to the default Description and Average fields.

4-6 The Datalog

Test results are recorded in the Datalog window pane.

Description	Layer	Average	Differential	Even Mode	Odd Mode	SD
Coated Microstrip 1B	1	50.69				0.54
Edge Coupled Coated Microstrip 1B	1	97.29	Yes	57.94	48.65	0.97
Offset Stripline 1B1A	3	50.67				0.51
Edge Coupled Offset Stripline 1B1A	3	97.29	Yes	57.94	48.65	0.99
Offset Stripline 1B1A	4	50.66				0.50
Edge Coupled Offset Stripline 1B1A	4	97.31	Yes	57.92	48.65	0.97
Coated Microstrip 1B	6	50.65				0.51
Edge Coupled Coated Microstrip 1B	6	97.23	Yes	57.91	48.61	0.99
* End *						

With a test file loaded, as the first test is executed the test list is added to the Datalog window. As each test is executed its results are displayed in columns in the Datalog.

To display other result fields right click into the Datalog window pane and choose **Select Columns** — the Select Datalog Display Columns window is displayed:

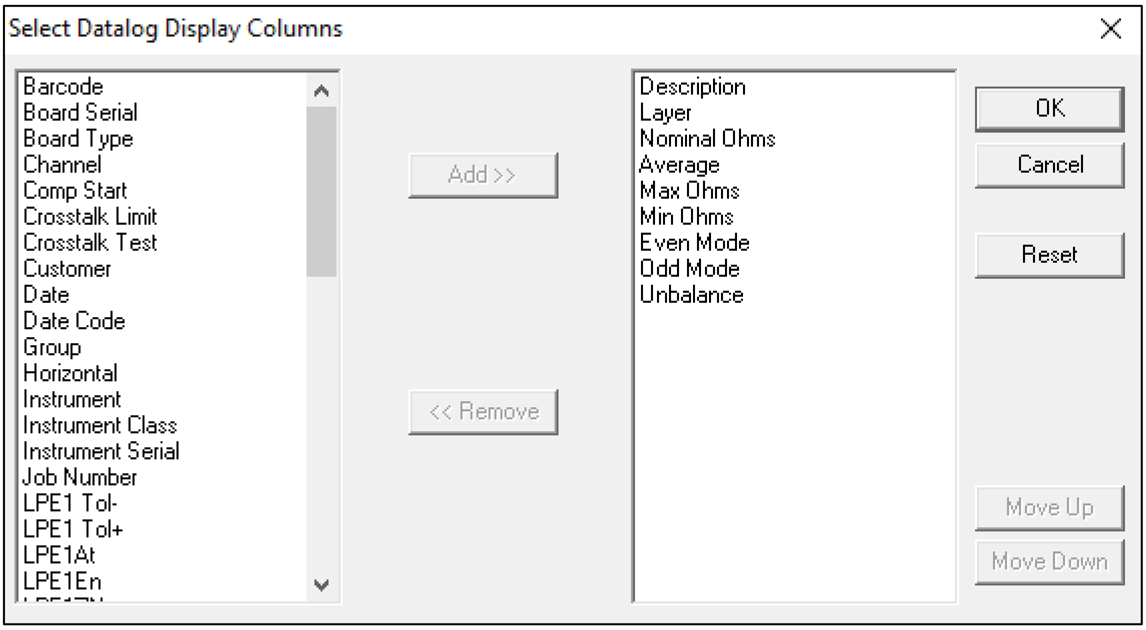


Fig 4-14 Adding and removing fields with the Select Datalog Display Columns dialog box

Click on the field of interest in the list of available fields and press Add to include a new column to the Datalog window pane. To remove a column, select the field from the list of displayed fields and click the Remove button.

If logging is turned off, each time a test is repeated the test results overwrite previous data. A yellow circle alongside each test result signifies that the results have not been logged. Data logging is discussed in Section 4-9 – LOGGING TEST DATA

4-7 The Status bar

The CITS880s status bar displays activity and status information and messages to assist the user during CITS880s operation.

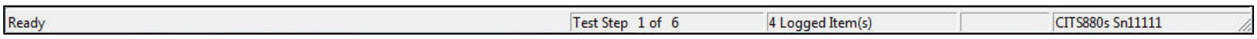


Figure 4-15 CITS880s status bar

The status bar comprises three sections:

Current activity — the CITS880s reports its current activity, Ready... etc. When the mouse is moved over a Toolbar button this portion of the Status Bar is used to display a brief description of the button function.

Test step number

Data logging information — the number of logged items, updated as each batch of tests is completed for a board.

Calibration state — the CITS880s applies a time delay of approximately 20 minutes to allow for warm up and stabilisation. During this interval the status bar displays the count down until calibration is valid along with a message that calibration is not yet valid:

Cal Valid in 18:43

CITS880s serial number

4-8 Testing printed circuit boards

IMPORTANT The CITS880s is an extremely sensitive measuring instrument. To prevent damage to the CITS880s observe static precautions at all times. Polar IPS and IPDS probes are precision moulded from ESD dissipative materials and include internal ESD grounding. For maximum protection against ESD damage Polar recommends operators use a wrist strap connected to an appropriate ESD ground point. See Appendix B for information

It is important to ensure high quality test connections (e.g. use IPS and IPDS Polar supplied microstrip probes) to minimise aberrations.

The procedure for testing printed circuit boards is similar to that described for the sample tests earlier.

Select a test file if one exists (or create a new file and insert tests for each controlled impedance on the board. Each test will include a complete set of test parameters for the trace under test — see Section 5 — Editing Test Files). Select the test to be executed (usually the first test in the list).

Connect the tip of the Microstrip probe to the board terminals or connections (be careful to maintain correct polarity of signal and ground connections). See 3-1 Testing the sample coupon traces

*Execute the tests via the **Board** menu or click the **Test** button (see note below).*

If data logging has been turned on, when all tests for the board are completed supply board details for data logging in the Datalog Board Information dialog box.

Note: For convenience, users are recommended to use the Foot Switch to operate the CITS880s in a “hands-free” mode. Using the Foot Switch allows the operator to use both hands to hold the probe in proper contact with, and support, the board under test).

Selecting a test file

Prior to testing a board or batch of boards a test file containing tests associated with the board type must be selected (or created if none exists.) See Section 5 — *Test Setup Editor*.

Select the **File** menu and the **Open...** command — the CITS880s displays the **Open** dialog:

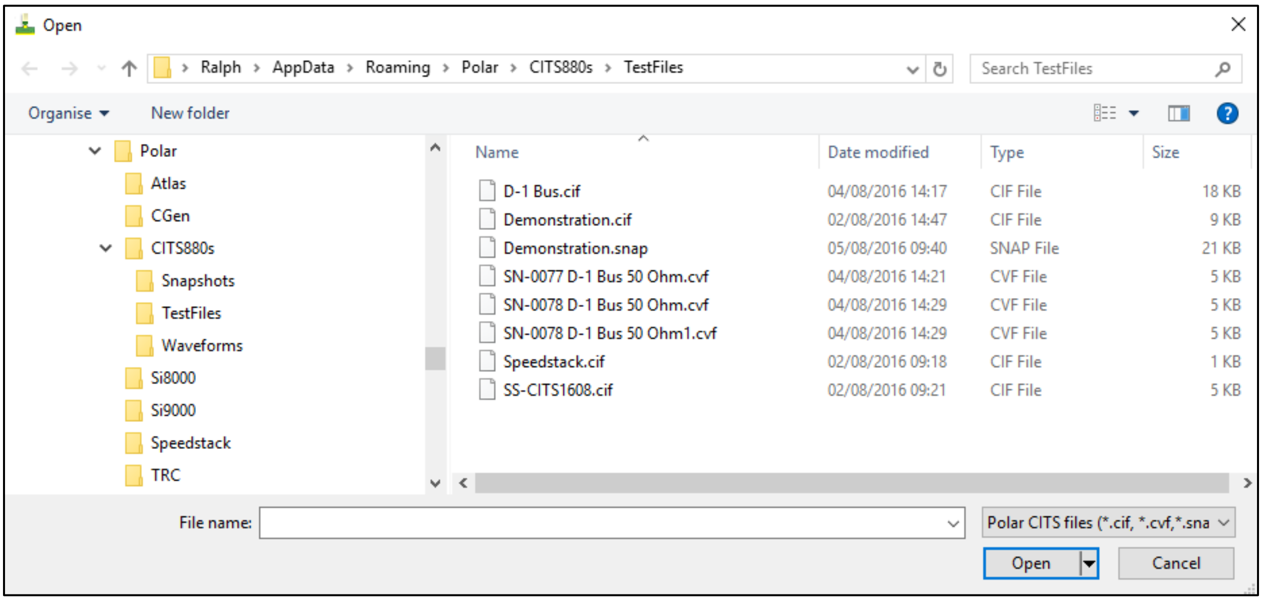


Figure 4-16 Selecting a test file

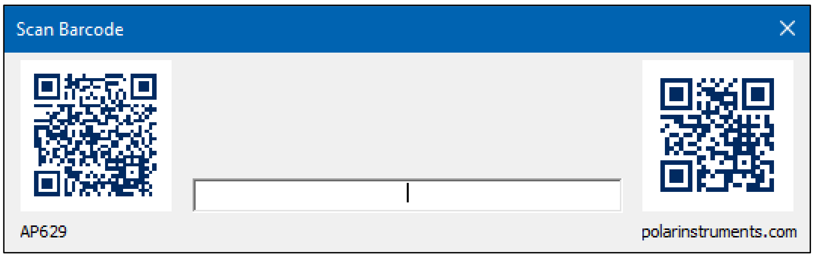
The **Open** dialog opens with the list of files (identified by the **.cif** extension) in the current folder displayed. (Test files may also be selected from the recently used file list from the **File** menu.)

Choosing a CITS880s test file via a bar code reader

Scan Barcode

Barcode readers often employ a USB interface so can be plugged in to an empty USB slot on the host computer without rebooting the host and generally need little configuration. powered directly from the USB interface,.

The CITS880s Scan Barcode dialog can be utilised to scan the barcode for the item to be tested and load the associated CITS test file from the CITS880s test files folder. Click Scan Barcode to initiate the scan



Both CITS native .CIF and XML test files can be loaded via the barcode reader.

(*Accessing the Polar web site via the barcode reader*

Scan the QR codes ® in the Scan Barcode dialog to access Application Note AP629 *Using barcode readers in Polar products* or go to the Polar web site home page.

QR Code ® is a registered trademark of DENSO WAVE INCORPORATED)

With the test file loaded, click on the first test.

The CITS880s displays the name of the selected file in the Title Bar and the first test's impedance and distance scales and test limits in the Waveform Display window pane.

From the **Datalog** menu click on **Autolog** to turn automatic data logging on and select **Auto Advance** and choose **After Test** to step through the tests automatically and log results to the log file.

Select the test to be run and run the test.

The **Auto Advance** function controls how tests in the test file are sequenced. Autoloading is controlled using the options in the **Auto Advance** sub-menu — **Off, On Pass, After Test**.

If **Auto Advance** is turned **Off** the CITS880s will not automatically sequence through the tests. Steps in the sequence must be manually selected then run.

If **Auto Advance** is set to **After Test** the CITS880s will sequence automatically through the tests, regardless of test results.

When **Auto Advance** is set to **On Pass** the next test file in the sequence is automatically loaded if the current test records a PASS.

To advance to the next test in the list manually, use the mouse or the arrow keys on the keyboard.

Executing the Test

Important: Use only the precision cables supplied by Polar Instruments; the CITS880s is calibrated using the supplied Polar cables (labelled with the channel numbers). Use of any other cables will invalidate the calibration of the CITS880s.

Most board testing will be performed with Polar microstrip probes. Using microstrip probes minimises measurement errors due to mismatch between the impedance of the measurement system (50Ω) and the track under test.

Keep to a minimum the number of changes in impedance between the CITS880s and the PCB track. For more information and hints on testing PCBs and test coupons see the notes at the end of this section.

Locate the microstrip probe in position on the circuit board under test (or coupon). Connect the signal pin to the signal trace pad and the ground pin to the ground plane (reference plane) pad.

Hint: On test coupons the signal and ground pads can be identified by shape (signal pins pads are commonly round in shape, ground pins square.)

Select the **Test** function from the Board menu (or click the mouse on the **Test** button or use the Foot Switch for hands-off operation).

When the test screen is displayed the limits of tolerance defined in the test for the tested portion of the track will be indicated by the intermediate and cross-hatched areas (at installation the CITS880s test window is set to its default – a green PASS area, an orange INTERMEDIATE area and red cross-hatched FAIL area on a black background — see the **Utilities** menu for information on changing screen colors).

During a board test the system checks that the impedance waveform falls within the limits defined in the test file.

Select the first test and test the first impedance trace; the results are displayed on screen and added to the log and the CITS880s selects the next test in the list (in Auto Advance). Test each of the traces on the coupon.

As each group of tests is completed (i.e. when the whole board has been tested) the Board Information box is displayed so that board information may added to the test results and logged.

Data in the log may be processed by the optional Datalog Report Generator.

Deleting test results

From the **Board** menu select the **Clear All Waveforms** command to clear all test data from the current set of results.

Caution: Selecting **Clear All Waveforms** *will clear all result entries from the Test List window pane and all unlogged data from the Datalog window pane but will not remove logged data.*

4-9 Logging Test Data

The **Datalog** function tests and records the results of a series of tests on a board or batch of boards. CITS880s creates a log file (a text file containing test data) for archiving and later analysis. The log file is stored in delimited form (using the | character as the delimiter between fields.) This format will be found suitable for import into most spreadsheet or database programs — and can be printed out for hard copy.

Polar Instruments supply a Datalog Report Generator accessory to automatically process this data for use in statistical process control. To enable logging select the **Datalog** menu and ensure **Autolog** is turned on. Test the board using the test file; when the test is complete, the **Datalog - Board Information** dialog box is displayed — Figure 4-7. (For details of creating user-defined fields, e.g. Batch, Process, Type, etc., see SYSTEM CONFIGURATION.)

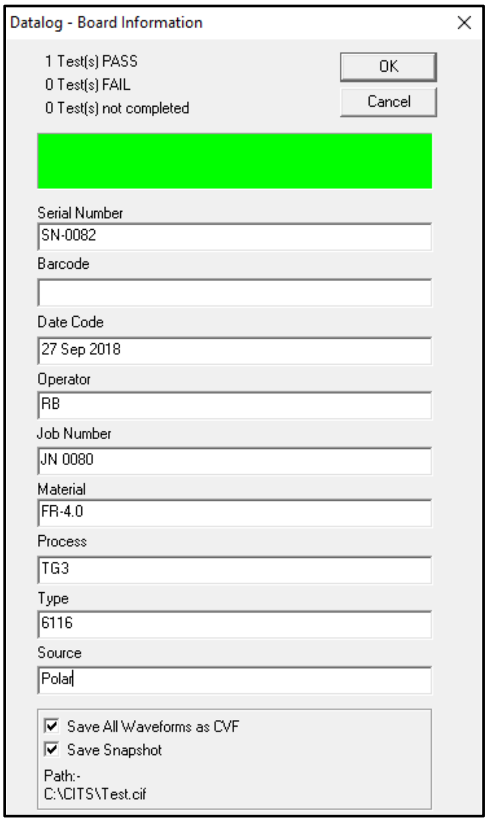


Figure 4-7 Datalog information dialog box

Enter the details for the board under test — serial number, date code and operator name, etc. and press **OK**.

To save waveforms and snapshot automatically during logging click the **Save all** W**aveforms as CVF** (.cvf files) and **Save Snapshot** check boxes; waveform and snapshot files will be saved automatically at the datalog point. Files will be saved and named using the board serial number and test name (e.g. SN-0082.snap, SN-0082 Test50Ohm.cvf).

The Data Log window

The Data Log window displays all logged entries in the log file.

Test results are stored sequentially as records in the log file. If necessary, use the scroll bar to scroll through the list when inspecting records in the log. Each entry comprises a subset of the logged data — board details, test name, trace layer, the result of each test, average impedance and test date and time are included by default. Columns for Maximum impedance, Minimum impedance and Standard Deviation have been added to the Datalog window pane.

Description	Nominal Ohms	Average	Differential	Max Ohms	Min Ohms	Even Mode	Odd Mode	SD
✔ 50 Ohm single	50.00	50.50		50.83	49.87			0.22
✔ 75 Ohm single	75.00	72.10		74.42	69.00			1.13
✘ 100 Ohm single	100.00	95.00		98.85	89.19			2.35
✔ 100 Ohm Diff	100.00	96.46	Yes	97.86	94.78	58.05	48.23	0.82
✔ 50 Ohm single	50.00	50.50		50.83	49.94			0.24
✔ 75 Ohm single	75.00	72.11		74.24	69.28			1.13
✘ 100 Ohm single	100.00	95.04		98.55	89.47			2.39
✔ 100 Ohm Diff	100.00	96.34	Yes	97.53	94.75	57.92	48.17	0.82
* End *								

Figure 4-17 Datalog window pane with logged data

To include other information such as statistical data and test parameters right click into the Datalog window pane and choose Select Columns.

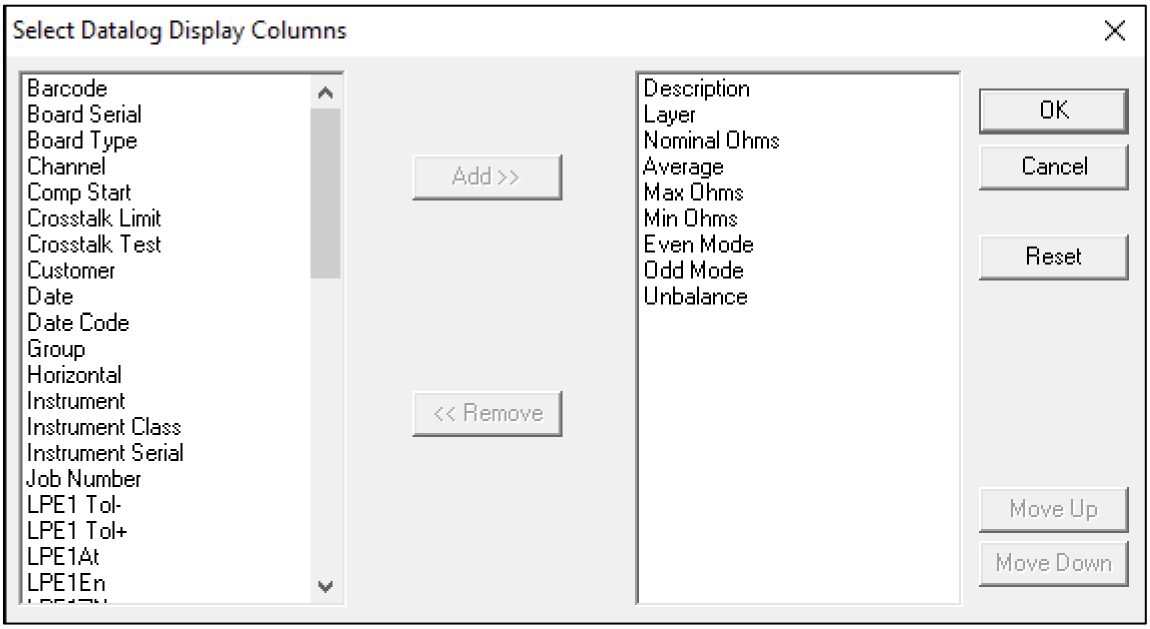


Figure 4-18 Select Datalog display columns window

Choose the fields containing the statistical data or test parameters and click **Add** then **OK** — the new fields will be added to the log window.

Deleting records

To delete a single record from the log file, scroll through the list of entries, select the record with the mouse or the keyboard cursor keys and press the **Delete** button — all the tests for the board will be deleted.

Note: The record will be permanently deleted.

Editing records

Each line of logged data (a small yellow circle is shown against data not yet logged) can be edited if necessary (e.g. to correct for the results of spurious readings, intermittent connections, etc.) with the **Edit Line** command. The **Edit Line** command is "greyed out" for data not yet logged.

Right click onto the line to be modified and choose **Edit Line** to display the **Edit Datalog Line** dialog box.

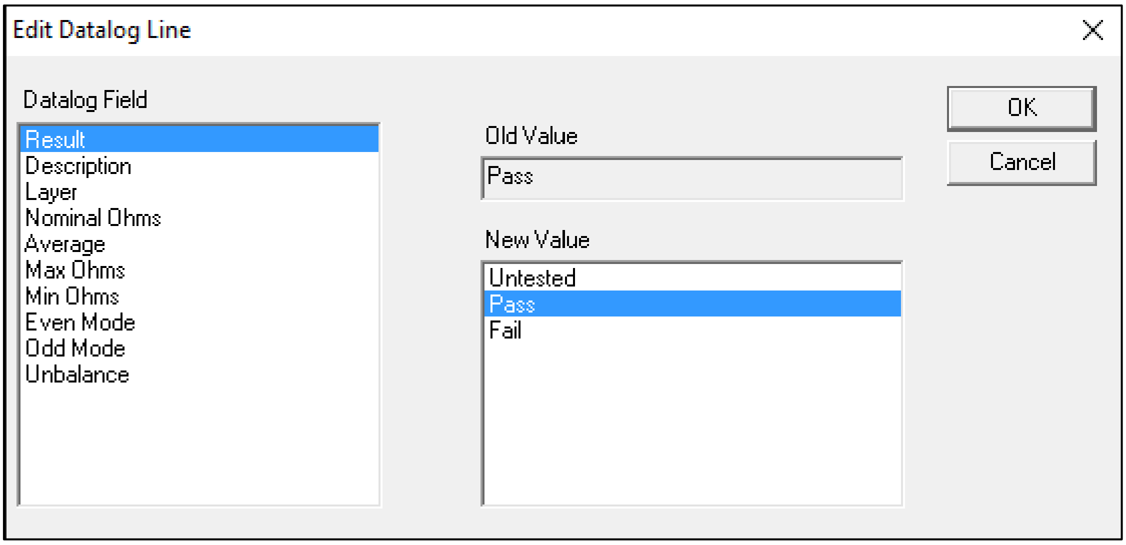


Figure 4-19 Edit Datalog Line dialog box

The Datalog field box lists the columns (fields) displayed in the Datalog window.

Choose the Field to be edited.

Select a value from the New Value list or type a new value in the New Value box to replace the entry in the Old Value text box. Press OK to confirm the new value.

Printing logged data

To print the complete datalog right click into the Datalog window pane and choose the **Print** command from the short cut menu. To print only selected lines use the left mouse button + Shift or Control to select the lines required.

4-10 Using Delta Time Cursors

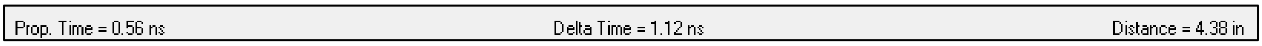
Propagation delay times may be measured by positioning the cursors at the beginning and end of the test specimen.

To enable the cursors select **Cursors** from the **View** menu or from the Waveform Display short cut menu.

To position a cursor click the left mouse button on the cursor (the mouse pointer changes to a double headed arrow); drag the cursor onto the required location on the waveform. Release the mouse button.

The screen displays the impedance value along with the time or distance from the waveform start where each cursor crosses the impedance waveform.

The cursor readings, Propagation time, Delta time and Distance between the cursors are displayed at the top of the waveform window.

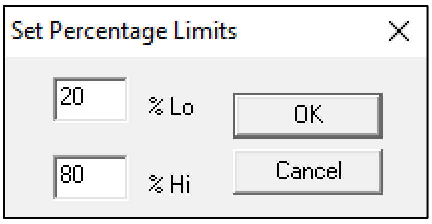


Use the **Snap Test Limit to Cursor** command to reassign the **Test From:** and **Test To:** distances to the displayed cursor positions.

Snapping test limits to Percent between cursors

Use the **Snap Test Limits to Percent between Cursors** command to change the horizontal **Test From** and **Test To** limits to percentage values of the current lower and upper cursor time positions.

Use Set Percentage Limits dialog box to specify the **Test From** and **Test To** limits



For example, if the cursors are set to test from 2 to 8 inches (a 6 inch test range) using the above values will change the lower limit to 3.2 inches (2 + 1.2) and 6.8 inches (8 – 1.2).

4-11 Viewing differential waveforms

By default only the differential impedance waveform is displayed. During differential testing, however, the CITS880s records the differential impedance of the pair of traces, the single-ended impedance of each line to ground and the differential even mode impedance of the pair.

Results for odd and even mode impedance, crosstalk and unbalance between the lines are logged and displayed on screen. The results displayed by the CITS880s take into account the effect of unbalanced lines.

To view the single-ended and even mode waveforms (e.g. for engineering analysis) select **Show Differential Waveforms** (right-click the waveform window to display the short cut menu).

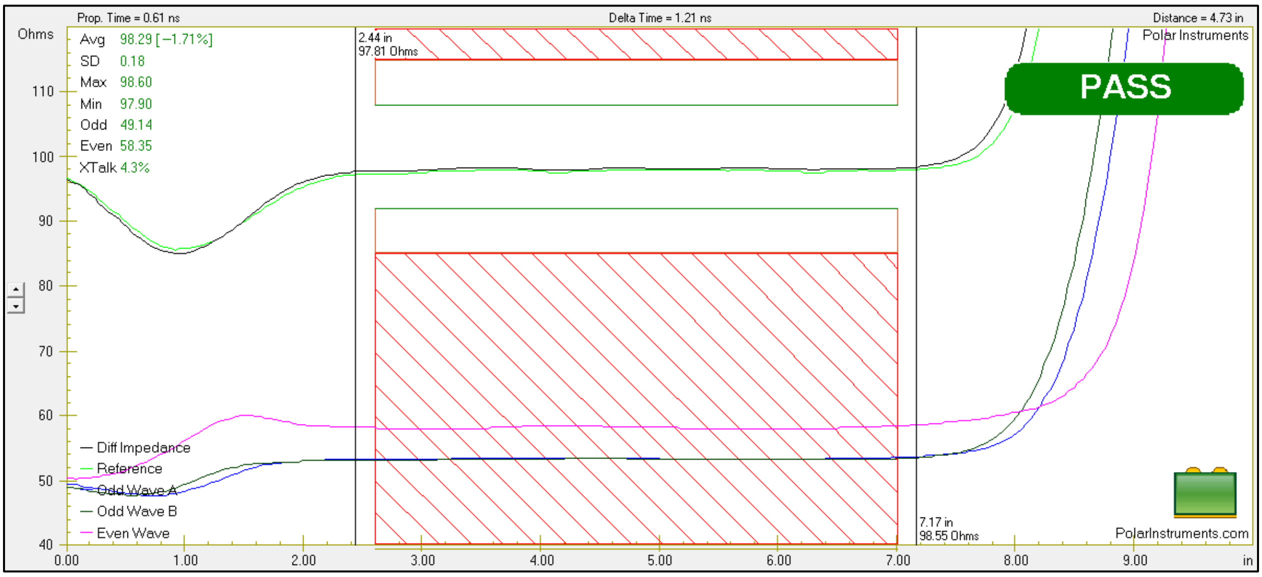
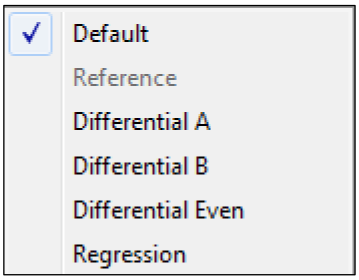


Figure 4-20 Waveform window showing differential waveforms

Offset the display vertically using the up and down arrows (or mouse wheel) to display all waveforms. The display above shows the 100Ω differential impedance waveform along with the reference waveform (shown in green), two single-ended waveforms (approximately 53Ω) and the even mode waveform (approximately 58Ω).

Attaching cursors to waveforms

The cursors can be used to display values along each of the waveforms. Select the **Attach Cursor To** command and from the sub-menu choose the waveform to be measured.



The color of the cursors changes to the color of the chosen waveform.

Calculating waveform slope

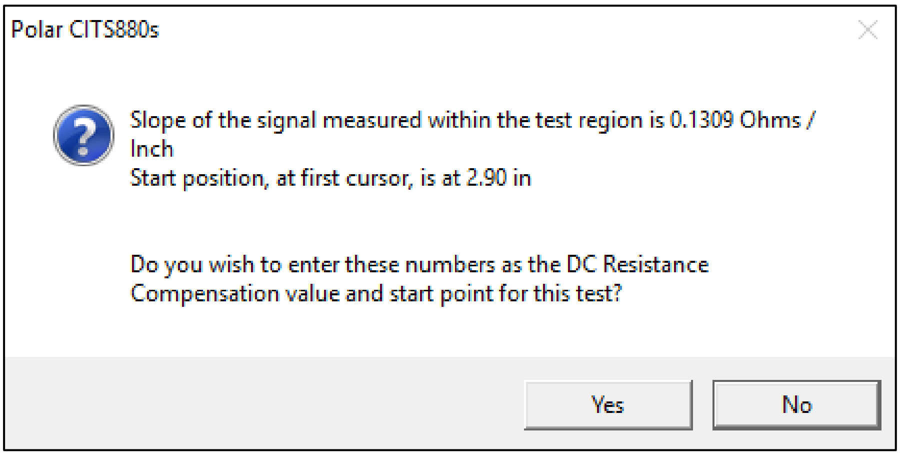
Series resistance will appear as a ramp in the waveform with impedance increasing linearly with distance. Series resistance simply adds to the characteristic impedance over the length of the waveform. (See the section *Test Editor|DC resistance compensation* for a brief discussion of DC resistance compensation.)

Series DC resistance can be compensated for by adjusting the slope of the waveform by a specified number of ohms/horizontal unit. This cancels out the series resistance leaving the true characteristic impedance displayed.

Applying DC resistance compensation

Caution! Applying DC resistance compensation may invalidate results.
A sloping waveform may be attributable to a number of causes. Consult the board design authority before applying DC resistance compensation.

Right-click the waveform display window and choose the **Calc and apply slope of Test Region** command: the CITS880s displays the slope of the waveform within the test region along with the horizontal position (i.e. the distance) of the first cursor.



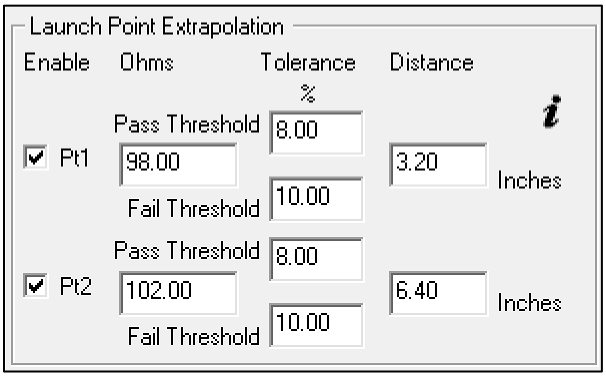
To apply DC resistance compensation locate the first cursor at the horizontal distance DC resistance compensation should begin. Click **Yes** to apply the values for DC resistance compensation and start point, click **No** to leave the data unmodified.

The waveform is shown with small triangle added at the beginning of the compensated portion of the waveform. To remove the compensation start the Test Setup Editor (right click the waveform or the test name in the test list and choose Edit…) and reset the DC resistance Compensation setting to Default.

Launch point extrapolation

The CITS880s supports *launch point extrapolation* (LPE.) LPE applies a regression line fit to a stable sample of the reflection from the trace and projects this regression line back to the launch of the trace. LPE can better reflect the impedance that the signal sees as it launches into the trace. This can be beneficial with thin copper and narrow traces.

To define LPE limits, using the Test Editor, define the target impedance, the test region and associated limits and the distance along the trace for each of the LPE points.



The CITS880s displays the slope of the trace over the test region extending the line (and displaying the values) through the extrapolation points (shown as error bars in Figure 4-12.) See *Section 5 Test Editor – Launch point extrapolation*.

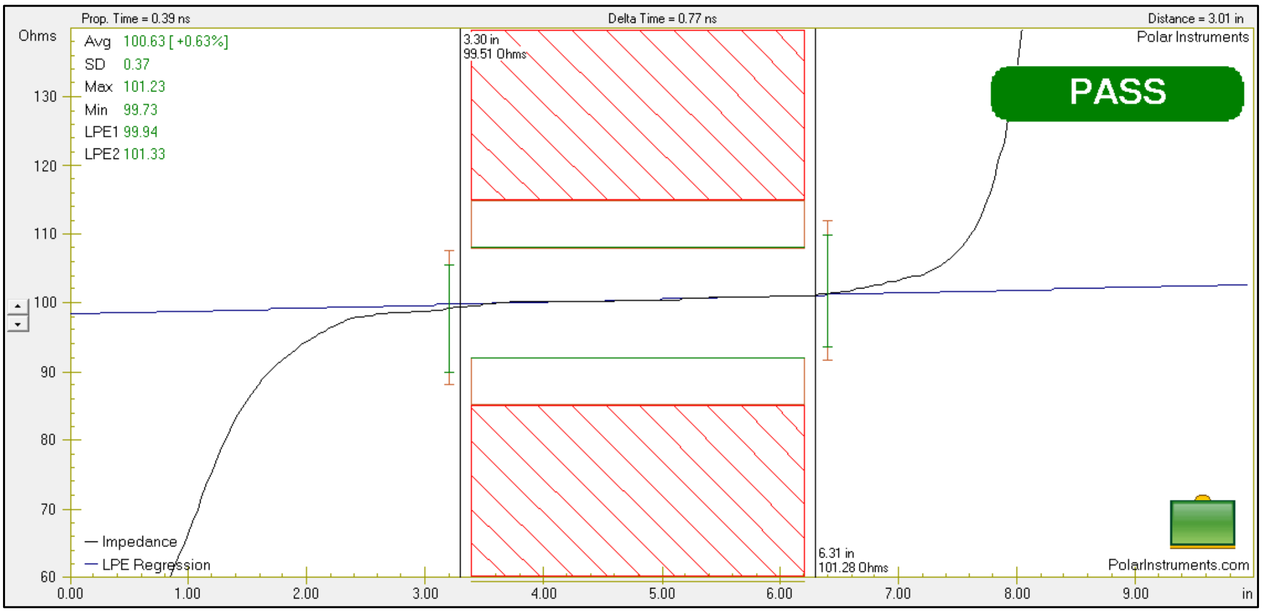


Figure 4-121 Launch point extrapolation slope and test points

Click the *i* button to access Polar Application Note AP8505 on the Polar Instruments web site for further information on launch point extrapolation.

4-12 Printing waveforms, datalog or test results

Select the **Print** function from the **File** menu.

The Print dialog box includes the Select Printout group of options — choose Waveform, Datalog or Test List for printout. Use the text box to add comments to the printout. See Figure 4-13.

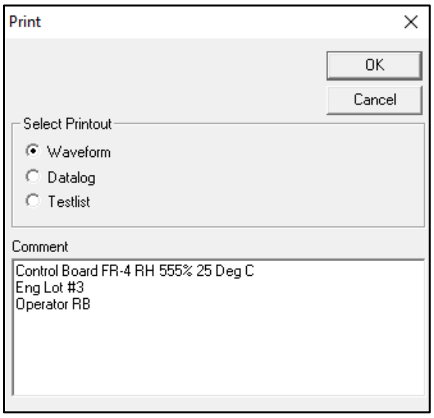


Figure 4-14 Print dialog box

Select **OK** to proceed with printing.

4-13 Saving and viewing waveforms

The **Save Waveform** function allows the operator to store individual test waveforms on disk. Test waveforms are stored as files with the **.cvf** file extension. With the waveform displayed in the Waveform Display window pane select **Save Waveform** from the **Waveform** menu —the system will display the **Enter Waveform Filename** dialog box.

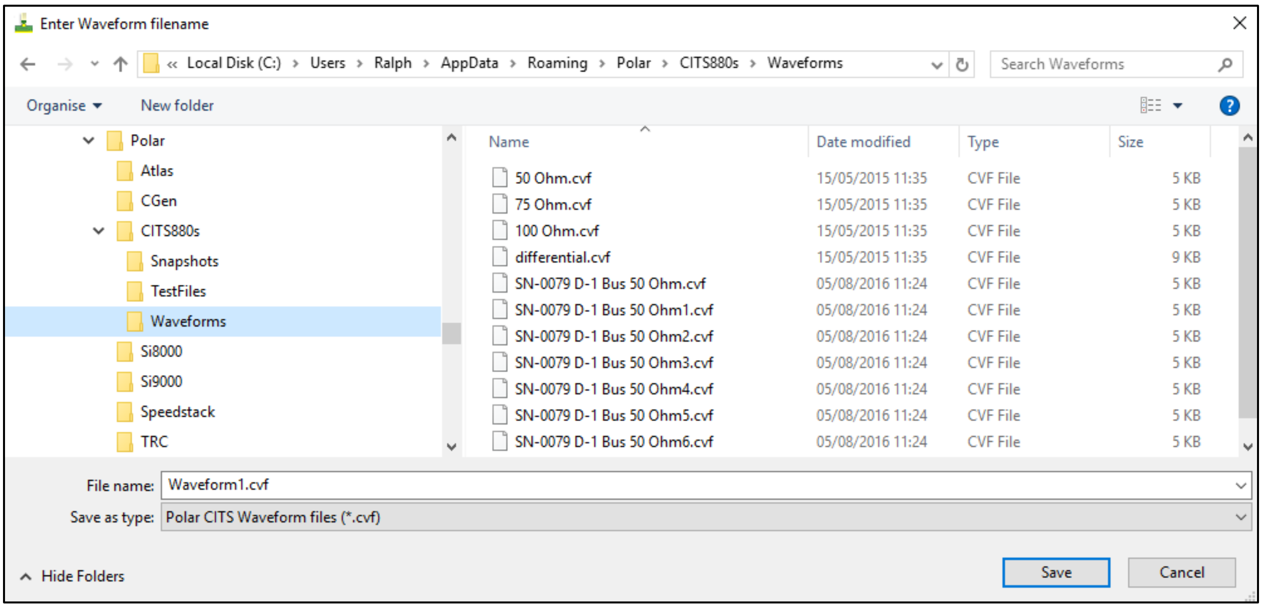


Figure 4-22 Save waveform dialog box

Choose a name for the waveform and press **Save** — the CITS880s displays a Notes text box; add comments (board serial number, date code, the operator's name, etc.) and press **OK**.

To overwrite a previously stored waveform select the name of an existing waveform file from the list and press **OK**.

Saving waveforms as csv files

*Click the **Save Waveform as CSV** command to save the waveform in comma separated text format suitable for importing into text editors, spreadsheets and databases.*

Viewing recorded waveforms

Waveforms stored on disk with the **Save Waveform** function may be retrieved and printed with the **File Open** command.

Select **Open** from the **File** menu — a list of previously recorded waveforms is displayed. Use the cursor keys or the mouse to highlight and select a file from the list and press **OK**. The CITS880s displays the stored waveform and associated statistics; results may be printed out using the **Print** command as described earlier.

The items displayed in the Waveform Display window pane can be controlled via the View menu (or the Waveform Display short cut menu.) Select items for display (readout, cursors, etc.) as necessary.

Clearing the waveform screen

To delete the waveforms and test results from a test, select the test from the test list and use the **Clearscreen** command

4-14 Reference Waveforms

The CITS880s incorporates the facility to store a reference waveform as part of the definition for each test in a file; the reference waveform is displayed, e.g. as an example of a good trace, when the test is selected.

Setting a Reference Waveform

With a good waveform displayed, to save the current waveform as the reference waveform for a test use the **Save Reference** command from the **Waveform** menu. The waveform is then displayed whenever the test is selected. To make this change permanent save the test file and reference to disk using the **Save** command from the **File** menu.

Viewing a Reference Waveform

To view the current reference waveforms for the tests use the **View References** command from the **Waveform** menu.

4-15 Overlaying waveforms

The **Overlay** command from the **Waveforms** menu allows waveforms from a series of test operations to be superimposed, or overlaid. The **Overlay** option displays a sub-menu from which the user specifies the number of waveforms to be superimposed — 2, 5, 10, 20 or 50.

With the **Overlay** option selected, the waveform window is not cleared between board tests. The results of the last 2, 5, 10, 20 or 50 tests will appear superimposed until **Overlay** is deselected (set to **Off**) — when the maximum number of overlays is reached the oldest test result will be discarded first. See Figure 4-15.

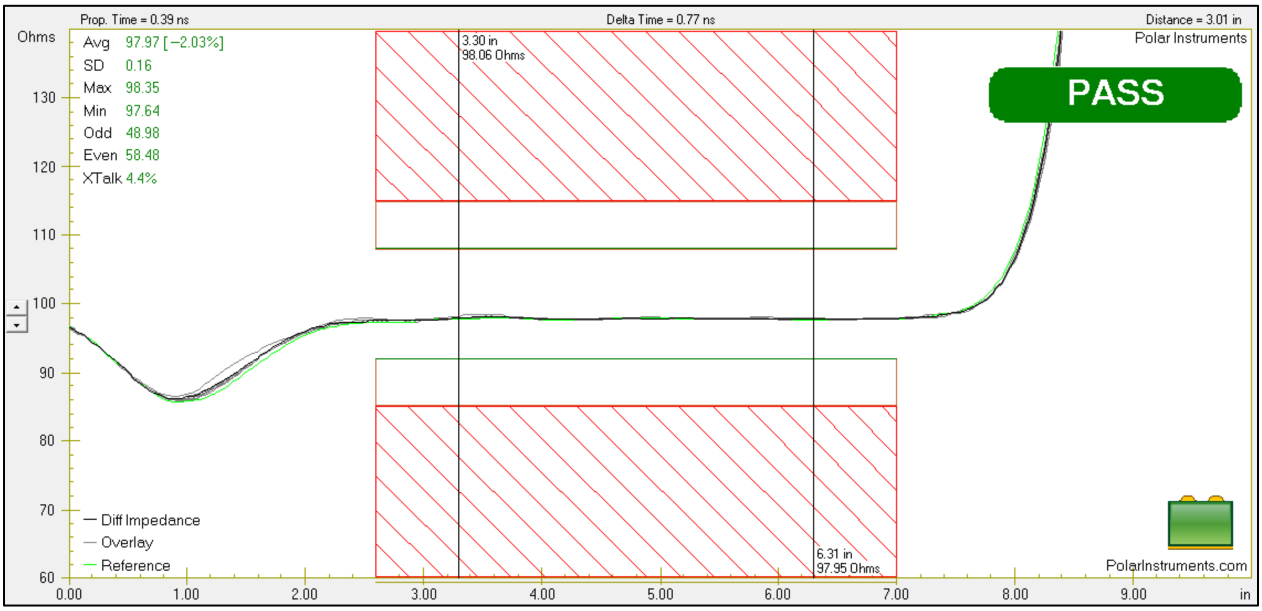


Figure 4-23 Waveforms superimposed in **Overlay** mode

Test the board or batch of boards as described earlier — the test waveforms from each test operation will be overlaid on the previous waveforms until **Overlay** is switched off.

Note: the PASS/INTERMEDIATE/FAIL result and information appearing in the Statistics area **ONLY** refer to the most recent test. The Statistics area does not accumulate data.

Turn **Overlay** off to clear the overlaid waveforms.

Note that the last test result is not cleared — if necessary use **Clearscreen** to clear the screen.

4-16 Exiting the CITS880s program

Select **Exit** from the **File** menu to leave the CITS880s program.

SECTION 5 — EDITING TEST FILES

TEST PARAMETER FILES

EDITING TEST FILES

Each board type to be tested is tested in accordance with one or more tests each of which includes a set of test parameters. Typically the set of tests for one board type will be stored in a single test file.

For example, the coupon test files contained the tests for the sample coupons supplied with the CITS880s. The diagram below illustrates the test parameters specified in a test.

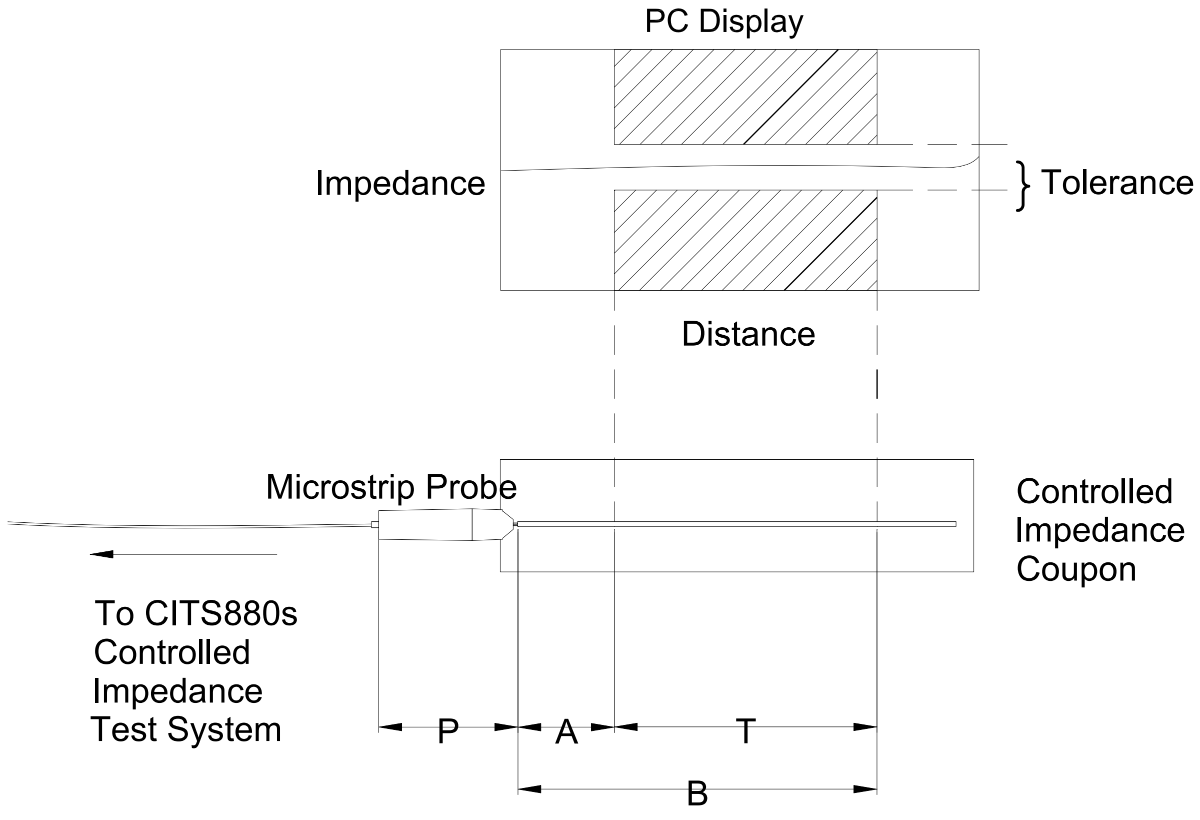


Figure 5-1 Test parameters defined in a test

Test parameters

In Figure 5-1 letters P, A, B, T signify the test parameters listed below:

P	=	Probe Length
A	=	Test From
B	=	Test To
T	=	Tested region (B – A)

The test parameters will be defined in the Test Setup Editor.

The Test Editor contains setting for probe lengths and coupon test regions, impedance values and tolerances and test types (i.e. single-ended or differential) and test methods along with limits for unbalance between lines and crosstalk.

The Test Editor also includes parameters for the CITS880s launch point extrapolation (LPE) which uses line fitting to the TDR trace.

LPE parameters comprise target impedances and limits for each of the LPE points (set at user-selectable distances along the TDR trace.)

5-1 The Test Setup Editor

Test parameters for boards under test may be defined or modified using the integrated **Test Setup Editor**.

See Figure 5-2.

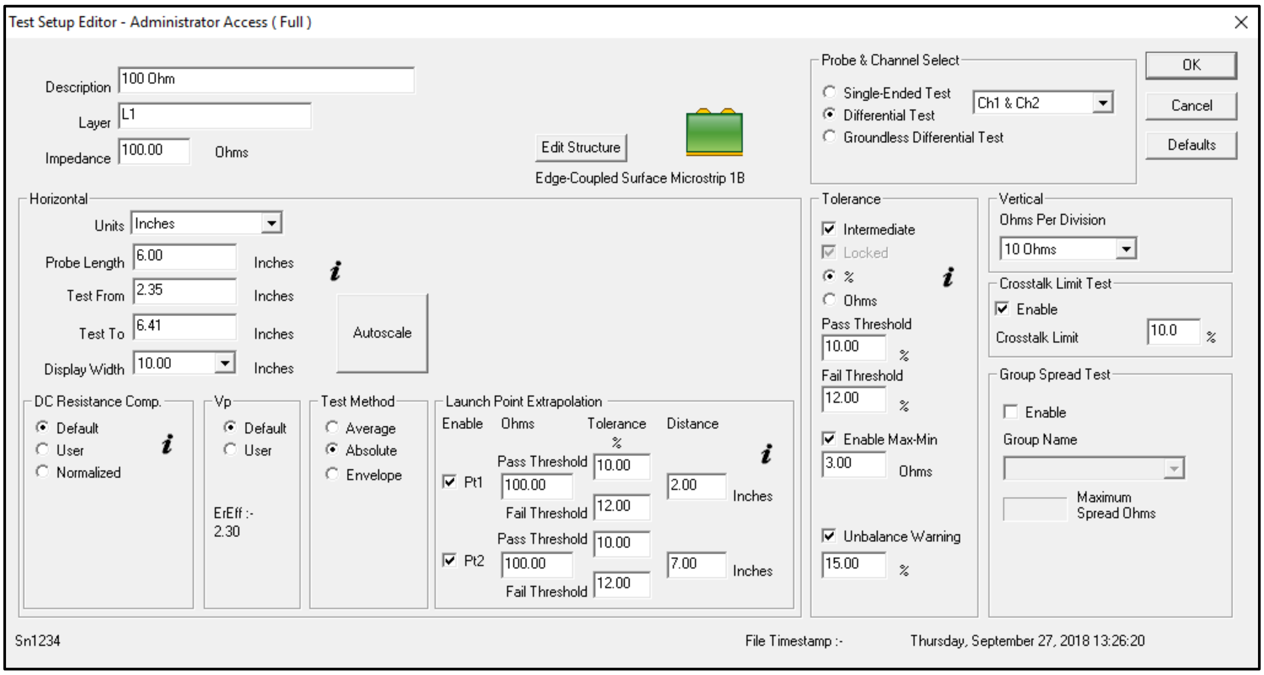


Figure 5-2 The Test Setup Editor

5-2 Creating and modifying test files

Creating a new test file

To create a new test file choose the **New** command from the **File** menu. This will display the **Edit Board Details** dialog box; this dialog will be displayed each time a new batch of tests (i.e. a new board type) is created.

Enter the details for the board under test, Customer, Board Type, Part Number and Revision Number and notes.

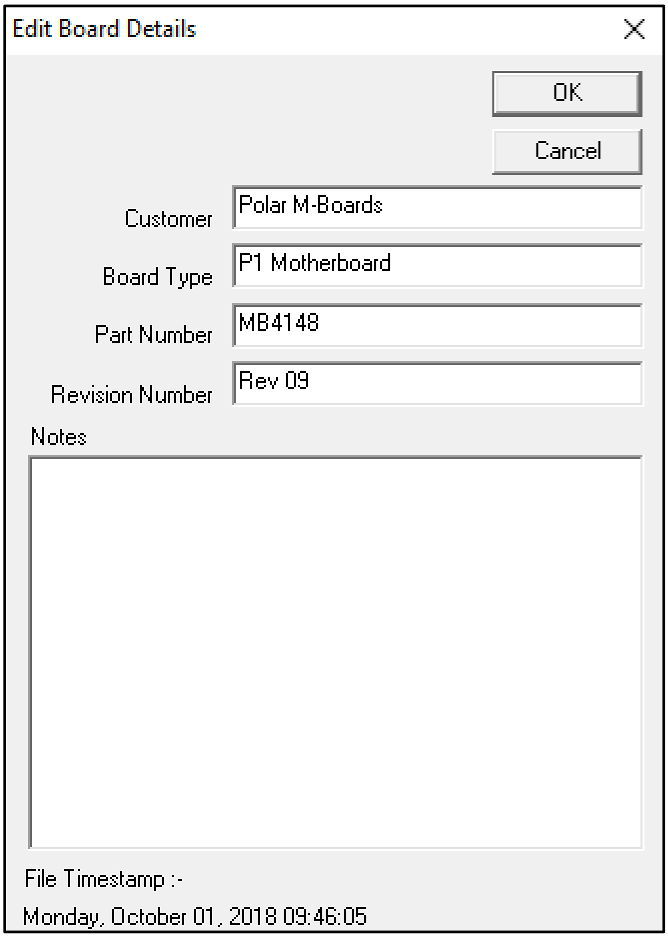
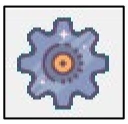


Figure 5-3 Edit Board Details dialog box

Press **OK** to create the new (empty) file. Add tests to the file via the Insert command as described below.

Inserting tests

Select the Insert command from the Board menu (or press the Insert key) — the Test Setup Editor (Figure 5-2) is displayed.

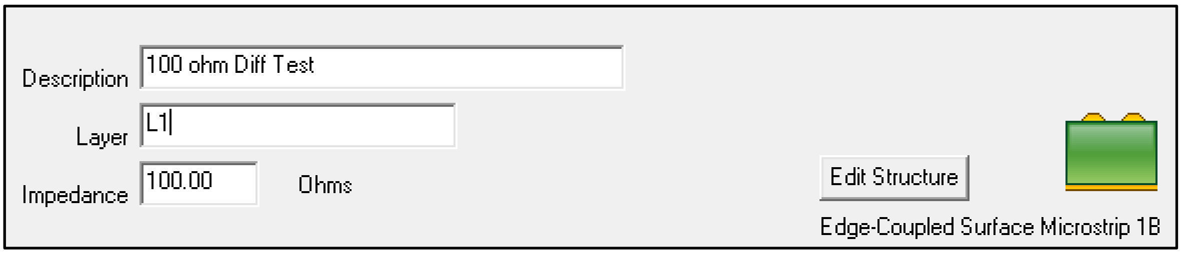


Test Editor icon

Each parameter is defined and displayed in a *parameter field*. To create or edit a test, modify the test parameters as required and then use the **OK** button to confirm the field edits. The fields are described in the following sections.

5-3 Board test parameters

Entries in the fields contained in the Test Setup Editor will be available for display in the Test List and Datalog and printed out with the test results.



Description

Enter the test type into the **Description** field (e.g. D-1, 50 Ohm Trace, etc.) The Description is included as part of the data for a board.

Layer

Use the **Layer** field to indicate the trace layer (e.g. L1)

Impedance

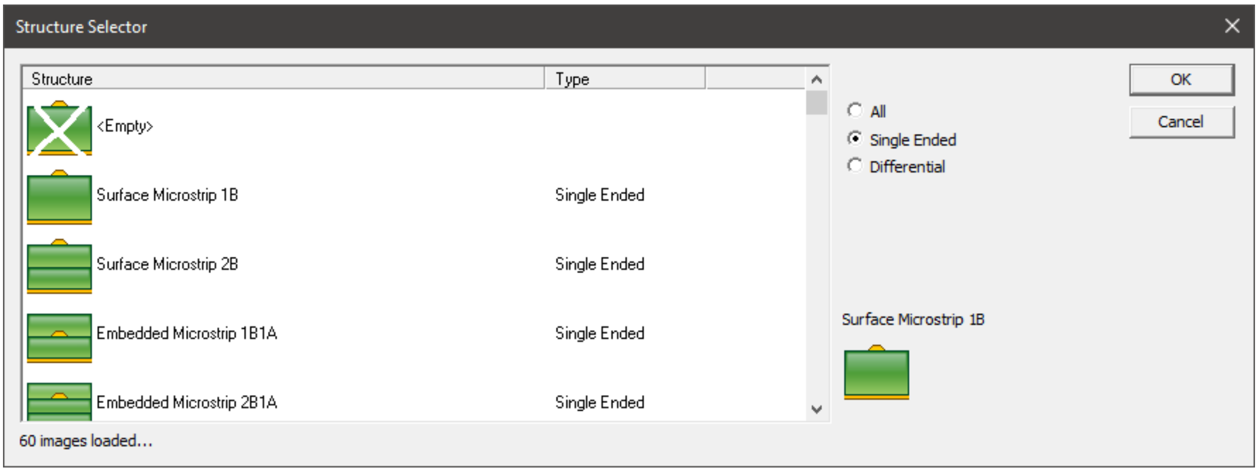
Use the **Impedance** field to define the nominal impedance in ohms of the PCB track under test.

This field must contain a number of up to 4 significant digits in the range 10.10 – 200 Ohms.

Adding a structure graphic

Click Edit Structure to Display the Structure Selector dialog.

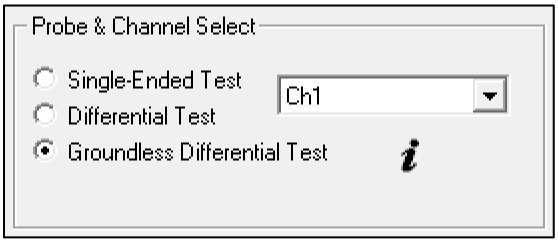
Select the structure graphic to be added to the test file



The graphic will be saved with the test file.

Probe Channel Select

Use the **Probe Channel Select** function to specify the CITS880s channel or channels to be used for the test.



Specify any of the four channels for single-ended tests or for groundless differential tests. For differential tests use Channels 1 & 2 and Channels 3 & 4.

The chosen test type will be reflected in the structure Selector window (See Edit Structure below.).

Click the *i* button to access Polar Application Note AP8507 on the Polar Instruments web site for further information on groundless differential probes.

Single-Ended Tests

To perform a single-ended test click the **Single-Ended Test** option button and click the channel number check box.

Important: Use only the precision cables supplied by Polar Instruments; the CITS880s is calibrated using the supplied Polar cables labelled with the channel number and instrument serial number. Use of any other cables will invalidate the calibration of the CITS880s.

To perform single-ended testing, connect a probe cable to its corresponding CITS880s channel and connect the IPS Microstrip probe to the probe cable.

Differential Tests

To perform a differential test, click the **Differential Test** check box. In order to perform differential measurements the CITS880s uses Channels 1 & 2 and Channels 3 & 4 as differential channels. Differential testing is performed using the IPDS100 Differential Probe. For differential testing, connect the differential probe to Channels 1 & 2 or Channels 3 & 4 using the supplied cables. Use the Channel combo box to specify the CITS880s channel pair.

Note: It is critical for a differential test that the probe cabling for both channels is of matched impedance and length.

Groundless Differential Tests

Note: It is essential that groundless differential tests are performed with the Polar supplied groundless differential (GDPS) probes.

Polar GDPS probes are designed to allow the CITS880s to measure the impedance of balanced differential traces without the need to make a ground connection to the board or coupon under test. They may prove useful for situations where access to the ground plane of the PCB is impracticable or where there is a need to test a balanced differential pair such as a broadside coupled surface trace on a flex circuit.

Click the **Groundless Differential Test** check box.

Setting up the end of probe and the test region needs to be done with care. For the groundless differential probe an end of probe setting of 8 inches is recommended.

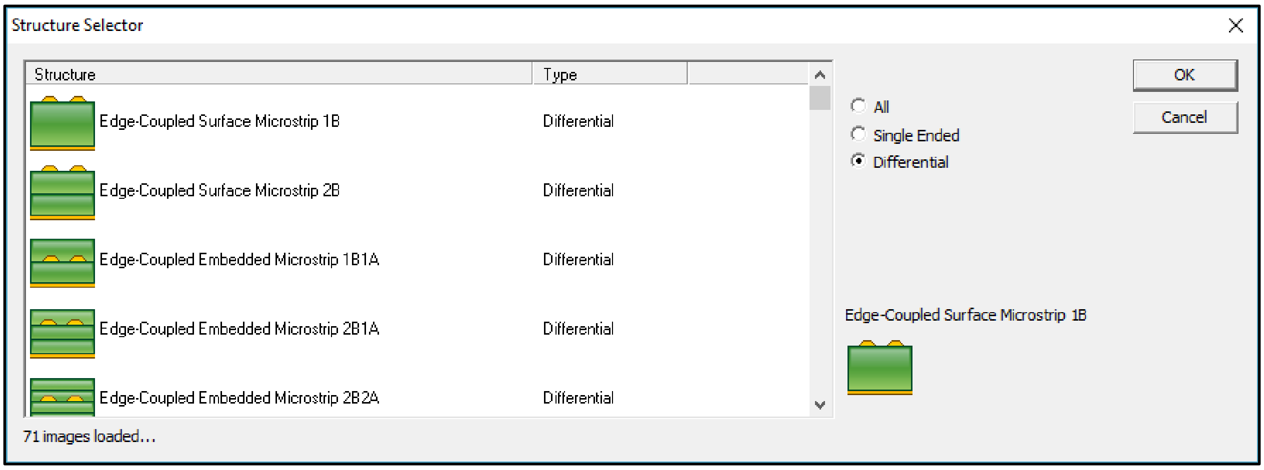
To determine the end of probe with greater precision, verify at a short and not at the open circuit of a probe held in the air. Begin with the probe length set to zero, place the probe on a conductor so that both pins are shorted then scroll the trace up so that the point at which the trace levels off at near zero can be seen. Take the probe length from that point.

To set the test region, pick the flattest portion of the test trace before the trace goes to the top of the screen where the open at the end of the trace is detected.

Please note: Even though they may look like ordinary single ended IP probes and have only one precision probe cable, Polar groundless differential probes are not capable of single ended measurement.

Selecting a structure graphic

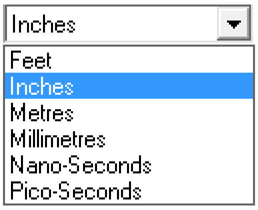
Click the Edit Structure button to add a thumbnail graphic of the controlled impedance structure for the test.



Scroll to the associated structure graphic and click OK – the graphic chosen will be displayed in the waveform window along with the test limits, waveform(s) and test results.

Horizontal Units

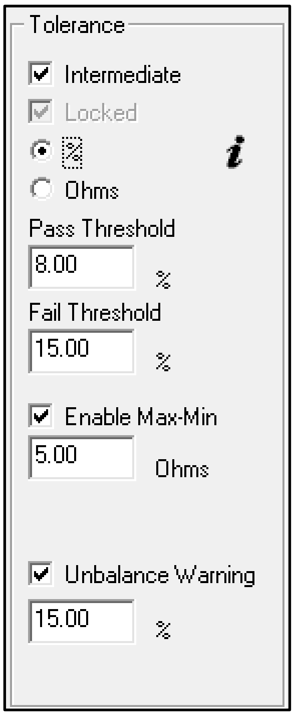
The horizontal axis on the Waveform Display screen can display either distance along the trace under test or "real (i.e. out and back) time". Click on the drop down list box arrow to display the units available:



The **Units** field specifies the units (Feet, Inches, Millimeters, Meters, Nano-Seconds and Pico-Seconds) that will be used for the Test From, Test To and Probe Length fields. It defines the units used to specify all the distance or time parameters and those used on the horizontal axis of the displayed waveform. If time units are selected the Waveform Display window displays "real time", i.e. the "out and back" time for the TDR pulse.

Tolerance

Set the tolerance levels for PASS and FAIL; in the dialog shown below, the Intermediate option has been selected to provide a guard band between PASS and FAIL. Readings of ±8% from the nominal impedance constitute a PASS; readings greater than ±8% but less than ±15% from nominal return an INTERMEDIATE result; readings greater than ±15% from nominal return a FAIL.



Click the Locked check box where Plus and Minus tolerances are to be locked to the same value, leave unchecked to set each value is set independently

Note: when the Intermediate check box is ticked the Locked option is disabled.

The tolerance must be set to a value in the range 0.10% to 99.99% in 0.01% steps; alternatively, it may be set directly in Ohms. Click the % or Ohms option buttons to select.

Choose Enable Max-Min to specify in ohms the maximum range of impedance values over the tested waveform.

Setting the Unbalance Warning Limit

During differential testing the CITS880s checks the single-ended impedance of both signal lines. The CITS880s logs the percentage difference between lines and issues a warning if the unbalance exceeds the threshold set in the **Unbalance Warning Limit** field. Use the **Unbalance Warning Limit** field to set the limit as required.

Display Width

Use the Display Width control to specify the horizontal time or distance scale maximum.

2.50
5.00
7.50
10.00
12.50
15.00
17.50
20.00
22.50
25.00
27.50
30.00
32.50
35.00
37.50
40.00
45.00
50.00
75.00
100.00

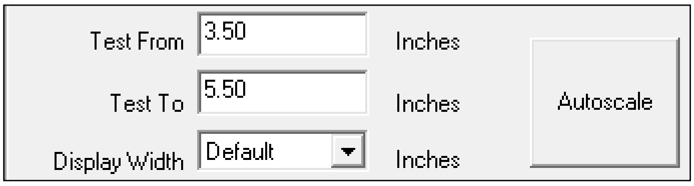
The horizontal axis will extend from 0.0 to the specified value. Display Width distance values can vary from 2.50 – 100 inches (0.02 – 7.0 feet, 0.065 – 2.0 metres, 65 – 2000 millimetres;) Display Width time values can range from 0.6 – 22.0 nanoseconds (600 – 22000 picoseconds.)

Setting Display Width automatically

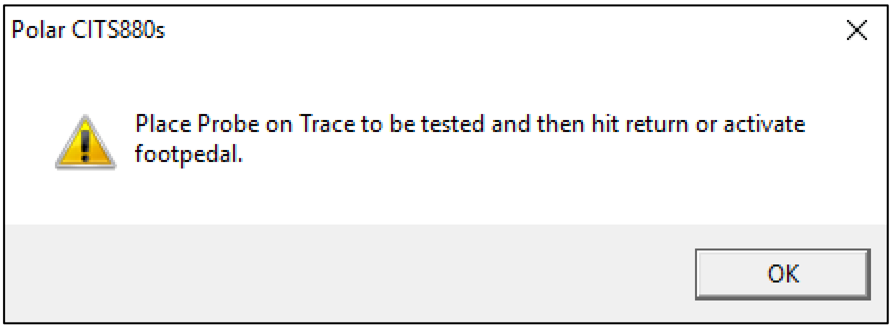
If the Display Width is set to Default the display width is automatically adjusted for the most meaningful waveform display each time the Test From and Test To settings are changed. (To prevent this autoscaling, choose a Display Width setting from the range of numerical values – the display width will remain fixed regardless of the Test From and Test To settings defined for the test.)

Autoscale

Use the Autoscale function to choose the optimum horizontal display width. The CITS880s will use the waveform under test to calculate the width that should give the most meaningful display.



Click the Autoscale button – the CITS880s will prompt for a test on the associated coupon trace.



Run the test on the trace – the CITS880s will use the impedance waveform to decide the optimum display width.

Test From

This parameter, along with the **Test To** parameter enables the user to specify the length of trace or propagation time to be tested. This allows the user to avoid testing for controlled impedance in an area where the displayed waveform may be ringing (e.g. where a sharp change of impedance occurs in the test system connection).

The **Test from** parameter specifies the distance or time from the start of the display to the *start* of the length or time over which impedance is to be tested (see Figure 5-1).

It defines the *start* of the tested area within the display window.

Test from may be set in the range:

Distance

0 to 78 inches

0 to 6.5 feet

0 to 2 meters

0 to 2000mm

Time

154.04nS

154040pS

Test To

The **Test To** parameter specifies the distance or time from the start of the display to the *end* of the length or time over which impedance is to be tested (see Figure 5-1).

It defines the end of the tested area within the display window. It is important to set **Test From** and **Test To** to define part of the undisturbed interval in the display.

Test to may be set in the range:

Distance

0 to 78 inches

0 to 6.5 feet

0 to 2 meters

0 to 2000mm

Time

154.04nS

154040pS

Note that **Test To** must be greater than **Test From**.

Probe Length

The **Probe Length** field specifies the distance or time from the end of the CITS880s cable to the beginning of the displayed graph on the PC (see Figure 5-1).

Probe length may be set in the range:

Distance

0 to 78 inches

0 to 6.5 feet

0 to 2 meters

0 to 2000mm.

Time

154.04nS

154040pS

DC Resistance Compensation

Caution! Applying DC resistance compensation may invalidate results. A sloping waveform may be attributable to a number of causes. Consult the board design authority before applying DC resistance compensation.

Applying DC resistance compensation for series loss

The DC resistance Compensation field may be used to compensate for series DC resistance in the track being tested.

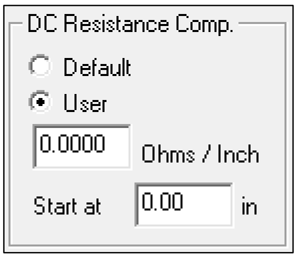
Any series resistance will appear as a ramp in the waveform with impedance increasing linearly with distance. Series resistance simply adds to the characteristic impedance over the length of the waveform. This phenomenon is caused by the DC resistance of the track combined with high frequency skin effects reducing the effective cross-sectional area of the track.

Series DC resistance can be compensated for by adjusting the slope of the waveform by a specified number of ohms/horizontal unit. This cancels out the series resistance leaving the true characteristic impedance displayed.

Note: Series DC resistance may be distinguished from the case of a slightly tapered track by testing from both ends of the trace. In the case of series DC resistance the impedance waveform will appear to have the same rising slope when tested from both ends.

For normal use it is suggested that DC resistance compensation should be *left in the default state — disabled*. In some instances, however, where long conductors or those with small cross sectional area are being tested enabling DC resistance compensation may prove useful.

Select **User** to display the DC Resistance Compensation text box then type in the desired value.



See SPECIFICATIONS for the range of acceptable values.

Velocity of Propagation (Vp)

The Velocity of Propagation (Vp) is the speed at which electrical signals propagate along a cable or printed circuit board trace. Vp is given as a percentage of the speed of light, c.

The speed of the signal depends on the dielectric of the medium in which it travels. For simplicity of operation the CITS880s program assumes that all cables and PCB tracks have a velocity of propagation of 66% the speed of light.

The CITS880s calculates displayed distance or time from time based on a default Vp of 0.66. This value will be found valid for typical coaxial cables and circuit board traces.

This will, however, result in some apparent errors in the indicated distances and times in systems that have significantly different velocities of propagation.

For example, airlines, which have a very high velocity of propagation (98–99% the speed of light), will appear shorter than their true physical length if both are measured with the default Vp. Since the purpose of the CITS880s is to measure impedance, for most applications the linear accuracy of the horizontal scales will probably not be critical.

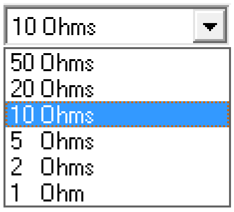
If desired, the Vp used for display of test waveforms can be adjusted for the display window. If Vp is correctly adjusted then the displayed electrical length of any tested specimen will match its physical length. This adjustment is applied to all of the displayed waveform.

For most applications leave the **Vp** setting at **Default**.

Selecting the **User** option displays a text box containing the current value of Vp. With the text box displayed use the left and right arrow keys or the mouse to locate the cursor and type in the desired value.

Ohms per Division

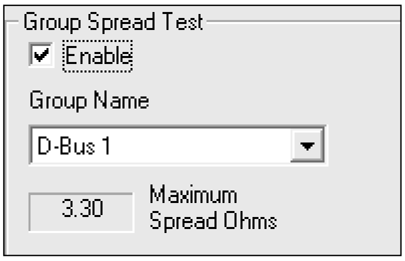
The vertical axis on the PC screen is scaled in ohms per vertical division. The scale may be set to one of the pre-defined values **1**, **2**, **5**, **10**, **20** or **50** ohms/div.



Click the dropdown list box arrow to select the vertical scale value. Choose the scale factor which gives optimum display — lower values display the waveform in greater detail.

Group Spread Test

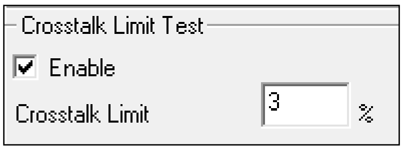
The test may be designated as part of a test group defined by the **Board|Edit Groups…** command. See *Section 4-4 Group Testing*.



To assign the test to a group click the **Enable** check box and select the group from the **Group Name** combo box.

Crosstalk Limit Test

For differential tests limits for allowable crosstalk may be applied to a test. Click Enable and supply the Crosstalk Limit value as a percentage.

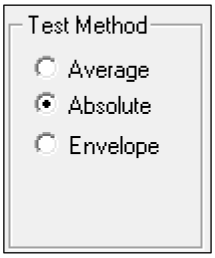


Values of crosstalk exceeding the limits specified in the Crosstalk Limit text box will result in a test FAIL.

5-4 CITS880s Test Methods

The CITS880s provides for several test methods to accommodate traces with different characteristics, for example, uninterrupted traces, traces with vias and traces exhibiting significant loss.

The **Absolute** test method is the preferred test method and is selected by default.



Absolute test method

When the Test Method parameter is set to **Absolute** the CITS880s will record an INTERMEDIATE if the trace enters the INTERMEDIATE area *at any point* or a FAIL if the trace waveform crosses the FAIL threshold (i.e. touches the crosshatch area of the test limits) *at any point* over the tested area. The Absolute method test window is shown below. The nominal impedance is 100 ohms, INTERMEDIATE impedance threshold is ±8% and the FAIL threshold is ±15%.

Result values are shown to the left of the display window.

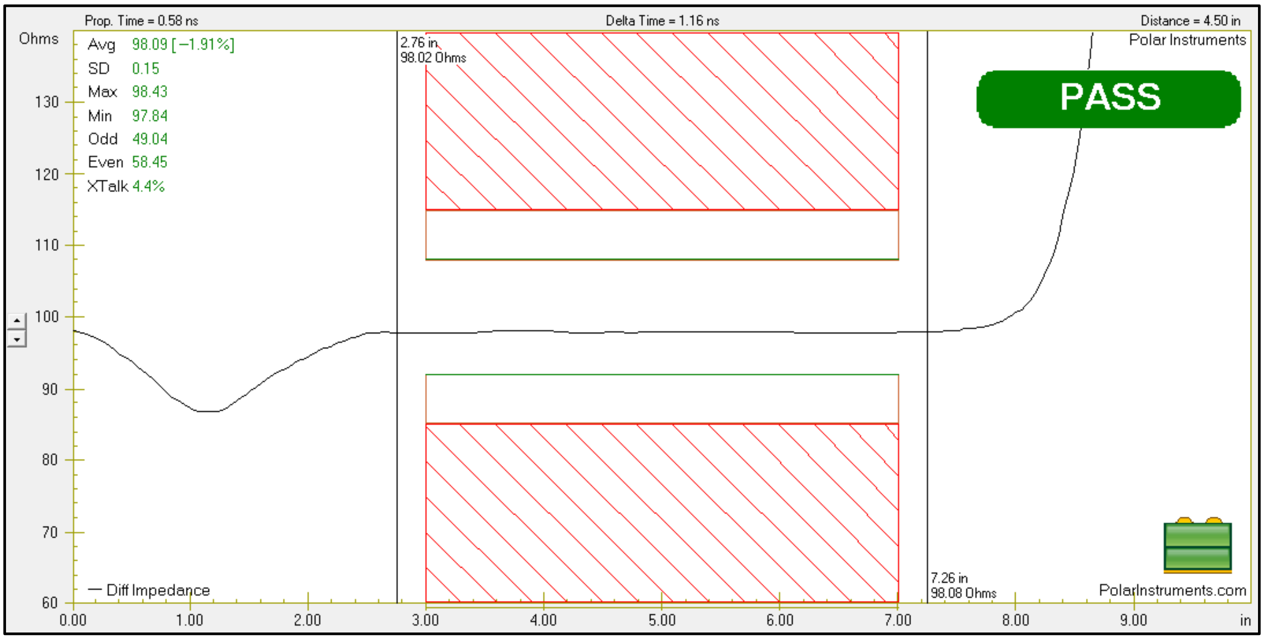


Figure 5-4 Absolute Test Method display window

Average test method

(Retained for legacy applications)

Note: The Average test method should only be used with the express approval of the specifying authority.

The **Average** method sums the value of all the points within the horizontal test limits and divides by the number of points in that interval.

Selecting **Average** will cause the test to fail only if the *average impedance* value (shown in the top left of screen statistics box) is out of tolerance.

The Average test method is a method which was used for legacy backplanes. It was found useful when large numbers of via holes were likely to disturb the PCB trace impedance waveform. It is included from the days when risetimes were slower and backplanes designed with higher nominal impedance for the trace and the via capacitance used to “pull” the average line impedance down.

When **Average** is selected the test limits (100Ω nominal impedance, ±10% between 2 inches and 6 inches) are displayed as shown in the diagram below:

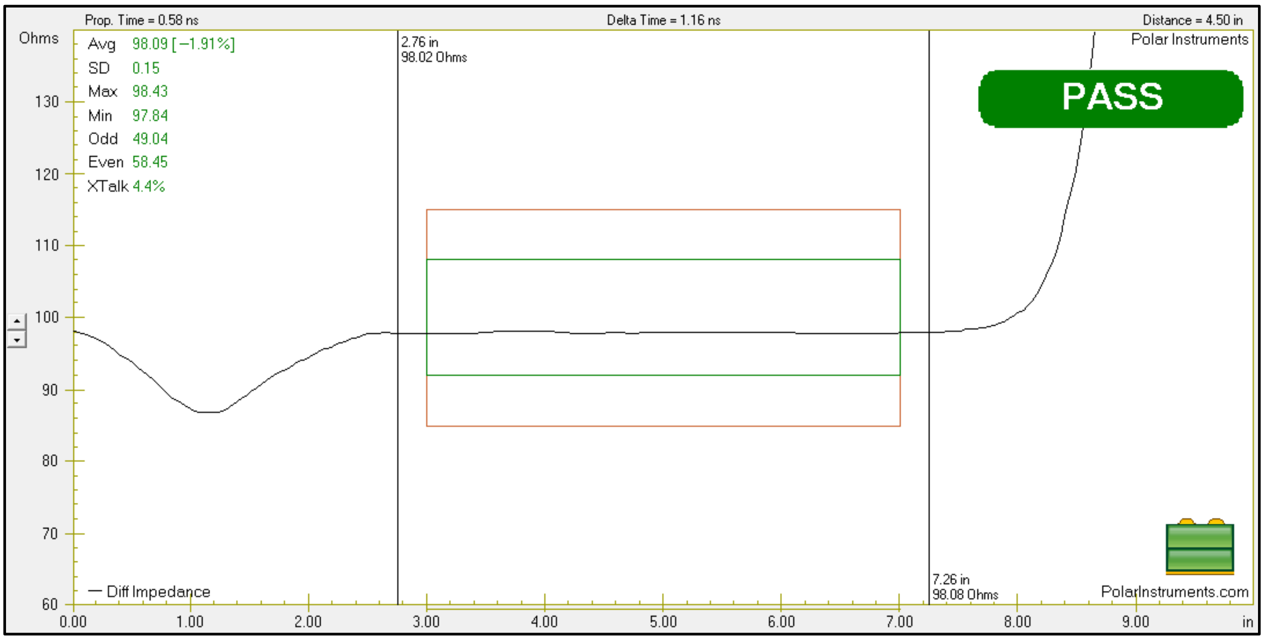


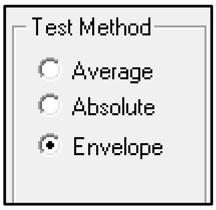
Figure 5-5 Average Test Method display window

The **Average** method is used most often when large numbers of via holes are likely to disturb the PCB trace impedance waveform. Typical examples include backplane and similar traces.

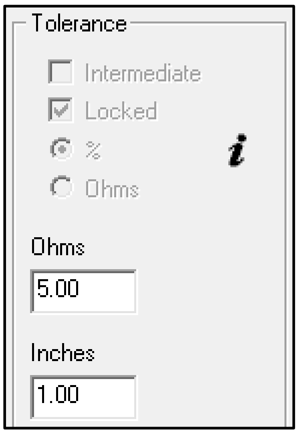
Envelope test method

Using the **Envelope** test method a waveform is acquired and used as a reference waveform. A user tolerance specified *envelope* is drawn around each data point in the tested region of the acquired reference waveform (as shown in the diagram below); each data point in subsequent acquired waveforms is tested against its associated envelope in the reference waveform.

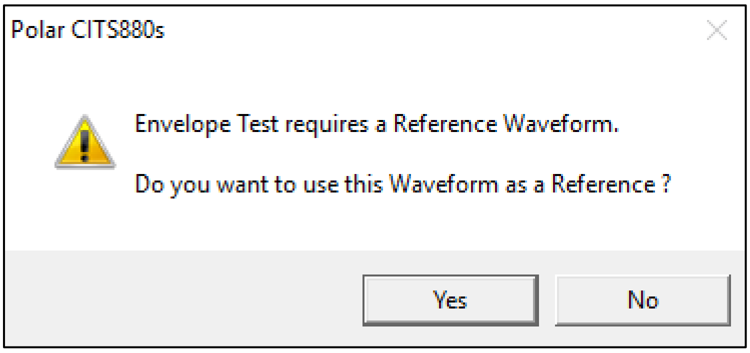
Click the **Envelope** method from the Test method option group.



Specify the impedance and time or distance tolerances for the envelope; the size of the envelope is thus determined by the Tolerance settings – vertically in Ohms, horizontally in distance units, millimetres, inches, etc. or in time units, nano-seconds or picoseconds.



When first run, the **Envelope** test method acquires its reference waveform; the CITS880s acquires the first trace and offers to save it as a reference



A tolerance envelope is shown around each data point in the reference waveform in the diagram below; for the test to record a PASS each data point for a coupon under test must sit within its associated envelope.

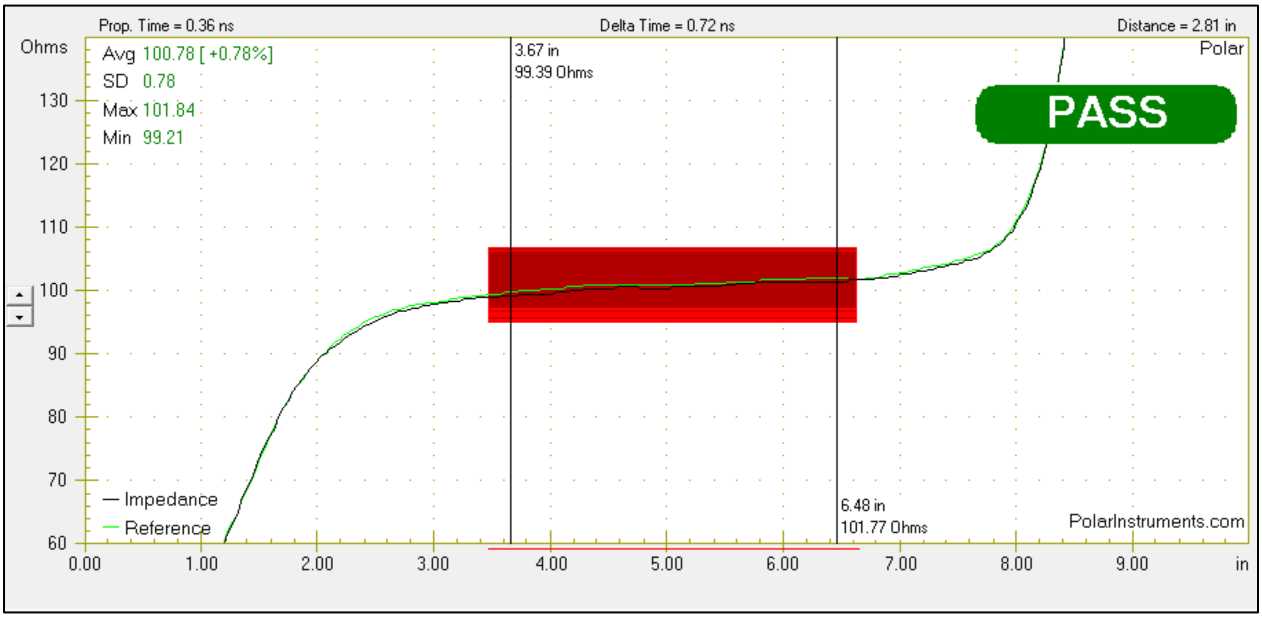


Fig 5-6 Envelope Test Method display window

5-5 Launch point extrapolation (LPE)

Note: Launch point extrapolation (LPE) is IPC approved but should be used in conjunction with the express clearance of the specifying authority.

Measuring instantaneous impedance on the CITS880s

With thinner copper and finer PCB traces, TDR traces are often seen exhibiting an upward slope from left to right, the trace gradient increasing for fine trace widths or as the copper layer gets thinner. As the TDR reflection returns to the measurement system, a combination of DC and AC trace resistance adds to the reflection of the instantaneous impedance resulting in an upward sloping trace.

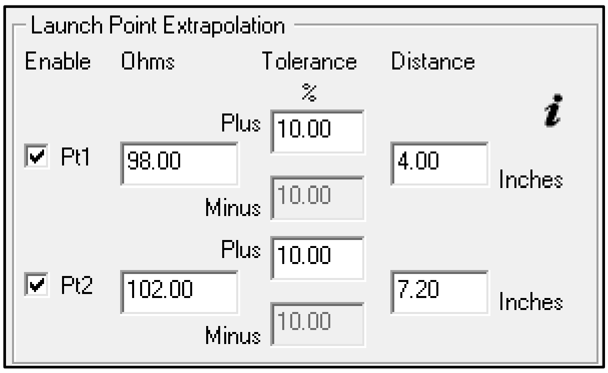
The impedance calculated with a field solver is the *instantaneous impedance*, i.e. the impedance (if it were possible to slice through any point on the trace and apply an ideal TDR pulse) at the point of launch into the trace section.

Launch point extrapolation applies a regression line fit to a stable sample of the reflection from the trace and projects this regression line back to the launch of the trace – hence *launch point extrapolation*. This technique requires a TDR with as flat a pulse as possible and, ideally, minimum leading edge perturbations. CITS880s supports this technique in addition to conventional impedance measurements for less challenging geometries.

To define LPE limits, click Enable for each of the points and define the target impedance for each point.

Note: the test limits and time position of the launch point and end point extrapolation are the primary responsibility of the PCB specifier and fabricators should seek their customers' guidance if in any doubt.

The CITS880s uses the values defined in the Tolerance section of the Test Editor window to set the LPE limits.



Define the distance along the trace for each of the LPE points. The CITS880s uses the tolerance and distance values to draw the associated error bars on screen.

The launch impedance (LPE Pt1) is typically set close to the launch, near the start of the coupon.

LPE Pt2 is set further down the line (this could be past the end of the coupon) as a check that the slope is not too steep.

Note: Some OEMs may prefer to set the limits for LPE Pt1 and LPE Pt2 in time units and in this case the CITS880s editor should be set to display time rather than length.

i Information

Click the information icon to access Polar Application Note AP8505 *Instantaneous impedance measurement with LPE (Launch Point Extrapolation).*

As the test is run the CITS880s calculates and displays the slope of the trace over the test region and extends the line through the extrapolation points, fitting the line to a regression calculation of the data points between the Test From and Test To distances (below.)

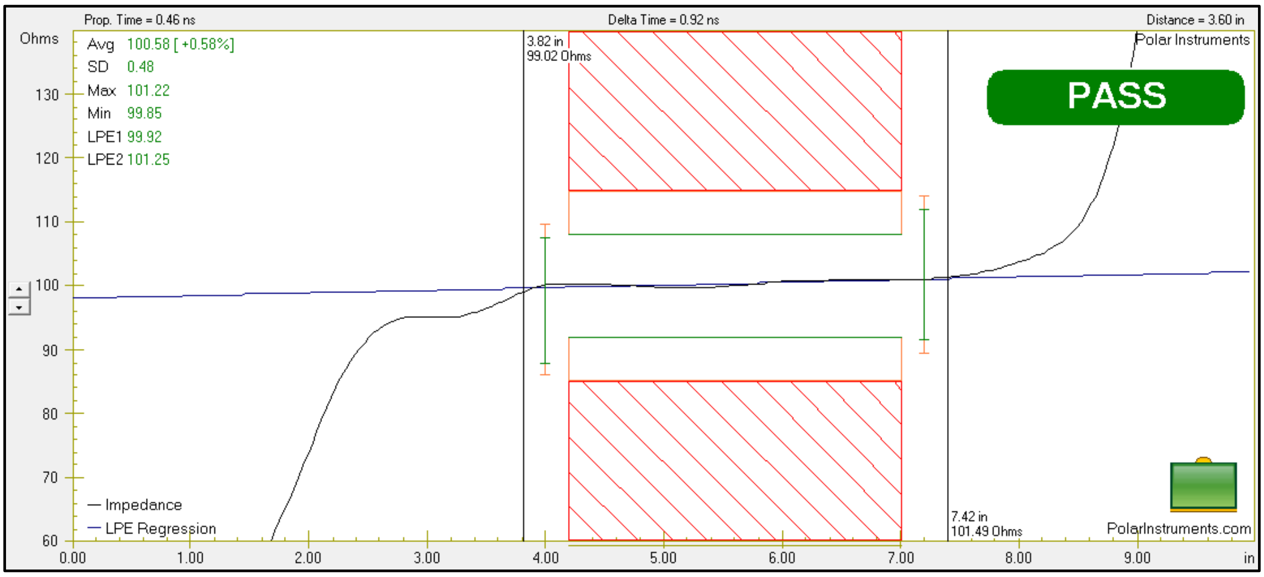


Fig 5-7 Launch point extrapolation (LPE)

With all settings completed press **OK** to confirm the test parameters and close the Test Setup Editor.

5-6 Saving the test file

Press the Save button to save the file

When all tests for the board under test have been specified press the **Save** button, or use the **Save** or **Save As** commands from the **File** menu, to store the file as a new test file. The system will display the **Save As** dialog box to request the new file name.

Naming test files

Names assigned to test files must conform to the Microsoft Windows conventions for file names. File names must be unique and may contain up to 255 characters. The following characters may be used in file names:

Letters A to Z and a to z

Numbers 0 to 9

and the following special characters:

- ! $ % ^ & ( ) @ ~ # { } ` ' _

Operating system reserved characters such as slashes (/ \), question marks (?), asterisks (*) and less and greater than (< >) are not permitted in file names. For more information on file naming conventions, consult the Windows operating system user guides.

It is recommended that users employ systematic test naming schemes in which tests are assigned descriptive names

Saving test files under new names

To save a file under a new name select the existing file using the **Open** command from the **File** menu, choose the **Save As** command and name the new file (if necessary edit the file).

5-7 Using existing files as templates

An alternative method of creating a new test file is to open an existing test file, save it under a new name and then edit it. If this is a new test file, select a suitable existing file and edit the parameters for each test as required.

5-8 Printing test files

To obtain hard copy of test files (e.g. for reference or customer conformance reports) right click the Test File window pane (or select the **Print** command from the File menu (or press Ctrl-P).

The Print function will print to the default Windows printer.

Click the Print Preview command to inspect the printout prior to printing.

SECTION 6 — MAINTENANCE AND FAULT FINDING

MAINTENANCE AND FAULT FINDING

6-1 System check

Single ended tests

From the File menu create a new test file.

From the Board menu Insert a new test. When the Test Editor opens, type Ch1 in the Description box, change Probe Length to zero and Tolerance to 5%.

Repeat for Channels 2 to 4, supplying an appropriate description for each and selecting the appropriate test channel.

Differential tests

Create another new test and enter description “Differential CH1/2”, select Differential and Channel “Ch1 & Ch2”. Change Probe Length to zero and set Impedance to 100 ohms

Create a similar differential test for channels 3 and 4.

From the Utilities menu click on Relay and Cable Test and agree to the tests being added.

With nothing attached to the cables (ensure these are the test cables that will normally be used with the CITS) run the Learn Cable Length from the Utilities menu and then run the four cable and relay tests.

Attach the calibrated semi-rigids supplied with the CITS880s to the appropriate cables and run the 6 tests created.

Save the test file for future use.

6-2 Cable Replacement

Whenever cables are replaced on a system the CITS880s should be recalibrated. Failure to do so may result in the instrument not meeting specifications. Return the CITS880s to your Polar Service Center for calibration.

Should the power supply cable need replacing ensure that the new cable is sourced from Polar Instruments to be certain it fully complies with all safety requirements. Use of an inadequate cable could cause a hazard to employees or damage to the instrument.

6-3 CITS880s Servicing

WARNING This instrument should only be serviced by a qualified electronics technician.

IMPORTANT The CITS880s is an extremely sensitive measuring instrument.
To prevent damage to the CITS880s observe static precautions at all times. See Appendix B for information

Refer all servicing to qualified service personnel. There are no user serviceable parts within the instrument enclosure.

Microstrip probes

If a different pitch between the ground and signal pins on the Microstrip probes is required this may be adjusted with the aid of a soldering iron. (In the event of damage or loss to the spring loaded pins, replacements are obtainable from I.D.I or their local agents. The order code is SS 75E 4.9 G)

Cleaning

Clean the instrument with a cloth lightly moistened with water with a small amount of mild detergent. Alternatively, a cloth lightly moistened with alcohol (ethanol or methylated spirit) or isopropyl alcohol (IPA) may be used.

Do not spray cleaners directly onto the instrument.

Technical Support

For technical support contact your local Polar Instruments distributor or Polar Instruments. See front cover for email address and fax numbers.

Consumable parts

Cables and probes should be replaced every two years or when showing signs of significant wear.

6-4 Fault diagnosis

The following symptoms may be investigated by the user. More serious faults should be referred to qualified personnel.

Symptom	Test
Communication Error reported by the host computer	Check CITS880s power is switched on. Check CITS880s BUSY LED is lit for a few seconds on power up then extinguished. If the LED stays lit or turns red, the CITS880s is faulty; refer to the supplier or agent Check the connection of CITS880s to the PC meets the USB 2.0 specification (check for "Enhanced" USB Controller in the Universal Serial Bus section of **Windows Control Panel|System|Hardware|Device Manager**.) Check that the USB 2.0 cable used is the cable supplied with the CITS.
CITS880s displays USB power warning	Check that the USB 2.0 hub is not shared with a high powered USB accessory.
Foot switch not working	Check that the Foot switch is plugged in to the host computer.
Printer fails to work	Check the printer is switched on. Check connection of the PC to the printer. Print a window test page for the printer.

APPENDIX A

CHARACTERISTIC IMPEDANCE OF CONDUCTORS

The characteristic impedance of a conductor is a function of the dimensions of the conductor, its surrounding environment and the dielectric constant E_r of the insulating material.

The diagram below includes equations for calculating the characteristic impedance of coaxial cable, microstrip and stripline.

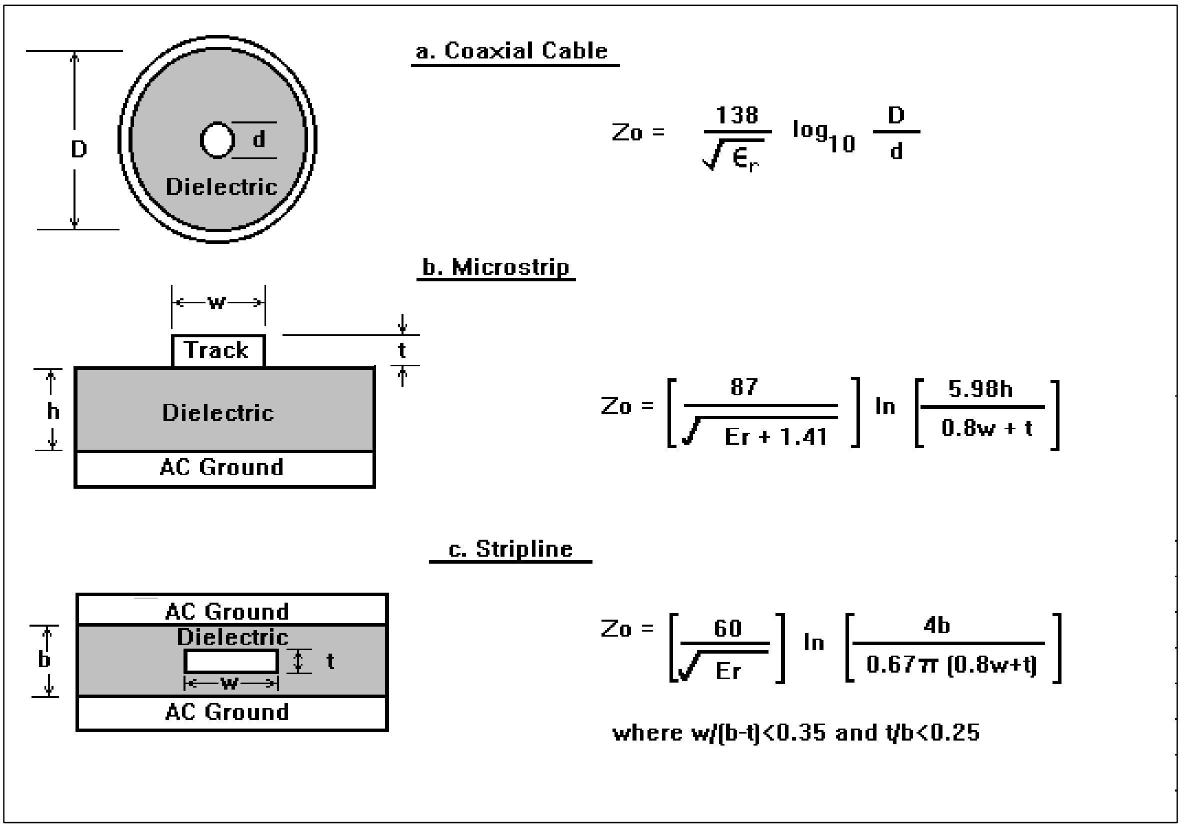


Figure A-1 Typical conductors and associated impedance equations

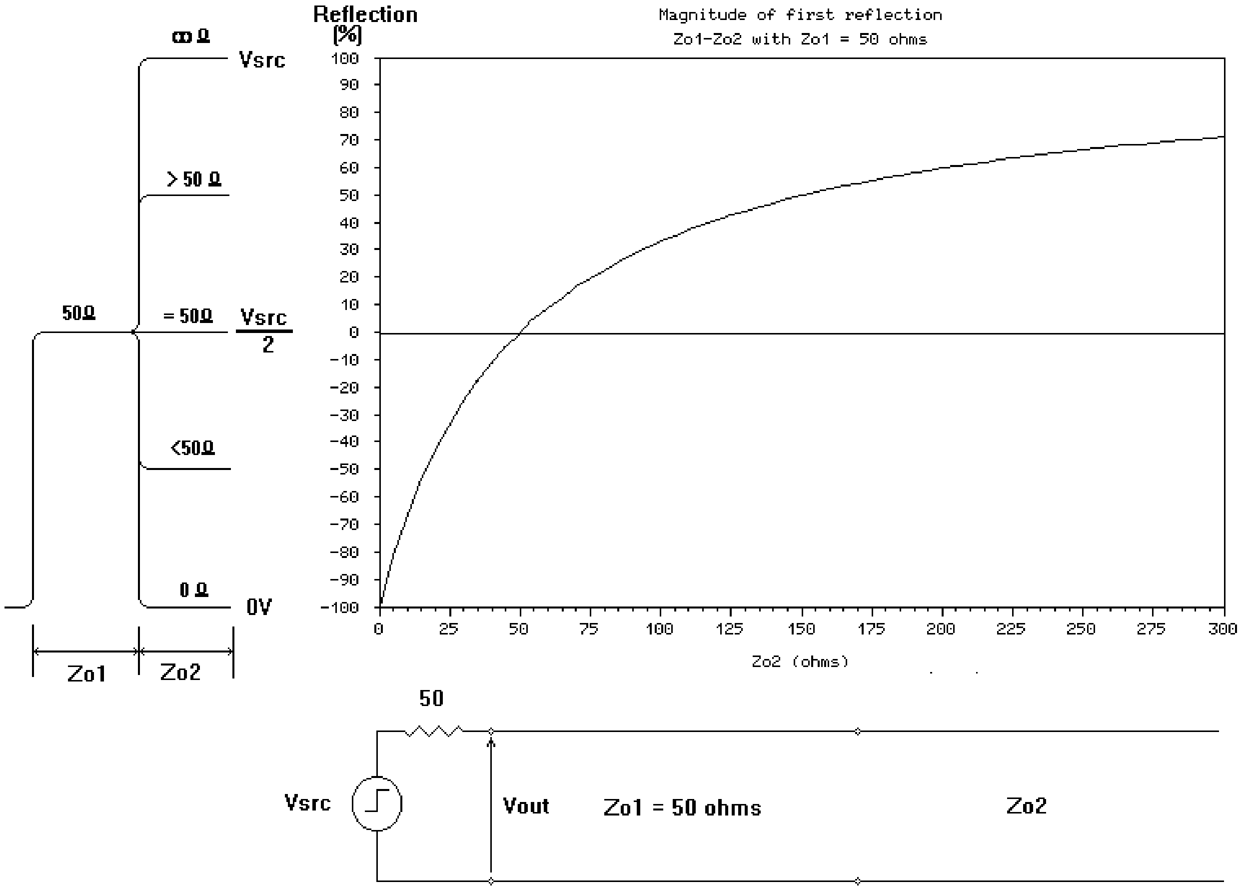


Figure A-2 Reflection magnitude v discontinuity impedance for a 50Ω Z_o, step output TDR

Determination of characteristic impedance

The CITS880s displays a graph of the characteristic impedance of a specified length of PCB trace. This is achieved by calculating the impedance along the length of the cable or PCB based on the size of the reflections measured using time domain reflectometry.

The above graph shows the size of reflection from an impedance discontinuity encountered by the out-going pulse of a 50Ω, step output TDR such as the CITS.

The CITS880s software translates the magnitude of voltage reflections measured by the TDR into a linear plot of impedance against distance. Note that the size of the reflection is not linearly related to the impedance discontinuity. As the impedance gets larger the slope of the curve is reduced so that at high impedances a large change in impedance will only cause a small change in reflection. Consequently the accuracy of measurements of high impedances is reduced.

APPENDIX B

ELECTROSTATIC DISCHARGE

PROTECTING THE CITS880s FROM ELECTROSTATIC DISCHARGE

> *Caution: The probe/input circuitry of the CITS880s includes sensitive components that are susceptible to damage from electrostatic discharge — precautions must be taken to avoid static discharge into the probe.*

Many of the components in modern instruments like the CITS880s employ internal construction that may be damaged by electrostatic discharge (ESD). Such components are often referred to as *static sensitive*.

Damage caused by electrostatic discharge may be severe enough to result in the complete and instant failure of a component. Often, however, components are not destroyed but merely degraded and failure occurs in later use.

Some devices are sensitive enough to be damaged or degraded by electrostatic discharge of only several tens of volts, voltages not uncommon at unprotected workstations.

Everyday activities such as applying tape from a dispenser, walking across nylon carpets or separating plastic transparency films can generate charges of several thousand volts.

Sources of static electricity

There are two sources of static electricity most likely to be encountered by the technician:

People (especially when wearing clothes made from synthetic fibre).

Packaging materials such polythene (e.g. bags or tubes), polystyrene containers or padding (e.g. chipples, etc.) and adhesive tape used to seal containers.

Static free workstations

Static sensitive components, including completed circuit boards, should only be used (i.e. inserted or replaced) at a static free workstation. The static free workstation will typically include anti-static bench mats, floor mats and wrist straps and should be kept free from materials which could generate or store a static charge.

Working with the CITS

When using the CITS880s observe the same procedures as when handling static sensitive components:

Use the CITS880s at an approved anti-static workstation.

Wear a wrist strap connected to a suitable earth point. A wrist strap is provided with the CITS880s (connect the wrist strap to the stud on the CITS880s front panel).

Other protective clothing, such as conducting heel straps and metallised coats can be worn if available.

Keep materials that may produce static electricity away from the workstation.

Treated completed circuit boards as static sensitive components.

Avoid dragging the CITS880s probes across work surfaces.

Do not point the probe tip at surfaces that may have a static charge, e.g. monitor screens.

APPENDIX C

STATUS OUTPUT CONNECTOR DETAILS

Pin	Name	Description (all outputs are open-collector)
1	Pass	On if test passes
2	/Pass	Off if test passes
3	Fail	On if test fails
4	/Fail	Off if test fails
5	Testing	On during testing
6	/Testing	Off during testing
7	Strobe	Turns On to strobe Pass and Fail outputs
8	/Strobe	Turns Off to strobe Pass and Fail outputs
9	Common	Common line for all outputs

Note: All outputs are opto-isolated from ground. For continued safety do not elevate any pin to more than +/–30V DC relative to ground.

Output transistors are NPN with open collectors connected to pins 1 to 8. Emitters are all commoned to pin 9.

Maximum collector to emitter voltage is 15V enabling interfacing to most logic families. The outputs cannot drive relays directly.

APPENDIX D

USING BARCODE READERS IN POLAR PRODUCTS

Using barcodes in Polar products

Barcodes are used in Polar products, e.g. CITS880s Controlled Impedance Test System to choose test files and to link to the Polar web site and display application notes.

A barcode is a method of representing data in machine-readable form. Fast and accurate data capture can reduce errors and increase productivity.

Several Polar products incorporate the option to utilise barcode readers for rapid and reliable interaction with the application. The barcodes used in Polar products range from linear 1D barcodes to 2D QR (Quick Response) Codes ®

test.xml

Linear barcode

QR Code®

Barcode readers

Barcode readers are readily available and inexpensive – the barcode reader illustrated below is widely obtainable online as a computer accessory at low cost

Choosing a CITS880s test file

The CITS880s Scan Barcode dialog can be utilised to scan the barcode for the item to be tested (for example, a controlled impedance test coupon) and load the associated CITS test file from the CITS880s test files folder. Both CITS native .CIF and XML test files can be loaded via the barcode reader.

Accessing the Polar web site

Scan the QR Codes® in the Scan Barcode dialog to access Application Note AP629 or go to the Polar web site home page.

Barcode readers often employ a USB interface so can simply be plugged in to an empty USB slot on the host computer without rebooting the host and generally need little configuration. In addition, they are generally powered directly from the USB interface, so do not require extra power supply cables.

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APPENDIX E

NOTES ON USE OF POLAR XML INTERFACE FOR CITS

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From CITS Version 18:05 provision is provided to read a simple XML file that the CITS software can then create a native test file (.cif) from.

This document is the format specification for the source XML file that needs to be created by the user of this feature.

The overall structure of the XML file is very simple, in fact the following file will generate a testfile with three default tests in it:–

```
<?xml version="1.0" encoding="UTF-8"?>
<PolarXML>
    <Header></Header>
    <Setup></Setup>
    <Setup></Setup>
    <Setup></Setup>
</PolarXML>
```

While the above is interesting, it's not very useful; it does however show the main sections of the simple XML format employed.

PolarXML Tag – this contains all of the data needed for the file. Only one PolarXML tag pair is expected in the source file.

Header Tag – this contains one off header information for the file such as 'Customer Name'. Only one Header tag pair is expected in the source file.

Setup – this contains the data required for each test, multiple Setup tag pairs are expected, one for each test step in the final .cif test file.

The following documents the optional tags that can be present in the Header section and the Setup section and how they function.

The order that tags are within a section is not relevant, generally if a tag is not present then a default of some kind will be used.

All strings ARE case sensitive – so 'TRUE' is not the same as 'True' or 'true'

Header Section Tags

<Customer>XXXYYYZZZ</Customer> Text found in this tag will be put into the Customer Name field of the Board Details in the final file.

<BoardType>XXXYYYZZZ</BoardType> Text found in this tag will be put into the Board Type field of the Board Details in the final file.

<PartNumber>XXXYYYZZZ</PartNumber> Text found in this tag will be put into the Part Number field of the Board Details in the final file.

<RevisionNumber>XXXYYYZZZ</RevisionNumber> Text found in this tag will be put into the Revision Number field of the Board Details in the final file.

<Notes>XXXYYYZZZ</Notes> Text found in this tag will be put into the Notes field of the Board Details in the final file. This may be a multiline entry; i.e. the following is allowed:

<Notes>

Line1

Line2

Line3

</Notes>

<DebugFilePath>C:\xxx\yyy\zzz.txt</DebugFilePath> An optional fully qualified file path to a target text file that can be written to for debug purposes by the input XML reader in the CITS.

<TargetFilePath>C:\xxx\yyy\zzz.txt</TargetFilePath> An optional fully qualified file path to a target file .cif file to be generated. If this tag is not present then the generated .cif file will be generated in the same directory as the source XML file and have the same filename.

i.e. if the source XML file is C:\junk\input.xml and this tag is not found then the generated cif file will be found at C:\junk\input.cif

Setup Section Tags

There may be multiple Setup pair tags, one for each item in the final test list. If a tag pair is not present then the default value from the default test specified by hitting the Edit Default Test button found on the Utilities\ Config \ General Tab will be used.

The following tags can be present in the Setup Section, they generally map to the functionality and fields of the same name in the Test Editor.

<Description>xxxyyyzzz</Description>

Text Field

<Layer>xxxyyyzzz</Layer>

Text Field

<Impedance>nn.nn</Impedance>

Numeric Floating point value in Ohms, Minimum 0.10, Maximum 250.00

<TestMethod>xxxx</TestMethod>

Text Field, two options are supported

Absolute Average

<HorizontalUnits>xxxx</HorizontalUnits>

Text Field, nominates the horizontal units employed, options are:

- Feet
- Inches
- Metres
- Millimetres
- Nanoseconds
- Picoseconds
- Seconds

<ProbeLength>nn.nn</ProbeLength>

Numeric Floating point value - Probe Length in nominated units

<TestFrom>nn.nn</TestFrom>

Numeric Floating point value - Test To Length in nominated units

<TestTo>nn.nn</TestTo>

Numeric Floating point value - Test To Length in nominated units

<VP>0.66</VP>

Numeric Floating point value – Minimum 0.33, Maximum 0.99

<TolerancePlus>nn.nn</TolerancePlus>

Numeric Floating point value – Test Tolerance Plus in percent Minimum 0.00, Maximum 99.00

<ToleranceMinus>nn.nn</ToleranceMinus>

Numeric Floating point value – Test Tolerance Minus in percent Minimum 0.00, Maximum 99.00

<TolerancePlusOhms>nn.nn</TolerancePlusOhms>

Numeric Floating point value – Test Tolerance Plus in Ohms Minimum 0.00, Maximum 99.00

<ToleranceMinusOhms>nn.nn</ToleranceMinusOhms>

Numeric Floating point value – Test Tolerance Minus in Ohms Minimum 0.00, Maximum 99.00

<TestType>xxx</TestType>

Text Field, supported options are :-

Single Ended

Differential

Groundless Differential

<ChannelSelection>nn</ChannelSelection>
Text Field, supported options are:

For Single Ended and Groundless Differential

CH1

CH2

CH3

CH4

For Differential

CH12

CH34

<VerticalScale>nn</VerticalScale>

Vertical scale in Ohms per division, options are :-

50

20

10
5

2

1

<DifferentialUnbalanceWarningLimit>nn.n</DifferentialUnbalanceWarningLimit>

Numeric Floating point value – if the value is <=0.0 or > 99.9 then Differential Unbalance is turned OFF

<DCResistanceCompensation>xxx</DCResistanceCompensation>

Text Field, Indicates if DC Compensation is employed: options are

Default

LossUser

LossNormalized

<DCResistanceStart>nn.nn</DCResistanceStart>
Start point for DC Resistance Compensation in distance units previously specified

<DCResistanceOhms>nn.nn</DCResistanceOhms> Resistance in Ohms per unit

<LPEP1Enable>xxxx</LPEP1Enable>

Text Field, FALSE disables LPEP1, TRUE enables
LPEP1<LPEP1Impedance>nn.nn</LPEP1Impedance>
Numeric Floating point value in Ohms, Minimum 0.10, Maximum 250.00

<LPEP1TolPlus>nn.nn</LPEP1TolPlus>
Numeric Floating point value – Test Tolerance Plus in percent Minimum 0.00, Maximum 99.00

<LPEP1TolMinus>nn.nn</LPEP1TolMinus>
Numeric Floating point value – Test Tolerance Plus in percent Minimum 0.00, Maximum 99.00

<LPEP1TolPlusOhms>nn.nn</LPEP1TolPlusOhms>
Numeric Floating point value – Test Tolerance Plus in Ohms Minimum 0.00, Maximum 99.00

<LPEP1TolMinusOhms>nn.nn</LPEP1TolMinusOhms>
Numeric Floating point value – Test Tolerance Plus in Ohms Minimum 0.00, Maximum 99.00

<LPEP1Distance>nn.nn</LPEP1Distance>
Numeric Floating point in units previously specified, distance to LPEP1

<LPEP2Enable>xxx</LPEP2Enable>
Text Field, FALSE disables LPEP2, TRUE enables LPEP2

<LPEP2Impedance>nn.nn</LPEP2Impedance>
Numeric Floating point value in Ohms, Minimum 0.10, Maximum 250.00

<LPEP2TolPlus>nn.nn</LPEP2TolPlus>
Numeric Floating point value – Test Tolerance Plus in percent
Minimum 0.00, Maximum 99.00

<LPEP2TolMinus>nn.nn</LPEP2TolMinus>
Numeric Floating point value – Test Tolerance Plus in percent
Minimum 0.00, Maximum 99.00

<LPEP2TolPlusOhms>nn.nn</LPEP2TolPlusOhms>
Numeric Floating point value – Test Tolerance Plus in Ohms Minimum 0.00, Maximum 99.00

<LPEP2TolMinusOhms>nn.nn</LPEP2TolMinusOhms>
Numeric Floating point value – Test Tolerance Plus in Ohms Minimum 0.00, Maximum 99.00

<LPEP2Distance>nn.nn</LPEP2Distance>
Numeric Floating point in units previously specified, distance to LPEP2

<StructureNumber>nID</StructureNumber> Numeric, Options currently supported are

nID	Structure	Differential
0	Empty	FALSE
11	Surface Microstrip 1B	FALSE
12	Surface Microstrip 2B	FALSE
22	Embedded Microstrip 1B1A	FALSE
23	Embedded Microstrip 2B1A	FALSE
24	Embedded Microstrip 2B2A	FALSE
25	Embedded Microstrip 1B2A	FALSE
32	Offset Stripline 1B1A	FALSE
33	Offset Stripline 2B1A	FALSE
34	Offset Stripline 2B2A	FALSE
35	Offset Stripline 1B2A	FALSE
51	Coated Microstrip 1B	FALSE
52	Coated Microstrip 2B	FALSE
55	Dual Coated Microstrip 1B	FALSE
56	Dual Coated Microstrip 2B	FALSE
64	Embedded Microstrip 1E1B1A	FALSE
65	Embedded Microstrip 1E1B2A	FALSE
111	Edge-Coupled Surface Microstrip 1B	TRUE
112	Edge-Coupled Surface Microstrip 2B	TRUE
122	Edge-Coupled Embedded Microstrip 1B1A	TRUE
123	Edge-Coupled Embedded Microstrip 2B1A	TRUE
124	Edge-Coupled Embedded Microstrip 2B2A	TRUE
125	Edge-Coupled Embedded Microstrip 1B2A	TRUE
127	Edge-Coupled Embedded Microstrip 1B2A1R	TRUE
128	Edge-Coupled Embedded Microstrip 1B1A1R	TRUE
129	Edge-Coupled Embedded Microstrip 2B1A1R	TRUE
132	Edge-Coupled Offset Stripline 1B1A	TRUE
133	Edge-Coupled Offset Stripline 2B1A	TRUE
134	Edge-Coupled Offset Stripline 2B2A	TRUE
135	Edge-Coupled Offset Stripline 1B2A	TRUE
137	Edge-Coupled Offset Stripline 1B1A1R	TRUE
138	Edge-Coupled Offset Stripline 2B1A1R	TRUE
139	Edge-Coupled Offset Stripline 1B2A1R	TRUE
151	Edge-Coupled Coated Microstrip 1B	TRUE
152	Edge-Coupled Coated Microstrip 2B	TRUE
155	Edge-Coupled Dual Coated Microstrip 1B	TRUE
156	Edge-Coupled Dual Coated Microstrip 2B	TRUE
164	Edge-Coupled Embedded Microstrip 1E1B1A	TRUE
165	Edge-Coupled Embedded Microstrip 1E1B2A	TRUE
194	Edge-Coupled Embedded Microstrip 2B2A1R	TRUE
211	Surface Coplanar Waveguide With Lower Gnd 1B	FALSE
212	Surface Coplanar Waveguide With Lower Gnd 2B	FALSE
222	Embedded Coplanar Waveguide With Lower Gnd 1B1A	FALSE
223	Embedded Coplanar Waveguide With Lower Gnd 2B1A	FALSE
232	Offset Coplanar Waveguide 1B1A	FALSE

233	Offset Coplanar Waveguide 2B1A	FALSE
234	Offset Coplanar Waveguide 1B2A	FALSE
235	Offset Coplanar Waveguide 2B2A	FALSE
251	Coated Coplanar Waveguide With Lower Gnd 1B	FALSE
252	Coated Coplanar Waveguide With Lower Gnd 2B	FALSE
255	Dual Coated Coplanar Waveguide With Lower Gnd 1B	FALSE
256	Dual Coated Coplanar Waveguide With Lower Gnd 2B	FALSE
311	Diff Surface Coplanar Waveguide With Lower Gnd 1B	TRUE
312	Diff Surface Coplanar Waveguide With Lower Gnd 2B	TRUE
322	Diff Embedded Coplanar Waveguide With Lower Gnd 1B1A	TRUE
323	Diff Embedded Coplanar Waveguide With Lower Gnd 2B1A	TRUE
332	Diff Offset Coplanar Waveguide 1B1A	TRUE
333	Diff Offset Coplanar Waveguide 2B1A	TRUE
334	Diff Offset Coplanar Waveguide 1B2A	TRUE
335	Diff Offset Coplanar Waveguide 2B2A	TRUE
351	Diff Coated Coplanar Waveguide With Lower Gnd 1B	TRUE
352	Diff Coated Coplanar Waveguide With Lower Gnd 2B	TRUE
355	Diff Dual Coated Coplanar Waveguide With Lower Gnd 1B	TRUE
356	Diff Dual Coated Coplanar Waveguide With Lower Gnd 2B	TRUE
411	Surface Coplanar Strips With Lower Gnd 1B	FALSE
412	Surface Coplanar Strips With Lower Gnd 2B	FALSE
422	Embedded Coplanar Strips With Lower Gnd 1B1A	FALSE
423	Embedded Coplanar Strips With Lower Gnd 2B1A	FALSE
432	Offset Coplanar Strips 1B1A	FALSE
433	Offset Coplanar Strips 2B1A	FALSE
434	Offset Coplanar Strips 1B2A	FALSE
435	Offset Coplanar Strips 2B2A	FALSE
451	Coated Coplanar Strips With Lower Gnd 1B	FALSE
452	Coated Coplanar Strips With Lower Gnd 2B	FALSE
455	Dual Coated Coplanar Strips With Lower Gnd 1B	FALSE
456	Dual Coated Coplanar Strips With Lower Gnd 2B	FALSE
511	Diff Surface Coplanar Strips With Lower Gnd 1B	TRUE
512	Diff Surface Coplanar Strips With Lower Gnd 2B	TRUE
522	Diff Embedded Coplanar Strips With Lower Gnd 1B1A	TRUE
523	Diff Embedded Coplanar Strips With Lower Gnd 2B1A	TRUE
532	Diff Offset Coplanar Strips 1B1A	TRUE
533	Diff Offset Coplanar Strips 2B1A	TRUE
534	Diff Offset Coplanar Strips 1B2A	TRUE
535	Diff Offset Coplanar Strips 2B2A	TRUE
551	Diff Coated Coplanar Strips With Lower Gnd 1B	TRUE
552	Diff Coated Coplanar Strips With Lower Gnd 2B	TRUE
555	Diff Dual Coated Coplanar Strips With Lower Gnd 1B	TRUE
556	Diff Dual Coated Coplanar Strips With Lower Gnd 2B	TRUE
611	Surface Coplanar Waveguide 1B	FALSE
612	Surface Coplanar Waveguide 2B	FALSE
622	Embedded Coplanar Waveguide 1B1A	FALSE
623	Embedded Coplanar Waveguide 2B1A	FALSE
651	Coated Coplanar Waveguide 1B	FALSE
652	Coated Coplanar Waveguide 2B	FALSE
711	Diff Surface Coplanar Waveguide 1B	TRUE
712	Diff Surface Coplanar Waveguide 2B	TRUE
722	Diff Embedded Coplanar Waveguide 1B1A	TRUE

723	Diff Embedded Coplanar Waveguide 2B1A	TRUE
751	Diff Coated Coplanar Waveguide 1B	TRUE
752	Diff Coated Coplanar Waveguide 2B	TRUE
811	Surface Coplanar Strips 1B	FALSE
812	Surface Coplanar Strips 2B	FALSE
822	Embedded Coplanar Strips 1B1A	FALSE
823	Embedded Coplanar Strips 2B1A	FALSE
851	Coated Coplanar Strips 1B	FALSE
852	Coated Coplanar Strips 2B	FALSE
911	Diff Surface Coplanar Strips 1B	TRUE
912	Diff Surface Coplanar Strips 2B	TRUE
922	Diff Embedded Coplanar Strips 1B1A	TRUE
923	Diff Embedded Coplanar Strips 2B1A	TRUE
951	Diff Coated Coplanar Strips 1B	TRUE
952	Diff Coated Coplanar Strips 2B	TRUE
1111	Edge-Coupled Surface Without Gnd 1B	TRUE
1112	Edge-Coupled Surface Without Gnd 2B	TRUE
1122	Edge-Coupled Embedded Without Gnd 1B1A	TRUE
1123	Edge-Coupled Embedded Without Gnd 2B1A	TRUE
1125	Edge-Coupled Embedded Without Gnd 1B2A	TRUE
1132	Broadside Stripline 2S	TRUE
1133	Broadside Stripline 3S	TRUE
1134	Broadside Stripline 1E2S	TRUE
1135	Broadside Stripline 1E3S	TRUE
1136	Broadside Without Gnd 2S	TRUE
1151	Edge-Coupled Coated Without Gnd 1B	TRUE
1152	Edge-Coupled Coated Without Gnd 2B	TRUE

Example Files and Output

In the same directory as this document should be an example input XML file called Test.xml and an example output debug file called XMLImportDebug.txt.

The final file that they generate called TestXML.cif is also included.

Please send any questions / feedback to PolarCare@polarinstruments.com