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Polar Instruments Ltd.
Garenne Park
Rue de la Cache
St. Sampson's
Guernsey
Channel Islands
GY2 4AF
England
http://www.polar.co.uk

Fax: +44 (0)1481 52476
Email: polar@itl.net

MAN 152-9702

CITS FOR WINDOWS OPERATOR MANUAL

CITS FOR WINDOWS
CONTROLLED IMPEDANCE TEST SYSTEM OPERATOR MANUAL

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EC Council Directive 89/336/EEC on the approximation of the laws of the Member States relating to electromagnetic compatibility.

EC Council Directive 73/23/EEC on the harmonisation of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits.

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

EN 50081-1:1992
EN 50082-1:1992
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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 setting corresponds with the local mains power supply. See the rear panel for line voltage settings.

To change the line voltage settings refer the instrument to a skilled electronics technician. Instructions for changing the line voltage settings are contained in the CITS Service Manual published by Polar Instruments.

CITS for WINDOWS OPERATION

> *This manual contains instructions and warnings which 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.*

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

If it is likely that the protection has been impaired the instrument 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 CITS 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	0 – 500Ω	
Impedance Tolerance Range	1 – 100%	
Measurement Accuracy	1% at 50Ω	
Vertical Display Ranges	1, 2, 5, 10, 20, 50Ω/division	
Horizontal Display Ranges	Automatically set by software	
Testable Trace Lengths		
Maximum	15 meters	
Minimum (using non-matched probe)	0.09 meters	
Minimum (using matched probe)	0.04 meters	
Horizontal Distance Units	Inches, feet, meters, millimeters	
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	
Series Loop Compensation	0 – 15Ω/meter	
Vp Compensation	(inches)	0.33 – 0.82
	(meters, millimeters, feet)	0.33 – 0.99

ENVIRONMENTAL OPERATING CONDITIONS

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

Altitude	Up to 2000m
Temperature	+5°C to +40°C ambient
Relative humidity	RH 80% maximum at 31°C — derate linearly to 50% at 40°C
Mains borne transients	As defined by Installation Category II (Overvoltage Category II) in IEC664
Pollution Degree	2 (IEC664)

Power Requirements

230V ± 10%, 115V ± 10% or 100V ± 10% at 50/60Hz, 20VA.

Physical characteristics (excluding accessories)

Temperature

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

Dimensions 443 mm (17.44 in.) wide
114 mm (4.48 in.) high
280 mm (11.02 in.) deep

Weight 5.0kg (11 lb.)

SYMBOLS


CAUTION No external voltage should be applied to these terminals.


CAUTION Static sensitive devices — observe static precautions. A wriststrap is provided with the CITS (connect the wriststrap to the stud on the CITS rear panel).

Note: The CITS contains static sensitive devices — observe static precautions at all times.

PERSONAL COMPUTER REQUIREMENTS

Computer	IBM PC AT or compatible
Processor	80386 or better
Operating system	MS-DOS 3.3 or later
	Microsoft Windows ® 3.1 or later running in 386 Enhanced Mode
System memory required	4Mb
Hard disk space required	1Mb
Video standard	VGA (640 x 480 min.)
Diskette drive	3½" High density – 1.44Mbyte
Mouse	Microsoft compatible
Printer port	1 x parallel printer port
Communication ports	1 available serial communication port required

ACCESSORIES

Standard Accessories

Probe Cable (x 2 for CITS200)	WMA258
IP-50 Microstrip Probe (50Ω)	
IPD100 Differential Probe	
Verification Test Coupon	MPCD950
Operator manual	MAN152
RS-232 interface cable ACC142	
Foot Switch	ACC124
Antistatic wristband	ACC175
Wristband ground cord ACC176	
Manufacturing data files diskette	FSW148

Optional Accessories

Instrument carrying case (ACC125)	ACC125
IP-75 Microstrip Probe (75Ω)	
IP-100 Microstrip Probe (100Ω)	
Coupon Holder	ACC153
CITS Service Manual	MAN143

GUIDE TO THE MANUAL

Note: Except where noted this manual applies to both CITS100 and CITS200.

INTRODUCTION	An overview of the Polar CITS100 and CITS200. A description of the principles of operation and connector and rear panels
INSTALLATION/SET UP	Connecting the instrument to a power supply, installation of software and preparation for use. Specifying the instrument type, PC communication ports, calibration type and passwords.
GETTING STARTED	Introduction to basic CITS operation using the supplied Verification Test Coupon.
OPERATION	Operation of the CITS100 and CITS200. Information about the different ways in which the facilities of the CITS100 and CITS200 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.

Operating the CITS100 and CITS200

The CITS software is designed for use within the Microsoft Windows environment. Familiarity with the Microsoft Windows environment (3.1 or later) is assumed.

For more information on basic Microsoft Windows operation consult the Microsoft Windows User Guide.

CITS100 and CITS200 functions are controlled by selecting the associated commands from pull-down menus or clicking the "short-cut" buttons with the mouse.

Selecting a command:

using the keyboard:

- activate the CITS menu bar by pressing the Alt key on the keyboard
- press the underlined letter in the menu name to display the command list
- press the underlined letter in the command name.

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 <Enter> key on the keyboard.

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

On-line help

The CITS software incorporates comprehensive on-line operating information. The Help command offers a rapid and convenient way to find information, such as how to perform tasks. Press the <F1> key to access the Help file.

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CITS MACRO REPORT GENERATOR

SECTION 1 — INTRODUCTION

INTRODUCTION TO CONTROLLED IMPEDANCE TESTING

The CITS100 and CITS200 Controlled Impedance Test Systems are designed to provide low cost automated measurements of the characteristic impedance of printed circuit boards.

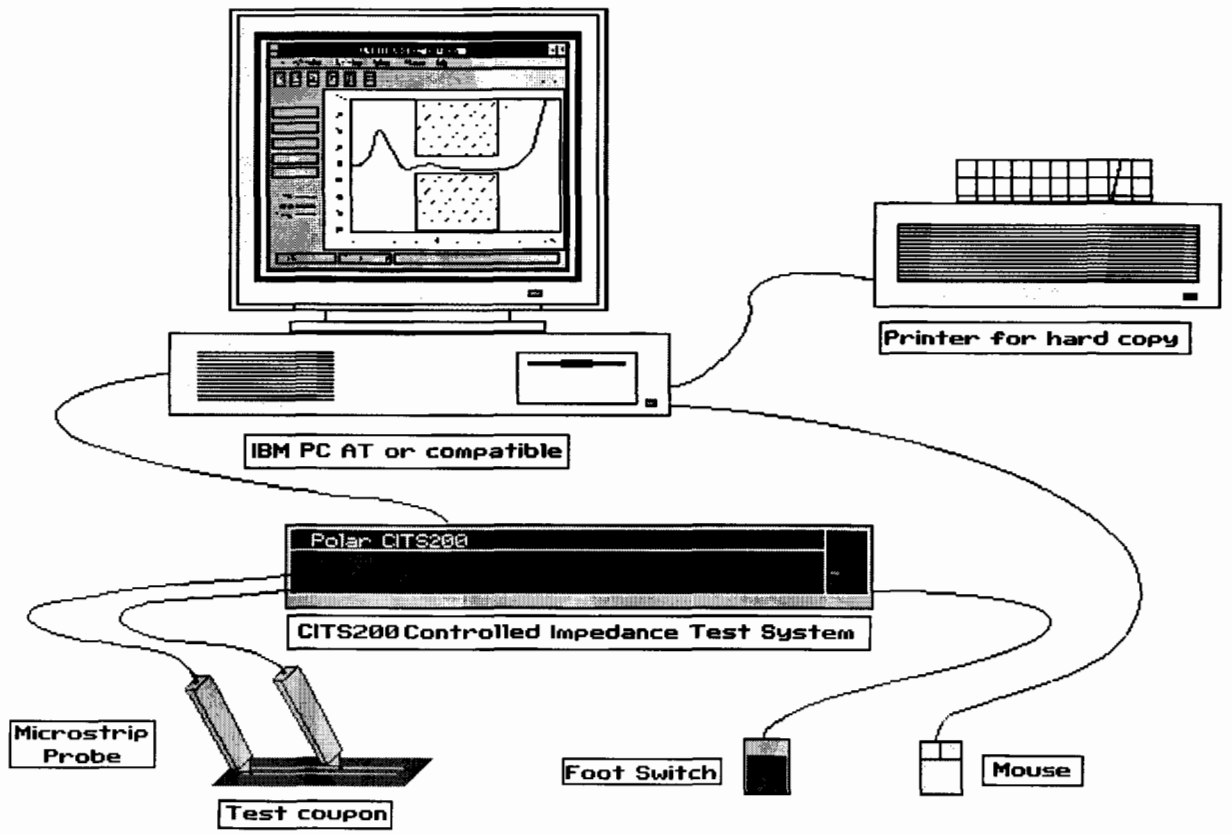


Figure 1-1 The CITS Controlled Impedance Test System

As shown in the diagram above the Controlled Impedance Test System comprises a measurement system controlled by software running within the Microsoft Windows environment on an IBM PC AT or compatible.

Connection between the CITS and boards under test is achieved using probe cables and Microstrip probes.

1-1 The CITS software

The CITS100 and CITS200 instruments are designed to facilitate rapid and convenient testing of controlled impedance printed circuit boards.

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

The CITS 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 CITS to allow the operator to perform hands-off testing.

The CITS200 incorporates facilities for differential impedance measurements.

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 using the integrated test file editor — most files will be created with just a few key strokes and mouse clicks.

Sequences of a number of test files may be generated by creating a *macro file* to provide for automated testing of boards with a number of different controlled impedance traces.

1-3 Data analysis

Test results are displayed as a graph of impedance against distance along a PCB track and a PASS or FAIL result is reported according to whether or not the trace remains within tolerance over the full length of the tested region. The average, standard deviation, minimum and maximum impedance values over the tested region are displayed on screen along with the waveform.

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.

1-4 CITS features

The CITS100 and CITS200 systems include the following features:

- Automatic instrument setup
- Linear display of impedance against distance
- Differential impedance measurement facility (CITS200 only)
- Rapid data logging of test results
- Microsoft Windows environment
- Mouse driven user interface for ease of use
- Pass/Fail testing of PCB tracks
- Disk storage of test results
- Hard copy of test & stored results
- Statistical analysis for process control
- Integrated test file editing
- Comprehensive on-line help
- Waveform overlay for rapid comparison of results
- Dedicated Microstrip probes for easy connection to the board under test

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 increasingly need to be considered as transmission lines.

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 performance are the distributed series inductance and parallel capacitance of the conductors.

These parameters give rise to the characteristic impedance Z_o.

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

where L is in henrys per unit length, C is in farads per unit length and Z_o in ohms.

Consider an electrical signal travelling through a conductor such as a PCB track.

When the signal encounters a change of impedance, i.e. 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 which 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 CITS100 and CITS200 Controlled Impedance Test Systems make 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 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.

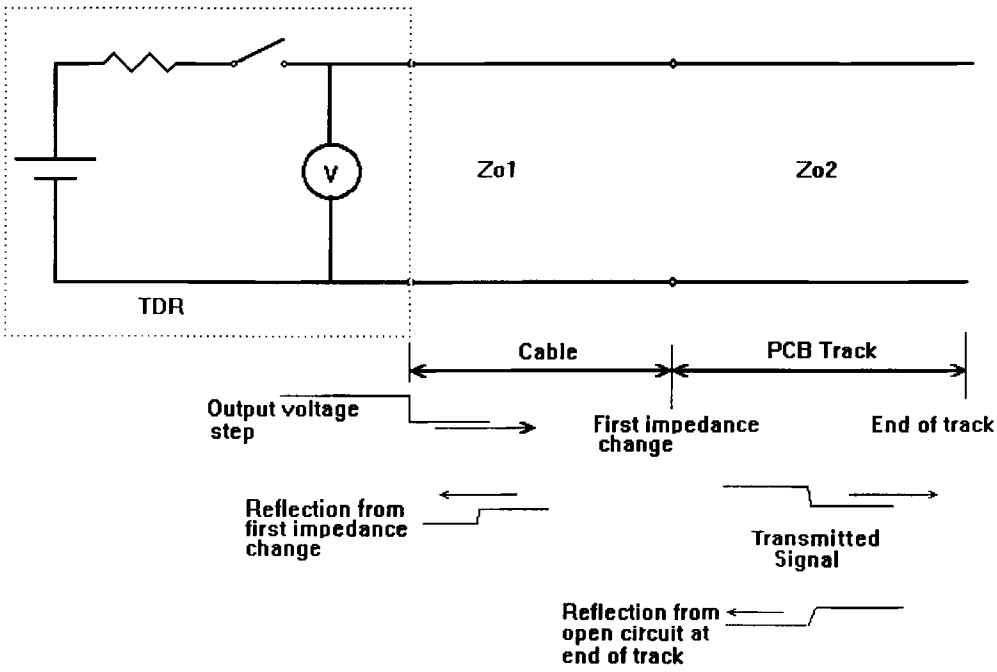


Figure 1-3 Simplified TDR-cable system equivalent circuit

The diagram below shows a typical TDR waveform.

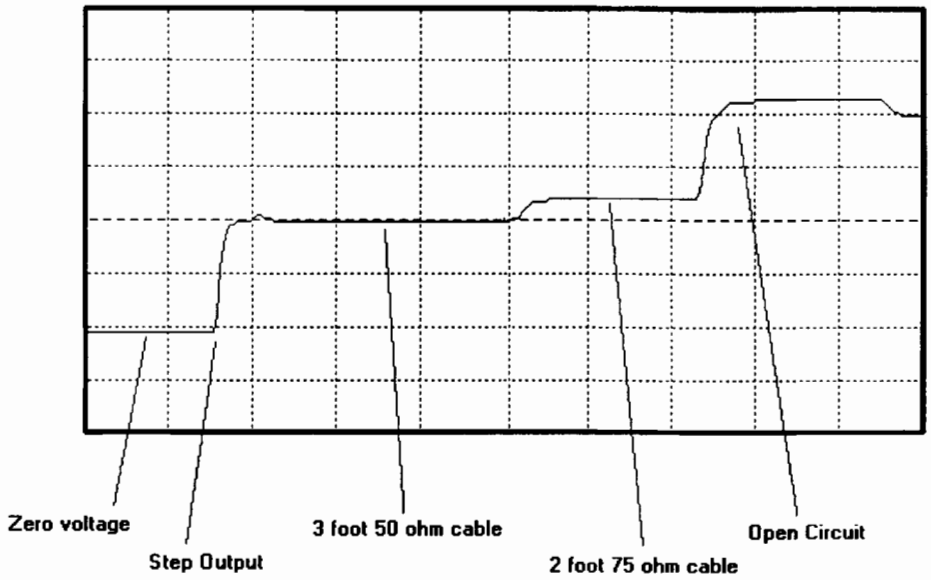


Figure 1-4 TDR trace showing voltage steps at impedance discontinuities

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

This is shown, for example, in the diagram above 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.

The 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 CITS measurements

The CITS 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*.

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 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 CITS200 includes all the features and measurement facilities of the CITS100 as well as the facility to make *differential* impedance measurements in which the impedance between conductors is tested as well as the impedance between conductors and ground.

SECTION 2 — INSTALLATION AND SET UP

SETTING UP THE CITS SYSTEM

System requirements

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

Computer	IBM PC AT or compatible
Processor	80386 or better
Operating system	PC-DOS/MS-DOS version 3.3 or later Microsoft Windows 3.1 or later
System memory required	4MB
Hard disk space required	1MB
Video standard	VGA (640 x 480 minimum)
Diskette drive	3½" High density 1.44MB
Mouse	Microsoft compatible
Printer port	1 x parallel printer port
Serial Communication ports	1 x available serial communication port 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.

The package should contain:

- CITS100/200
- Probe cable (2 probe cables for CITS200)
- IP50 Microstrip probe (2 IP50 Microstrip probes for CITS200)
- Verification test coupon
- Power cord
- RS 232 interface cable
- Foot pedal
- Accessory pouch
- Operator manual
- Program installation diskette

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 Connecting to a power supply

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

If the rating on the label is not suitable for the local power supply refer the instrument to a skilled electronics technician. Instructions for changing the line voltage settings are contained in the T1000A Service Manual.

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 color 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.

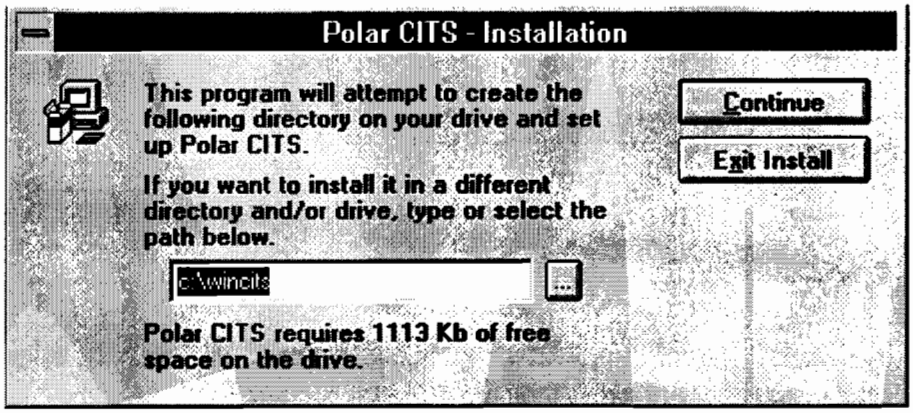
2-3 *Installing the CITS software*

Users are recommended to make working copies of the CITS installation diskettes before installation and store the master diskettes in a safe place.

Backing up the installation diskettes

Use the PC/MS-DOS **diskcopy** or the Windows File Manager **Copy Disk...** command to make working copies of the installation diskettes. See the PC/MS-DOS operating system manual or the Microsoft Windows User Guide for details.

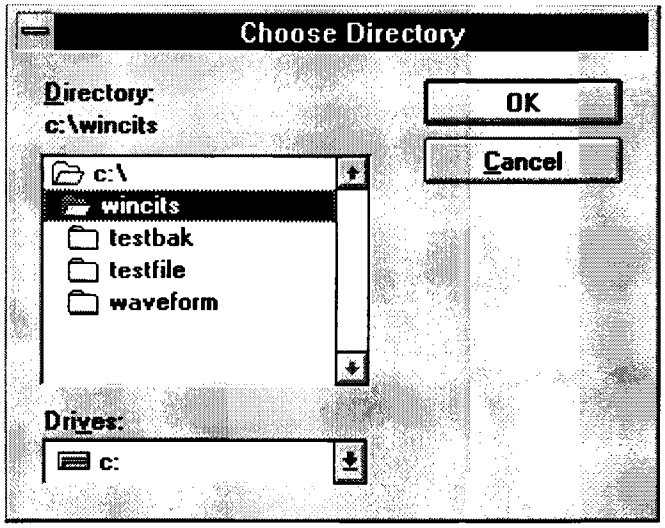
- If Microsoft Windows is not already running start Windows by typing **WIN** at the C:\> prompt.
- Insert the working diskette in the diskette drive. From the Program Manager's or File Manager's File menu select **Run...**, type **A:Install** and press <**Enter**>. (Drive A: is assumed – if the drive letter is not A: supply the appropriate drive letter, e.g. drive B:, and press <**Enter**>.)
- The CITS Installation program proposes the drive and directory of the hard disk onto which the CITS program is to be installed (by default **c:\wincits**).



Press <**Continue**> to accept the proposed destination drive and directory or type the name of an alternative drive and directory.
To choose an existing drive and directory press the Choose Directory button:

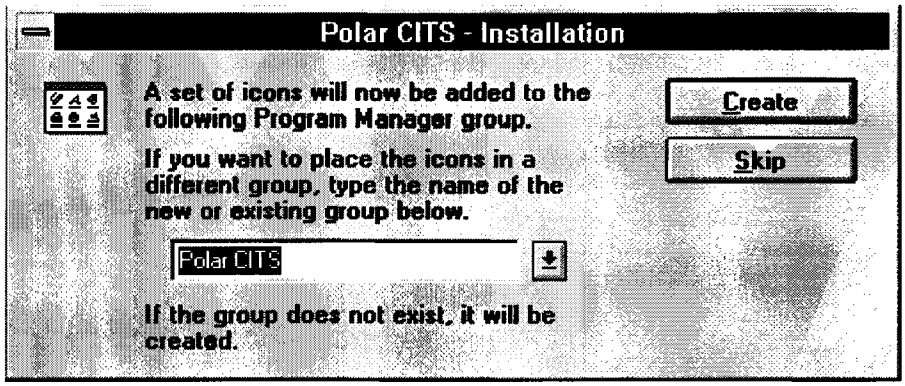
[...] the Choose Directory button

Select the destination directory from the Directory box and press **OK**



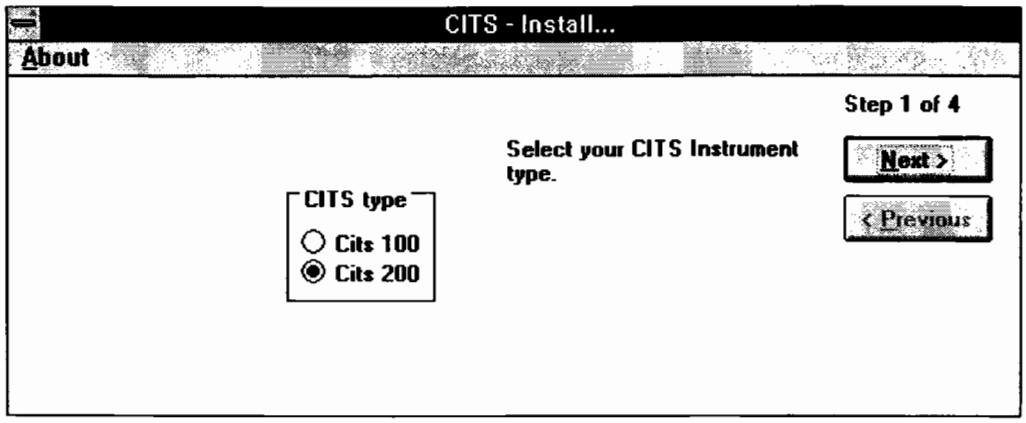
Press <**Continue**>.

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

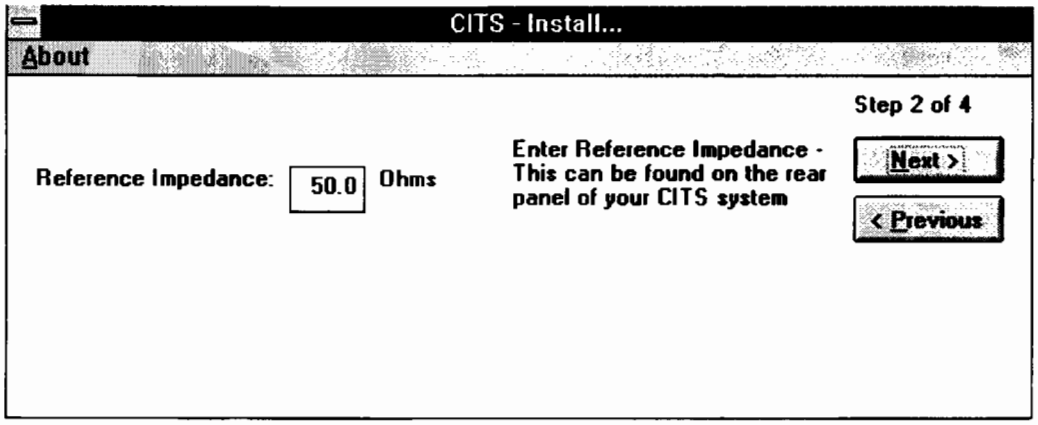


Press <**Enter**> to accept the proposed name, or type in a different name in the name box or select an existing group (press the drop-down list box arrow to display the current group list).

- The Installation program will prompt for the CITS instrument type (CITS100 or CITS200) – click on the appropriate instrument type and click on <**Next**>



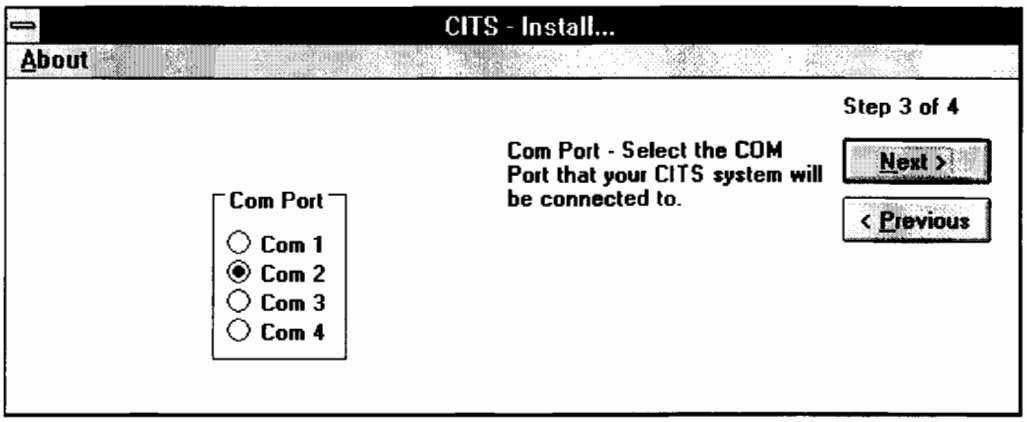
- The Installation program will next prompt for the Reference Impedance of the CITS. This is recorded on a label on the rear panel of the instrument.



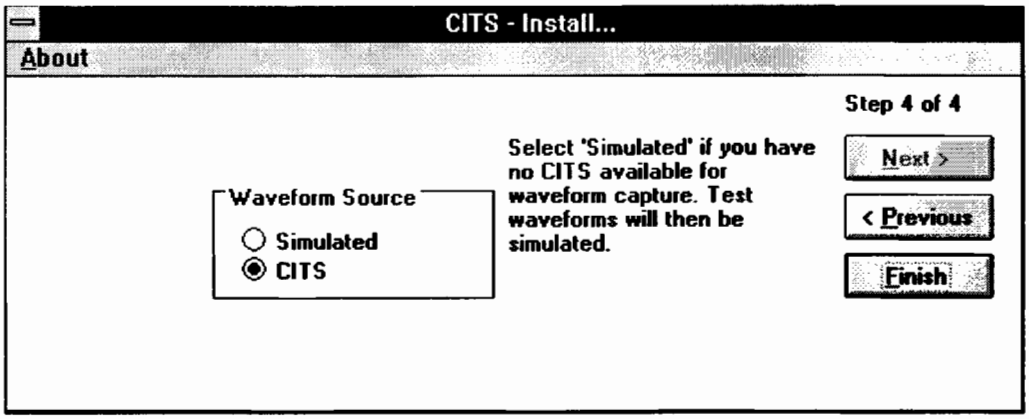
- *This value is unique to each CITS – enter the value exactly as shown on the rear panel of the instrument.*

- If no instrument is available at the time the software is installed, enter the default value **50.00**. *If an instrument is later connected to the PC use System Config (Options menu) to enter its Reference Impedance.* Press **<Next>**.

- The Installation program will next prompt for the host computer's Serial Communications Port to be used when transferring commands and data – select the appropriate port and press **<Next>** to confirm and proceed with installation.



- The Installation program will next prompt for the Waveform Source.



The CITS software may be operated in either CITS mode (the normal operating mode) or Simulated mode for use when no instrument is connected (in Simulated mode the software simulates the operation of a CITS instrument). Select the desired option and press **Finish**.

- (If any of the values are incorrect or need to be changed, press the **Previous** key to step back through the installation and repeat the installation steps as necessary.)

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

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

2-4 Connecting the computer to the CITS

CITS commands and data are transferred between the CITS and the host computer via a serial communication (RS 232) link using the supplied cable.

Ensure the host computer and the CITS are both powered down before connecting cables.

Connect the cable between the host computer's serial port and the connector on the rear of the CITS. Ensure the connections are secure.

If a serial mouse is connected to the PC, the mouse will normally be connected to the host computer's serial port COM1 or COM2 – connect the CITS serial cable to an available port (using a 9 to 25 pin adaptor if necessary).

Plug the Foot Switch ¼" jack plug into its socket on the rear of the CITS.

Connect the supplied probe cable to the front panel SMA connector of the CITS and connect the Microstrip probe to the probe cable.

If hard copies of waveforms and data are required, connect the printer as LPT1 using a standard 25 way D to Centronics connector printer lead.

Power up the CITS and the host computer.

2-5 *Running the program*

To start the program, double click the CITS icon with the mouse or highlight the icon and press <**Enter**>.

After a few seconds the main CITS display will appear.

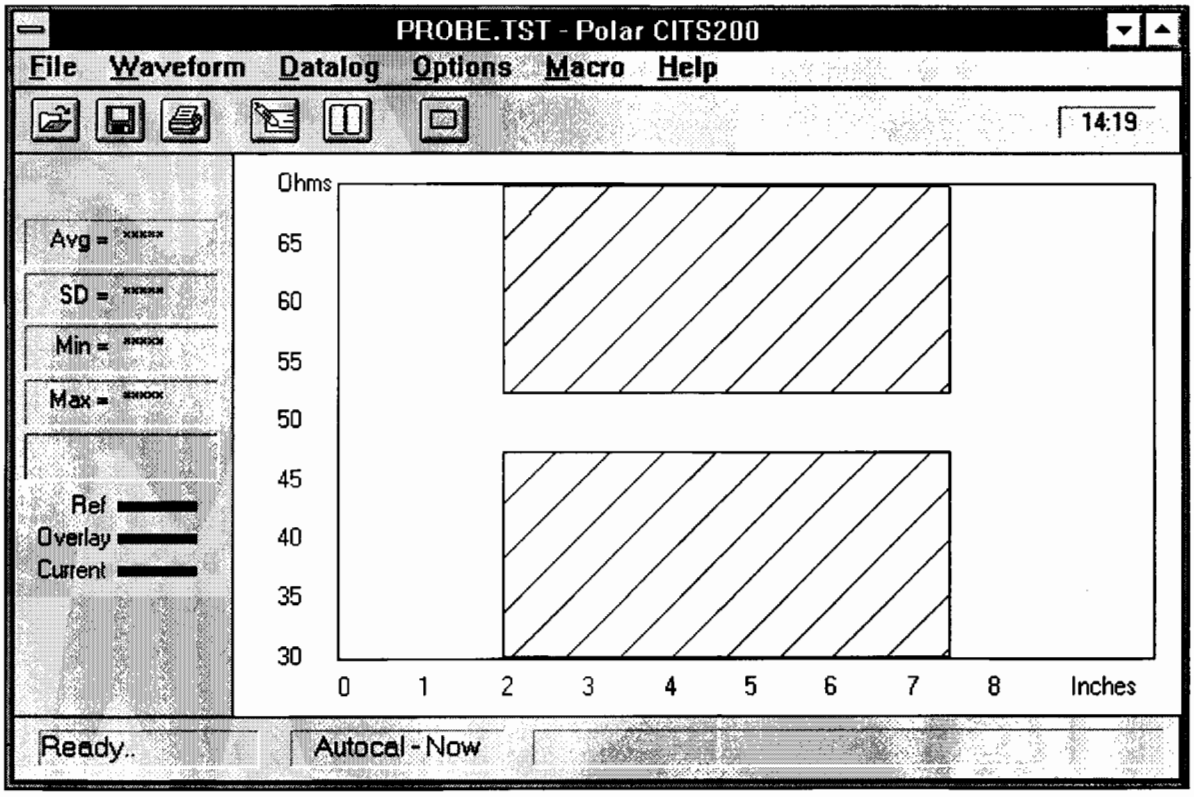


Figure 2-1 The CITS200 Main screen

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 slightly from the system in use.

2-6 *System configuration*

The System Configuration dialog allows the operator to specify the CITS type, CITS100 or CITS200, reference impedance and calibration mode and add a user name and password. Specifying a password will prevent unauthorised users from modifying the files which contain the test parameters.

The dialog also enables the operator to specify which of the serial communications ports of the host computer will be used by the CITS.

From the **Options** menu select **Config...** to display the **System Configuration** dialog:

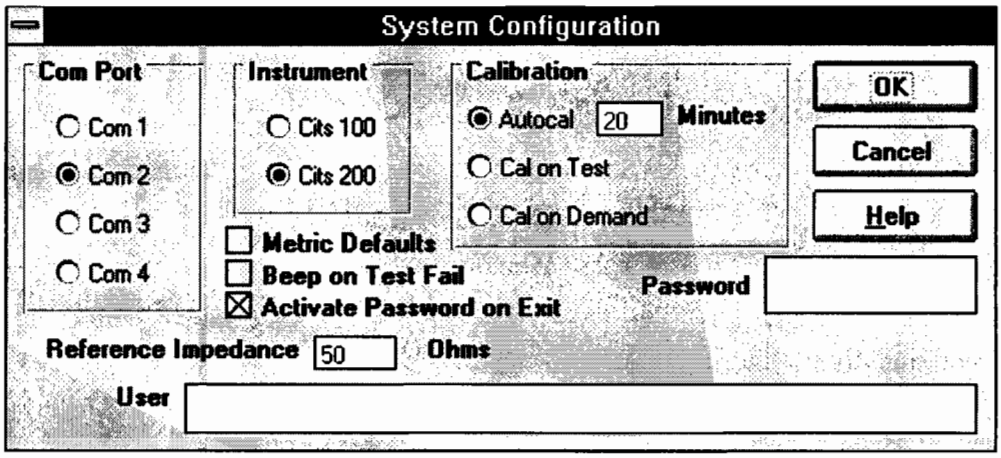


Figure 2-2 The System Configuration menu

Specifying a user name

The **User** field is provided to allow users to add their company name to printouts. To modify the name, use the <**Tab**> key to activate the **User** field, delete the existing name (if any) and enter the new name. The name will be included in subsequent hardcopies of test results.

Specifying a password

Specifying a password is optional; if a 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.

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 a the CITS displays a confirmation box. The CITS requests that password be retyped in the confirmation box to verify the original.

Activate Password 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.

Specifying the serial communications port

Commands and data are transferred over the RS232 serial communications link via one of the host computer's serial communications ports.

The **Com Port** field allows the serial communications port through which the PC communicates with the CITS to be specified or changed.

Typically, if a serial mouse is in use, it will be connected to serial communications port COM 1. The CITS must therefore be connected to a different port.

The system displays the current communication port; specify a new communication port if necessary — the system will enable the selected port.

Other serial communication parameters are set automatically by the CITS system.

Specifying the Instrument type

The current instrument type must be selected here. Setting the instrument type to CITS200 will enable differential test options.

Note: Differential testing is only possible with the CITS200.

Reference Impedance

This must be set to the reference impedance value written on the rear panel of the CITS instrument.

Beep on Test Fail

If this box is checked the system produces an audible warning when a test fails.

Metric Defaults

When this box is checked the Defaults button in the Test File Editor is made to generate distances in metric units.

Calibration

The **Calibration** parameter specifies when the CITS performs a self-calibration.

Three modes of **Calibration** are available:-

Autocal

In Autocal mode the CITS self-calibrates automatically at a given interval in time. This may be specified from 1 to 60 minutes (the default is 20 minutes). This is the normal mode of operation.

Cal On Test

In Cal on Test mode the CITS self-calibrates before every test. This gives the best possible accuracy but slows down operation.

Cal On Demand

If Cal on Demand mode is selected the Calibrate Now command is added to the Options menu. Self-calibration takes place only when the user chooses Calibrate Now from the Options menu.

Press the **Help** button to obtain information on each of these options.

To exit the **System Configuration** menu without recording any changes press <**Esc**> or click the **Cancel** button.

SECTION 3 — GETTING STARTED

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

BASIC CITS OPERATION

The section discusses the basic operation of the CITS program using the verification test coupon included with the CITS.

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

This section assumes that the installation/setup procedure has been successfully completed.

Power up the CITS and PC, start Microsoft Windows and double-click the CITS icon to start the CITS program. The CITS main screen is shown in Figure 3-1.

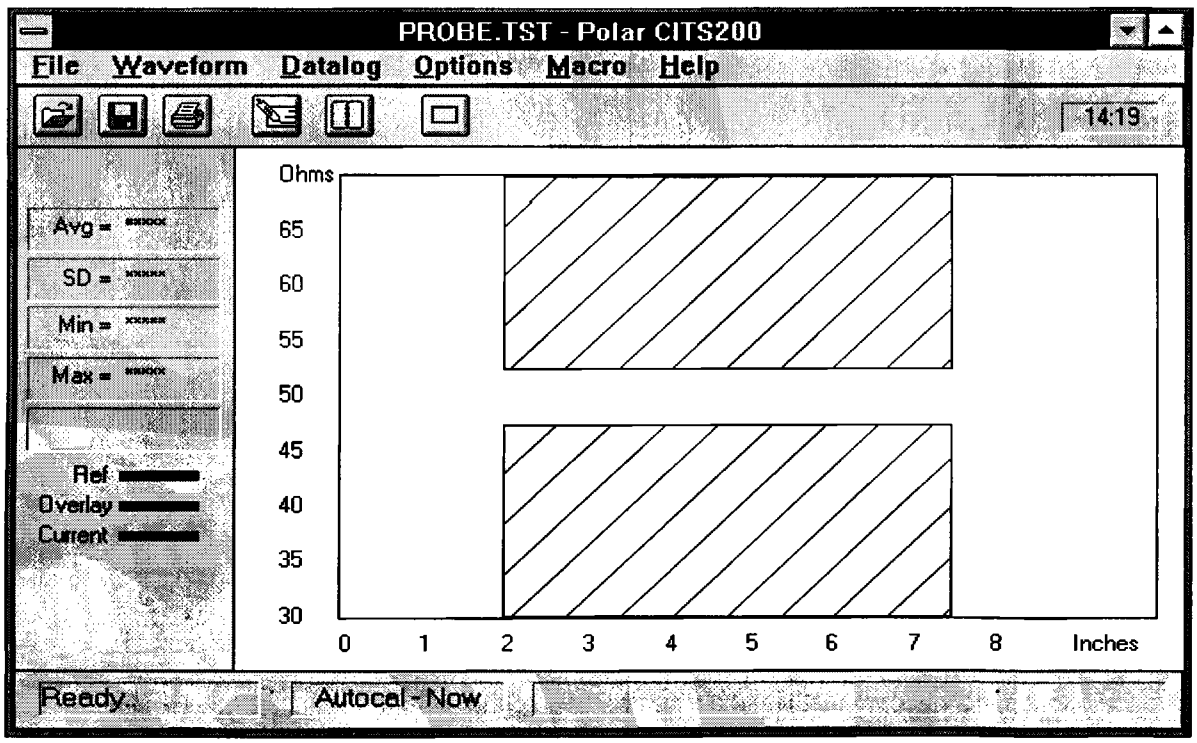


Figure 3-1 The CITS main screen

The CITS window may be increased in size by dragging the window borders with the mouse.

Press the Maximise button to increase the display size to full screen.

3-1 Testing the verification coupon

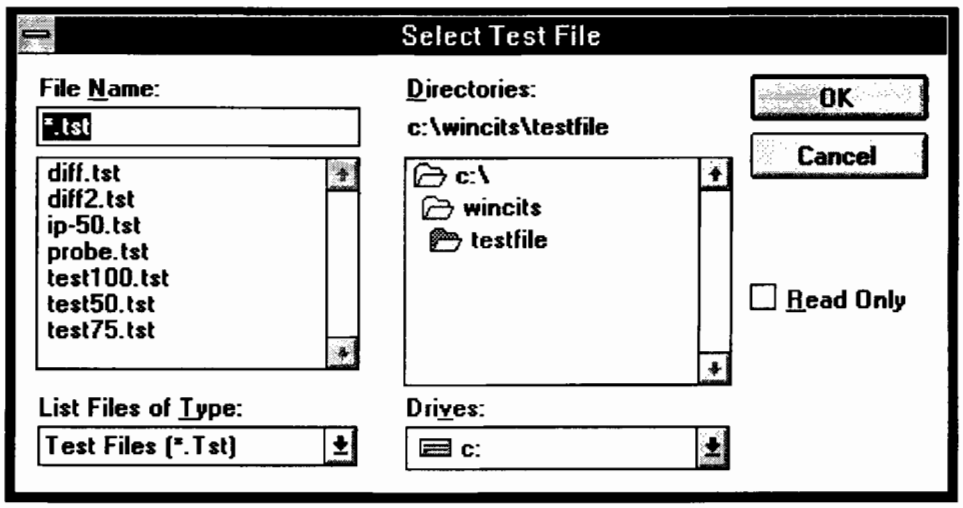
The coupon comprises three PCB traces of nominal impedance, 50Ω, 75Ω and 100Ω; the CITS sotware includes three test files associated with the coupon. The actual values measured at the factory are recorded on the test coupon.

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

Selecting a test file

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

The file **Open...** button



Figue 3-2 The Select Test File dialog

In this example we will test the coupon's 50Ω trace using the TEST50.TST file.

Select the file by either clicking the mouse on its name in the file list window or stepping the selection down to it with the cursor direction keys. Click on **OK** to select the file.

The CITS loads the selected test file and displays the impedance and distance scales and a cross hatched area indicating the region over which impedance will be tested — Figure 3-3. The impedance scale indicates the nominal impedance (in this case 50Ω) and acceptable impedance range (45 – 55Ω).

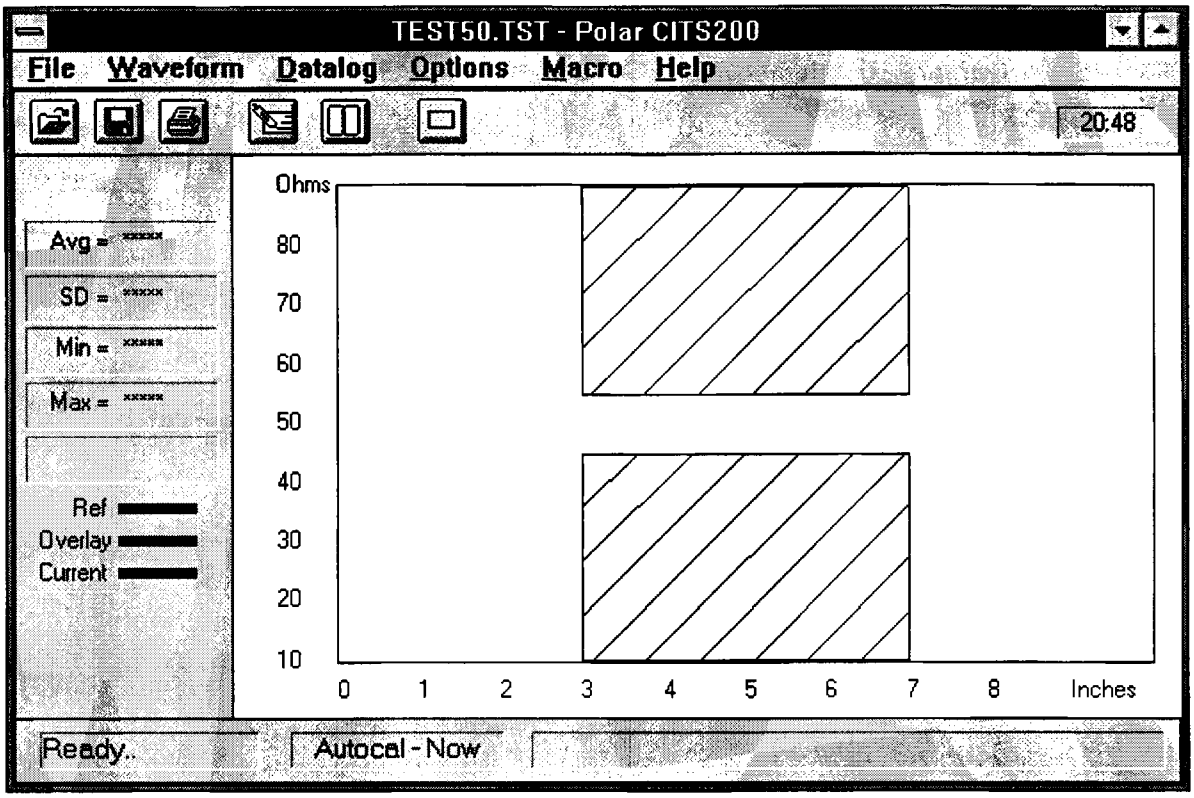


Figure 3-3 The CITS test window

Testing the coupon

Note: *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.*

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 CITS **Test** button

The system will take a few seconds to set up the instrument for testing and will graph the impedance of the 50Ω trace.
The CITS displays the trace's impedance against the test program limits
— Figure 3-4.

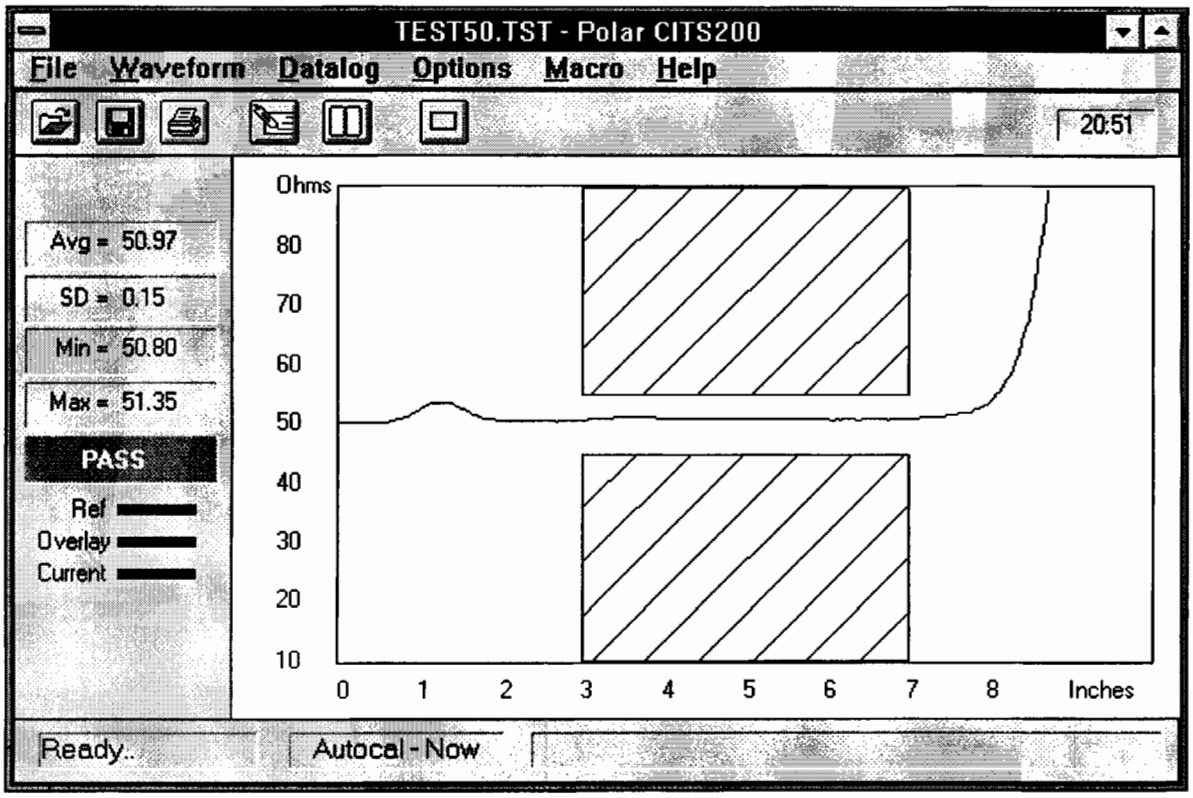


Figure 3-4 Graph of 50Ω impedance within limits

The waveform in Figure 3-4 remained between the crosshatched area over the whole of the tested region so the CITS recorded a **PASS**.

3-2 Displaying the impedance statistics

The CITS includes the PASS/FAIL result for the test and provides a display of the average, standard deviation, minimum and maximum impedances over the tested area in the associated boxes on screen along with the impedance waveform.

If the displayed waveform extends into the crosshatched area the CITS records a **FAIL** — see Figure 3-5.

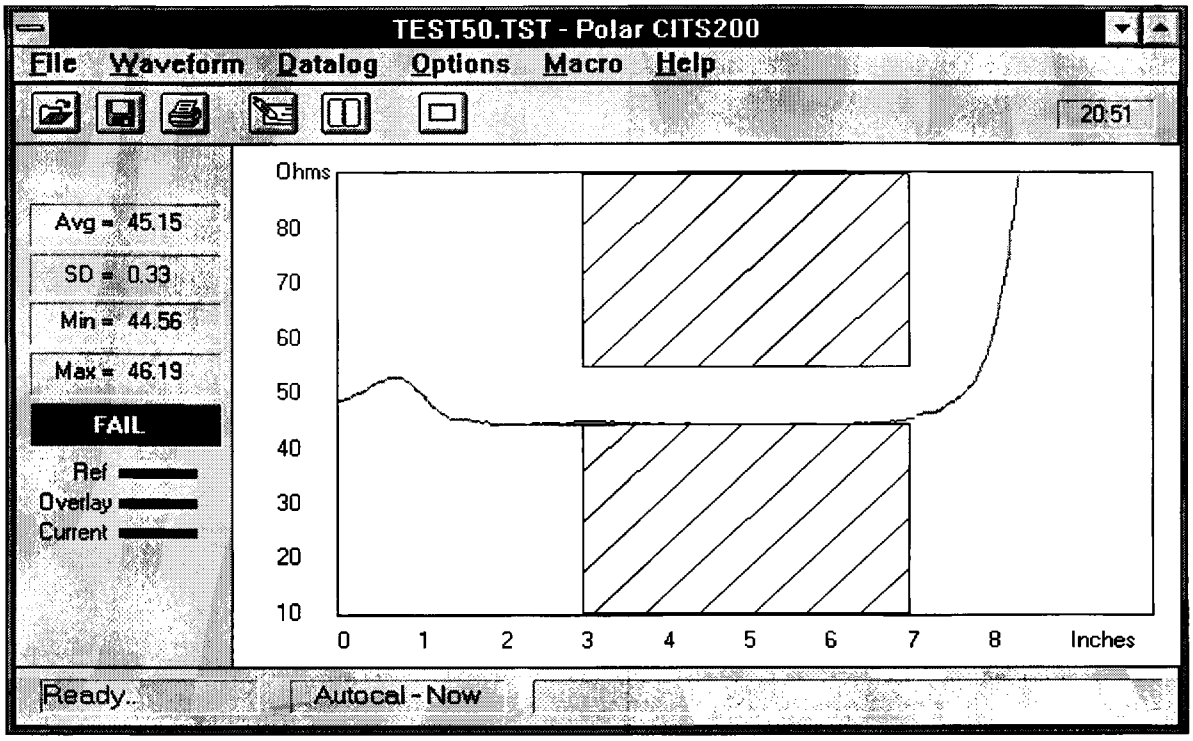


Figure 3-5 Graph of 50Ω impedance outside limits

(If the CITS recorded a **FAIL** check for correct probe/coupon polarity and good contact between the Microstrip probe and the 50Ω trace on the coupon and try again.)

Repeat the procedure for the 75Ω and 100Ω nominal impedance traces on the verification test coupon using the TEST75.TST and TEST100.TST files respectively.

3-3 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

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

USING THE CITS FOR WINDOWS PROGRAM

Double clicking the CITS icon starts the CITS FOR WINDOWS program.

When the CITS program runs, the main CITS screen is displayed loaded with the last test file used.

Figure 4-1 shows the CITS main screen

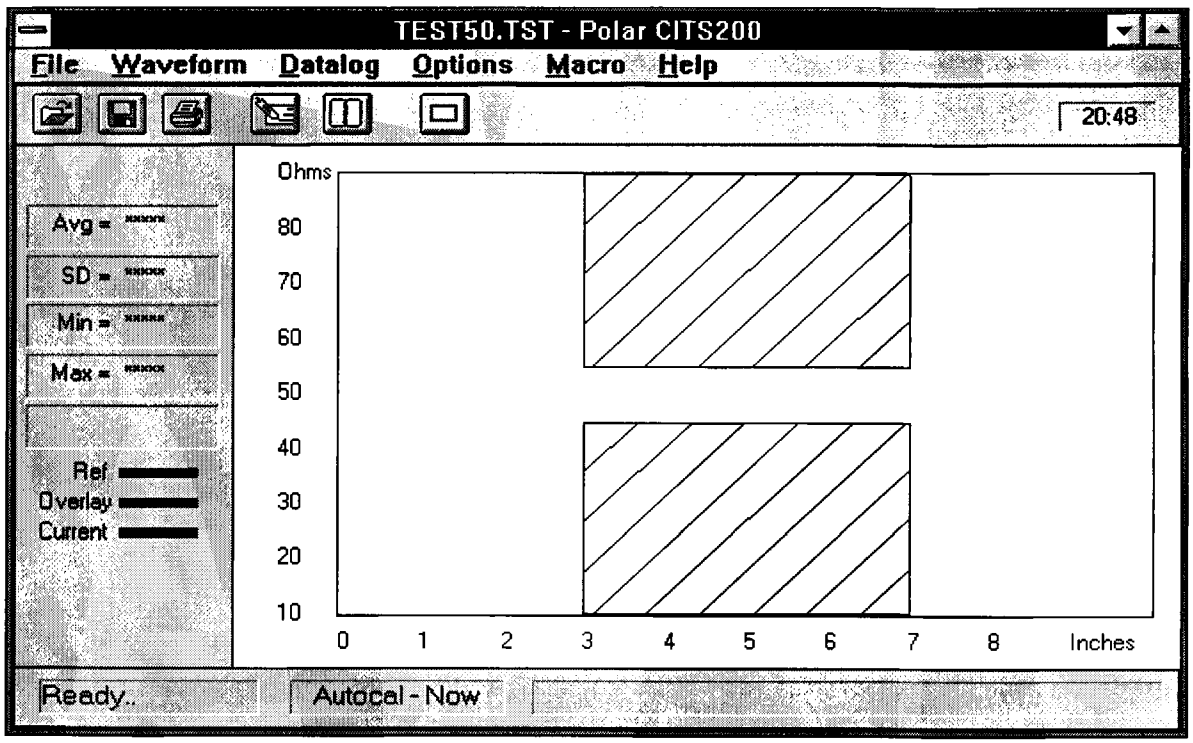


Figure 4-1 The CITS main screen

4-1 The CITS screen

The CITS screen comprises five sections:

- the menu bar
- the tool bar

- the main test window
- the statistics/results area
- the status bar

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

4-2 The CITS menu bar

All CITS commands are available from pull-down menus; commands can be accessed via the keyboard or mouse (see GUIDE TO THE MANUAL).

The File menu

The **File** menu provides the commands for working with test files — the user is able to:

- create new test files
- open, save and edit existing files
- execute tests using the selected file
- exit from the CITS program

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

The Waveform menu

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

- save the current waveform to disk for later viewing
- view recorded waveforms
- save the current waveform as the reference waveform for a test file — the waveform is then displayed whenever the test file is selected

The Datalog menu

The **Datalog** menu allows test data to be automatically logged to a text file for archiving and subsequent analysis. The log file can be printed out or imported into a spreadsheet.

Automatic data logging can be toggled on or off via the **Autolog** command (**Autolog** is ON by default).

Viewing logged data

Test data is added to the log file as each test is logged. The **View Log** command enables the Data Log Window which displays the entries in the log file. To view data as it is being logged select **View Log** in the **Datalog** menu.

The log window may be kept in constant view by selecting **Always on Top** from the **Datalog** menu.

The Options menu

Users can change operating conditions during normal CITS operation via the **Options** menu:

- Clear the screen of the current waveform and data.
- Overlay Multiple Waveforms — allowing comparison of a sequence of test results.

- Change the test window screen colors.
- Specify the host computer's serial communications port.
- Specify the instrument type — setting this to CITS200 will enable differential test options
- Specify the Reference Impedance — this must be set to the calibration constant value written on the CITS rear panel
- Set the calibration mode — the CITS can calibrate automatically at a given time interval, calibrate before every test for best possible accuracy or calibrate only when the user chooses the Calibrate Now command.
- Display Delta Time cursors — the Delta Time cursors may be used to measure propagation delay times. The CITS calculates the time interval between the two cursors based on the setting of Vp (velocity of propagation) in the current test file — see Section 5-3.

The Macro menu

The Macro menu allows the user to create and modify Test File Macros — lists of test files which may be cycled through in sequence automatically or manually selected.

When a macro file is loaded the CITS displays a list of the individual test files in the sequence. The operator can select test files from the list using the mouse or keyboard arrow keys or use the CITS foot pedal to advance through the list and perform each test in the sequence without the use of mouse or keyboard operations.

If the **Autoload Next** command in the **Macro** menu is selected, as each test is completed the next test file in the sequence is automatically loaded. The operator advances to the next test in the list with the mouse or the arrow keys on the keyboard.

Autoload Next is turned on by default. If **Autoload Next** is turned off the CITS will not automatically sequence through the tests. Steps in the sequence must be manually selected then run.

Test results are displayed next to each test file as testing progresses.

The Help menu

The Help menu includes concise explanations and instructions for every CITS operation — press the F1 function key to access the on-line help from anywhere in the program.

4-3 The CITS main tool bar

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

File Open... — press this button to display the **Select Test File** dialog box and choose a test file.



File Save — save the current test file.



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



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



Edit Test File — open the test file editor dialog box to edit the current test file.



Clear — Clear the test window of waveform and statistical data.

4-4 The statistics/results area

The CITS displays the PASS/FAIL result of a test and the statistical data over the tested region of the displayed waveform in the statistics/results area.

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

Four values are displayed:

- Average
- Standard deviation
- Minimum
- Maximum

4-5 The Status bar

The CITS status bar displays activity and status information and messages to assist the operator.



Figure 4-2 The CITS status bar

The status bar comprises three sections:

- Current activity — the CITS reports its current activity, Ready... (awaiting instructions), Calibrating..., Setting up..., Testing..., etc.
- Calibration mode — indicates the currently selected Calibration mode (Cal on demand — manual calibration, Autocal — timed calibration or Cal on Test — calibration before each test is executed).
- Operator Message — special instructions for testing, etc.

4-6 Testing printed circuit boards

The procedure for testing printed circuit boards is similar to that described for the verification test coupon in the previous section:

- Select a test file if one exists (or create a new file and define the board test parameters — see Section 5 — Editing Test Files).
- Connect the Microstrip probe to the board terminals or connections
- Execute the test via the **File** menu or click the **Test** button.
- Supply board details for data logging in the Board Information dialog box.
- For convenience, users are recommended to use the Foot Switch to operate the CITS in a "hands-free" mode. Using the Foot Switch allows the operator to hold the probe in contact with the board under test with both hands.

Selecting a test file

Prior to testing a board or batch of boards a test file containing test parameters associated with the board type must be selected (or created if none exists). See Section 5 — Test File Editor for details of creating, modifying and saving test files.

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

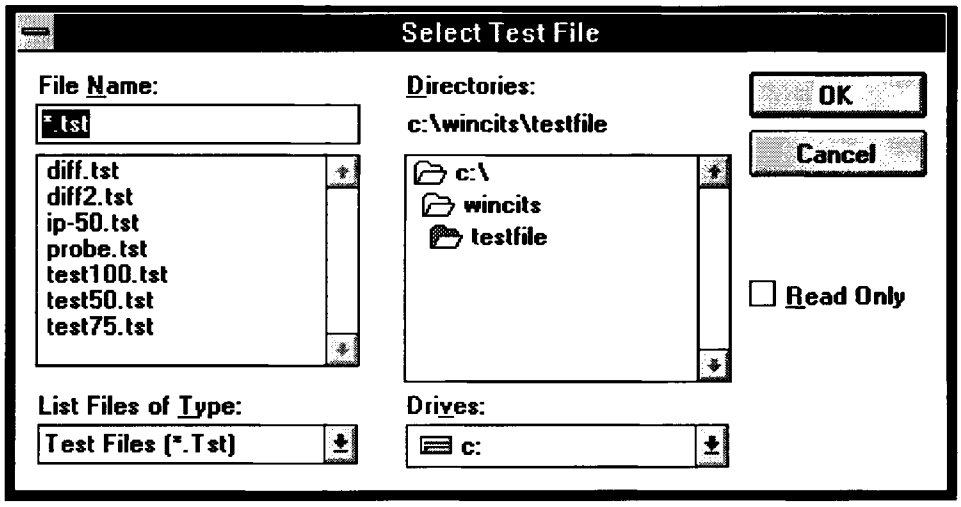


Figure 4-3 Selecting a test file

The **Select Test File** dialog opens with the list of **.tst** files in the current directory displayed. (Test files may also be selected from the recently used file list from the **File** menu.)
Select the board test file by clicking the file name with the mouse (or press the <**Tab**> key to move into the file list field and use the cursor keys to highlight the test file) — press **OK** to load the file.

The CITS displays the name of the selected file in the Title Bar and the test file's impedance and distance scales in the test window.

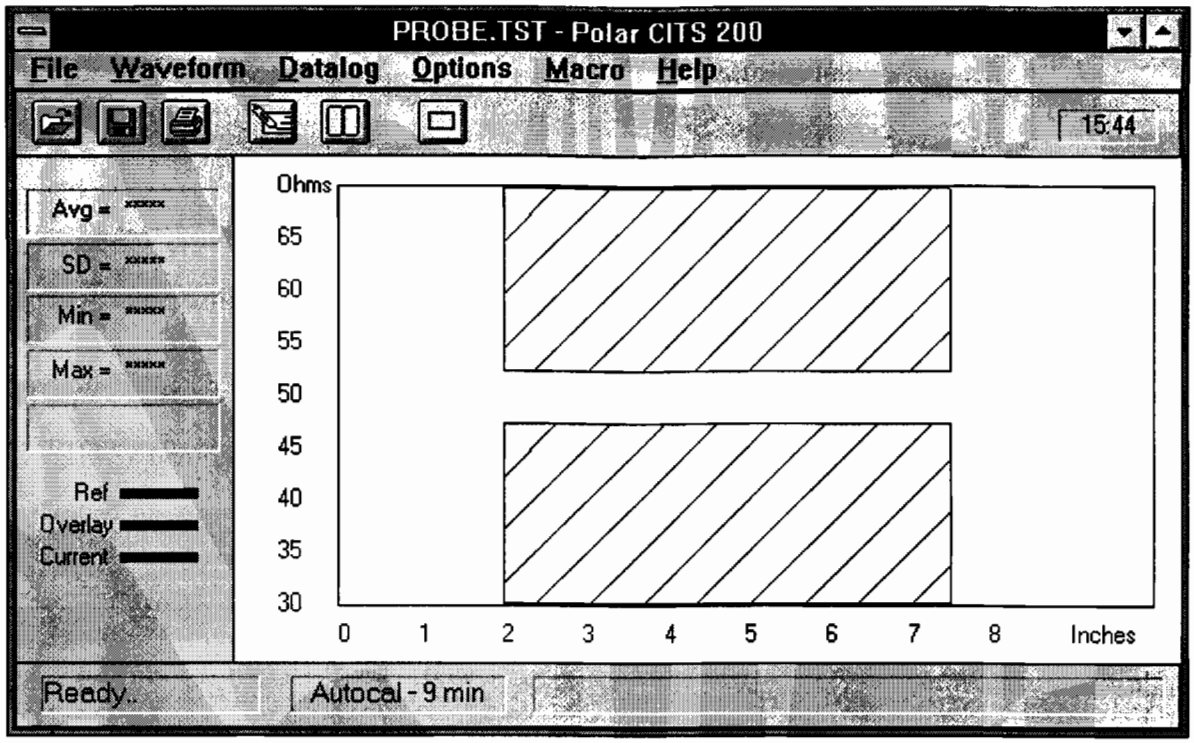


Figure 4-4 CITS screen with test file loaded

Executing the Test

Most board testing will be performed with Microstrip probes. Using Microstrip probes will minimise 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 CITS and the PCB track. The CITS output impedance is rated at 50Ω so as far as possible use cabling and connectors from the CITS to the PCB track with 50Ω characteristic impedance.

For more information and hints on testing PCBs see the notes at the end of this section.

Locate the Microstrip Probe in position on the circuit board under test.
Select the **Execute Test** function (using the Foot Switch will probably be found most convenient).

When the test screen is displayed the limits of tolerance defined in the test file for the tested portion of the track will be indicated by the cross-hatched areas (at installation the CITS test window is set to its default — red cross-hatched areas on a black background — see System Configuration for information on changing screen colors).

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

If successful the CITS records a **PASS** — Figure 4-5.

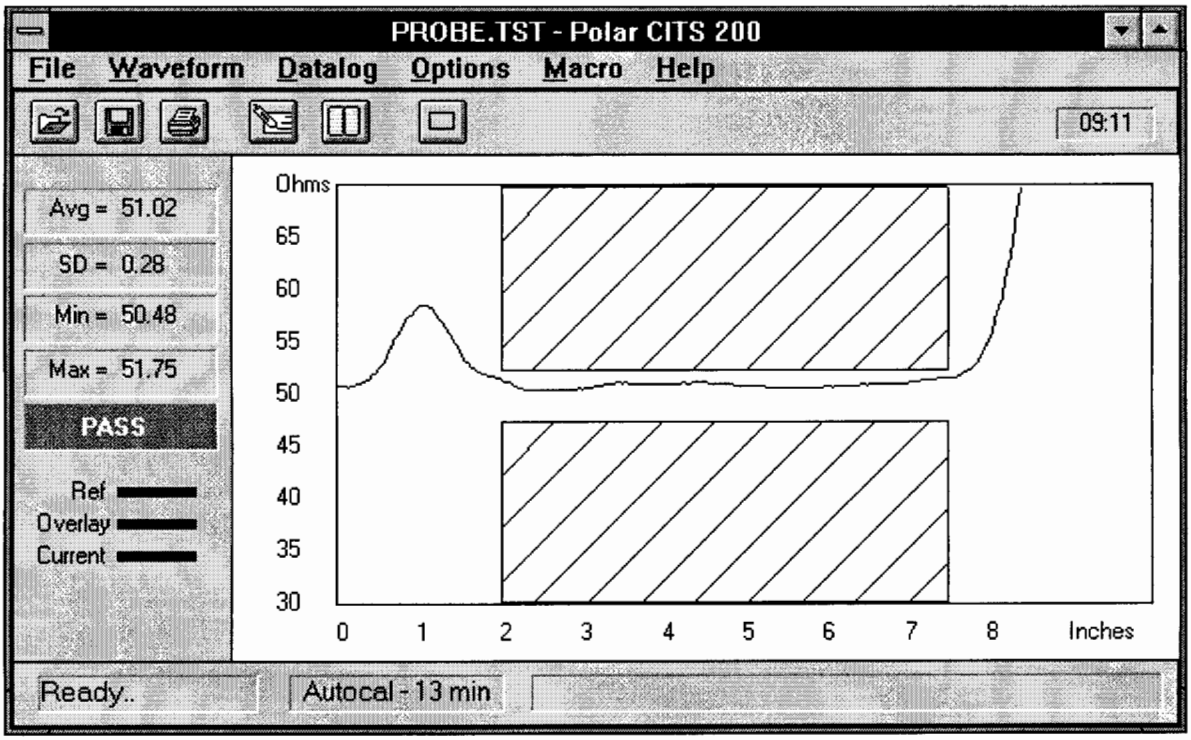


Figure 4-5 PASS screen

As each test is completed the Board Information box is displayed so that test results may be logged to a *log file* — see *Logging Test Data*.

4-7 Logging Test Data

The **Datalog** function allows the operator to test and record the results of a series of tests on a board or batch of boards. The CITS creates a log file (a text file containing test data) for archiving and subsequent analysis.

The log file is stored in comma delimited form — suitable for import into most spreadsheet programs and can be printed out for hard copy.

The log file is stored under the same name as the test file but with the **.wlg** file extension. (If data logging is performed while running a macro the log file is stored under the same name as the macro file but with the **.csv** extension — see Section 5-7 — Test File Macros).

To enable logging select the **Datalog** menu and ensure **Autolog** is turned on. **Autolog** is turned on by default.

Test the board using the associated test file; when the test is complete, the **Board Information** dialog box is displayed — Figure 4-6. Enter the details for the board under test — serial number, date code and operator name and press **OK**.

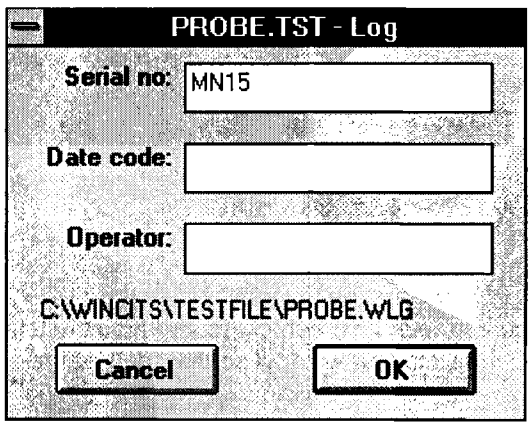


Figure 4-6 Datalog information dialog box

Each time data is logged the user is asked to confirm the board information.

Note: If a numeric value is entered into the **Serial no** field (e.g. SN001), each time test results are added to the Log the numeric value will be automatically incremented by one. This value may be edited by the operator if necessary.

Press **Cancel** if the current results are not to be logged (in the case of invalid data due to bad probe/board connection, etc.).

Viewing Log Data

To view data as it is being logged select **View Log** in the **Datalog** menu to enable the Data Log window — Figure 4-7.

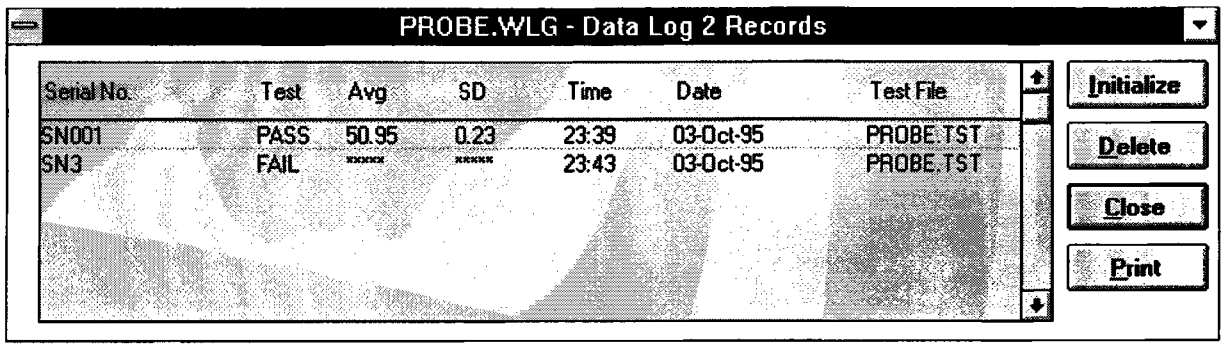


Figure 4-7 The Data Log Window

The Data Log window

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

Each entry comprises a subset of the logged data — board details, test date and time and the result of each test are included along with the average and standard deviation statistics for the board.

(If the Data Log window obscures the test screen press and hold the left mouse button down in the Data Log window title bar and drag the Data Log window so that the test window is visible.)

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.

Initialising the log file

Press the **Initialize** button to clear all test data from the log file.

Caution: Selecting **Initialize** *will clear all entries in the log.*

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. *The record will be permanently deleted.*

Printing logged data

To print logged data press the **Print** button — the Print... dialog box is displayed:

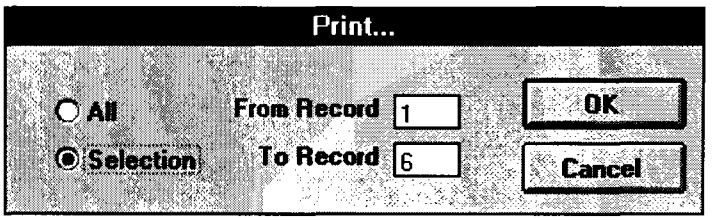


Figure 4-8 Selecting logged records for printing

Click the **All** option button to print the complete log.

To select a range of records for printing click the **Selection** button and type the starting and ending record numbers in the **From Record** and **To Record** text boxes. Press **OK**.

The log window may be kept in constant view by selecting **Always on Top** from the **Datalog** menu.

4-9 Using Delta Time Cursors

If the velocity of propagation, Vp, of the track under test is known, propagation delay times may be measured by positioning the Delta Time Cursors at the beginning and end of the test specimen.

To enable the cursors select **Delta Time** from the **Options** menu.

The cursors will appear in the graphical display area and a readout of the time interval between them is displayed to the right of the tool bar buttons — see Figure 4-9.

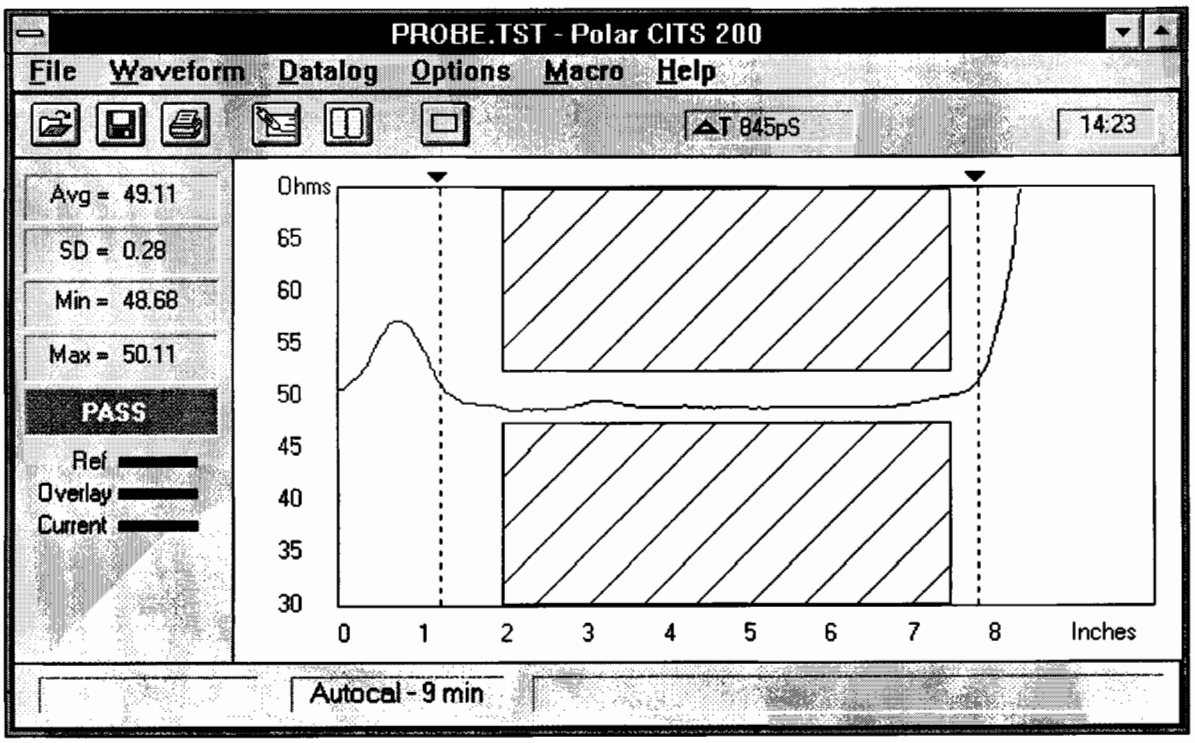


Figure 4-9 Using the Delta Time Cursors to measure propagation delay

To position a cursor click the left mouse button on the triangular marker at the top of the cursor (the selected marker changes to a grey rectangle); drag the marker into the display area and place the cursor onto the required location on the waveform. Release the mouse button.

The system calculates the time interval between the two cursors based on the setting of Vp (velocity of propagation) in the current test file — see Section 5-3.

If the plotted waveform crosses into either of the cross-hatched areas the CITS system will report a **FAIL** — Figure 4-10.

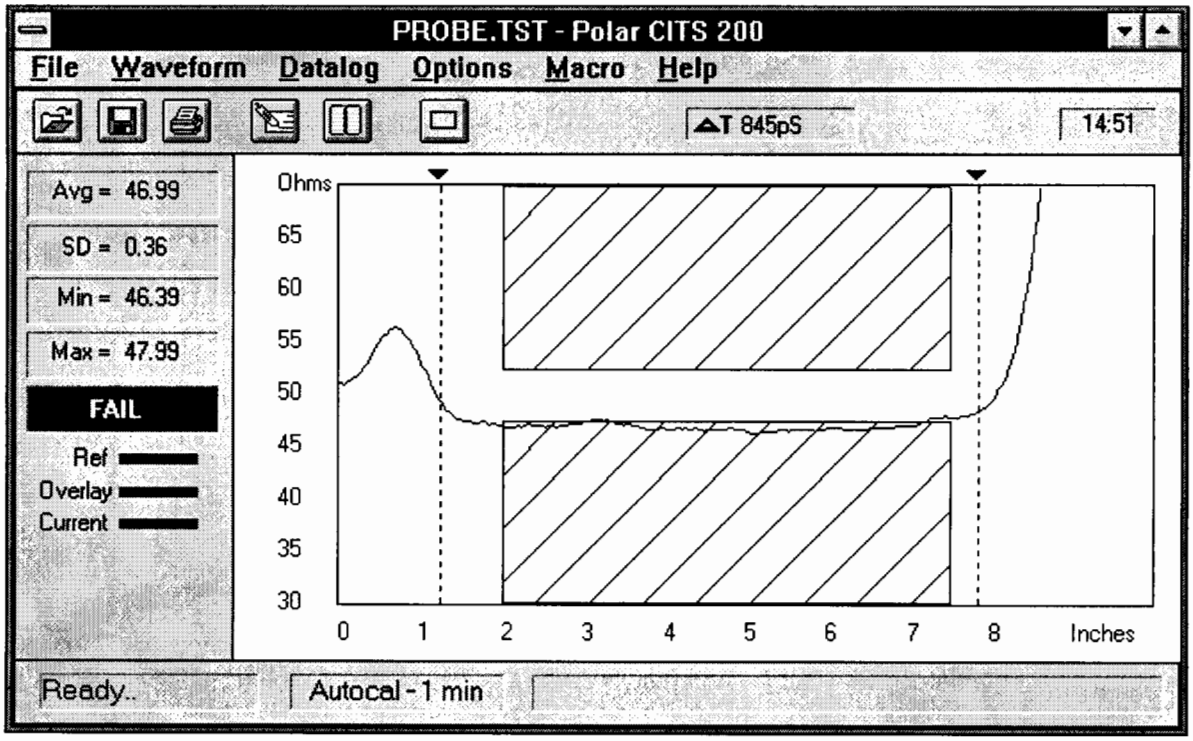


Figure 4-10 FAIL screen

4-10 Printing waveforms and test results

Select the **Print** function to produce a printed copy of the results of a board test.

The system will prompt for information which will be printed with the test results, Board serial no., date code, the operator's name and comments — Figure 4-11.

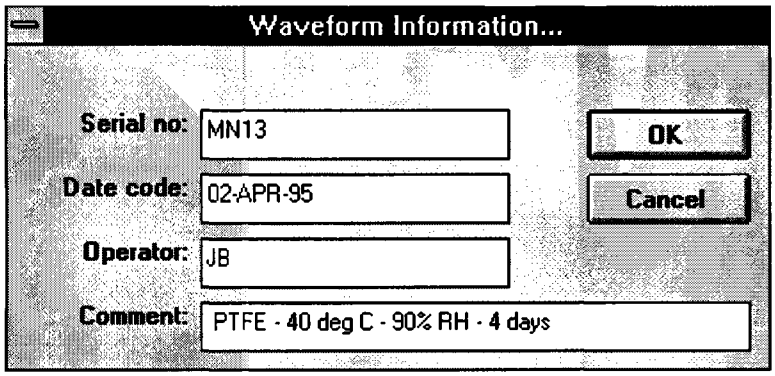


Figure 4-11 Waveform Information dialog

Select OK to proceed with printing. The current results plus any overlay and reference waveforms enabled are printed along with test file and results data.

A sample printout is included overleaf.

4-11 Recording test waveforms

The **Record Current Waveform** function allows the operator to store a test waveform on disk. Test waveforms are stored as files with the **.dat** file extension.

The system will display the **Waveform Information** dialog box — see Figure 4-11 above — requesting the board serial no., date code, the operator's name and comments.

Step through the information fields with the <**Tab**> key. Press **OK** when all fields are completed — the **Save Waveform File** dialog box is displayed.

Type a new file name in the **File Name** box and select **OK**

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

A warning message requests confirmation of the decision to replace existing data with the current test results.

Viewing recorded waveforms

Waveforms stored on disk with the **Record Current Waveform** function may be retrieved and printed with the **View Recorded Waveform** command.

Select **View Recorded Waveform** from the **Waveform** menu — the 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 recorded waveform and associated statistics are displayed.

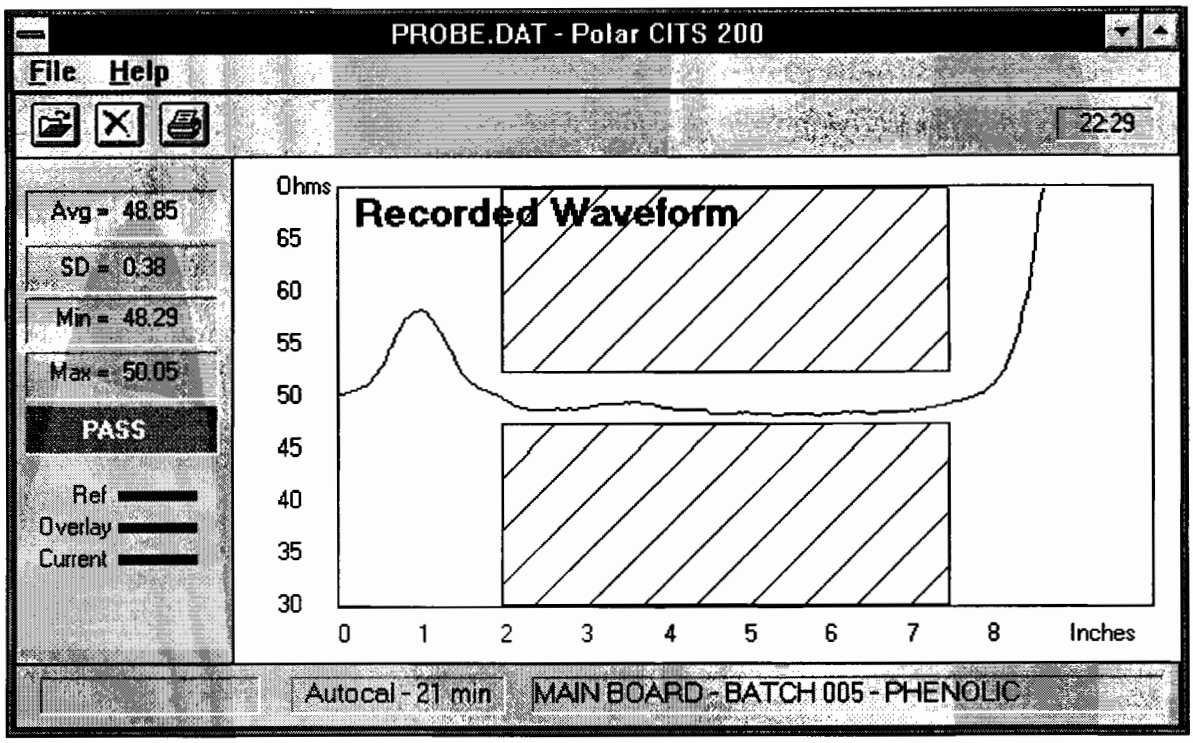


Figure 4-12 Viewing the recorded waveform and statistics

Note that when viewing test waveforms the message **Recorded Waveform** appears in the display.

Further waveforms may be inspected using **Open** on the **File** menu and results may be printed out using the **Print** command as described earlier.

To return to normal operation select Close from the File Menu.

The Recorded Waveform tool bar

When viewing test waveforms a restricted menu (the **File** menu) and toolbar are displayed.

Press this button to view other stored waveforms.



Press this button to return to normal operation.



Press this button to print out the displayed waveform.

4-12 Reference Waveforms

The CITS incorporates the facility to store a reference waveform for every test file — the reference waveform is displayed as an example of a good trace when the test file is selected.

Setting a Reference Waveform

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

Clearing a Reference Waveform

To clear the current reference waveform for a test file use the **Clear Reference Waveform** commend from the **Waveform** menu. To make this change permanent save the test file to disk using **Save** from the **File** menu.

4-13 Overlaying waveforms

The **Overlay** command from the **Options** 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, 15 or 20.

With the **Overlay** option selected, the waveform window is not cleared between board tests, so the results of the last 2, 5, 10, 15 or 20 tests will appear superimposed until **Overlay** is deselected (set to **Off**) — older test results will be discarded — Figure 4-13.

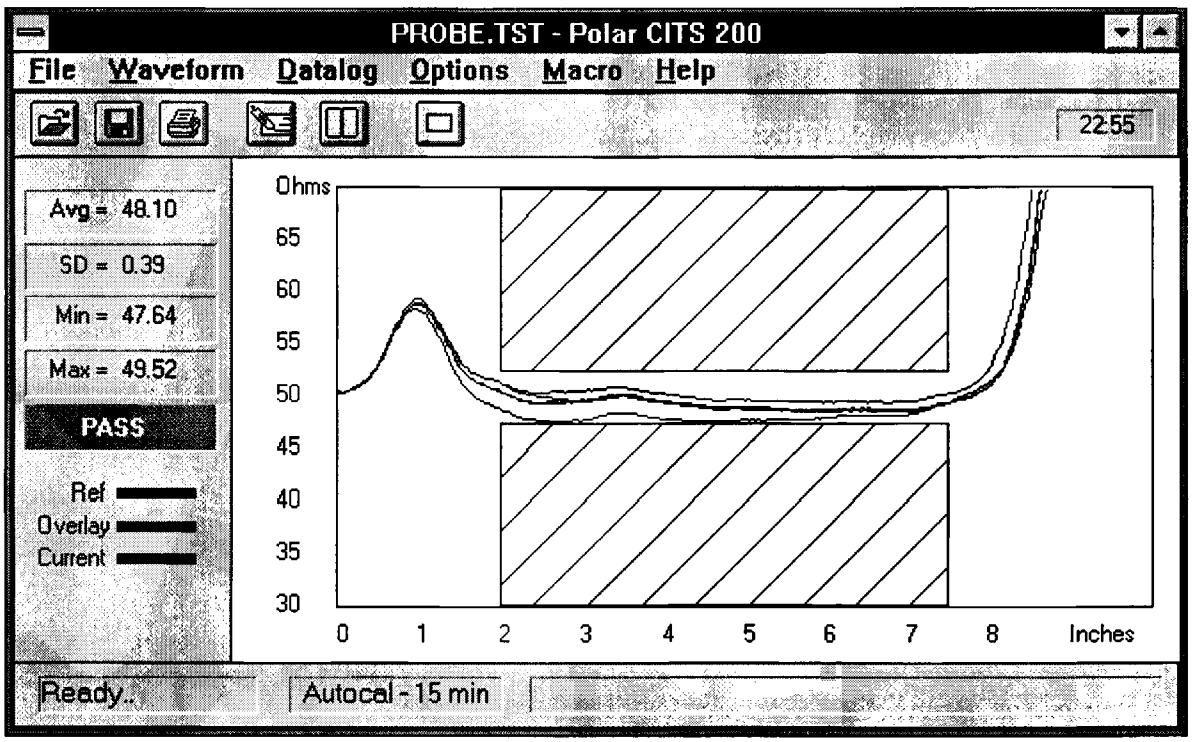


Figure 4-13 Waveforms superimposed in **Overlay** mode

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/FAIL result and information appearing in the Statistics area refer to the most recent test only. The Statistics area does not accumulate data.

Use **Clearscreen** from the **Options** menu or the **Clear** button to clear the screen.

4-14 Exiting the CITS program

Select **Exit** to leave the CITS program and exit to the operating system.

4-15 Notes on testing printed circuit boards

Board testing should normally be carried out using Microstrip probes. These probes are designed to minimise measurement errors caused by mismatch between the impedance of the measurement system (50Ω) and the PCB under test.

Operation is possible however using direct connections to a board.

Note the following observations when not using the Microstrip probes.

Keep impedance changes to a minimum

When setting up PCBs for test, best results will be achieved by keeping to a minimum the number of changes in impedance between the CITS and the PCB track.

The CITS output impedance is rated at 50Ω so as far as possible use cabling and connectors from the CITS to the PCB track with 50Ω characteristic impedance.

Use a probe which minimises the impedance discontinuity at the interface to the PCB.

Use high quality cabling.

Always use high quality cable. Low quality cable may show series resistance. Series resistance will be displayed as a gradual increase in characteristic impedance along the cable.

Inexpensive cables also tend to have greater impedance variations over their length and at the connectors at each end.

Precision cables (50Ω ±1Ω) are provided with the CITS.

Compensate for unavoidable impedance changes

When testing 75Ω tracks using 50Ω cabling the level of ringing and aberrations in the leading edge of the plot is noticeably worse than for a 50Ω track. This is because of the step in impedance at the probe to PCB interface.

This can be compensated for in two ways:

(i) Measure impedance only over the relatively flat portion of the plot.
Set the **Test from:** and **Test to:** parameters to avoid ringing and aberrations in the leading edge of the TDR trace.
(ii) Use a 75Ω Microstrip probe so that aberrations occur at the 50Ω cable to probe interface and there is a smooth transition at the probe to PCB interface.

SECTION 5 — EDITING TEST FILES

TEST PARAMETER FILES

Each board type to be tested is tested in accordance with a set of test parameters. Each set of parameters is stored in a *test file*.

Figure 5-1 diagramatically illustrates the test parameters specified in the test file.

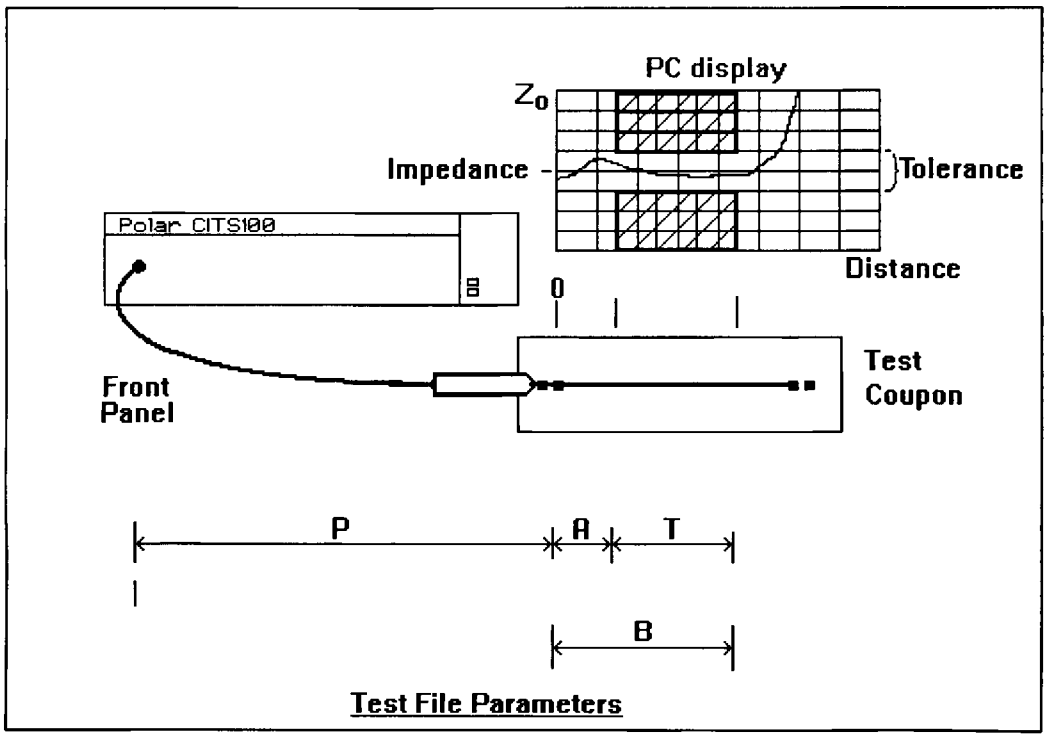


Figure 5-1 Test parameters defined in a test file

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)

5-1 The Test File Editor

Test parameters for boards under test may be defined or modified using the integrated **Test File Editor** — see Figure 5-1.

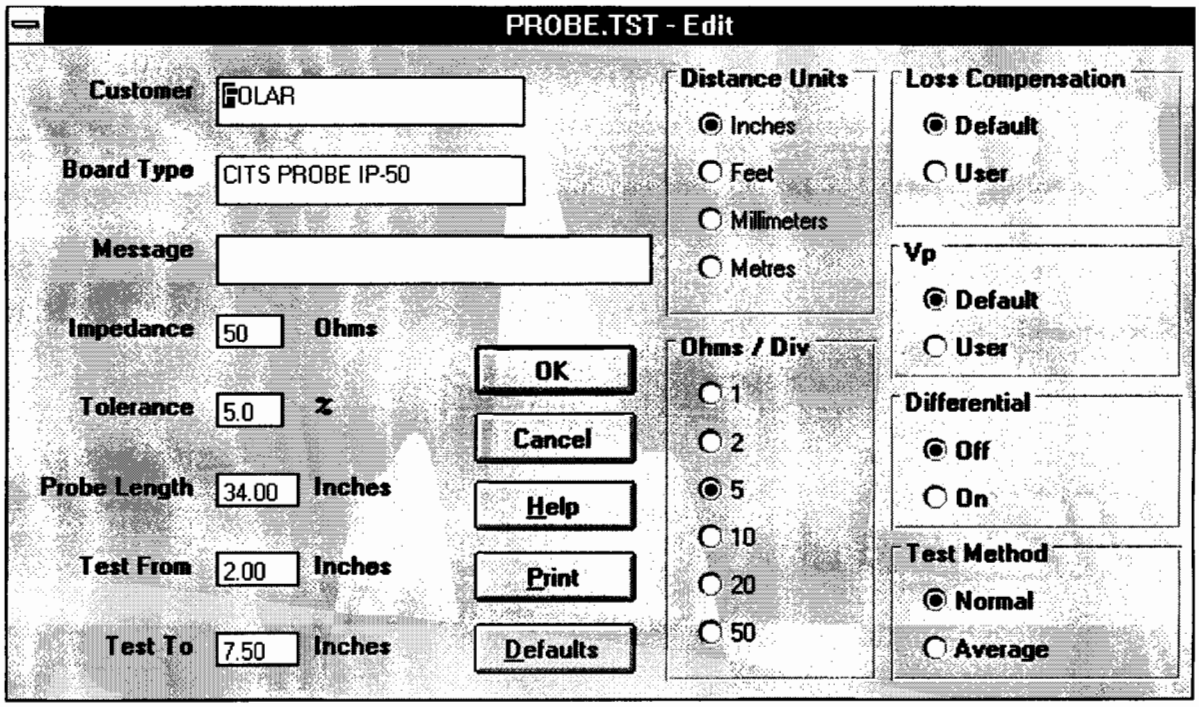


Figure 5-2 The Test File Editor

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 load a test file called **Untitled.tst** and open the test file editor dialog using default test parameters — see Figure 5-2.

Each parameter is defined and displayed in a *parameter field*. To create or edit a test file, 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

Customer

The **Customer** field is provided so that the customer name may be included as part of the data for a board (e.g. "XYZ Computers Ltd"). The customer name will be printed out with the test results.

The **Customer** field may include up to 20 characters of text.

Board type

The **Board type** field allows up to 20 characters of text to be included to define the type of board under test (e.g. "Main CPU Board").

The board type will be printed out with the test results.

Message

The **Message** field allows specific instructions to aid the operator during testing to be included with the test file (e.g. "Use 75Ω Microstrip Probe").

Text typed into this field will be displayed in the status bar of the main window when this test file is selected.

Impedance

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

This field must contain an integer in the range 10 to 500 ohms.

Tolerance

This parameter defines the tolerance about the nominal impedance to which the track will be tested. The tolerance must be set to a value in the range 0.1% to 100% — the CITS will accept fractional tolerances, e.g., 0.5%.

Ohms/div

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.

Press the up or down arrow keys to step through the vertical scale value options.
Choose the scale factor which gives optimum display — lower values display the waveform in greater detail.

Regardless of the vertical scale factor chosen, the display will center vertically about the value specified for the nominal impedance.

Distance units

The horizontal axis on the PC screen displays the distance along the PCB track under test.

The **Distance units** field specifies the units (inches, feet, millimeters or meters) which will be used for the distance related fields. It defines the distance units used to specify all the distance parameters and those used on the horizontal axis of the displayed graph.

Probe length

The **Probe length** field specifies the distance from the CITS front panel connector to the beginning of the displayed graph on the PC (see Figure 5-1).

If the supplied cable and a Microstrip probe are used **Probe Length** can be left at its default value (45 inches).

If a different connection method is used **Probe Length** can be used to define the starting point of the display (i.e. the left edge of the graph) in terms of the distance from the CITS front panel. For example, if 37 inches is specified the display will show a graph of impedance starting 37 inches from the CITS.

Probe length may be set in the range:

0 to 600 inches
0 to 50 feet
0 to 15 meters
0 to 3000mm.

Test from

This parameter, along with the **Test to** parameter enables the user to specify the length of PCB track of interest for testing.

This allows the user to avoid testing for controlled impedance in an area where the CITS trace may be ringing (e.g. where a sharp change of impedance occurs in the test system).
The **Test from** parameter specifies the distance from the end of the test probe to the *start* of the length 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:

0 to 600 inches
0 to 50 feet
0 to 15 meters
0 to 3000mm.

Test to

The **Test to** parameter specifies the distance from the end of the test probe to the *end* of the length over which impedance is to be tested (see Figure 5-1). It defines the end of the tested area within the display window.

It will normally be set to a point just before the plot starts rising toward infinity due to the open circuit end of track.

Test to may be set in the range:

0 to 600 inches
0 to 50 feet
0 to 15 meters
0 to 3000mm.

Note that **Test to** must be greater than **Test from**.

Loss Compensation

The Loss Compensation field may be used to compensate for any series loss 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 phenomena is caused by the DC resistance of the track combined with high frequency skin effects reducing the effective cross-sectional area.

Series loss can be compensated for by adjusting the slope of the waveform by a specified number of ohms/meter or ohms/foot. This cancels out the series resistance leaving the true characteristic impedance displayed.
Note: Series loss may be distinguished from the case of a slightly tapered track by testing from both ends of the trace. In the case of series loss the impedance waveform will appear the same from both ends.

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

Select **User** to display the Series Loss text box — use the left and right arrow keys or mouse to locate the cursor 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 coefficient of the medium in which it travels. For simplicity of operation the CITS program assumes that all cables and PCB tracks have a velocity of propagation of 66% the speed of light. The CITS calculates displayed distance 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 in systems which have significantly different velocities of propagation. For example, airlines, which have a very high velocity of propagation (98 to 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 CITS is to measure impedance, for most applications the accuracy of the distance 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 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.

Differential

This option is only available when the instrument type has been specified as CITS200 in the system configuration screen. If the instrument is a CITS200, differential testing may be enabled using this control.

The CITS100 does not support differential impedance measurements — the CITS100 will show the **Differential** options greyed out.

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.*

Where higher performance (e.g. greater noise immunity) is required a more complex type of controlled impedance structure is employed — that of a differential pair of signal conductors. The 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 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.

To facilitate differential measurements the CITS200 provides two SMA connectors on its front panel. Differential testing is performed using the IPD100 Differential Probe.

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

It is recommended that the cables supplied with the instrument are used.

To perform a differential test check the **On** option in the **Differential** section.

Note: With the exception of the **Customer**, **Board type** and **Message** fields, each field must contain a test parameter; the **Customer**, **Board type** and **Message** fields may be left blank.

Test Method

When this parameter is set to **Normal** the CITS will record a FAIL if the trace is out of tolerance *at any point* over the tested area.

Selecting **Average** will cause the test to fail only if the *average impedance* is out of tolerance.

When **Average** is selected the test limits are displayed as the diagram below:

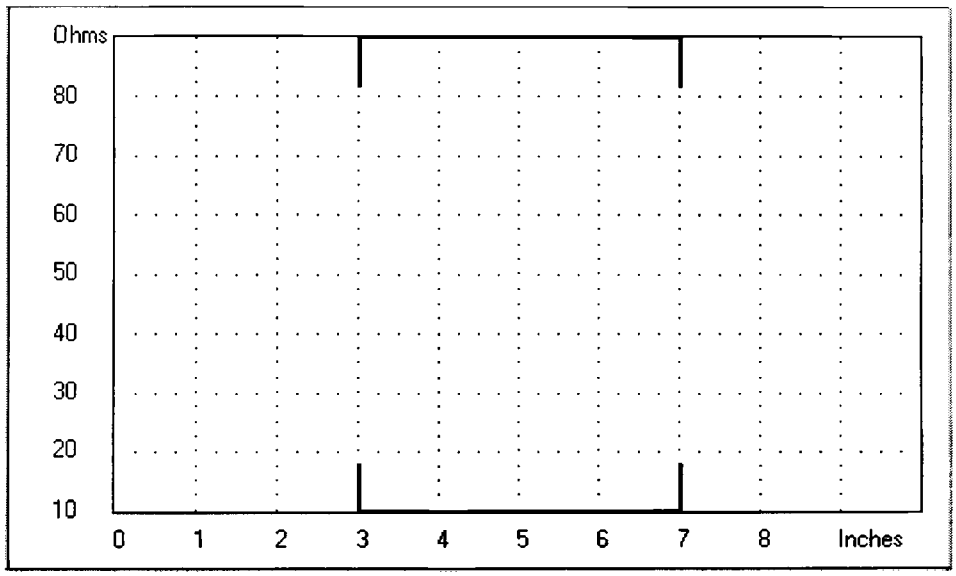


Figure 5-3 Average Test Method display window

Modify the test parameters as required and then use the **OK** button to confirm the new values.

5-4 Saving the test file

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

 Press the Save button to save the file.

Note: if the **Untitled.tst** file is overwritten the modified parameters become the defaults for a new test file.

Naming test files

Names assigned to test files must conform to the MS-DOS conventions for file names. File names must be unique and may contain up to eight characters.
The PC operating system will allow the following characters to be used in file names:

Letters A to Z and a to z
Numbers 0 to 9

and the following special characters:

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

Spaces, commas, periods and backslashes (\ )are not permitted in file names. For more information on file naming conventions, consult the MS-DOS operating system user guide.

Saving test files under new names

Users will frequently need to rename files or create files with test parameters similar to existing files. It will often be most convenient to modify and rename an existing file.

Select the existing file using the **Open** command from the **File** menu, press the **Edit** button to edit the file, modify test parameters as required, press the **Save As** button and name the new file.

5-5 Using existing files as templates

An alternative, and in many cases quicker, method of creating a new test file is to open an existing test file, edit it and then save it under a new name. If this is a new test file, select one of the three supplied templates and edit the parameters as required (the procedure for editing test parameters and saving files is described below).

Modifying an existing test file

To create or modify the current test file select the **Edit** command from the **File** menu or press the **Edit** button — the Editor will open with the selected file displayed. Change the test parameters as required and save the file.



Press this button to edit the current test file.

Press **Alt-F4** to exit the Editor.

5-6 *Printing test files*

Select the **Print** function (or Alt-P) to obtain hard copy of test files.

5-7 *Test File Macros*

The CITS incorporates facilities to create and run sequences of test files — called *macros* — to automate the process of performing a complex series of tests.

Macros are generated using the Macro Editor. Using the Macro Editor the user specifies a list of test files to be run in sequence; the test files are cycled through automatically.

When a macro file is loaded the CITS displays a list of the individual test files in the macro sequence to the right of the waveform display area. The current test file is shown highlighted.

Test files may be selected using the mouse or keyboard arrow keys — Figure 5-4.

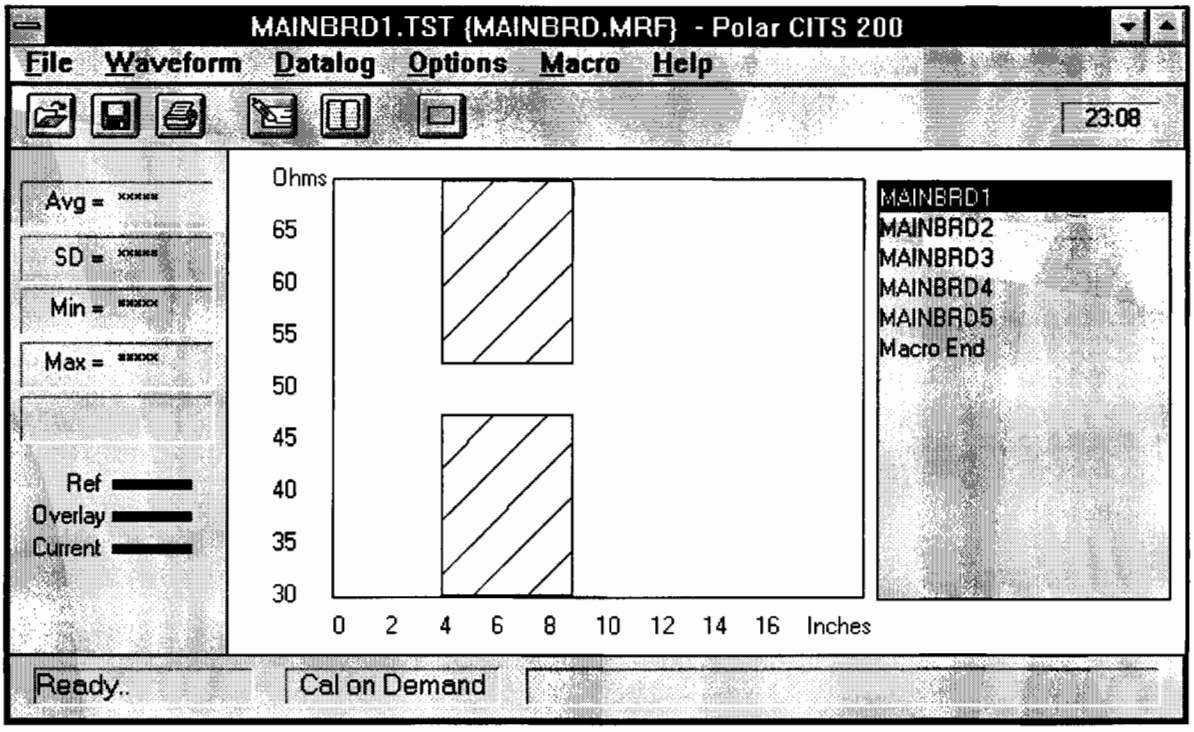


Figure 5-4 Main screen with displayed macro sequence

The CITS foot pedal can be used to advance through the list and perform each test in the sequence without the use of the mouse or keyboard. Test results (PASS/FAIL) are displayed next to each test file as testing progresses.

Creating a new macro

To create a new macro file select **New** from the **Macro** menu. The CITS loads the macro file **Untitled.mrf**.

The Macro Editor window is displayed to allow test files to be added to the macro sequence — Figure 5-5.

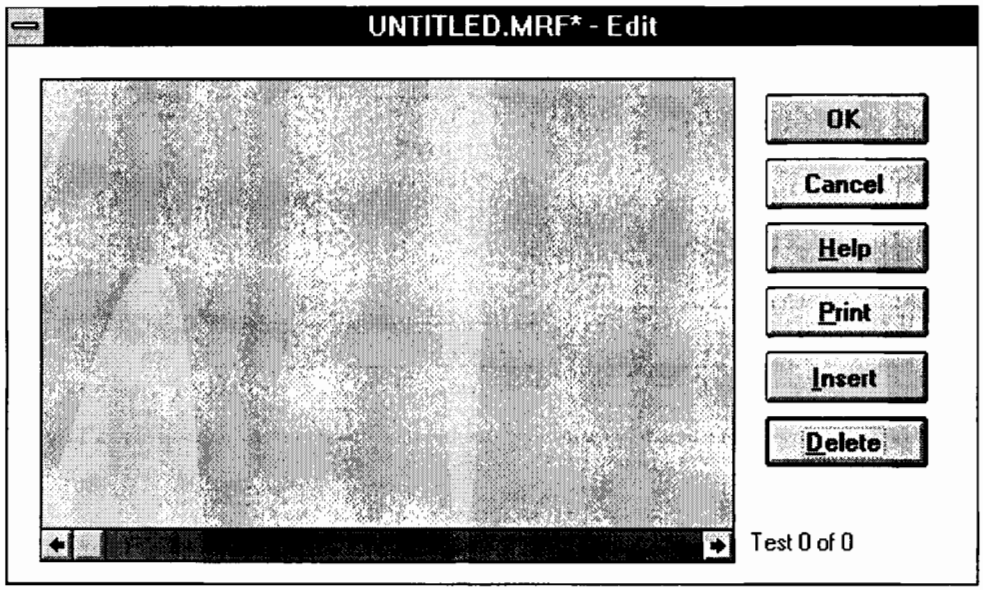


Figure 5-5 The Macro editing screen

Note: If macro files already exist it will often be more convenient to select an existing macro file, edit this as desired and then use **Save As** on the **Macro** menu to save it as a new file.

If an existing macro file is opened The Macro Editor displays a list of all the test files in the test sequence.

Test files can be inserted at any point in the test sequence or deleted from the test list as required.

Selecting the **Print** function produces a hard copy of the test sequence.

Adding a test file to a macro

Select the position in the test list (using the mouse or cursor keys) and press the **Insert** button — the CITS displays the list of available test files:

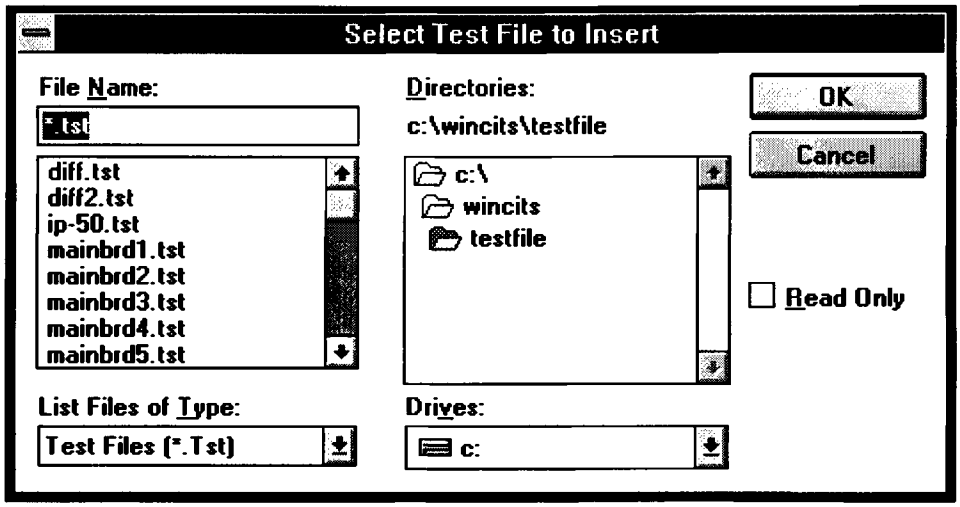


Figure 5-6 Adding test files to a macro

Select the test file and press **OK** — the file will be added to the list. Continue adding test files until all test files required are included in the macro list — see Figure 5-7. Press **OK** to confirm the files and close the Macro Editor.

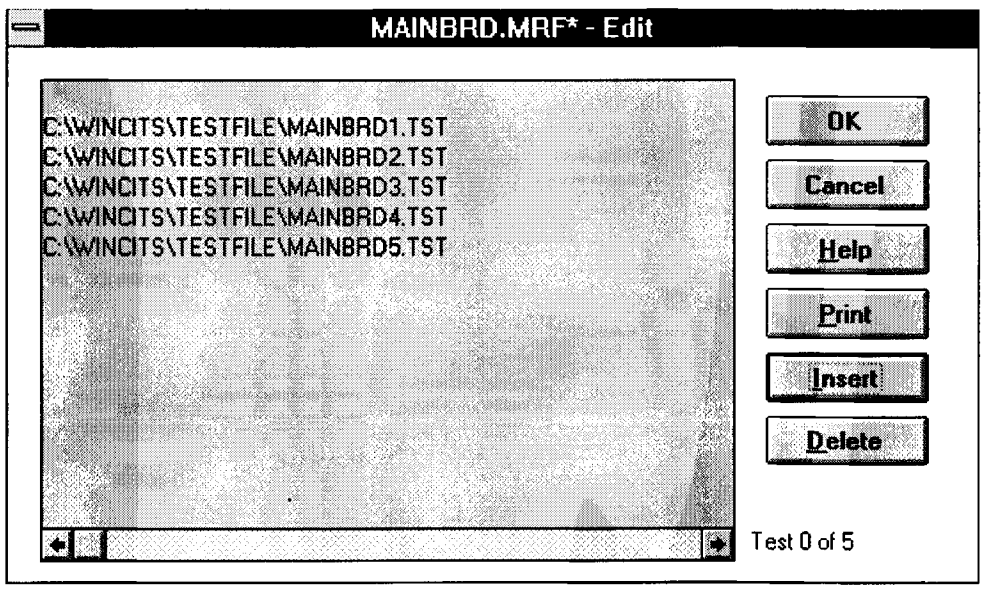


Figure 5-7 Completed macro list

Saving a macro

To save the new macro file use **Save** or **Save As** from the **Macro** menu. The CITS will request a name for the new file.

Loading a macro

To load a macro Select **Open** from the **Macro** menu. The CITS displays the **Select Macro File** dialog box:

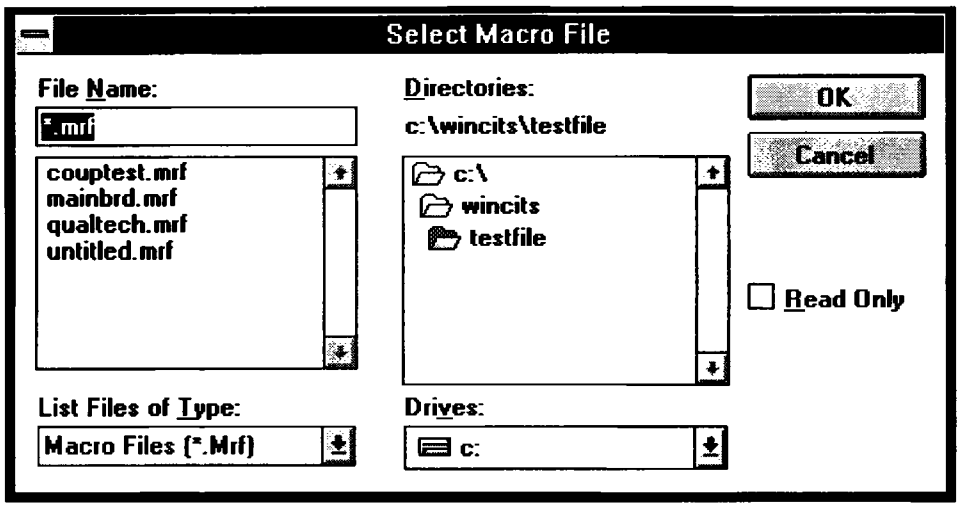


Figure 5-8 Selecting a macro file

Editing a Macro

To edit the current macro file select **Edit** from the **Macro** menu. The Macro Editor window is displayed with the current macro loaded. The Editor allows test files to be added to or removed from the macro file.

Press the **Insert** button to add a file to the list as described earlier. To remove a file from the list highlight the file with mouse or arrow keys and press the **Delete** button.

Note: If no macro file is currently active the **Select Macro File** dialog box is displayed to allow a macro file to be selected.

Closing the Macro Editor

To finish the current editing session and close the Editor press the **Close** button.
Select the macro file of interest and press **OK**.

With the macro loaded the test file sequence is displayed to the right of the waveform display area. The first file in the list is highlighted to indicate that this is the current test file.

Running a macro

Select the test to be run and press the foot pedal to run the test.

If the test passes the next test file in the sequence is automatically loaded (check that **Autoload Next** in the **Macro** menu is turned on — **Autoload Next** is turned on by default). To advance to the next test in the list manually, use the mouse or the arrow keys on the keyboard.

Selecting tests manually

If **Autoload Next** (in the **Macro** menu) is turned off the CITS will not automatically sequence through the tests. Steps in the sequence must be manually selected then run.

Macro data logging

If Data Logging is selected, when the user reaches the end of the list of test files the Board Information dialog box is displayed.

Enter the details for the board under test — serial number, date code and operator name as described in Section 4-7 — Logging Test Data.

If data logging is performed while running a macro the log file is stored under the same name as the macro file but with the **.csv** extension.

SECTION 6 — MAINTENANCE AND FAULT FINDING

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

Refer all servicing to qualified service personnel. Polar Instruments publishes a CITS Service Manual to assist the service technician.

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	i. Check CITS power is switched on. ii. Check CITS green BUSY LED is lit for a few seconds on power up then extinguished. If the green LED stays lit, the CITS is faulty; refer to the supplier or agent iii. Check the connection of CITS to the PC. iv. Check that the cable used is the cable supplied with the CITS. v. Check that the COM port connected to the CITS matches that selected via the System Configuration screen.
Foot switch not working	i. Check that the RS232 cable in use is the cable supplied. ii. Ensure that if a 9–25 way RS232 adaptor is used all 9 signal lines are connected.
Printer fails to work	i. Check the printer is switched on. ii. Check connection of the PC to the printer.

Cleaning

Clean the CITS200 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.

Microstrip probes

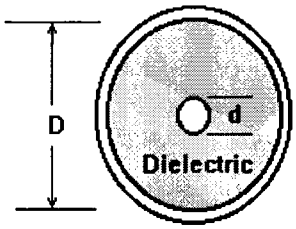
If a different pitch between the ground and signal pins on the Microstrip probes is required this may be adjusted with the aid of a soldering iron. (In the event of damage or loss to the spring loaded pins, replacements are obtainable from I.D.I or their local agents. The order code is SIE 3.8 G)

APPENDIX A — CHARACTERISTIC IMPEDANCE

Characteristic Impedance of conductors

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

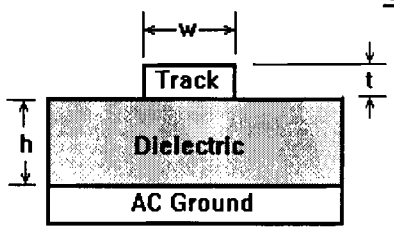
The diagram below includes equations for calculating the characteristic impedance of coaxial cable, microstrip and stripline.



a. Coaxial Cable

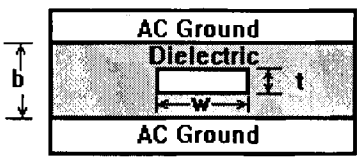
$$Zo = \frac{138}{\sqrt{\epsilon_r}} \log_{10} \frac{D}{d}$$

b. Microstrip



$$Zo = \left[\frac{87}{\sqrt{Er + 1.41}}\right] \ln \left[\frac{5.98h}{0.8w + t}\right]$$

c. Stripline



$$Zo = \left[\frac{60}{\sqrt{Er}}\right] \ln \left[\frac{4b}{0.67\pi (0.8w+t)}\right]$$

where $w/(b-t)<0.35$ and $t/b<0.25$

Figure A-1 Typical conductors and associated impedance equations

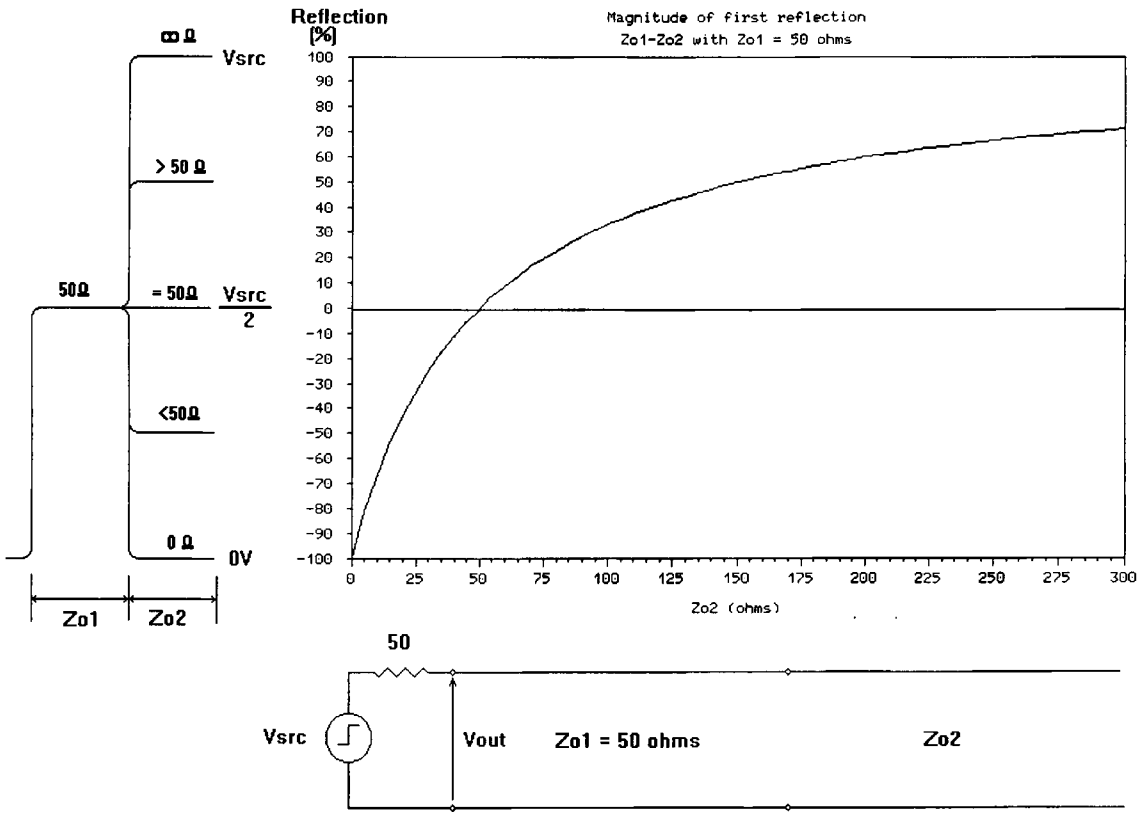


Figure A-2 Reflection magnitude v discontinuity impedance for a 50Ω Z_o, step output TDR

Determination of characteristic impedance

The CITS 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 CITS 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

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

Protecting the CITS from electrostatic discharge

Many of the components in modern instruments like the CITS employ internal construction which 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 a typical unprotected work station.

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 workstation

Static sensitive components, including completed circuit boards, should only be used (i.e. inserted or replaced) at a static free work station. The static free work station 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 CITS observe the same procedures as when handling static sensitive components:

- Use the CITS at an approved anti-static work station.
- Wear a wrist strap connected to a suitable earth point. A wrist strap is provided with the CITS (connect the wrist strap to the stud on the CITS rear panel).
- Other protective clothing, such as conducting heel straps and metallised coats can be worn if available.
- Keep materials which may produce static electricity away from the work station.
- Treated completed circuit boards as static sensitive components.
- Avoid dragging the CITS probes across work surfaces.

CITS MACRO REPORT GENERATOR (MRG)

OVERVIEW

The MRG software is an optional accessory for the CITS for WINDOWS and may be ordered as part number FSW139.

The MRG software, running under Microsoft Excel (version 5.0 minimum), will perform the following operations on CITS macro test files:

- Create an Excel file containing a copy of the CITS test results and the associated test files
- Generate statistical data based on the test results
- Produce a Report and/or Summary of the test results (either all data or Passes only)
- Produce an archive copy of the CITS macro results file and clear the original results file ready for future logging

After the data is imported, it is password protected. Removal of the protection allows modification of the imported data before printing the report. In addition, when protection is removed, the user is able to make certain modifications to allow extra statistical calculations, alter terminology, add a company logo, etc. The user will require knowledge of Excel to be able to make this type of modification.

MRG can accommodate up to 60 tests within the macro and up to 9999 coupons per report.

Installation

To use the MRG software the CITS software must already be installed on the host system. The MRG software is installed from Microsoft Windows Program Manager:

- From the Program Manager **File** menu Select **Run**
- Type **A:INSTALL** and press <Enter>
- Follow the instructions on the screen

By default the CITS software will be located in a directory **WINCITS** in the root directory of the host drive. The MRG installation routine will offer to create a sub-directory under **WINCITS** called **EXCEL** and copy its files into **\WINCITS\EXCEL**. If the CITS has been installed in its default location simply select the <Continue> button.

*If the CITS has been installed in a different directory, it will be necessary to change the path so that the MRG directory **EXCEL** is created as a sub-directory of the directory where the CITS software has been installed.*
After installation, an extra icon **Macro Report Generator** will be added to the **Polar CITS** program group.

Double clicking on this icon will open Microsoft Excel and the MRG software.

To open both the CITS and MRG software automatically each time Windows is started move or copy the two icons to Program Manager's **StartUp** group. (Refer to the Microsoft Windows User Guide for further information.)

Setting up your Company template

To open the MRG software either:

- double click on the Macro Report Generator icon or
- with Microsoft Excel running, open the file \WINCITS\EXCEL\CITS.XLS

This will both load CITS.XLS and display the default TEMPLATE.XLS file.

Customising the Summary Sheet

With the TEMPLATE.XLS file displayed, click on the Summary sheet tab to display the Summary sheet. Any of the text in red in the Summary Sheet may be altered by the user at any time. In this screen the user can overwrite the red type to enter Company name, address, telephone and fax numbers. After making the changes save the file under the same name, TEMPLATE.XLS. This file will become the standard template for all of the future reports generated with the MRG software.

Report Sheet options

Displaying the Minimum and Maximum value columns

Click on the Report sheet tab to display the Report sheet. Use the Show Min and Max Columns Check Box to display or hide the columns containing the Minimum and Maximum values.

Displaying the Test File Name

The Show Test File Name check box allows the name of the Test File appearing on the Summary sheet to be added to the column titles.

Changing the column title text

The column title text may be changed from its default value of *Test*. The column title text is derived from a hidden named cell *Column Title* (cell reference A4). Select the *Column Title* cell via the Name Box and edit the cell contents as required.

The installation routine also copies a backup copy (TEMPLATE.BAK) of the original TEMPLATE.XLS into the installation directory (e.g. \WINCITS\EXCEL\).

Should disaster strike (for example if the template file is damaged or corrupted during use, the password is lost, or modifications are carried out which damage the operation of the software) this read-only backup file can be opened in Excel, renamed TEMPLATE.XLS and the Company name, etc. added as described above.

Password Protection

It is possible to make changes to the black text, add a Company logo, alter text fonts, add extra statistical calculations to the report, etc. if the protection is removed by clicking on **Remove Protection** and entering the password.

When the software is shipped, the password is set to "Polar" (*note that password recognition is case sensitive*). After the changes are completed and protection installed (click on **Install Protection**), a new password may be entered which will be needed for subsequent access to protected areas.

It is strongly recommended that in normal use, the protection is left on to prevent accidental errors. It is also recommended that a written record of the password is kept in a secure location — without the password full access to the system is denied.

To avoid errors the following areas should not be changed:

A number of cells that appear to be blank (i.e. are blank on the display) are used by the software as *named cells* — removing or altering any of these names is likely to cause the Reporter software to produce errors. Named cells are identified by the description in the Name Box — the box on the left hand side of the formula bar — when the cells are selected. For example, ReportTopLine is a defined cell name (cell names appear instead of the more usual cell reference, e.g. A8). *Do not make any alterations to cells that are named.*

Some calculations are linked — for example 'Cpk' requires 'Min.', 'Max.' and 'Std.Dev.' — removal of any of these three will cause the software to produce a blank field for 'Cpk'.

File management

The following system is recommended for storing Test files and Macro files within CITS:

- Create a directory for each coupon type (named, for example, POL123)
- Store each of the individual track test files in this directory (file names can be used to indicate details, e.g. 1L50TA.TST for layer 1, 50 ohm, TOP, trace A)
- Store the macro file for the coupon in this directory giving it the same name as the coupon type, e.g. POL123.MRF

The CITS is used in the normal way to test coupons using a macro with Autolog selected.

The CITS will automatically log the results in a datafile with the same name as the macro (POL123.CSV for this example) and the file will be in the same directory as the macro file (POL123 in this example).

When each batch is tested it is suggested that the batch reference number is used as the filename for the Excel report.

The system described above is not mandatory but is recommended. Its benefit is that one directory whose name will uniquely identify the coupon will contain all the Test files, the macro file and, eventually, all of the test results and Reports produced by the Macro Report Generator software for that particular coupon:

- Test files (.TST)
- Macro file (.MRF)
- The current datalog file (.CSV) for the coupon
- The archived datalog file(s) (.OLD) for batches processed using the MRG
- The Excel file(s) (.XLS) for batches processed using the MRG

Using the Macro Report Generator software

When testing is complete, switch to Excel by double-clicking on the MRG icon.

With the Summary sheet of the MRG software displayed clicking on the **Load from CITS** button opens the Datalog file for the test just completed. This will be located in the same directory as the macro file (POL123 in this example).

Note that if the recommended directory system is followed, there will only be one file in the directory that the software will display as suitable for opening. In this case the user will open POL123.CSV.

The MRG software will then import:

- All Datalog results
- A copy of the macro file
- Copies of all the test files used by the macro

A dialog box then prompts for a name for the Report; it defaults to the "Date Code" entered by the operator during testing (e.g. 9546). The user can either accept this or type in an alternative (up to a maximum of 8 characters).

The software will then save the Excel file using this name (i.e. creates file 9546.XLS) and re-name the original CITS Datalog file to 9546.OLD. Both files will be saved in the original macro directory (i.e. POL123 in this example).

At this stage the user can change any of the red characters on the Report (e.g. a change of operator, dates, etc.). The black text is password protected.

The imported data and Report can be viewed by clicking on the appropriate tab at the bottom of the screen.

Two types of Report can be produced by clicking on the **Generate Report** button:

- A full Report which contains all of the data (i.e. PASS, FAIL and UNTESTED) or
- A Report which contains the PASS results only.

In both cases, the Report is sorted by Serial Number of the coupon.

If protection is removed the datalog can be edited.

Selecting **Generate Report** on the summary screen will regenerate the report using the modified data.

From the Summary page, the user can select the **Print** button and is offered two options:

- A full report (i.e. all Test Results and the Summary) or
- Summary only

The user will be prompted to save the file when either closing the file or Excel regardless of whether any changes have been made. The user should select Yes to ensure that any changes made will be saved.

A report can be viewed and printed at a later date by loading the appropriate file into Excel.

Data imported from CITS

On the Summary sheet, the source of imported data is as below:

General Information

Customer:	Customer name as it appears in the first TEST file used by the Macro
Board Type:	Board type as it appears in the first TEST file used by the Macro
Date Code:	Date Code as it appears in the first record of the Datalog
Operator:	Operator as it appears in the first record of the Datalog
Test Start	The date and time of the first record in the Datalog
Test End	The date and time of the last record in the Datalog

All of the above entries are displayed on the screen and, as they appear in red, may be changed by the user (if required), before printing and saving.

Test Summary

Test	The number of the test in the order specified by the Macro
Test File	The filename of the test
Min. Z	The minimum allowable impedance for the test obtained from the test file using the Impedance and Tolerance fields
Max. Z	The maximum allowable impedance for the test obtained from the Test file using the Impedance and Tolerance fields
Method	Normal or Average test method as specified in the Test File
Differential	On or Off as specified in the Test file
Notes	Notes as they appear in the Test file

The above Test Results details cannot be altered in the Summary without entry of the password.

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