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T4000 OPERATOR MANUAL

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T4000 FAULT LOCATOR OPERATOR MANUAL

WARRANTY

1. Subject to the conditions set out below we warrant that the goods will be free from defects in material and workmanship for a period of 12 months from the date of invoice.
2. The above warranties given by us are subject to the following conditions:-
 - (a) We shall be under no liability in respect of any defect arising from fair wear and tear, wilful damage, negligence, abnormal working conditions, failure to follow our instructions (whether oral or in writing), misuse or alteration or repair of the goods without our approval;
 - (b) We shall be under no liability under the above warranty (or any other warranty, condition or guarantee) if the total price for the goods has not been paid by the due date for payment.
3. Subject as expressly provided in these terms and conditions all warranties, conditions or other terms implied by statute or common law are excluded to the fullest extent permitted by law.
4. Any claim by you which is based on any defect in the quality or condition of the goods shall be notified to us within 7 days from the date of delivery or (where the defect of failure was not apparent on reasonable inspection) within a reasonable time after discovery of the defect or failure. You must notify both the carrier and us of any claim for damage in transit within two working days of receipt. Failure to do this may result in the carrier and/or us refusing to accept liability, and you shall be bound to pay the price as if the goods had been delivered in accordance with the Contract.
5. Except in respect of death or personal injury caused by our negligence, our entire liability (whether caused by the negligence of us, our employees or agents or otherwise) under or in connection with the Contract including, without limitation, in respect of any representation (unless fraudulent), or any implied warranty, condition or other term, or any duty of common law, or under the express terms of the Contract shall not exceed the price of the goods.
6. When a claim is accepted by us under section 4, we (or our agent) shall, without charge, repair or, at our option, replace the goods if found to be defective in materials or workmanship. Any goods returned to us (or our agent) must have the transport prepaid.

DECLARATIONS

European Community Directive Conformance Statement

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

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.

A declaration of conformity with the requirements of these Directives has been signed by:

POLAR INSTRUMENTS (UK) LTD
11 College Place
London Road
Southampton
England
SO1 2FE

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

EN 50081-1:1992
EN 50082-1:1992
EN 61010-1:1993

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 Service Manual published by Polar Instruments.

T4000 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 instrument 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.

SPECIFICATIONS

MODEL	T4040	T4080	T4000,T4128
Test Channels			
Program and Test	40	80	128
Live	2 x 20	2 x 40	2 x 64
Test Ranges			
Junction 1V 500μA			✓
Logic 10V 5mA	✓	✓	✓
Low 10V 150mA	✓	✓	✓
Med 20V 1mA	✓	✓	✓
High 50V 1mA	✓	✓	✓
Test Frequencies			
Low 90Hz	All modes	All modes	All modes
Medium 500Hz	All modes	All modes	All modes
High 2kHz	Live only	Live only	All modes
Live modes			
Manual, Auto, Cycle	✓	✓	✓
Pulse Generator DC, Pulse mode 1, Pulse mode 2 0 – ±5V variable level Pulse width variable	Live only	Live only	All modes
Shorts test – identifies shorts to common			✓
Test – Auto compare of signatures	All modes	All modes	All modes
Test/Learn time 40 pin IC on 4 ranges	5 seconds	5 seconds	5 seconds
Tolerance adjustment, 1 – 99%	All modes	All modes	All modes
Loop, continuously repeats test	All modes	All modes	All modes
Data logging of test results	✓	✓	✓

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 $\pm$ 10%, 115V $\pm$ 10% or 100V $\pm$ 10% at 50/60Hz, 35VA.

Channel A and B Protection Fuses

160mA Fast Blow

Physical characteristics (excluding accessories)

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

Weight 7.0kg (15.4 lb.)

SYMBOLS



CAUTION

To prevent damage to this product and to ensure its safe use observe the specifications given in this manual when connecting to terminals marked with this symbol.



COM

This terminal is internally connected to earth (ground).

ACCESSORIES

Standard Accessories

Probe set	MMP159
Pair of Red and Black Test leads	ACC110, ACC111
Pulse Generator leads	ACC112
Operator manual	MAN138
16 way test clips and cables (T4128/T4000 x 2, T4040/T4080 x 1)	ACC107
40 way test clips and cables (T4128/T4000 x 2, T4040/T4080 x 1)	ACC106
Foot Pedal	ACC124
RS-232 interface cable	ACC126
Accessory pouch	ACC105

Optional Accessories

Adaptor Board	T41282
Instrument carrying case	ACC125
SMD probes	T131 – T141
9 – 25 Pin RS232 Adaptor	ACC127
T4128MDA Option	ACC164
SOIC Test Clip Set	ACC160
PLCC Test Clip Set	ACC161
DIP IC Test Clip Set – 6 types	ACC140
DIP IC Test Clip Set – 10 types	ACC139

GUIDE TO THE MANUAL

INTRODUCTION	An overview of the Polar T4000 fault locator and its applications.
GENERAL DESCRIPTION	A description of the principles of operation and connector and rear panels.
INSTALLATION AND SET UP	Connecting the T4000 to a power supply, installation of software and preparation for use.
DEVICE TESTING	Information about the different ways in which the facilities of the T4000 can be used and how to test devices.
UTILITIES	Customising the T4000 operating environment – defining user access rights, specifying the PC communication ports and installing the printer driver program.
LIVE MODE	Operating the T4000 manually – getting acquainted with the display modes and test parameters for various device types.
PROGRAMMING THE T4000	Operation of the T4000 under computer control. Description of writing, saving and running test programs.
TEST	Running test programs compiled under the Program option.
FILE MANAGEMENT	Using the T4000 File Management functions to organise program storage, and copy and delete, archive and restore test programs.
SIMPLE MAINTENANCE	Details of maintenance and cleaning procedures.

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SECTION 1 – INTRODUCTION

1.1 THE T4000 FAULT LOCATOR

The T4000 Fault Locator provides a fast and efficient means of testing components, either in isolation or in circuit. The T4000 is designed to run under the control of an IBM PC or compatible host computer. Safe, low power drive voltages are applied to components to produce an "impedance signature" on the CRT. All testing is done with power disconnected from the circuit, so there is no risk to the user and components under test cannot be damaged.

An integral Pulse Generator enables three-terminal devices such as transistors, SCRs and Triacs to be tested.

An integral Scanner is incorporated to facilitate testing of integrated circuits (ICs). The Scanner is able to rapidly scan and display the signature of each pin of an integrated circuit or multi-pin component in full color on the screen of the host computer. Where a good board is available for reference, the signatures can be compared automatically.

The T4000 can be operated in **Live** mode, in which the user directly examines the signatures of a device, or in programmed mode, in which users, without specialist computer programming knowledge, are able to compile and run comprehensive programs of component tests within a logically structured programming/testing environment. Good device signatures can be rapidly digitised, viewed and stored on the hard disk of the host computer and printed out as hard copy on a wide range of printers.

The T4000 can automatically compare signatures of suspect devices with the reference signatures stored on disk and print out test results and good and bad signatures for comparison. Libraries of good signatures can be compiled from good circuit modules and sent to service centres with T4000 facilities and used for comparison in place of reference modules.

The T4040 has 40 scanner channels, the T4080 has 80 channels. The T4128 and T4000 have 128 channels. These are generally referred to as T4000 throughout this manual, and operating details are identical except as noted in this manual.

1.2 *Areas of application*

The T4000 is an ideal instrument for a wide range of applications:

- Field Service – fault finding.
- Manufacturing – goods inwards testing and troubleshooting.
- Repair – rapid diagnostics.

1.3 PC Control

The T4000 program provides the T4000 with the facility to operate under the control of an IBM PC (or compatible) host computer. The program provides an integrated environment for writing test programs, digitising, viewing and storing device signatures, managing program files and controlling system security. Signatures may be readily digitised and stored for reference on the hard disk of the host computer and compared with the signatures of suspect devices or printed out for hard copy.

On-line help is available using the <F1> key.

Comprehensive programs of device tests can be rapidly and conveniently compiled and stored on the host's hard disk and backed up to diskette for archiving or transfer to service organisations, repair centres, etc.

Programs and data are transferred over a high speed RS232-C link via one of the host's serial communication ports.

System requirements

Before installing the T4000 control program ensure that the host computer meets the following specifications:

- Computer – IBM PC or compatible
- Processor – 80286 or better
- Memory – 640 kbyte RAM
- Video card and monitor – VGA color
- 5¼" or 3½" diskette drive
- 20Mbyte free space on hard disk
- RS 232 C Serial communication port
- Parallel printer port
- Operating system – PC-DOS/MS-DOS version 3.3 or later
(MS-DOS version 5 or later must be installed if printed copies of device signatures are required)

SECTION 2 – GENERAL DESCRIPTION

2.1 PRINCIPLES OF OPERATION

The T4000 Fault Locator tests components by applying a current-limited alternating (AC) drive voltage across the component and monitoring the resultant current flow to display impedance signatures. Signatures for different types of components have distinctly different shapes that can be easily distinguished.

Two channels, A and B, enable the signatures of a reference and a faulty component or circuit to be compared. Faults in complex circuits can be diagnosed without detailed knowledge of the circuit functions; this facility will be found particularly useful when documentation is not available.

2.2 Controls and connectors

The T4000 Connector Panel

The connector panel has connections for:

- 40-way Scanner Channels A and B on the T4040 and T4080.
- 40 and 26-way Scanner Channels A and B on the T4128 and T4000.
- Channel A and B probes
- Two paralleled COM (common return) connectors.
- Two Pulse Generator outputs.

Scanner Channels

The T4000 Scanner provides the facility for rapid scanning of signatures on all pins of an IC under test. The Scanner is automatically selected when the **Sip** or **Dip** options are selected from the **Format** menu. This connects the multi-way IDC connectors to Channels A and B. Signal return is via the COM connection. 16 pin and 40 pin IC test clips are provided to connect channels A and B of the Scanner to the ICs under test. Connect the IC test clips to the polarised connectors A and B.

Note: The multi-way connectors *must* be used in conjunction with the return path provided by the COM socket.

Channel A and B probes.

The T4000 is supplied with a pair of DVM style probes which are connected to the A and B sockets. The Channel A and B probes are connected in parallel with the Scanner inputs to facilitate checking for open circuit clip connection — probe across devices (between Channel A and COM or Channel B and COM) to observe device signatures.

When the T4000 is set to **Probes** the 40 and 26-way connectors are isolated and input to the T4000 is from the probes only. This will be of use where low-capacitance tests are being made as the stray capacitance from the Scanner is disconnected from the input.

COM (common return) connectors

The T4000 incorporates two paralleled COM (common return) connectors — connect the COM test clip to the ground of the board (or boards) under test. If two boards are being compared, both grounds must be connected to the instrument's COM sockets.

Pulse Generator outputs

The T4000 incorporates pulse generating circuitry which allows the conduction state of transistors, SCRs, Triacs and other 3-terminal devices to be controlled by adjusting the level, width, polarity and time delay of pulsed outputs. Two outputs are provided to permit live comparisons of two boards

Connect the Pulse Generator cables to the two blue, PULSE OUT sockets on the connector panel. The Pulse Generator produces identical outputs between each PULSE OUT socket and the black COM sockets. The PULSE OUT signals are identical but driven individually, so that, although the same pulse output appears on both connectors, a load on one output does not affect the other.

The T4000 Rear Panel

The IEC power connector, power ON/OFF switch, FOOT SWITCH socket, RS 232 connector and line and input protection fuses are mounted on the rear of the instrument.

FOOT SWITCH socket

The Polar Foot Switch (ACC124) is connected to the FOOT SWITCH socket.

RS232 socket

The RS232 socket is used to transfer T4000 commands and data between the T4000 and the host computer. *Use only the supplied cable (ACC126).*

<i>Ensure the host computer and the T4000 are both powered down before connecting cables.</i>

Connect the cable between the host computer's serial port and the T4000 RS232 socket.

SECTION 3 – INSTALLATION AND SETUP

3.1 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 T4000 pack should contain:

- T4000
- Power cord
- Pair of probes (red and black)
- Pair of test clips (red and black)
- Pair of Pulse Generator test clips (blue)
- Pair of 16-way IC test clips and cables (T4128/T4000 only)
- Pair of 40-way IC test clips and cables (T4128/T4000 only)
- 16-way IC test clips and cables (T4040/T4080)
- 40-way IC test clips and cables (T4040/T4080)
- RS 232 interface cable (9-pin)
- Foot pedal
- Accessory pouch
- Operator manual
- T4000 program installation diskettes (3½")

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.

3.2 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 T4000 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 supply and switch on (the power switch is located at the rear of the instrument under the power inlet socket).

If the power on self test is completed successfully the SYSTEM OK LED is illuminated.

A flashing SYSTEM OK LED indicates that one or more of the power-on diagnostics failed – call your nearest Polar Instruments representative.

3.3 Installing the T4000 software

Backing up the installation diskettes

Users are recommended to make working copies of the T4000 installation diskettes before installation and store the master diskettes in a safe place.

Use the MS-DOS **diskcopy** command to make working copies of the installation diskettes. See the PC/MS-DOS operating system manual for details.

Insert the working diskette in the diskette drive and type **A:** or **B:** as required and press <Enter> to make the drive current.

Type **Install** and press <Enter>.

The installation program will create the T4000 directory and file structure and copy the T4000 files onto the hard disk.

3.4 Connecting the computer to the T4000

T4000 commands and data are transferred between the T4000 and the host computer via a serial communication (RS 232) link using the supplied cable.

Ensure the host computer and the T4000 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 T4000. Ensure the connections are secure.

Power up the T4000 and the host computer.

3.5 Running the program

To start the program, ensure the C:\> command prompt is displayed and type **T4040**, **T4080** or **T4128** (for both T4128 and T4000) as appropriate and press <Enter> – the T4000 Main menu is displayed.

The Main menu

The T4000 is designed for operation via a logically structured menu system. Selecting each menu option opens the associated sub-menu until the desired function screen is reached. The Main menu displays the top level options:

T est
P rogram
F ile Management
U tilities
L ive
e X it to dos

Operating functions may be selected by pressing the associated selection key (shown in upper case bold above) or by moving the highlight via the cursor keys to the desired option and pressing the <Enter> key. The Main menu screen also displays the version number of the T4000 software, and the Security Status.

Using the on-line help

The T4000 program provides help screens containing brief summaries of the functions available on the displayed screen. Press the <F1> key to obtain help; use the <PgUp> and <PgDn> keys to scroll through the help screens until the desired function summary is displayed. Press the <Esc> key to exit from the help screen.

SECTION 4 – DEVICE TESTING

IMPEDANCE SIGNATURES

Impedance signatures are graphs of current against voltage, plotted on a scale which has its origin at the centre of the display screen. Positive voltages and currents are displayed in the upper right quadrant on the display. Negative voltages and currents are displayed in the lower left quadrant (see Figure 4-1 Display X and Y Axis).

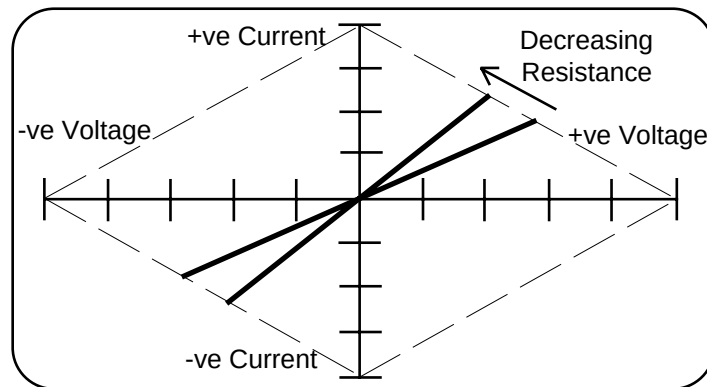


Figure 4-0Z1 Display X and Y Axis

Table 4-1 shows the peak voltage and current for each voltage range.

Range	Peak Voltage	Peak Current
Junction	1V	500 μ A
Logic	10V	5mA
Low	10V	150mA
Med	20V	1mA
High	50V	1mA

Table 4-1 Drive Ranges

All signatures are contained within the diamond shaped area formed by the "load lines" joining the ends of the marked axes.

Signature shapes

The following sections explain the characteristic shapes of signatures. Normally, the fastest diagnosis is made by comparing two signatures. There is often no need to analyse the shape of the signature in detail.

PASSIVE COMPONENTS R, L, C

4.1 Resistors

The signature produced by a pure resistance is an inclined straight line whose slope (gradient) is dependent on the value of resistance.

A high value of resistance will only pass a small current if a low test voltage is applied. The resulting signature may not be easily distinguishable from the open circuit horizontal trace. By selecting the **High** voltage range a larger current flows and a more recognisable sloping signature is displayed.

Figures 4-2, 4-3 and 4-4 show typical signatures for three resistor values.

Table 4-2 gives the ranges against approximate resistor values for which signatures can be distinguished from a short circuit (vertical trace) or an open circuit (horizontal trace).

Range	Resistor Value (Ohms)
Junction	1K to 50K
Logic	300R to 6K
Low	16.5R to 300R
Med	5K to 60K
High	12K to 150K

Table 4-2 Resistance Ranges

Figure 4-0Z2

2K Resistor
Logic Range
Low Frequency.

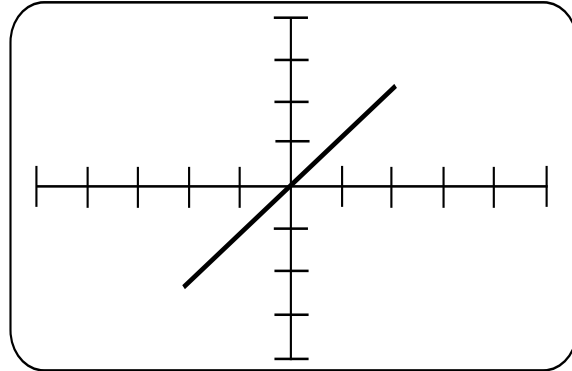


Figure 4-0Z3

10K Resistor
High Range
Low Frequency

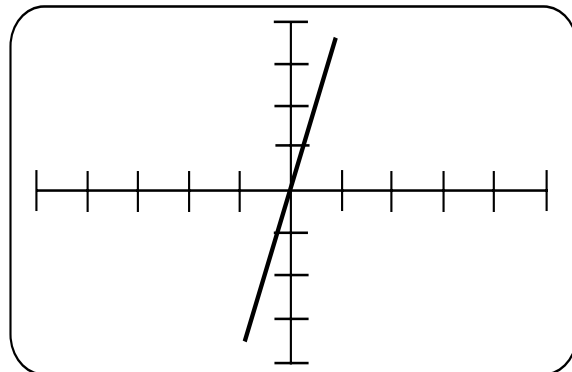
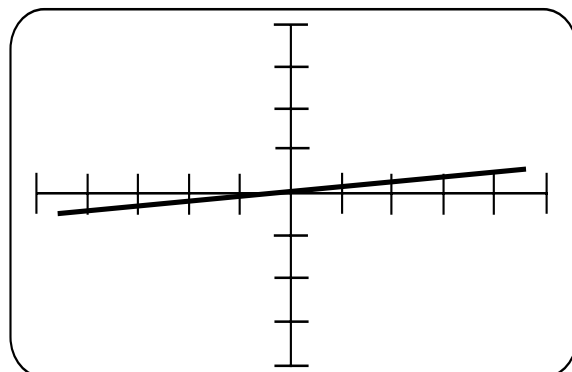


Figure 4-0Z4

270K Resistor
High Range
Low Frequency



4.2 Capacitors and Inductors

Due to their energy storage characteristics, reactive components produce a phase shift between voltage and current flow. This is displayed as a circular or elliptical signature. Figures 4-5, 4-6 and 4-7 show typical signatures for three capacitors.

For a pure reactance the major and minor axes of the ellipse align with the display axes. If the resistance in circuit is significant compared with the impedance of the reactive component, the elliptical signature is tilted. Figure 4-8 shows the signature of a defective 47 μ F capacitor which has gone resistive. Figure 4-9 shows how the signature of the same type of capacitor should appear for a good part. By choosing a different test frequency to vary the impedance, the effect of resistance can be exaggerated or minimised as required.

Figure 4-0Z5

22 μ F Capacitor
Low Range
Low Frequency

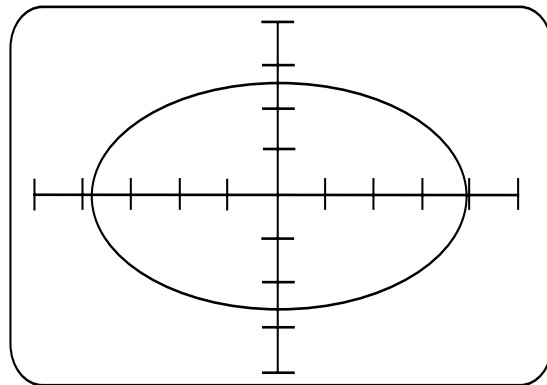


Figure 4-0Z6

10 μ F Capacitor
Low Range
Low Frequency

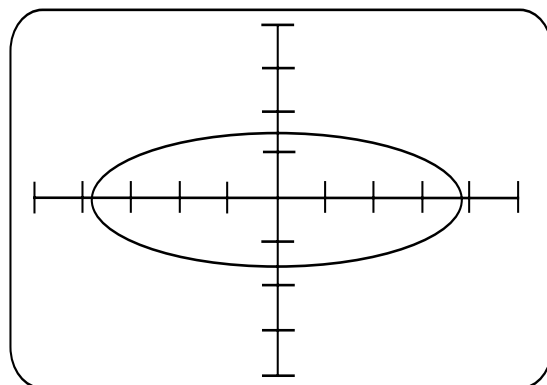


Figure 4-0Z7

82pF Capacitor
High Range
High Frequency

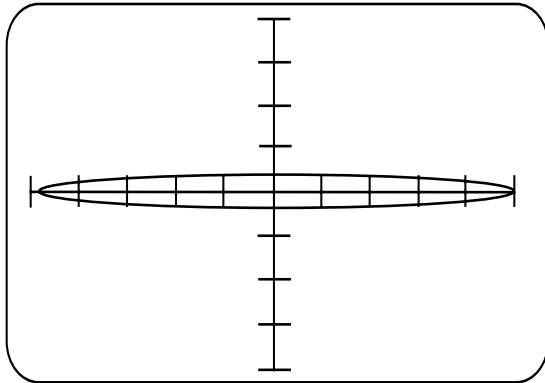


Figure 4-0Z8

47uF Capacitor
Low Range
Low Frequency
 Faulty capacitor
 Resistive

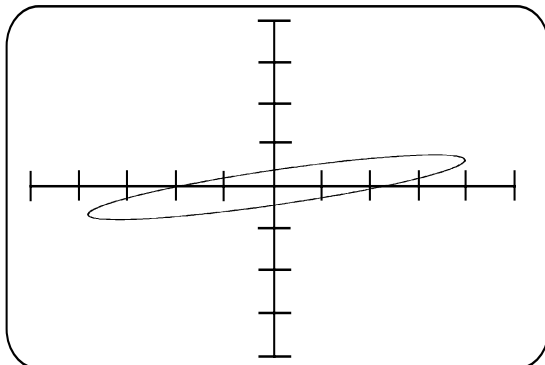
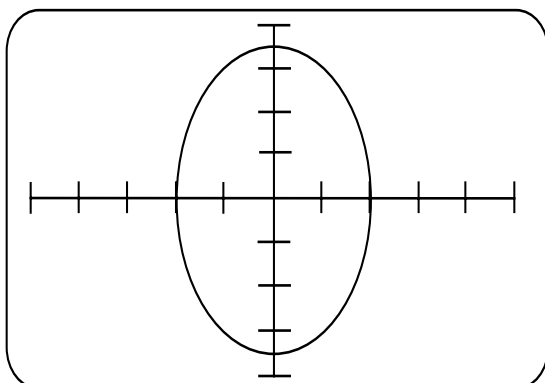


Figure 4-0Z9

47uF Capacitor
Low Range
Low Frequency
 Good component



Tables 4-3 and 4-4 show the ranges of capacitors and inductors covered by each combination of frequency and drive voltage.

Range	Frequency		
	Low	Med	High
Logic	300nF – 6uF	56nF – 1uF	15nF – 300nF
Low	6uF – 100uF	1uF – 20uF	300nF – 5uF
Med	30nF – 300nF	5nF – 68nF	1.5nF – 15nF
High	10nF – 150nF	2nF – 30nF	500pF – 7nF

Table 4-3 Capacitor Range

Range	Frequency		
	Low	Med	High
Logic	500mH – 11H	100mH – 2H	25mH – 500mH
Low	30mH – 500mH	6mH – 100mH	1.5mH – 25mH
Med	10H – 110H	2H – 10H	500mH – 5H
High	20H – 300H	4H – 50H	1H – 12H

Table 4-4 Inductor Range

Figure 4-10 shows the signature of a ferrite transformer primary winding with the test voltage range set **Low** and test frequency set **High**. This demonstrates the effect of a significant value of resistance causing the inductive ellipse to be tilted.

Figure 4-11 shows a similar (defective) transformer with a shorted turn.

The operator can select the most suitable test frequency with the **Low**, **Med** and **High** keys on the Range Panel. In a capacitor more current flows at higher frequencies and produces a larger vertical excursion of the signature. In an inductor more current flows at lower frequencies.

Figure 4-0Z10

Ferrite transformer
Primary winding
Low Range
High Frequency

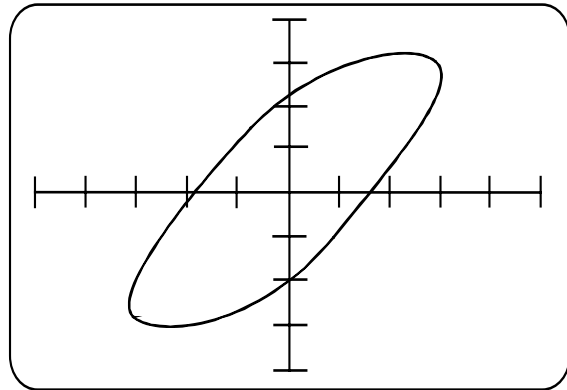
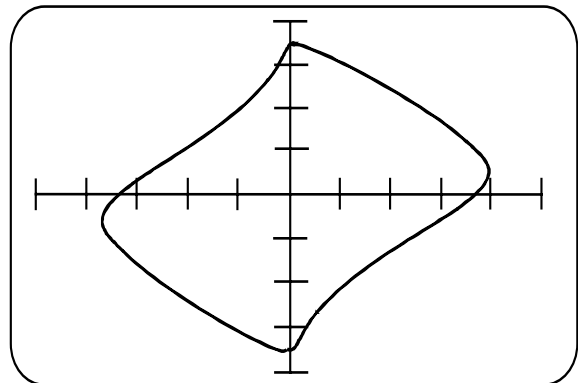


Figure 4-0Z11

Ferrite Transformer
Primary winding
Low Range
High Frequency
Shorted turn



SEMICONDUCTORS

4.3 Diodes, LEDs and Zeners

When forward biased, a diode exhibits a low resistance and a voltage drop of approximately 0.6V. This produces a signature that is an almost vertical trace close to the Y axis (see Figure 4-12).

When reverse biased, the high resistance characteristics of the diode approaches that of an open circuit, producing a horizontal trace close to the X axis. A light emitting diode (LED) shows a similar signature to a conventional diode, except that the forward voltage drop is approximately 1.5V.

A Zener diode exhibits the same signature as a conventional diode for voltages below the Zener voltage. When the reverse bias exceeds the Zener voltage, a low resistance signature is displayed. Figure 4-13 shows the signature of an 8.2V Zener diode.

When testing Zener diodes the graduations on the display X axis can be used to measure the Zener voltage (see Table 4-1 at the beginning of this section).

Suitable voltages ranges are:

Power diodes	Low
Signal diode and LED	Logic
Zener diode	Med up to 20V
	High above 20V

Note: The signatures are inverted if the test probe and COM connections are reversed.

Figure 4-0Z12

Signal diode
Logic Range
Low Frequency

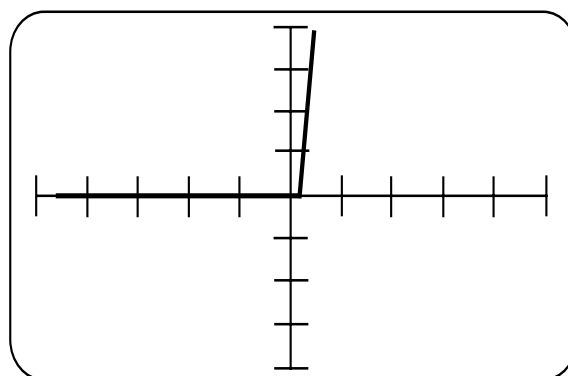
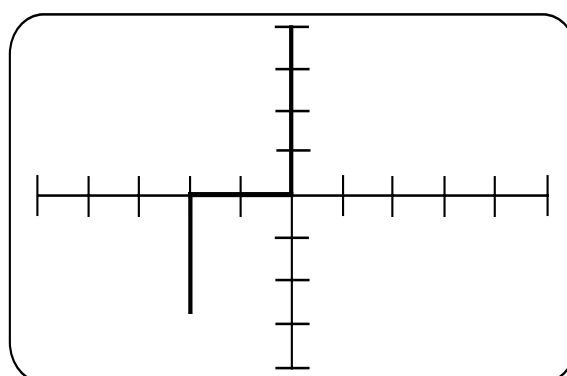


Figure 4-0Z13

8.2V Zener diode
Med Range
Low Frequency



4.4 Transistors

A transistor contains two semiconductor junctions connected "back-to-back" (one between base and collector, the other between base and emitter).

Figures 4-14 – 4-16 show typical signatures for an NPN transistor (in which the collector and emitter are N-type material and the base P-type).

The base-emitter signature (Figure 4-14) is similar to that for a Zener diode.

High-frequency small signal transistors should not be operated in this mode for long periods. Prolonged reverse-breakdown of the base-emitter junction may permanently affect the characteristics of the device.

See "Three Terminal Testing" for a method that does not reverse-bias the transistor base-emitter junction.

The base-collector (Figure 4-15) signature is similar to that of a conventional diode.

The collector-emitter signature (Figure 4-16) is similar to that of a diode in series with a Zener diode. When the drive voltage is positive (right quadrant) the collector-base is reverse biased and the base-emitter forward biased. The reverse biased collector-emitter prevents current flow, producing an open-circuit signature (a horizontal line).

When the drive voltage is negative (left quadrant), the collector-base is forward biased and the base-emitter reverse biased. The base-emitter exhibits Zener breakdown as described above, producing a Zener "tail" signature.

See the warning above about operation of the transistor with the base-emitter reverse biased.

The signatures for a PNP transistor will be mirror images of those for an NPN transistor.

Identifying Transistor Terminals

The terminals of an unknown transistor may be identified as follows:

Select **Logic** Range, **Low** Frequency.

Connect the COM clip to one lead of the transistor and probe the other two leads in turn, looking for a match with the signatures shown in Figures 4-14 – 4-16. If the signatures are mirror images of the figures, the transistor is a PNP device.

Figure 4-0Z14

NPN Transistor
base-emitter
Med Range
Low Frequency

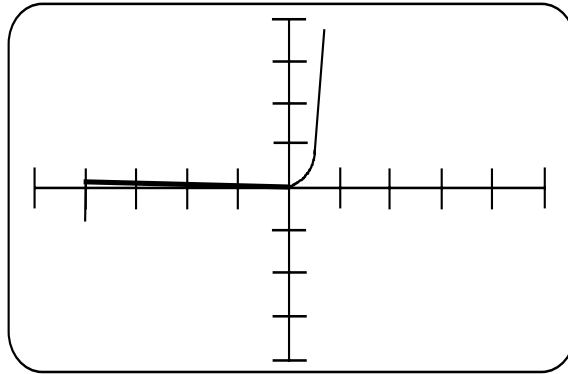


Figure 4-0Z15

NPN Transistor
base-collector
Med Range
Low Frequency

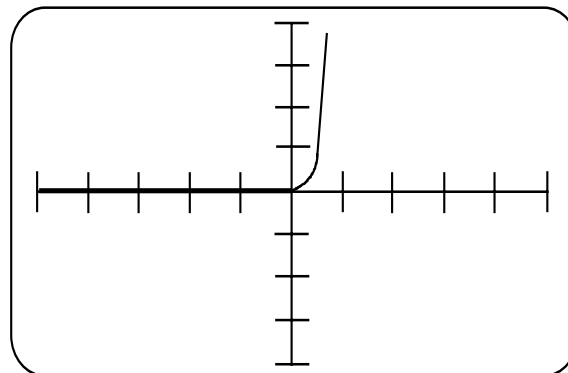
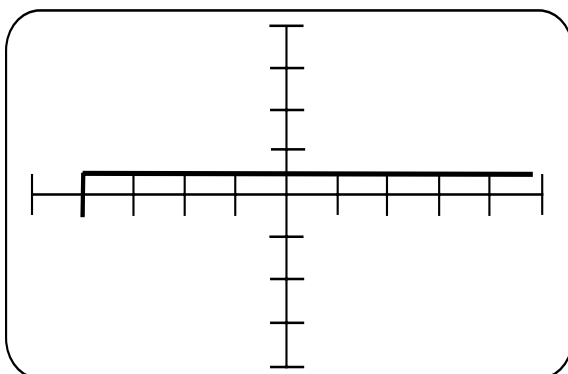


Figure 4-0Z16

NPN Transistor
emitter-collector
Med Range
Low Frequency



Three Terminal Testing of Transistors

A functional test may be carried out by driving the transistor base to verify that this controls conduction between the collector and emitter.

The following procedure applies to an NPN transistor. The meaningful part of the signature appears in the upper right quadrant of the display; ignore the lower left quadrant. Except where noted, the procedure for a PNP transistor is identical but displays will be mirror-images (i.e. the meaningful signature will appear in the lower left quadrant):

1. Connect the collector to Channel A, the emitter to COM and the base to one of the Pulse outputs.
2. Select **Logic** Range, **Low** Frequency, Pulser Mode **DC+** (for NPN) or **DC –** (for PNP). Set **Level** to 0.
3. The signature in the right quadrant is a horizontal line, indicating no conduction. As **Level** is increased, the base-emitter will become forward biased and the transistor will begin to conduct, producing a signature as shown in Figure 4-17. This signature is similar to that seen using a conventional curve-tracer except that only a single curve is shown. Increasing **Level** further will saturate the transistor, producing an almost vertical line close to the Y-axis.

Since the transistor is being operated as a switch, when it starts to conduct the signature may look more like that shown in Figure 4-18 (which is inverted because it is for a PNP transistor). This does not indicate a fault, but shows the device switching between normal conduction and saturation. A more stable display may be obtainable by selecting a different voltage range.

4. Selecting the **P1+** output from the Pulse Generator enables both the conducting and non-conducting signatures to be displayed. Leaving **Level** unchanged from the previous step, rotate the **Width** control to vary the pulse period. When the pulse is high, the base-emitter is forward-biased and the transistor will conduct. When it is low, the transistor will not conduct, producing an open circuit signature.

Figure 4-17

NPN Transistor
Low Range
Low Frequency
 collector-emitter
 Pulser Mode **DC-**
 to base

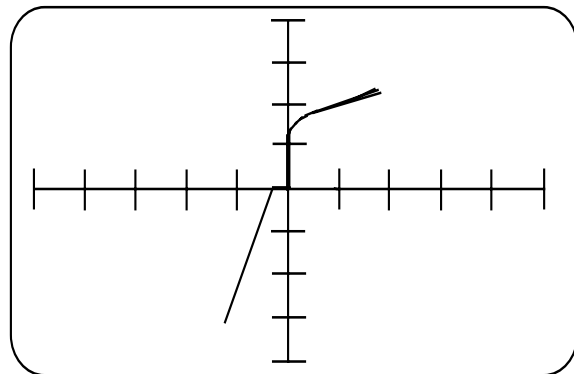
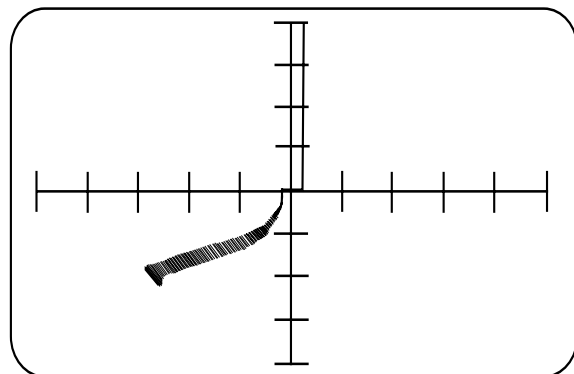


Figure 4-18

PNP Transistor
Logic Range
Med Frequency
 collector-emitter
 Pulser Mode **P1-**
 to base



4.5 Junction Field Effect Transistors (JFETs)

The junction field effect transistor (JFET) consists of a bar of semiconductor material (the "channel") and a region doped with material of the opposite semiconductor type to the channel (the "gate").

The gate forms a diode junction with each end of the channel (the "source" and "drain") and these may be tested as conventional diodes.

The signature between source and drain (Figure 4-19) shows a low value, non linear resistance. To obtain a stable display it is usually necessary to connect the gate to the source. An open circuit gate terminal is extremely sensitive to interference from the test signal.

Three Terminal Testing of Junction FETs

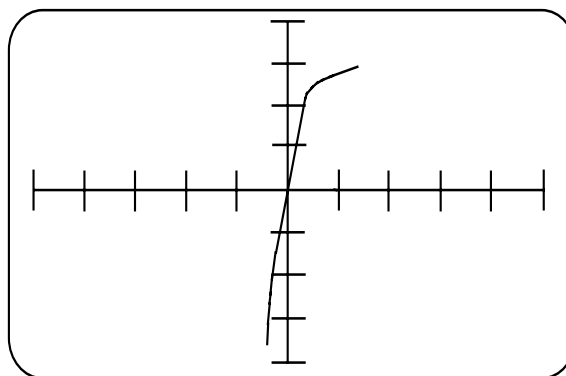
The conduction between the source and drain of a JFET is controlled by reverse biasing the gate-source junction.

The following procedure applies to an N channel FET. The meaningful part of the signature appears in the right quadrant of the display; ignore the left quadrant. Except where noted, the procedure for a P channel FET is identical and displays will be mirror-images (i.e. the meaningful signature will appear in the left quadrant):

1. Connect the drain to Channel A, source to COM, and the gate to one of the Pulse outputs.
2. Select **Logic** range, **Low** frequency, Pulser Mode **DC+** (for P channel) or **DC-** (for N channel). Set **Level** to 0.
3. When **Level** is zero, the drain-source signature will be similar to Figure 4-19. As **Level** is increased (increasing the reverse bias of the gate-source junction), conduction in the channel is reduced. As **Level** is further increased, all conduction will cease and the signature in the right quadrant will be a horizontal line.

Figure 4-19

Junction FET
Logic Range
Low Frequency
 drain-source
 Pulser Mode **DC+**
 to gate



4.6 MOSFETS

*CAUTION: Observe static precautions whenever handling MOSFETs. Use **Logic** range for testing (or **Low** for power MOSFETs). Do not use **Med** or **High** ranges.*

MOSFETs are field effect transistors in which the gate is insulated from the channel. The gate-drain and gate-source tests will usually produce an open-circuit signature, although some MOSFETs have a protection diode between the gate and source. In these cases the gate-source signature will be that for a Zener diode (Figure 4-13).

Three Terminal Testing of MOSFETs

As in a JFET, source-drain conduction is controlled by the gate-source voltage. However, MOSFETs are available that operate in either "enhancement" or "depletion" mode, where conduction is controlled by forward/reverse bias of the gate-source junction respectively. Follow this procedure for an N channel, enhancement mode MOSFET. The meaningful part of the signature appears in the right quadrant of the display; ignore the lower left quadrant. Except where noted, the procedure for a P channel FET is identical and the displays will be mirror-images (the meaningful signature will appear in the left quadrant):

1. Connect the drain to Channel A, source to COM, and the gate to one of the Pulse Generator Outputs.
2. Select **Logic** range, **Low** frequency, Pulser Mode **DC+** (see note below). Set **Level** to 0.

To determine the polarity required for the gate drive, note that the junction is forward biased for enhancement mode FETs and reverse biased for depletion mode. Thus N channel enhancement mode and P channel depletion mode FETs require positive gate voltage, N channel depletion and P channel enhancement mode FETs require negative gate voltage.

3. When **Level** is zero, the drain-source signature will be a horizontal line indicating no conduction. As **Level** is increased (increasing the forward bias of the gate-source junction) conduction in the channel is increased, producing a signature as shown in Figure 4-19. As **Level** is further increased, conduction will increase until the signature approaches that of a very low resistance (an almost vertical line).

4.7 Opto Isolators

An opto isolator consists of an input LED and an electrically isolated output transistor (with base unconnected).

The input diode can be checked like a conventional diode. The signature of the output transistor (i.e. its collector-emitter characteristic) will be either a horizontal line (open-circuit) or similar to Figure 4-16.

Three Terminal Testing of Opto Isolators

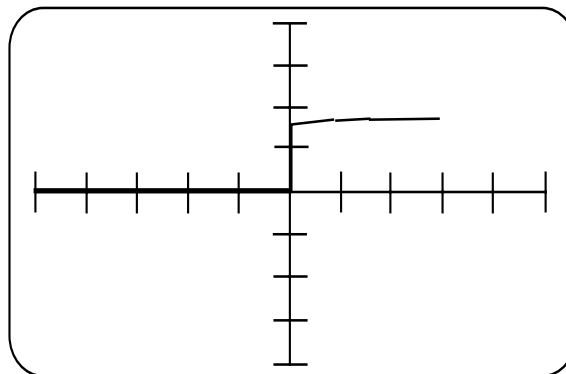
The conduction of the output transistor is controlled by light emitted by the input LED. This stimulates the creation of charge carriers in the transistor, causing it to conduct.

The opto isolator operation may be tested by driving the input LED using the Pulse Generator, and displaying the signature of the output transistor.

1. Connect the output transistor collector to Channel A and emitter to COM. Connect the input LED anode to one of the Pulse outputs, and the cathode to COM.
2. Select **Logic** range, **Low** frequency, Pulser Mode **DC+**. Set **Level** to 0.
3. The signature in the right quadrant is a horizontal line, indicating no conduction . As the **Level** is increased, the LED will be forward biased. Light emitting from the LED will stimulate conduction in the output transistor, producing a signature as shown in Figure 4-20. Further increasing **Level** will saturate the output transistor, producing an almost vertical line in the right quadrant close to the Y-axis.

Figure 4-20

Opto isolator
Logic Range
Low Frequency
 Pulser Mode **DC+**
 Output transistor
 collector-emitter



4.8 SCRs

An SCR can be regarded as a diode with an additional control terminal (the "gate").

1. Connect the anode to Channel A, cathode to COM and the gate to one of the Pulse outputs.
2. Select **Low** range, **Low** frequency, Pulser Mode **DC+**. Set **Level** to 0.
3. The signature produced is a horizontal line, indicating no conduction. As **Level** is increased, gate current flows. When this reaches a sufficient value, the SCR "triggers" i.e. conducts, producing a signature similar to that for a conventional diode (Figure 4-12).
4. Selecting the **P2+** pulse output enables both conducting and non-conducting operation to be displayed. Leaving **Level** unchanged from the previous step, rotate the **Width** control to vary the pulse period. When the pulse is high, the SCR conducts. When it is low, the SCR is switched off. The signature is shown in Figure 4-21. The horizontal line corresponds to the time the pulse is low, and the vertical line to the time the pulse is high.

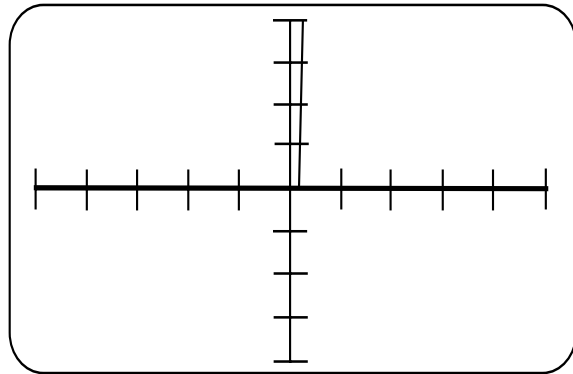


Figure 4-21
SCR Signature

4.9 Triacs

A Triac is similar to an SCR, except that it conducts in both directions, and can be triggered by either positive or negative gate current.

1. Connect the MT2 terminal to Channel A, MT1 to COM and the gate to one of the Pulse outputs.
2. Select **Low** range, **Low** frequency, Pulser Mode **DC+**. Set **Level** to 0.
3. The signature is a horizontal line, indicating no conduction. As the **Level** is increased, gate current flows. When this reaches a sufficient value the Triac "triggers" i.e. conducts, producing a signature similar to that for a conventional diode (Figure 4-12). Further increasing **Level** causes the Triac to conduct in both directions, producing the signature shown in Figure 4-22.
4. Return **Level** to zero, then select negative Pulse polarity. Repeat step 3 to produce similar signatures.
5. Selecting the **P2** pulse output enables both the conducting and non-conducting operation to be displayed. Leaving **Level** unchanged from the previous step, rotate the **Width** control to vary the pulse period. When the pulse polarity is positive, the resultant signature is the same as for the SCR (Figure 4-21). When the polarity is negative, the display is a mirror image of Figure Figure 4-21).
6. Selecting **positive and negative (P2+/-)** pulses results in conduction in both directions, and produces the signature shown in Figure 4-23.

Figure 4-22

Triac
Low Range
Low Frequency
 Pulser Mode **DC+**
 MT2 – MT1

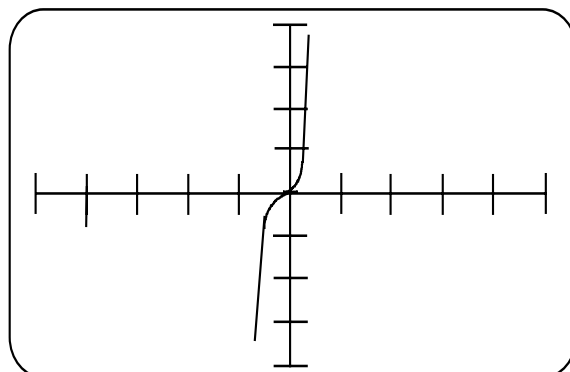
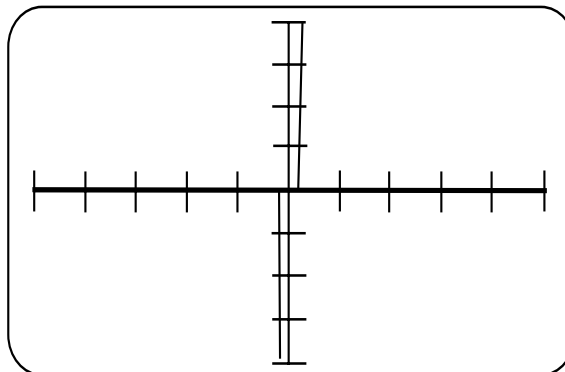


Figure 4-23
Triac Signature



INTEGRATED CIRCUITS

The **Logic** and **Junction** ranges and **Low** frequency are recommended for use when testing ICs.

All integrated circuits can be tested by probing pairs of terminals. Most ICs tested in this way display signatures similar to diodes or Zener diodes.

Note: ICs manufactured using different technologies can have distinctly different signatures. This must be considered before diagnosing a device as faulty.

When testing an IC it is usually appropriate to connect COM to the ground pin of the IC. Alternatively COM can be connected to Vcc.

In some circumstances unstable signatures can occur. Connecting **both** ground and Vcc pins to COM can overcome this effect.

Figures 4-24, 4-25 and 4-26 show signatures for a 74LS00 IC.

The signature in Figure 4-24 is dominated by the input protection diode with its anode connected to the COM probe via circuit ground.

The signature in Figure 4-25 is more complex as several output components within the IC influence the trace. The signature in Figure 4-26 shows the effect of a network of components within the IC.

The corresponding signatures for an HC gate (74HC02) and 4000 series CMOS (4017) are shown in Figures 4-27 to 4-29 and Figures 4-30 to 4-32 respectively.

Figure 4-0Z24

74LS00
Logic Range
Low Frequency
 Input to ground

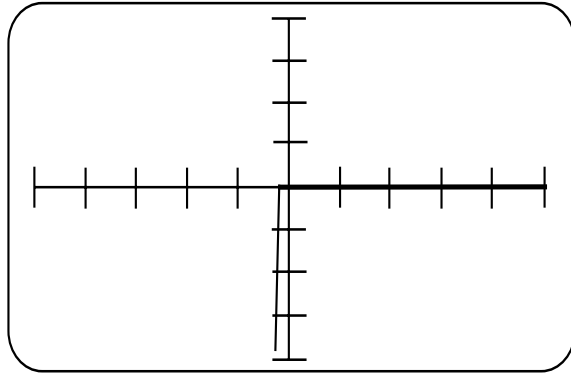


Figure 4-0Z25

74LS00
Logic Range
Low Frequency
 Output to ground

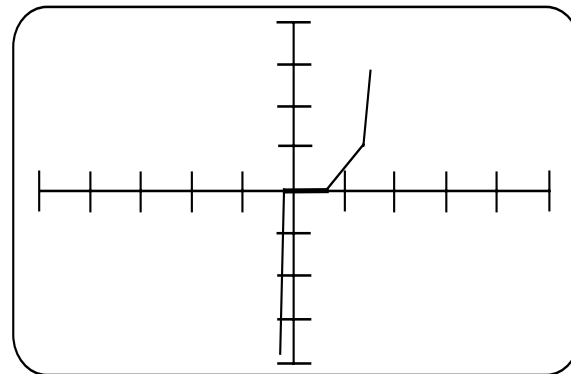


Figure 4-0Z26

74LS00
Logic Range
Low Frequency
 Vcc to ground

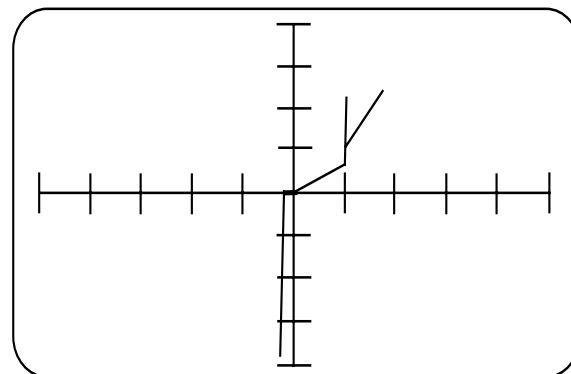


Figure 4-0Z27

74HC02
Logic Range
Low Frequency
 Input to ground

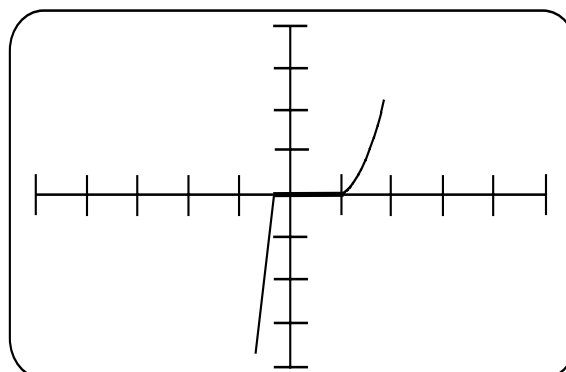


Figure 4-0Z28

74HC02
Logic Range
Low Frequency
 Output to ground

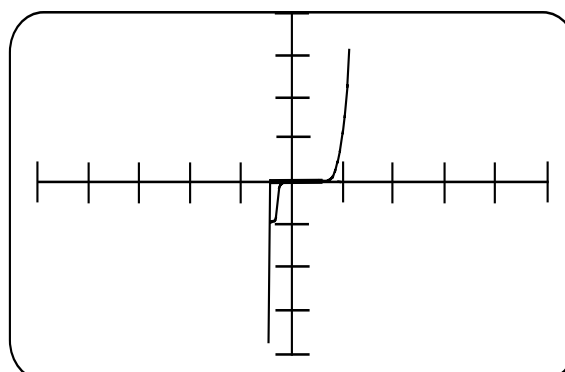


Figure 4-0Z29

74HC02
Logic Range
Low Frequency
 Vcc to ground

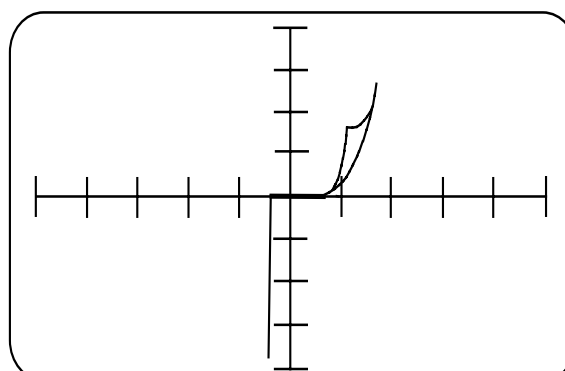


Figure 4-0Z30

4017
Logic Range
Low Frequency
 Input to ground

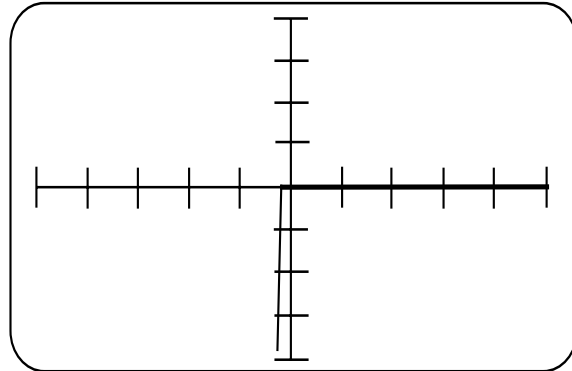


Figure 4-0Z31

4017
Logic Range
Low Frequency
 Output to ground

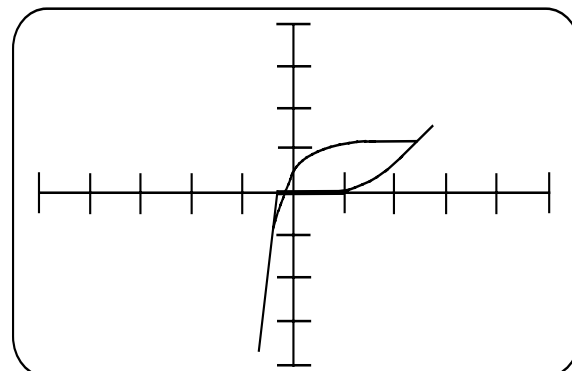
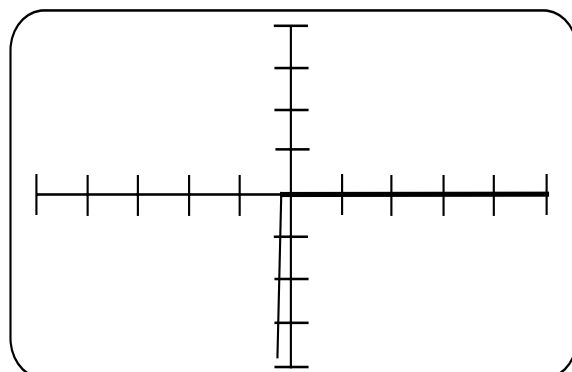


Figure 4-0Z32

4017
Logic Range
Low Frequency
 Vcc to ground



An example of a defect in an IC is shown in Figures 4-34 and 4-35. Figure 4-34 shows the signature between input and ground of a good IC type 7650 tested in circuit. Figure 4-35 shows the signature of a defective 7650 in the same circuit, where the input protection diode has become leaky.

Note that in Figures 4-28, 4-29, 4-31, 4-34 and 4-35 loops are evident due to capacitance within the ICs. Using **Med** or **High** frequency will exaggerate this effect. In general **Low** frequency should be used when testing ICs.

Figure 4-34

7650 in circuit
Logic Range
Low Frequency
Input to ground

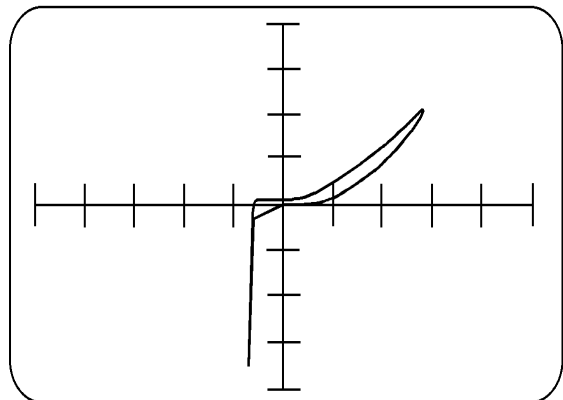
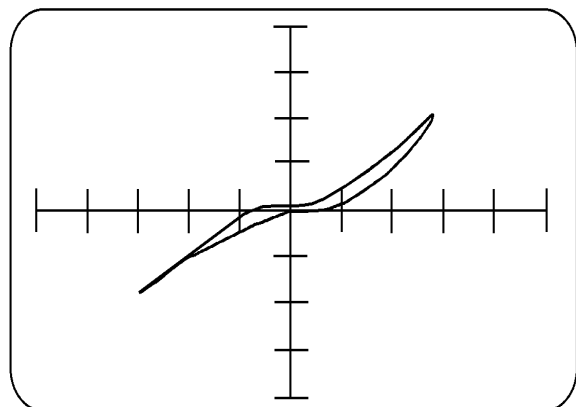


Figure 4-35

7650 in circuit
Logic Range
Low Frequency
Input to ground
Defective device



4.11 Testing Devices in Circuit

When testing a component in circuit, the signature is a composite of that device and other components in parallel. This is most often the case when diagnosing faults in service.

The characteristic signature at any probing point in a circuit is unique for that circuit. Using channels A and B to display the signatures of a suspect circuit and that of a good circuit is the best way to identify a fault.

A faulty component may affect the signatures of several connected components. The operator can 'home-in' on a fault by probing at several points in the circuit.

Circuit Example

Figure 4-37 is the signature of the power supply circuit shown in Figure 4-36 when probed at the secondary winding of the transformer. The ranges used are **Low** voltage and **Low** frequency. The looping of the signature is caused primarily by the smoothing capacitor (C1). The slope of the axes of the ellipse arise from diode resistances in circuit. The "knees" at either end of the ellipse are caused by the diodes in the rectifier bridge.

Figure 4-0Z36

Power
Supply
Circuit

Figure 4-37

Signature at
secondary winding
good circuit

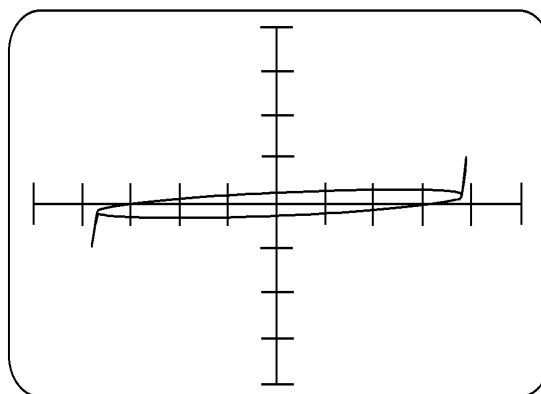


Figure 4-38

Signature at
secondary winding
D3 short circuit

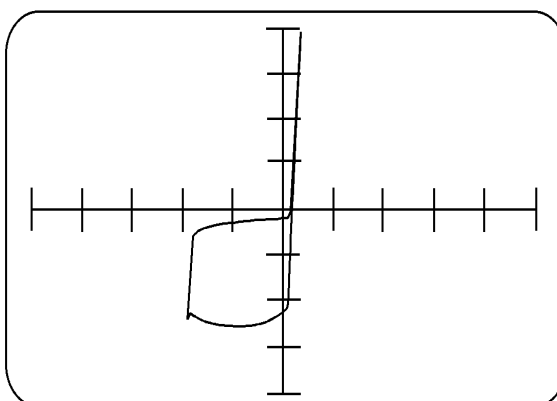


Figure 4-38 shows the effect on the signature in Figure 4-37 when one diode (D3) develops a short circuit.

During the positive half cycle of the drive voltage (right quadrant) the signature is effectively that of diode D1. The remaining components are short circuited by D3. During the negative half cycle (left quadrant) the signature is a composite of two current paths, one through the transformer secondary, the other through the short circuited D3, C1 and D2.

It is rarely necessary to analyse signatures in such detail. In this example the lack of symmetry clearly indicates the fault.

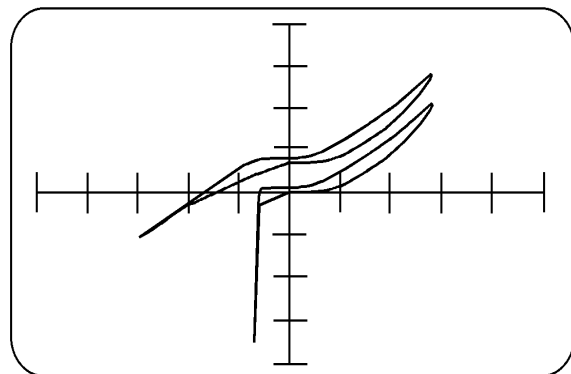
Moving the probes to test each component in the circuit quickly leads to probing across the short circuited diode.

Figure 4-40 shows the effect of superimposing two signatures to aid comparison diagnosis.

Note: When comparing the signatures of two circuits ensure that both circuits are connected to COM at the equivalent circuit points.

Figure 4-40

7650 in circuit
Input to ground
Channel 'A' (upper)
– defective
Channel 'B' (lower)
– good



4.12 Testing Bus-connected devices

When a number of devices are connected together on a common bus, the signatures on the bus lines may be compared to look for differences. Lines on the same bus will usually have similar signatures (eg all data lines will be similar to each other). If one line has a different signature from other lines on the same bus, this suggests that a device on that bus is faulty.

To isolate the fault to a specific device there are a number of methods:

1. If any devices are socketed, remove them one by one until the defective line's signature matches the other lines.
2. Each device will have one or more pins that are **not** connected to a bus, eg /CE (Chip Enable) or /OE (Output Enable). This provides a method for looking at the ICs individually. Instead of connecting the T3000's COM input to Vcc or ground, connect it to the defective bus line. Probe each of the devices' /OE or /CE pins, looking for a device whose signature differs from other similar devices.
3. If neither of the above methods locate the fault, it may be necessary to unsolder devices until the fault is cleared.

Figure 4-42 shows the signature of a data bus line of a microprocessor in circuit.

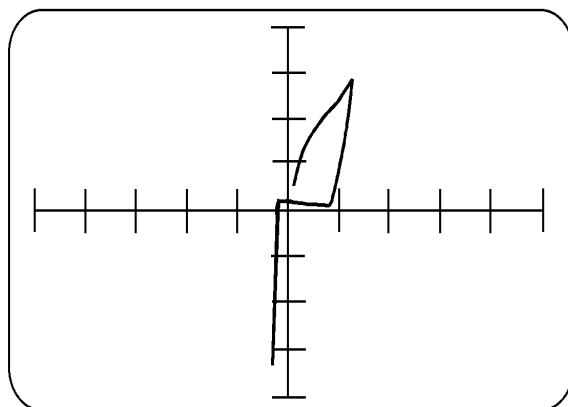


Figure 4-42

Microprocessor
data bus
in circuit

SECTION 5 – UTILITIES

THE UTILITIES MENU

5.1 *Setting up the T4000 control program environment*

The **Utilities** menu is provided to allow users customise the T4000 operating environment. From the **Utilities** menu the T4000 programmer can:

- Define passwords and operator access rights
- Specify which of the host's serial communication ports will be used to transfer data and commands
- Install the printer program to print hard copies of signatures
- Run diagnostic tests

These functions will normally be performed during installation.

The **Utilities** menu also provides the facility to:

- Compensate for capacitance in the scanning system and test clips
- Terminate the current T4000 session and exit to the MS-DOS operating system.

Select the **Utilities** option – the **Utilities** menu is displayed:

S ecurity
set T4000 com port
G raphics driver
D iagnostics
L oop compensation
e X it to dos

5.2 *Specifying the serial communication port*

Commands and data are transferred over the RS232 serial communications link via one of the host computer's serial communications ports. To specify which of the host's ports will be used to transfer data and commands, select the **set T4000 com port** option – the system displays the current communication port and prompts for a new port number:

e.g.

current com port – COM1 enter new com port number (1 – 4) _
--

Specify a new communication port if necessary – the system will enable the selected port and return to the **Utilities** menu. (Port 1 is usually correct if only one port exists. Some other device, e.g. a mouse, serial printer, etc., may, however, already be connected to port 1. It may be necessary to try the other communication port numbers until communication is established.) It is not necessary to specify the serial communication parameters – they will be set by the T4000 control program.

5.3 *Installing the Graphics driver*

The T4000 incorporates the facility to display device signatures on screen and produce hard copies if a suitable printer is attached to the host computer. To produce hard copies of signatures, it will be necessary to install the correct graphics driver; (i.e. load a program into memory that allows the operating system to print the displayed contents of the screen).

Note: *This setting is used only when printing signatures. It is ignored by other print functions. The facility to print device signatures is only available if MS-DOS version 5 has been installed on the host computer. If MS-DOS version 5 is not installed, or if printing is not required the printer option should be set to #0 (none.)*

Select the **Graphics driver** option – the list of supported printers is displayed. For details of which driver is required, refer to the MS-DOS User's Guide.

In the **Printer** box, enter the number which corresponds to the type of printer that will be used to produce hard copies of device signatures:

Printer :– (1 – 16)

(If unsure of the printer type, select number #6.)

Use the <Delete> and <Backspace> keys to correct any typing errors or press the <F9> key to clear the whole entry. When the correct number is displayed press <Enter>.

When a driver is selected, the T4000 program will insert the associated command into one of the host system's start up files (the "autoexec.bat" file.) To load the driver into memory, press the Control, Alt and Del keys simultaneously to "reboot" the host computer. At the command prompt, type **T4040**, **T4080** or **T4128** (for T4128 and T4000) as appropriate to restart the T4000 program.

Follow the above procedure if it becomes necessary to change the installed driver (e.g. to change to a different printer.)

Ensure the printer is switched on, correctly loaded with paper and "On-line" before attempting to print device signatures.

5.4 System Security

The **Security** option allows a system supervisor to set up a password to protect test programs and system settings from accidental erasure or modification. The T4000 system has two security states: "Locked" and "Unlocked". The current security status is displayed on the Main menu page.

When the system is Unlocked, the operator has access to all facilities.

When the system is Locked, an operator cannot access the Program, File management or Security functions; the Instructions file displayed during Test is read-only; the Initialise option to clear the test results data log is locked-out. If a user selects a protected function while the system is Locked, he will be prompted to enter the password to unlock the system.

Once the password has been entered, the system will remain Unlocked until the PC is rebooted or the Restrict Access function is used (see below).

Select **Security** – the main **Security** menu is displayed:

Set new password
Delete current password
Restrict access

The current password status is shown in the security status box: e.g.

System password programmed – NO

Setting passwords

Select the **Set new password** option and enter a new password at the prompt:

Enter new password –

The new password is replaces the old password (if set) and the system password status changes from **NO** to **YES**. Setting (or altering) a password will automatically set the Security Status to "Locked".

Restricting Access

The **Restrict Access** command permits the user to change the Security Status to Locked without rebooting the PC.

Note: A password must be currently set for the **Restrict access** option to be valid. If no password has been set, the system prompts for a password to be programmed.

5.5 *Diagnostics*

The **Diagnostics** option displays information necessary to assist Polar Instruments personnel when providing technical support.

5.6 *Loop compensation*

The T4000 provides the facility to compensate for capacitance in the Scanner system and test clips:

Remove the clips from the device under test and select **Loop compensation**; the T4000 performs an automatic loop compensation routine to "null out" the effects of the capacitance of the test clips. This will minimise the effects of capacitance within the measurement system on displayed signatures.

5.7 *Exiting the T4000 program*

At the end of a test or programming session, select the **eXit to dos** option, either from the Main menu or from the Utilities menu to terminate the current T4000 session and exit to the PC/MS-DOS operating system. The PC will return to the command prompt.

SECTION 6 – LIVE MODE

6.1 T4000 Live mode

In this section we examine the functions and discuss the manual operation of the T4000 – in the next section we discuss the programmed operation of the T4000 and write test programs to perform complex and repetitive operations automatically.

Live mode allows the user to operate the T4000 to examine device signatures directly either with the supplied test probes or, in the case of multi-pin devices, using the integral scanner and IC test clips.

In **Manual** mode the operator can manually select the drive voltage and frequency appropriate to the impedance under test. If **Auto** is selected the instrument will select an appropriate drive voltage automatically. The **Cycle** function allows the operator to view signatures sequentially on all drive ranges.

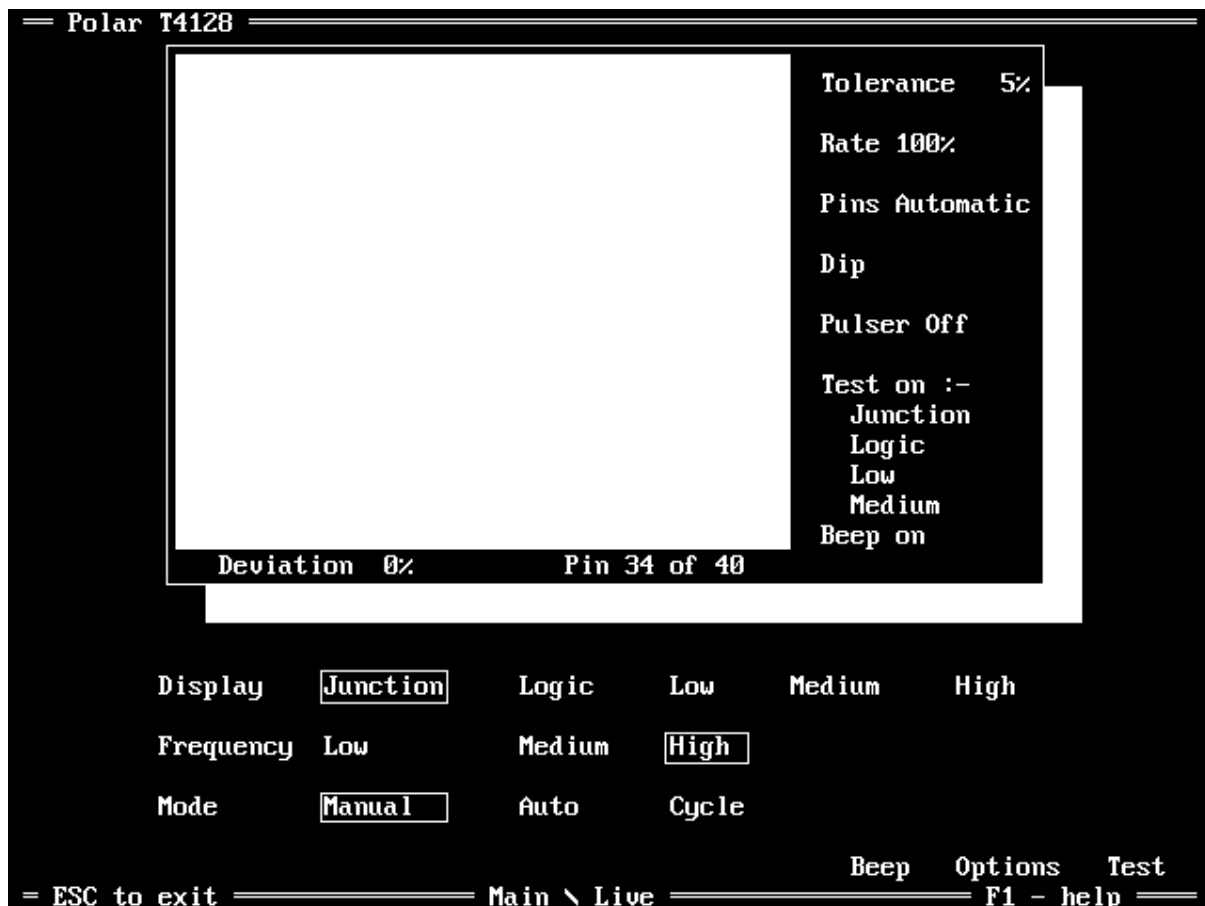


Figure 6-1 The Live screen

Component signatures are displayed on the display window of the host computer's screen. The signatures of devices connected to Channel A are shown in green, Channel B signatures are shown in red.

6.2 T4000 test facilities

The T4000 provides facilities for testing a wide variety of devices from simple two terminal devices to multi-pin modules using a range of test formats and the built-in Pulse Generator and IC Scanner.

Test formats

The T4000 includes three test formats:

- Probes** – for two terminal devices (e.g. resistors, capacitors, inductors and diodes)
- Sip** – for single in-line packages or surface mounted device probes
- Dip** – for dual in-line packages

In the **Sip** and **Dip** modes the T4000 Scanner can rapidly compare the signatures on the pins of a pair of ICs, automatically determining the number of pins on the ICs and displaying test results and signatures for each pin in order of error or pin number on the screen of the host computer.

The **Sip** and **Dip** formats will also be found useful when testing other package formats, e.g. modules with edge connectors.

The T4000 pulse generator

The T4000 incorporates pulse generating circuitry which allows the conduction state of transistors, SCRs, Triacs and other 3-terminal devices to be controlled by adjusting the level, width, polarity and time delay of pulsed outputs.

The Pulse Generator produces identical outputs between the two blue PULSE OUT sockets (which are connected internally in parallel) and the black COM sockets.

The Pulse Generator is controlled from the **Options** window and allows the operator to carry out a range of tests on a wide variety of three-terminal devices. The level of the pulser can be adjusted on the LIVE screen using either the +/- keys or the Page Up/Page Down keys.

The T4000 Scanner

The T4000 Scanner facilitates the rapid and convenient testing of a wide range of ICs in or out of circuit, enabling the signature of each IC pin to be automatically compared with known good signatures and displayed for inspection on the PC screen.

The T4000 is able to sequentially scan each pin of the IC under test, applying the test stimuli set by the **Voltage** and **Frequency** ranges, and compare the signatures with the signatures of a known good device.

Good device signatures may be derived from an adjacent similar device where available. The T4000 uses channel A as the reference.

TESTING DEVICES

In this section we show how the T4000 may be used to examine the signatures of two-terminal, three-terminal and multi-pin components.

For a full discussion of testing techniques for common devices and circuits see SECTION 4 – *DEVICE TESTING*.

6.3 *Testing two terminal devices*

Connecting the test cables

The T4000 is supplied with a pair of DVM style probes and a clip-on common return lead, which are connected to the A, B and COM sockets respectively.

Connect the Red probe to the Channel A socket, the Black probe to the Channel B socket, and the black test clip to a COM socket.

Connect the COM test clip to the ground of the board under test. If two boards are being compared, both grounds must be connected to the instrument's COM sockets.

The Channel A and B test probes are connected to the ungrounded ends of the devices under test – use Channel A as the reference channel; i.e. connect Channel A to the known good device.

6.4 Options – Specifying the test parameters

From the Main menu select **Live** then select **Options** to specify the test format and tolerance – the **Options** window is displayed:

Test Ranges	Junction	Logic	Low	Medium	High
Tolerance	50%				
Step Rate	100%				
Format	Dip				
Pins	Automatic				
Pulser Mode	Off				
Level	50%				
Width	50%				
Use Cursor Keys					

Figure 6-2 The Options window

The T4000 format, voltage and frequency settings are stored between sessions, so the settings displayed will be those from the previous session.

Defining test conditions

To specify test conditions, highlight the desired option (Format, Tolerance, etc.) using the up and down cursor keys and change the option setting with the left and right cursor keys.

6.5 The Format option – specifying the package type

To test two-terminal devices it will be necessary to select the **Probe** format; highlight the **Format** option and use the left or right cursor keys to scroll through the **Format** menu to select the **Probe** setting.

6.6 The Tolerance option – Setting the comparison threshold

The **Tolerance** option allows the user to alter the sensitivity of the signature comparison. **Tolerance** is specified as a percentage value.

The **Tolerance** setting will allow percentage values from 1 – 99% to be specified. Lower values represent a more exacting comparison, higher values will allow greater differences in signatures.

Use the left and right cursor keys to set **Tolerance** to a value of 5%.

The most effective values will be found by experiment; 5% will be found a good starting value; i.e. a value which will allow normal component tolerances but capture faulty devices.

(Users will normally find it most convenient to start testing with **Tolerance** set to approximately 5%. Its value may then be adjusted to make comparisons more or less sensitive, to allow for normal variations of similar components from different suppliers, tolerances, etc.)

Press the <Esc> key to store the settings and return to the **Live** screen

The two device signatures should appear on screen, the reference signature in green, the signature of the device under test in red.

Test Range selection

The **Live** screen menu provides for manual or automatic selection of drive voltages, frequencies and automatic testing. This allows the operator to select the most appropriate voltage and frequency range for a component or circuit under test. See Figure 6-3

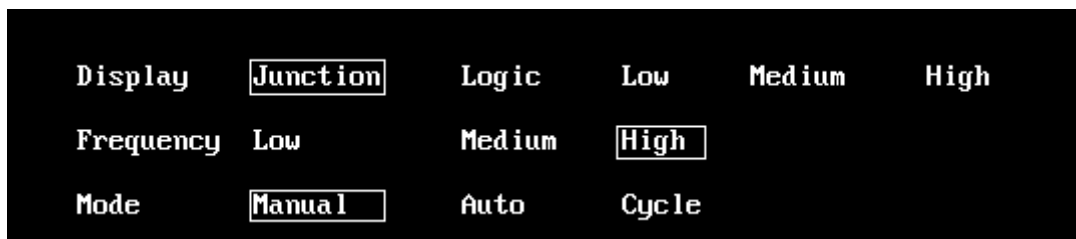


Figure 6-3 Test Range selection menu

6.7 Selecting the Voltage range

Drive voltages and frequencies may be defined manually or automatically.

Manual selection

Press the **Mode** hot key (the **M** key) until **Manual** mode is selected.

The T4000 provides a range of current limited drive voltages:

Setting	Voltage Range	Application
Junction	1V AC peak 500µA current limit	Use on semiconductor components and circuits, e.g. signal diodes, recommended for testing ICs.
Logic	10V AC peak 5mA current limit	Safe for use on most circuits. Ideal for light emitting diodes. Low voltage and current reduce the possibility of over stressing components.
Low	10V AC peak 150mA current limit	Low resistance circuits and power diodes. Not suitable for low power components.
Med	20V AC peak 1mA current limit	Medium resistance circuits or components, Zener and other diodes with breakdown voltages up to 20V. Useful for checking diode leakage.
High	50V AC peak 1mA current limit	High resistance components. Diodes with breakdown voltages in the 20V to 50V range, and diode leakage.

Note: The **Junction** range is available on the T4128 and T4000 only.

Only one drive voltage can be selected at a time.

Use the **Display** hot key or the left and right cursor keys to select the drive voltage to provide meaningful signatures (this will usually mean choosing the range which produces maximum deflection).

By selecting the higher voltage ranges larger values of current flow and more recognisable sloping signatures are displayed.

6.8 Selecting the Frequency range

The operator can select the most suitable test frequency, **Low**, **Med**, or **High** with the **F** Frequency hot key.

Signature shapes

The signature produced by a pure resistance is an inclined straight line whose slope (gradient) is dependent on the value of resistance. For a purely resistive component the frequency selected will not significantly affect the appearance of the signatures.

Due to their energy storage characteristics, reactive components produce a phase shift between voltage and current flow. This is displayed as a circular or elliptical signature. For pure reactances the major and minor axes of the ellipse align with the display axes. If the resistive component of a circuit is significant compared with the impedance of the reactive component, the elliptical signature will be tilted. By choosing a different test frequency to vary the impedance, the effect of resistance can be exaggerated or minimised as required. In a capacitor more current flows at higher frequencies and produces a larger vertical excursion of the signature. In an inductor more current flows at lower frequencies.

See SECTION 4 – *DEVICE TESTING* for a discussion of semiconductor device signature shapes.

The following table is included as a guide to frequency selection.

Setting	Application
Low	90Hz signal is used for most troubleshooting.
Med	500Hz signal used to produce signatures of circuits with larger value inductors or capacitors; e.g. components in power supply circuits.
High	2kHz signal used to produce signatures of circuits with small value inductors or capacitors.

Only one frequency can be selected at a time.

Note: some "looping" of the displayed signature (due to stray capacitance) may occur even when the probes are not connected to the circuit under test, especially if **High** frequency is selected.

6.9 Automatic Test Facilities

The **Mode** setting also provides the operator with alternative methods of selecting the best signature.

The **Auto** mode automatically selects the optimum voltage range; **Cycle** mode continuously cycles through the allowed ranges, displaying the signatures on each voltage range.

The two automatic test modes, **Auto** mode and **Cycle** mode, are used in conjunction with the **Test Ranges** and **Step Rate** options.

Auto mode

Select **Auto** mode by pressing the **Mode** hot key until **Auto** is highlighted – the T4000 automatically selects one of the available voltage ranges to produce a meaningful display.

Test Ranges – Specifying the test voltage ranges

The voltage ranges available to the **Auto** and **Cycle** modes are defined via the **Test Ranges** option.

Activate the **Options** window via the **Options** hot key – ensure the **Test Ranges** option is highlighted.

At least one voltage range is made available at all times.

To specify a voltage range, highlight the range with the left and right cursor keys (highlighted ranges are shown boxed in red) and press the <Enter> key to activate the range (activated ranges are highlighted in blue).

Pressing the <Enter> key toggles a voltage range on and off. Up to four of the five available ranges may be specified.

Press the <Esc> key to save the options and return to the **Live** screen. **Auto** mode will automatically select one of the specified test ranges.

If two channels are displayed, Channel A will be used to select the range.

To exit **Auto** mode, press the **Mode** hot key or select a **Display** range (using the **Display** hot key). Selecting a **Display** range automatically returns the **Live** mode to **Manual**.

Cycle mode

Select **Cycle** mode – the T4000 will cycle through the specified test voltage ranges.

6.10 The Step Rate option

In certain circuit configurations, high capacitance values may result in charging times which are much greater than the signature acquisition time. This can cause the signature to vary in shape during the acquisition time. Using the **Step Rate** option, the user can adjust the rate at which signatures are acquired.

The dwell time on each range is thus determined by the setting of the **Step Rate** option.

Step Rate is specified as a percentage value; high values result in a short dwell time and a high switching rate – reduce the **Step Rate** percentage value to offset the effect of circuit capacitance. The optimum switching rate may be found by experiment. Setting the rate to 0% will cause the T4000 to single step on each pin of the device during **Learn** and **Test**.

To stop cycling, press the **Mode** hot key or select a **Display** range.

6.11 Testing three terminal devices

Pulse Generator applications

Connect the Pulse Generator cables to the two blue, PULSE OUT sockets on the connector panel.

Note that the PULSE OUT signals are identical but driven individually, so that, although the same pulse output appears on both connectors, a load on one output does not affect the other.

The Pulse Generator produces identical outputs between the two blue PULSE OUT sockets (which are connected internally in parallel) and the black COM sockets.

The **Pulser Mode** options in the **Options** window control the operation of the T4000 Pulse Generator and allow the operator to carry out a wide range of tests on three terminal devices. The level of the pulser can be adjusted on the LIVE screen using either the +/- keys or the Page Up/Page Down keys.

The **Pulser Mode** options are summarised in the table below:

Mode	Function
DC+	Selects a + DC voltage output. The level is adjusted with the Level control.
DC–	Selects a – DC voltage output. The level is adjusted with the Level control.
PULSE 1 + (P1+)	Selects a positive going pulsed voltage output with a characteristic shown in Figure 6-4a.
PULSE 1 – (P1–)	Selects a negative going pulsed voltage output with a characteristic shown in Figure 6-4a.
	The P1 pulse starts <i>at the zero crossover point</i> of the AC drive voltage waveform. The pulse width is determined by the Width control and its amplitude by the Level control.
PULSE 2 + (P2+)	Selects a positive going pulsed voltage output with a characteristic shown in Figure 6-4b.
PULSE 2 – (P2–)	Selects a negative going pulsed voltage output with a characteristic shown in Figure 6-4b.
	The P2 pulse starts <i>after the zero crossover point</i> at a position in the AC test waveform determined by the Width control. The pulse ends at the next zero crossover point. Its amplitude is varied by the Level control.
P1+/-	Selects a pulsed voltage output of both polarities with a characteristic shown in Figure 6a. Pulse width is set by the Width control and amplitude by the Level control.
P2+/-	Selects a pulsed voltage output of both polarities with a characteristic shown in Figure 6b. The pulse width is determined by the Width control, the amplitude by the Level control.
Off	Turns Off the Pulser outputs. (Outputs are open circuit.)
Width	Adjusts pulse width up to a maximum of half a cycle.
Level	Adjusts DC or pulse level between 0V and 5V.

Only one mode DC, PULSE 1 or PULSE 2 can be selected at any one time. See SECTION 4 – *DEVICE TESTING* for a discussion of three terminal device testing.

Figure 6-4a Pulser 1 Output

Figure 6-4b Pulser 2 Output

TESTING INTEGRATED CIRCUITS

All integrated circuits can be tested by probing pairs of terminals. Most ICs tested in this way display signatures similar to diodes or Zener diodes.

Note that ICs manufactured using different technologies can have distinctly different signatures. This must be considered before diagnosing a device as faulty.

See SECTION 4 – *DEVICE TESTING* for a discussion of IC testing – the discussion includes examples of typical IC signatures.

6.12 The T4000 Scanner

The T4000 Scanner provides the facility for rapid scanning of signatures on all pins of an IC under test.

The Scanner is automatically selected when the **Sip** or **Dip** options are selected from the **Format** menu. This connects IDC connectors to Channels A and B. Signal return is via the COM connection.

Channel A and B probes are also connected in parallel with the Scanner inputs to facilitate checking for open circuit clip connections.

When the **Probes** option of the **Format** menu is selected, the IDC connectors are isolated; input to the T4000 is then from the probes only. This will provide more accurate signatures where low-capacitance tests are being made as the stray capacitance from the Scanner is disconnected from the input.

Connecting IC test clips

16 pin and 40 pin IC test clips are provided to connect channels A and B of the Scanner to the ICs under test.

Connect the IC test clips to the polarised connectors A and B. The multi-way connectors must be used in conjunction with the return path provided by the COM socket.

The COM lead must be connected to a common point, usually 0V, on each board under test. It may also be useful to examine signatures using the Vcc pin as COM.
If the signatures are unstable, connecting both Vcc and ground to COM may solve the problem.

When comparing signatures, the test clips should be connected to the same IC on each board.

Pin 1 of the test clip, marked by the brown wire in its ribbon cable, must be connected to pin 1 of the IC in each case.

6.13 Testing ICs

The Scanner is able to automatically detect the number of pins on the IC on the selected channel. If both channels are being utilised, the number of IC pins on Channel A is detected.

The result is displayed on the **Live** window display.

To test the IC and activate the Scanner, first specify the settings in the **Options** window as appropriate; e.g.,

- select the **Sip** or **Dip** format
- specify the **Tolerance**
- specify the **Step Rate**
- specify the **Test Ranges** (the **Junction** and **Logic** ranges)
- ensure the **Pulser** is set to **Off**
- specify the **Pins** mode to **Automatic** (the Scanner will automatically check the number of pins on the device when the test is run)

Press the <Esc> key to save the selected options.

Select **Test** – the T4000 runs the test using the parameters specified in the **Options** window.

The Scanner first detects the number of pins on the device (on the T4128 and T4000 it also checks for short circuits between the pins and common) then acquires the signatures on each IC pin sequentially starting at pin 1.

When the **Test** function is completed, the outcome of the test is displayed in **Test Results** window.

For a successful test (i.e. if all signatures have matched at the end of testing) the window will look similar to the example below:

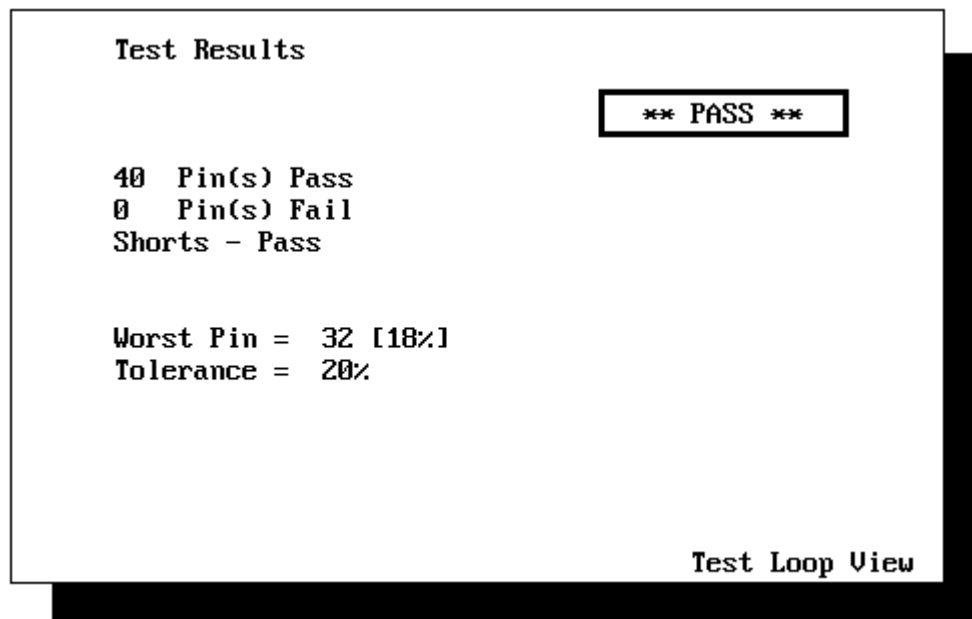


Figure 6-5 The **Test Results** window (PASS)

From this window the operator can choose to repeat the test (the **Test** option), run the test continuously, (the **Loop** option) or **View** each signature.

(If the test proves successful the operator will probably not wish to **View** but move on to the next device.)

If the test is unsuccessful, the **Test Results** window will indicate the number of failed pins along with the pin number of the pin with the highest deviation:

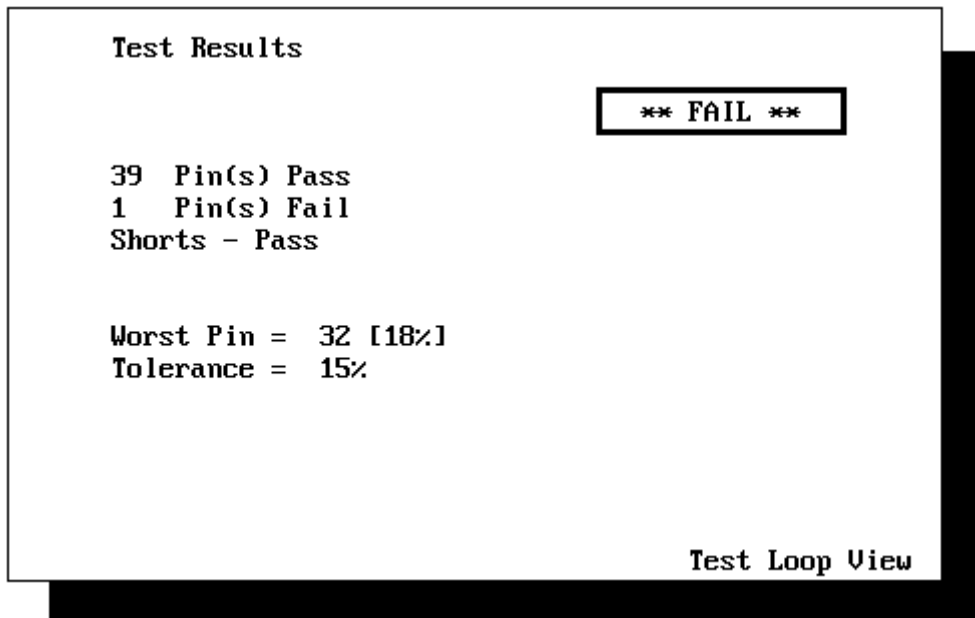


Figure 6-6 The **Test Results** window (FAIL)

If the test indicates a FAIL the operator may use the **View** option to examine the signatures on each pin of the device.

The **View** option is discussed in detail in SECTION 7 – PROGRAMMING THE T4000.

Press <Esc> to return to the **Live** screen

The **Live** screen displays the selected pin signatures and the deviation and test parameters.

Manually scrolling through the IC pins.

With the **Live** screen displayed, use the up and down arrow keys to manually select a specific pin of the IC.

(Prior to manually scrolling through the IC pins, ensure that **Test** has been run so that the correct IC pin number is indicated on the screen.)

Press the left and right arrow keys to display the signatures of the pin of interest on different ranges

Automatic device scanning

The T4000 Scanner is able to apply the automatic testing techniques discussed earlier:

The **Test** function successively displays the signature of each pin of the IC, at a rate set by the **Step Rate** control.

If **Auto** range is selected, the T4000 auto-ranges (automatically selecting the drive range for the most meaningful display) on each pin and the resulting signature is displayed.

If both channels are active, Channel A is used for auto ranging.

If **Cycle** is selected, the T4000 steps through the **Test Ranges** displaying the signature for the selected pin on each of the available voltage ranges .

6.14 The Pins – Manual option – setting the number of pins manually

The T4000 may be used to test a wide variety of circuit types.

In some situations the automatic Pins algorithm will be unable to identify the number of pins on the device under test (e.g. when pin 1 of an IC is unconnected, where there are a large number of unused connections on an edge-connector or when testing a cable harness for short circuits).

The T4000 will fail to register a connection to pin 1 so the program will display the message:

ABORT – No device found

In these cases it is necessary to manually set the number of pins on a device before each scan. The **Live** display window displays the currently selected method:

If it is necessary to perform tests under these conditions it will be necessary to set the number of pins manually.

The T4000 provides the facility to set the number of pins directly prior to each scan.

From the **Options** window, activate the **Pins** option and select **Manual**.

Using the Foot Pedal

The T4000 system includes a foot operated switch as a standard accessory.

This facility allows the user to operate certain functions with both hands occupied probing a circuit module.

The foot pedal duplicates the <Enter> key

Beep mode

The T4000 incorporates the facility to sound an audible warning when the deviation between two signatures under comparison exceeds a specified value.

This feature enables the operator to probe the devices under test without looking away from the circuit module.

SECTION 7 – PROGRAMMING THE T4000

7.1 *Program – compiling and editing test programs*

The **Program** option provides the functions and environment to create, modify and delete programs to test a wide variety of circuit components.

The programmer is guided through program creation via a logically structured system of menus and editing screens.

(A worked program/test example will be found in Appendix F – programmers may find it helpful to work through the example before reading this section.)

The T4000 program provides facilities whereby good device signatures may be stored for reference and viewed and the signatures of devices under test may be sorted and viewed in device pin order or in descending order of error.

Test program size

Up to 1000 devices (or 60,000 signatures) can be included in each program. The size of a program is continuously updated and displayed as each program is created or modified.

Refer to Appendix 3 for details of how to calculate the size of a test program.

Note: Program size will be a function of the number of devices and the test parameters specified for each device.

Programmers are recommended to limit program size to the capacity of the backup medium (e.g. 1.2Mbyte for 5¼" diskette, etc.)

Organising test program storage

Test programs are stored in "directories". A "default" directory (named **TESTPROG**) is created by the system. This default directory will be used by the T4000 to store test programs.

Users can create other sub directories in which to group related programs. If more than one directory exists, only one may be active (the "working directory") at any time.

Technical notes for MS-DOS users

1. Test programs are stored as sets of files on the host computer's hard disk (the T4000 creates file *filename.P*, *filename.S*, *filename.DOC* etc. for each program where *filename* is the name given to the program by the programmer.) If these files are manipulated in DOS they **must** be treated as sets.
2. All test program directories are sub-directories of **T4xxx\PROGRAMS**, where **T4xxx** represents **T4040**, **T4080** or **T4128** (for both T4128 and T4000). All sub directories for test program storage must be created within the **PROGRAMS** sub directory. The default directory **T4xxx\PROGRAMS\TESTPROG** must **not** be removed.

Select **Program** – the T4000 opens the device list screen.

The device list screen is comprised of four sections:

the **Device** box – the list of component circuit references and device types which have been specified for the selected program

the program **Status** box – which displays the position of the highlighted device in the program, the number of devices with learnt signatures and the disk space used by the program

the **Insert Template** box – which contains default settings for inserting new devices in a program

the function list

When the **Program** option is selected, the T4000 recalls the most recently used program (or an empty program named **UNTITLED** if no programs have been created).

7.2 File – Loading or creating a test program

A test program consists of a list of devices and associated test conditions, each program usually consisting of the devices located on one circuit module (e.g., circuit board, sub-assembly, etc.)

Up to 1000 devices can be include in each program, though programmers will often find it convenient to limit the number of devices to keep programs to a manageable size.

To create or load a program, select the **File** option – the **File** option opens at the current list of programs in the program directory.

To select an existing program use the cursors to highlight the program name or type the name in the filename box and press <Enter>.

To create a new program type the new program name in the filename box and press <Enter>.

Naming test programs

Program 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:

Upper and lower case letters A – Z
Numbers 0 – 9

and the following special characters:

! " £ \$ % ^ & * () @ ~ # { } `

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

The new file will be added to the program directory and a new program device list is displayed (for a new file the device list will be empty except for the ***END*** mark.)

7.3 Name – Specifying an extended program file name

The T4000 program allows test programs to be given qualifying or descriptive names in addition to the program name assigned in the **File** option.

Select **Name** and type the program description (e.g., main board, etc.) in the **Extended File Name** box.

Up to 25 characters may be used for the Extended File Name. The Extended File Name will appear alongside the file name and file size in the program list and at the top of the device list screen.

7.4 Insert – Adding a device

Insert adds a device in front of the current position of the highlight in the device list.

Select **Insert** – the device test parameter screen is displayed.

Insert starts with the contents of the Insert Template as parameter settings. See **Template – copying device parameters**.

The settings for the new device are saved by pressing the <F7> key . The entry is aborted if the <Esc> key is pressed.

7.5 The device parameter screen

The T4000 device test parameter screen provides the programmer with a logically structured environment in which to define operating conditions for each component to be tested.

To compile a test program the programmer must define the test parameters for each device.

The programmer must:

provide the circuit reference and device type for each device to be tested

specify the test conditions for the device under test
save each device type as an entry in the device list.

The programmer is also able to include general instructions for testing the board (see **Instructions file**) and brief operator instructions for a specific device within the **User Instructions** box.

The test parameter screen is displayed when **Insert** or **Edit** are selected. The user can move between fields using the cursor keys or <Enter>.

Note: While the test parameter screen is displayed, pressing the <F7> key at any time will save the current state of the screen and return the program to the device list screen.

Pressing the <Esc> key will abort the entry.

Specifying test parameters

Ref: – *specifying the circuit reference*

The screen opens with the **Ref:** (device circuit reference) field highlighted.

As each field is highlighted its name changes from grey type to bold yellow. Type the circuit reference value at the cursor (U11, C12, etc.) – up to six characters may be used in the device **Ref:** field.

Type: – *defining the device type*

Enter the device type (e.g., 74LS00, tantalum cap, etc.) in the **Type:** field; up to 13 characters may be used to specify the device type.

Specifying the T4000 settings

Test conditions for the device under test (voltage ranges, frequency, etc.) are specified in the **T4000 Settings** box.

Package – *defining the device configuration*

The T4000 is able to accommodate a wide range of component types from simple two-terminal devices to multi-pin ICs; the device configuration is defined in the **PACKAGE** field – highlight the **PACKAGE** field to specify the configuration of the part to be tested – the device configuration selection keys are displayed in bold upper case:

Pins [14]

Dip

Sip

proBe

The currently selected configuration is highlighted. Select the new device configuration by pressing the associated selection key:

D for dual in-line packages

S for single in-line packages or SMD Probes

B for devices which will be tested using the probe

For other package formats (e.g. edge connectors) select **Sip** or **Dip** as appropriate.

Refer to Appendix D for details of SIP and DIP numbering formats.

Specifying the number of pins

The device configuration determines the range of values which may be entered in the **Pins** field.

Package	T4040	T4080	T4128,T4000
Dual in-line packages	2 – 40	2 – 80	2 – 128
Single in-line packages	1 – 40	1 – 80	1 – 128
Probes	1	1	1

Note: For dual in-line package devices the T4000 will accept even numbers only.

Select **Pins** (press the **P** key) and enter the number of pins on the device. Invalid entries will be ignored.

Tolerance – *Setting the comparison threshold*

Selecting the **TOLERANCE** field allows the user to specify the sensitivity of the signature comparison as a percentage value.

Percentage values from 1 – 99% may be specified. Lower values represent a more exacting comparison, higher values will allow greater differences in signatures.

(The most effective values will be found by experiment; start with a value of 10 – 20%)

and adjust for a sensitivity which will allow normal component tolerances but capture faulty devices.)

For details of how to alter the Tolerance value for every device in the test program, refer to **Global**.

Frequency – *Setting the test frequency*

Highlight the **FREQUENCY** field and select **Low** or **Medium** (the T4128/T4000 also includes a **High** frequency range) as applicable – the active frequency range will be highlighted. The time taken to conduct a device test will depend on the test frequency – testing at the higher frequencies will be performed more quickly than at lower frequencies.

Shorts – *Testing for short circuits between pins and Common (T4128/T4000 only)*

With this option specified, the T4128 will check for short circuit conditions between pins and Common. Highlight the **SHORTS** field; pressing the <O> key toggles the **SHORTS** function **On** and **Off**.

Range – *Specifying voltage ranges*

Select the **RANGE** field – the currently selected voltage ranges will be highlighted. The range selection keys are shown in bold type, **High**, **Medium**, **Low**, **loGic** and **Junction** (**Junction** range on the T4128 only.) Each range is toggled on and off by its associated selection key.

The system keeps a minimum of one range selected at all times; up to four ranges can be selected for a device test. Note that test time and storage requirements will increase with the number of ranges selected.

Pulser – *Setting the Pulse Generator (T4128/T4000 only)*

The Pulse Generator incorporated with the T4128/T4000 will be found useful for testing many types of 3-terminal devices (e.g. SCRs, triacs, opto-isolators).

See SECTION 4 – **DEVICE TESTING** for a discussion of Pulser applications.

To incorporate the Pulse Generator in a test, scroll through the Pulser modes with the **Mode** selection key until the required pulse type is displayed.

Select the **Width** field to specify the width of the applied pulse – type a number between 1 and 100 in the **Width** field. Press <Enter> to store the **Width** value.

The amplitude of the pulse is similarly set via the **Level** field; activate the field and specify a value between 1 and 100% – press <Enter> to store the **Level** value. The default values are 50%.

Signal Processing

The Signal Processing functions are provided to compensate for situations which might cause false measurements to be recorded or displayed.

Filter – mathematically processing signatures

Some combinations of device type and T4000 range settings may on occasions give rise to unexpected effects or unpredictable results. For example, some types of CMOS device may exhibit spurious oscillations if driven by the higher voltage ranges. Users are normally able to avoid conditions which cause erroneous readings by careful selection of range setting.

There may be occasions, however, when it proves impossible to completely eliminate oscillation or instability in a device; the **FILTER** function allows signatures stored during acquisition to be mathematically processed by the T4000 program to reduce the effect of spurious oscillation or device breakdown. Highlight the **FILTER** field; the function can be toggled **On** and **Off** with the <O> key.

Note: **FILTER** should generally be set to **Off** unless problems are observed in the signatures.

Step Rate – Controlling the range and pin switching rate

In some circuit configurations, signatures may vary with time during the acquisition (highly capacitive circuits may exhibit charging times which are much greater than the signature acquisition time).

The **Step Rate** function allows the program to vary the rate at which signatures are acquired.

Highlight the **Step Rate** function and specify a value from 1 – 100%. The optimum value will be found by experiment. The default setting is 100% (i.e. fastest acquisition.) Setting the rate to 0% will cause the T4000 to single step on each pin of the device during **Learn** and **Test**.

7.6 User Instructions – Providing operator instructions

The test parameter screen incorporates a field in which the programmer is able to include operational notes or instructions which may prove necessary or helpful for the user when testing the board.

Highlight the **User Instructions** field and type information, special instructions, etc., at the prompt.

Use the cursor keys and <CR> to move within the field, and use the <Backspace> and <Delete> keys to correct typing errors. Pressing the <F9> key clears the entire field.

If there is insufficient space in the **User Instructions** field, further instructions may be incorporated into the **Instructions file** – see below.

7.7 Instructions file

Each test program has an associated Instructions file, which can be viewed during **Test**. This may contain general information (e.g. connection details, list of clips required, the date the program was written) or expanded instructions for a specific test if there is insufficient space in the **User Instructions** field. In addition, if the system is Unlocked this file can be edited during **Test** to add fault-finding hints "on-line". Press <F3> to open the Instructions file for editing. The current cursor position is displayed at the top of the window. The maximum length of the file is 200 lines.

Enter the text required, using the <Tab>, <CR> and the cursor keys as necessary to move within the file. Lines may be inserted or deleted using <F8> and <F9>.

When editing is complete, press the <Esc> key. The system will prompt the user to save the changes made, or leave the file unchanged.

7.8 *Edit – modifying device parameters*

To modify the test parameters of a device, highlight the device with the cursor keys and select the **Edit** option – the device test parameter screen is displayed.

Move the highlight to the field(s) to be modified and make changes as necessary; press <F7> to save the changes and exit the test parameter screen; press the <Esc> key to discard changes and leave the settings unaltered.

7.9 *Delete – removing devices from a program*

Use the **Delete** function to remove a component from a program.

Highlight the device to be removed and select **Delete** – the system issues a warning prompt; press <Y> to confirm the **Delete** operation.

7.10 *Template – copying device parameters*

It will often be found convenient when inserting new components into a program to base the new device on the parameters of an existing device. Highlight the device to be copied and select the **Template** option; the device reference and type are copied into the **Insert Template** box. **Insert** can now be used to enter additional components into the program.

Global – altering the Tolerance for all devices

Global provides a convenient way to change all the **Tolerance** values in a test program to a single new value.

Select the **Global** option – **Global** requests a tolerance value:

Change all test tolerance values
to %

Type a value between 1 and 99% and press <Enter> – type Y at the confirmation message to confirm the new tolerance value or press <Esc> to leave the tolerance values unchanged.

Note: The **Tolerance** for every device in the program will be set to the new value. The previous values will be replaced.

7.11 *Search – locating devices in the device list*

In a large program the list of devices may be distributed over many screens. Screen space allows up to 27 components to be displayed. The **Search** option enables the operator to locate a device (even if not displayed) by circuit reference. Select the **Search** option, enter the device reference in the **Circuit Reference** box and press <Enter>; if the device name was valid the highlighted device is placed in the top left corner of the device list box.

7.12 *Move – rearranging the device list*

The **Move** option enables programmers to change the order of the components in the device list. To relocate a device within the list, highlight the device and select **Move** – the **Select Destination** box is displayed.

Use the cursor keys or **Search** to move the highlight to the desired position in the device list. As the highlight is moved, the program checks the proposed destination and, if valid, (a device cannot be moved on top of itself) adds the prompt **CR to insert** to the **Select Destination** box; press <Enter> to confirm the **Move**. The device is inserted before the highlighted device.

7.13 *Print – prints a test program*

Select the **Print** option to obtain a hard copy of the Test Program – the list of devices with their associated test parameters for the selected test program.

An example printout is attached.

7.14 *Learn – acquiring reference signatures*

The **Learn** function enables the programmer to acquire reference signatures for all pins of the selected device.

Programmers will normally acquire the signatures of all devices of interest on a good circuit module and store them for reference.

The sequence for learning the signatures for a device is as follows:

- Use **Learn** to acquire a set of signatures as references (the **Learn** process automatically saves signatures to the hard disk of the host computer)
- **View** the signatures to check they appear to be correct
- Use **Verify** to confirm that the signatures are stable and will give consistent test results.

To **Learn** a device, with all test parameters defined for the device, connect the test leads between the T4000 and the device to be learnt, highlight the device in the device list and select **Learn**.

The T4000 acquires the device signatures using the specified test parameters and saves them to the hard disk of the host computer.

Any pins that are detected as being open-circuit will be listed on the **Learn** screen. These may be genuine open-circuits, or else indicate faulty connection of the test clip to the device under test.

If a faulty connection is suspected (e.g. if the test clips are not properly seated) try reattaching the clip and repeating **Learn**.

Alternatively, select **Verify** and rock the clip until the open-circuit is cleared. If a pin still appears to be open-circuit, use the probe to confirm that this is correct (remember to use the Channel B probe for pin numbers above 64).

Devices with acquired reference signatures are shown in bold in the device list.

7.15 *Verify – verifying signatures*

After a set of signatures has been stored as references, it is advisable to use the **Verify** function to confirm that the signatures are stable.

Verify continuously acquires signatures and compares them with the stored references. The Deviation between each pair of signatures is classified into one of four categories and a summary displayed in the **Verify Deviation** box. If the acquired signatures are stable, there will be very little difference between them and the stored signatures.

Provided the signatures are stable, all Deviations will fall into the 0–5% category. However, if the signatures are unstable, this will be indicated by Deviations exceeding 5%.

Verify can also be used to confirm that the Test Tolerance is set to a suitable value, by verifying a number of different boards.

If any show Deviations that exceed the Test Tolerance, then this suggests that the Tolerance is set too tightly and may lead to false error reports during **Test**.

Verify also updates the list of open-circuit pins after each acquisition.

7.16 *View – displaying device signatures*

The **View** function allows the programmer to inspect the reference signatures of the learnt device.

Select **View** – the T4000 displays the stored reference signatures.

Viewing the signatures

Each screen is able to display up to eight signatures from a device. When viewing a multi-pin device, use the cursor keys to keys to scroll through the pin signatures:

- <Home> – moves the first signature to the top left of the screen
- <End> – moves the last signature to the top left of the screen
- <PgUp> – moves to previous page of eight signatures
- <PgDn> – moves to next page of eight signatures
- Up and down arrows shift the display one signature up or down

Range – viewing signarures by range

The stored reference signatures are displayed in **View by Range** mode (see SECTION 8 –**TEST** for the **View-By** modes).

Selecting the **Range** option will cycle through the different ranges for which signatures are available.

Goto – selecting a signature for viewing

The **View** screen is able to display up to eight signatures simultaneously; most integrated circuits will have many more pins, therefore, than can be displayed on a single screen.

To select a signature which is not displayed, select **Goto**, specify a pin number in the **Goto Pin:** box and press <Enter>; the selected pin signature will be placed in the top left of the screen.

Zoom – displaying magnified signatures

On occasions users may find it helpful to inspect signatures in greater detail than that provided by the normal **View** resolution. The T4000 control program provides the operator with the facility to view magnified signatures via the **Zoom** function.

Ensure the device signature to be magnified is displayed on screen. Select **Zoom** – the top left signature is shown with a highlighted border; use the editing keys to select one of the signatures:

<Home> – selects the upper left signature

<End> – selects the lower right signature

The four arrow keys move the selection up, down, left or right

With a signature screen selected press <Enter> or select **Zoom** – the signature will be displayed, at the specified voltage range, magnified in a discrete window.

Press any key to cancel the **Zoom** function. Select the **Print** function to obtain a hard copy of the displayed magnified signature.

Print – producing hard copies of signatures

The **Print** option allows the programmer to produce a hard copy of the stored signatures for the selected device. Select **Print** – the system displays the **Print** option box:

Page	All
-------------	------------

Select **Page** to print the signatures displayed on screen or **All** to print all signatures for the selected device.

If **All** is selected, pressing the <Esc> key will terminate printing at the end of the current page of eight signatures.

See the attached sample printout.

Note: Do not abort printing by turning off the printer – this may cause a system error.

Shorts

Selecting **Shorts** will display the **Shorts** data for the device.

When displaying the data for an IC, the pins that are not classed as short circuit are indicated by an asterisk (*), the shorted pins are highlighted in yellow.

Use the cursor keys and the <Home> and <End> keys if necessary to see all of the information in the **Shorts** window.

Press <Esc> to close the Shorts data window.

SECTION 8 – TEST

RUNNING TEST PROGRAMS

The **Test** function provides the facility to run test programs compiled under the **Program** option.

Select **Test** from the Main menu – the test device list screen, showing the most recently used test program, is displayed.

Note: The first device in the list is shown highlighted.

User Instructions for the first device in the list are automatically displayed whenever the device is highlighted.

The screen consists of four subsections:

- The Device list showing the most recently used program (if any)
- The Test Results box
- The Status box
- The device Test menu.

To run a test on a circuit or module it is necessary to recall the program created under the **Program** option.

8.1 File – recalling a program

Select **File** – the T4000 displays the test program files in the current program directory.

Highlight the test program to be run and press <Enter> – the program device list is displayed.

8.2 Instructions – displaying the Instructions file

Selecting **Instructions** will display the Instructions file for the current test program.

If the system is Locked, then this file is Read Only. If the system is Unlocked, the user can edit this file, e.g. to add fault-finding hints.

8.3 Search – locating devices in the device list

The **Search** option enables the operator to locate a device test within the program (even if not displayed) by circuit reference. Select the **Search** option, enter the device reference in the **Circuit Reference** box and press <Enter>; the chosen device is highlighted and *placed in the top left corner* of the device list box.

8.4 Test – testing the device

To test a device within a program of tests the device of interest must be highlighted.

Use the editing keys to choose a device test:

- <Home> – moves to the first device test in the list
- <End> – moves to the last device test in the list
- <PgUp> – moves up one page of device tests
- <PgDn> – moves down one page of device tests
- Arrow keys – move forward or backwards through the device list

Selecting the **Test** function tests the device highlighted in the device list.

Note: Devices shown in grey do not have reference signatures stored and therefore cannot be tested.

Ensure the attached printer is switched on and On-line if printouts are required.

Connect the test leads between channel A of the T4000 and the device to be tested (ensure the COM connections between the device and the T4000 are correctly made) and select **Test** by pressing the <T> or <Enter> keys or the Foot Pedal.

If User Instructions have been entered for this device, they will be displayed before the test is executed; press <Enter> or the Foot Pedal to continue with test execution – the T4000 will conduct the highlighted test on the device and display the outcome of the test via the **Status** box and the attached printer if specified (see **Printmode**.)

Note: User Instructions are not displayed until **Test** is selected.

A brief summary of the device test (i.e. the number of failed pins, the Worst Deviation and Tolerance and the result of the **Shorts** test) is displayed in the **Test Results** box. Devices which record a **PASS** for a test are highlighted in green, devices which record a **FAIL** are highlighted in red.

At the end of each test the user has the option to repeat the test (by selecting **Test** again), **View** the acquired signatures or run the test continuously (**Loop**.) If **Loop** is selected, the test will be run continuously until <Esc> is pressed to terminate looping.

Analysis

After the T4000 has tested a device the **Status** box is renamed **Analysis**. If the test fails, then the T4000 analyses the signatures to try to filter out the effects of vendor-differences.

The same device obtained from different vendors may have different analog signatures (e.g. one vendor's device may have a protection diode on outputs, another may not).

The T4000 analyses the signatures of failed tests in an attempt to identify if the cause of failure is the result of devices from different vendors rather than defective devices.

If the results suggest that the reason for failure is likely to be a difference in vendors, rather than a defective device, the instrument displays the message:

Vendor difference?

otherwise the instrument recommends which signature to examine first.

Even if vendor-differences are detected, if they are not all explicable by vendor-difference then the T4000 will suggest a signature to examine.

Note: In cases where there are vendor-differences, the signature suggested may not be the one with the greatest deviation. This is because vendor-differences may result in large deviation values which can exceed the deviation due to a true fault. In this case the T4000 will suggest the highest deviation signature that is not explained by vendor-difference.

If **Loop** is selected, the test will be run continuously until <Esc> is pressed to terminate looping.

Select **Instructions** to review or make changes to the User Instructions file.

8.5 Tolerance – changing the test comparison sensitivity

Tolerance enables the user to change the Tolerance to a new value, which will apply to *all* tests. The Tolerance values stored in the test program will be ignored (but are not altered).

When a new **Tolerance** value is entered, the Deviations stored for devices already tested are compared with the new Tolerance, and the Pass/Fail indicators in the Device List are updated accordingly – it is not necessary to retest the board to determine the effect of changing the Tolerance.

Pressing <Esc> when prompted for the Tolerance will restore the original values from the test program.

Note: the Tolerance function is not available if the system is "Locked".

8.6 View – examining the acquired signatures

Select **View** to inspect the acquired signatures. Acquired signatures are displayed as red waveforms along with the previously stored reference signatures (shown as green waveforms) for comparison.

If the **Shorts** test has failed, the shorts data window will be automatically opened on entry to **View**.

View-by – specifying the signature display order

When both reference and acquired signatures are displayed, they can appear in two formats:

View by Error displays the signatures in order of deviation (i.e. the difference between the reference and acquired signatures)

View by Range displays the signatures in pin number order for a specific range

If only one set of signatures is displayed (i.e. reference only or acquired only) then only **View by Range** format is available. When both formats are available selecting the **View-by** option toggles between **VIEW by Range** and **VIEW by Error**.

Range – *viewing signatures on other ranges*

In **View by Range** selecting the **Range** option will cycle through the different ranges in which signatures have been acquired.

Goto – *selecting a signature for viewing*

Only eight signatures of the device under test are shown on screen at one time. To select a signature which is not displayed select **Goto**, specify a pin number in the **Goto Pin:** box and press <Enter>; the selected pin signature is placed in the top left of the screen.

Zoom – *displaying magnified signatures*

On occasions users may find it helpful to inspect signatures in greater detail than that provided by the normal **View** resolution. The T4000 control program provides the operator with the facility to view magnified signatures via the **Zoom** function.

Ensure the device signature to be magnified is displayed on screen.

Select **Zoom** – the top left signature is shown with a highlighted border; use the editing keys to select the signature to be magnified:

<Home> – selects the upper left signature

<End> – selects the lower right signature

The four arrow keys move the selection up, down, left or right

With a signature screen selected for magnification, press <Enter> or select **Zoom** – the signature will be displayed, at the specified voltage range, magnified in a discrete window.

Select the **Print** function to obtain a hard copy of the displayed magnified signature.

Press any key to cancel the **Zoom** function.

Live – *displaying a real-time signature*

Live displays a signature in real-time, by continuously acquiring the signature and displaying it on the PC screen.

Ensure the device signature to be viewed is displayed on screen.

Select **Live** – the top left signature is shown with a highlighted border; use the editing keys to select one of the signatures:

<Home> – selects the upper left signature

<End> – selects the lower right signature

The four arrow keys move the selection up, down, left or right

With a signature screen selected press <Enter> or select **Live** – the signature of the device under test will be continuously acquired and displayed in real time (in red) along with the reference signature (in green).

Press <ESC> to cancel **Live**.

Print – *producing hard copies of signatures*

The **Print** option allows the programmer to produce a hard copy of the stored signatures for the selected device. Select **Print** – the system displays the **Print** option box:

Page All

Select **Page** to print the signatures displayed on screen or **All** to print all signatures for the selected device.

If **All** is selected, pressing the <Esc> key will terminate printing at the end of the current page of eight signatures. See the attached sample printout.

Note: Do not abort printing by turning off the printer as a system error may otherwise occur.

Shorts – displaying the Shorts data for a device

Selecting **Shorts** will display the **Shorts** data for the device.

View displays both reference and acquired signatures; the **Shorts** data will indicate the differences between the stored data and the device under test.

Device pins that match the reference are shown as a PASS in white, pins exhibiting a short circuit are shown as a FAIL in red, open circuit pins are shown as a FAIL in yellow.

Use the cursor keys and the <Home> and <End> keys if necessary to see all of the information in the **Shorts** window.

Press <Esc> to close the Shorts data window.

8.7 Report – printing test results

The **Report** option allows the user to print a hard copy of the test results.

When **Report** is selected the system displays the **Comments** box; any remarks typed in this box will be printed in the report header. Press <Enter> to print the report.

The user can chose to print the results of all tests, or failed tests only. The results are listed in order of worst Deviation. Shorts test failures are listed first. A partial Report is shown below:

Sample Report

```
*****
TESTED BY KD. ALL OK

Date : Mon Apr 18 1995   Time : 14:50
BOARDNAME – NCL-DISK Demo PC Card

Total Devices on Board – 34

    9   Device(s) Pass
    1   Device(s) Fail
   24   Device(s) Not Tested
*****
```

8.8 Printmode

The T4000 control program incorporates the facility to produce on-line printing of the results of a device test.

The **Printmode** option allows users to specify the conditions under which results are printed. Selecting the **Printmode** option cycles through the alternative printing modes:

PRINT Off – no printout

PRINT on FAIL – prints the test result if a test fails

PRINT All Results – prints the test result for a Pass or Fail

Sample On-line Printing

Ref	Type	Shorts	Worst Pin	Tol	Pins Pass	Pins Fail	
U1	SN75189	Pass	10 [1%]	10%	14	0	PASS
U2	SN75189	Pass	8 [6%]	10%	14	0	PASS
U3	SN75189	Pass	1 [1%]	10%	14	0	PASS
U4	MC1488	Pass	9 [2%]	10%	14	0	PASS
U6	MC1488	Pass	1 [0%]	10%	14	0	PASS
U8	SN75189	Pass	1 [0%]	10%	14	0	PASS
U9	74LS245	Pass	10 [77%]	10%	10	10	**FAIL**

8.9 Clear

Selecting the **Clear** option clears all test results from the displayed program. This option is typically used at the start of a board test.

8.10 Datalog – datalogging results

The datalog stores the results of testing devices on the board.

When pressing **Clear** to start testing a new board, the user has the option of logging test results (if Datalogging is enabled).

To avoid logging incorrect data, the user can edit the results prior to logging by pressing the F2 key (which sets all tested devices to **PASS**) then successively highlighting the device(s) that actually failed and using the F3 key to set their status to **FAIL**.

Selecting **Datalog** will display an accumulated set of test results for each device on the board under test, in order of highest failure rate.

Initialise

Initialise sets the values for Pass, Fail and Samples to zero. Files created using Export are not affected.

Initialise is only active if the system security status is Unlocked.

Off

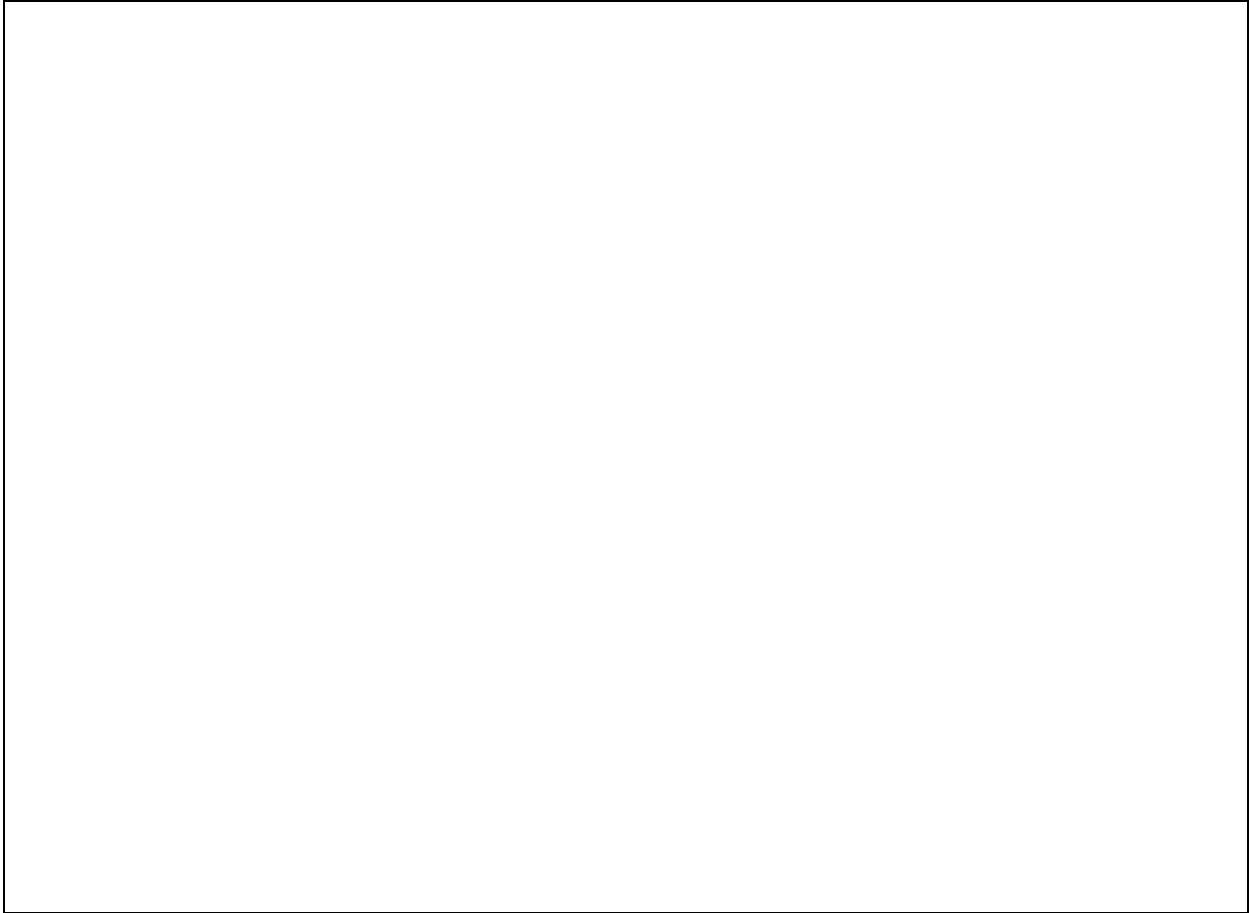
Turns datalogging off. The current contents of the datalog are not affected.

Print – printing the datalog

Select the **Print** option to print the datalog.

A sample printout is shown overleaf:

Sample printout



Export – copying the datalog to a file

Export copies the contents of the datalog to a file for use by database packages, etc. The log will be copied to the file <filename.LOG> in the directory **IT4xxx\DATALOG**, where *filename* is the name of the test program. The current contents of the file will be overwritten.

Each device in the file has four fields of data. Each field is delimited by blank characters. Each device is delimited by a <CR>:

<Ref>...<Type>...<Number of failures>...<Number of samples>...<CR>
<Ref>...<Type>...<Number of failures>...<Number of samples>...<CR> etc.

SECTION 9 – FILE MANAGEMENT

T4000 FILE MANAGEMENT

Selecting the T4000 **File Management** menu enables users to copy and delete test programs, back up test programs to floppy disk for archiving, restore archived programs and create directories for test program storage.

The **File Management** menu is displayed:

Delete test program
Copy test program
Backup test program
Restore test program
Program directory
backUp destination
Erase directory

9.1 Copy test program – Copying test programs

The **Copy test program** option will be found useful for rapidly creating new programs which are based on, or similar to, existing test programs.

Select the **Copy test program** option – the list of test programs in the current test program directory is displayed.

(If the program to be copied is not located in the displayed directory it will be necessary to change to the desired directory using the **Program directory** option.)

Select the program to be copied by moving the highlight with the cursor keys or typing the name in the filename box as described above; press <Enter>.

The system issues a prompt for the "target" filename, i.e. the name of the new file; type the new name at the cursor.

Example:

Selecting a file called MAINBRD1 and typing MAINBRD2 at the cursor will create a new file called MAINBRD2 identical to MAINBRD1.

If the target file already exists the **Copy** function will overwrite (and destroy) the target file.

Note: Copy test program can only be used to copy a file within the same directory.

If it is required to copy a file to a different directory, use the following procedure:

Use **backUp destination** to specify the desired directory as the backup device. Copy the file into the target directory using **Backup test program**. (Remember to restore the original setting of backup destination after copying files.)

9.2 Delete test program – Removing test programs

Selecting the **Delete test program** option displays the list of program files in the current test program directory (see **Program directory** for details on changing the test program directory).

Unwanted programs may be selected for deletion in two ways:

Highlight the program name with the cursor keys – the highlighted name will be reflected in the filename box as the highlight is moved through the program list.

Type the name of the program. The name appears in the filename box automatically replacing the displayed name.

Press <Enter> to delete the selected file.

Renaming a test program

A test program may be renamed by first copying it to a file with the new name using the **Copy test program** function then deleting the original program with the **Delete test program** function.

9.3 Backup test program – Backing up programs and data

Users are strongly recommended to employ a systematic backup procedure in which test programs are regularly backed up and stored.

Archiving to diskette

The T4000 File management provides programmers with the facility to back up test programs to diskette for security or archiving.

Ensure that a formatted diskette is inserted in the diskette drive slot before selecting programs for backing up.

Note that large programs with stored signatures can occupy up to several hundred kilobytes of disk storage – check that sufficient space exists on the diskette before backing up.

Select the **Backup test program** option – the program list is displayed. Select the program to be backed up and press <Enter>.

The program will be copied to the diskette.

A warning message is displayed if a file of the same name exists on the diskette. Proceeding with the backup will overwrite the program on the diskette.

Backing up groups of programs

It may be necessary on occasions to back up selected groups of programs. Programs may be backed up in groups by using the operating system "wild card" characters which act as substitutes for names and name characters.

There are two wild card characters:

The question mark (?) represents a single character

The asterisk (*) represents a group of characters

Example: specifying

Test????

in the **Backup** filename box will cause every program beginning with the letters **Test** to be copied to diskette.

Entering

T*

in the filename box will cause programs that begin with the letter **T** to be copied to diskette. Entering an asterisk in the filename box selects every program in the list for backup.

9.4 Backup destination – Specifying the destination for program archiving

When installed, the T4000 program is configured to select the A diskette drive as the destination for program backup. This can be changed (e.g. to the B diskette drive) using the **backUp destination** option. Selecting this option displays the current backup destination and prompts for a new destination.

Note: When a new destination is specified, the program checks its validity by writing to the destination before accepting the change in path.

Ensure that a diskette is placed in the destination drive before using this option.

Enter the new destination at the prompt and press <Enter>; the new path replaces the old and will remain set until changed with the **backUp destination** option.

9.5 Restore test program – restoring archived programs

Programs that have been backed up to diskette can be restored to the test program directory (specified by the **Program directory** option) on the hard disk with the **Restore test program** option. Selecting this option displays a list of programs stored on the diskette in the drive specified by the **backUp destination** option. Select the program with the cursor keys or by typing its name in the filename box and press <Enter>.

Groups of programs can be selected for restoring by using wild card characters.

Specifying the test program directory

The working directory is the directory on the hard disk where test programs are normally stored (the **TESTPROG** directory is created for this purpose during the installation process). When a program is loaded it is loaded from the working directory.

Users familiar with the disk operating system may wish to create other directories for program storage. The T4000 program will recognise sub directories created within the **T4xxx\PROGRAMS** directory structure. (See **Organising test program storage.**)

9.6 Program directory – changing/creating directories

Programs may be stored in and retrieved from directories other than the **TESTPROG** directory by changing the program source. The program source is a parameter which specifies where the system will store and look for test programs.

Selecting the **Program directory** option displays the directories available and the current working directory (set to **TESTPROG** during installation) and prompts for a new directory:

Working Directory :-
TESTPROG

New Directory :-

Use cursors or type the name to select the new directory and press <Enter> – the new source replaces the old. If the directory specified as the new source does not exist the system displays the message:

Create new directory?

Select <Y> to confirm the new directory and select this as the working directory.

9.7 Erase directory – removing program directories

Program directories (i.e. directories created within the **T4xxx\PROGRAMS** directory) may be removed using the **Erase directory** function.

The T4000 will only allow empty directories (i.e. directories containing no files) to be removed – if a directory which is to be removed contains files, all the files must be deleted prior to removing the directory (use the **Delete test program** function to delete program files.) The system will issue an error message if the user attempts to remove a directory containing files.

Select **Erase directory** to display the Program Directories list and the **Erase directory** box.

Use the cursors or type the name of the directory at the prompt to select a directory for removal; press <Enter> – the directory will be removed from the list.

Note: The program directory **TESTPROG**, created by the T4000 program during the installation process, cannot be removed.

SECTION 10 – SIMPLE MAINTENANCE AND CLEANING

WARNING This instrument should only be serviced by a qualified electronics technician.
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Refer all servicing to qualified service personnel. Polar Instruments publishes a T4000 Service Manual to assist the service technician.

10.1 Calibration requirements

To maintain the calibration of the instrument it is recommended that its Calibration/Adjustment Procedure is carried out at intervals not exceeding 12 months.

10.2 Input Protection Fuses

Channels A and B are protected by fast blow fuses. If the probes are connected to a powered board, or to a large, charged capacitor, these fuses open to minimise damage to the instrument.

To replace the channel protection fuses:

- Disconnect the power cord.
- Locate the fuses for Channel A and Channel B on the rear panel of the instrument.
- Test each fuse for continuity. Replace if necessary. *Fuses must only be replaced by fuses of the value and type shown on the label adjacent to the fuse-holder.*
- Reconnect the power cord.

10.3 Line fuses

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

To replace the line fuses:

- Disconnect the power cord.
- Locate the line fuses on the rear panel of the instrument.
- Test each fuse for continuity. Replace if necessary. *Fuses must only be replaced by fuses of the value and type shown on the label adjacent to the fuse-holder.*
- Reconnect the power cord.

10.4 Fault diagnosis

The problem most likely to be encountered is a blown Channel Protection Fuse.

Channels A and B are each protected by fast blow fuses. If the probes are connected to a powered board, or a large, charged capacitor, the fuses open to minimise damage to the T4000. When a channel is unconnected, its normal signature is a horizontal line. If its protection fuse has blown, then a vertical (short-circuit) signature will be displayed.

Refer to Section 10.2 for instructions on replacing the fuse.

The following symptoms may be investigated by the user. Refer all servicing to qualified service personnel.

Symptom	Test
T4000 reports protection fuse failure, but fuse is OK.	Ensure the board under test is disconnected from any power supply or external ground connection.
No LEDs lit.	Check power is switched on. If so, suspect a line fuse or a power failure. Refer to Section 10.3 for instructions on replacing line fuses.
Trace unstable	Check that the COM lead is connected. If testing ICs, connect the Vcc and ground pins together.
Scanner always indicates a fault on the same pin	Check the IC Test Clip by swapping the A and B clips.
Channel inputs do not appear to be active	Check T4000 is not in Probe mode
Communication Error reported by the host computer	Check that the Com port has been set up correctly. Check that the PC is connected to the T4000. Check that the communication cable being used is the cable that was supplied with the instrument.

10.5 Cleaning

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

Do not spray cleaners directly onto the instrument.

10.6 Technical Support

For technical support contact your local Polar Instruments distributor or Polar Instruments.

SECTION 11 – T4128MDA

11.1 Introduction

This section describes the operation of the T4128MDA software, which is an optional accessory for the T4128. The T4128MDA program includes specific features to optimise use of the T4128 in conjunction with bed-of-nails test fixtures, etc.

Using Analog Signature Analysis the T4128MDA can rapidly test the dynamic impedance characteristics (node signatures) of up to 128 nodes within a circuit, automatically comparing the signature of each node with known good signatures and displaying results for inspection on a PC screen.

Under program control, the T4128MDA is able to sequentially scan each node under test, applying appropriate test stimuli (set by the **Voltage** and **Frequency** ranges) for each node, and comparing the signatures with previously stored signatures from known good circuits.

Several pre-written test programs are supplied with the T4128MDA — users are recommended to use these when creating test programs.

The T4128MDA provides facilities to number and name each node under test and record nodal pass/fail statistics in a log file for subsequent analysis.

The system incorporates 128 test channels. Each T4128MDA channel (numbered 1 – 128) can be assigned a user node number and label to match signal lines, circuit test points, etc.

Voltage and frequency drive ranges may be set for each node, along with test tolerances and signal processing options

11.2 Starting the T4128 MDA program

In this section we describe only the functions that differ from the standard T4000 functions (discussed in their associated sections). For full details of system functions and the principles of Analog Signature Analysis refer to the relevant section.

The T4128 MDA is designed for operation via logically structured menus similar to the standard T4000 menu system — selecting each menu option opens the associated sub-menu until the desired function screen is reached.

Operation of the T4128MDA is similar to T4000 series operation — functions are selected by pressing the associated command or by moving the highlight via the cursor keys to the desired option and pressing the <Enter> key.

At the DOS command prompt type **T4MDA** and press <Enter> — the T4128MDA Main menu is displayed.

Test
Program
File Management
Utilities
Live
eXit to dos

Figure 11-1 T4128MDA Main Menu

Interface cables

For convenient connection to a test fixture the T4128MDA is supplied with pairs of 40-way and 26-way IDC cables.

Note: Remember to also connect the instrument's COM socket to the board under test.

11.3 Program — creating and editing test programs

The T4128MDA system incorporates 128 test channels.

The user first identifies each node to be tested (e.g. each pin on the fixture) then makes an entry in the Test List for each node.

The T4128MDA includes pre-written test programs designed as templates for user test programs. Programs are supplied for different numbers of nodes, each with pre-defined test parameter settings.

Each node can be given a reference (e.g. D0, D1, etc.) and a name (e.g. Data Bus 0, Data Bus 1...). The user specifies which channel on the T4128MDA is connected to the node.

Systems requiring more than 128 channels

If a program requires more 128 channels, a single test program can still be used, but it will be necessary for the operator to switch the connection from the T4128MDA to the appropriate bank of nodes.

By entering a User Comment (e.g. "Select Bank 2") the programmer can cause the system to wait until the foot pedal is pressed, allowing the operator to alter the connections.

New test programs

To compile a new test program use the **File** command to select one of the pre-written programs and the **Edit** command to change the test parameters as required for each node.

Specify the number, name and test conditions for each node to be tested and save the program under a new name.

Learning node signatures

To learn *all nodes* in a program press the <Enter> key or the foot pedal.

Select the **Learn** command to learn the highlighted node *only*.

11.4 Test — running test programs

Press the <Enter> key or the Foot Pedal to test *all nodes* in the program.

Selecting the **Test** function tests the highlighted node *only*. Use the editing keys to highlight a node test.

If User Instructions have been entered for a node, they will be displayed before a node test is executed; press <Enter> or the Foot Pedal to continue with test execution.

11.5 Live mode

Live mode allows the user to view the signature of a specific scanner channel in real time. From the Main Menu select **Live** mode — the Live screen is displayed:

Figure 11-2 The Live Screen

Test Range selection

Use the **Live** screen menu commands to select the most appropriate voltage and frequency range for the node under test. See Figure 3.



Figure 11-3 The Live menu

Use the up and down arrow keys to manually step through each node in sequence. To select a specific node select **Goto** and type the number of the node.

Press the **Display**, left and right arrow keys and the **Frequency** key to display the signatures of the node under test on different voltage and frequency ranges.

Press <Esc> to exit **Live** mode.

11.6 Detecting node-to-node shorts

Nodes on the board under test which are in a high-impedance state (e.g. bus lines in a microprocessor-based system) are likely to exhibit signatures similar to that of a diode (open circuit below 0.6V, short circuit above 0.6V).

In such cases a short circuit between two such nodes may be difficult to detect using ASA, as the signature for two diodes in parallel is almost identical to that of a single diode.

In practice this situation is usually resolved by the presence of pull-up resistors on the bus lines. If the Junction range is used, the slope resistance (in the region where the diode is not conducting) can be seen to change markedly when nodes are connected in parallel.

If pull-ups are not present on the board adding them externally can prove a useful test technique.

The Polar MDA Interface board (ACC164) includes resistors which can serve as pull-ups for node(s) on the board under test. If the board under test does not have pull-ups on its high impedance lines connect the external pull-ups to the lines and use the Junction range to monitor the slope resistance of suspect nodes to locate shorts between bus lines, etc.

11.7 The Utilities Menu — Setting up the T4128MDA environment

The **Utilities** menu is provided to allow users to customise the T4128MDA operating environment.

The standard utility functions are discussed in detail in Section 5 — Utilities.

Specifying the Result port

The T4128 MDA provides additional facilities to send PASS/FAIL signals for the complete test program to external circuitry (e.g. to a board routing mechanism) via one of the host computer's communication ports — the Result port. Result port RS232 signal connections are shown below.

Figure 11-4 PASS/FAIL signals

Use the **set Result port** option to specify which of the host's serial communication ports will be used as the channel for PASS/FAIL signals.

Select the **Utilities** option — the **Utilities** menu is displayed:

Security
set T4000 com port
Graphics driver
Diagnostics
Loop compensation
set Result port
eXit to dos

Figure 11-5 T4128 MDA Utilities Menu

Select the **set Result port option** — the system displays the current communication port and prompts for a new port number:

current result port – COM1
enter port # (0 – NONE) or 1 – 4_

Specify a new communication port if necessary — the system will enable the selected port and return to the **Utilities** menu.

Note: If the Result port facility is used it requires a unique RS232 communications port. It *cannot* use the same port that is specified for connection to the T4128 communication port. Note also that other devices, e.g. mouse, serial printer, etc., may already be connected to other ports.

The T4128MDA will return to the main menu.

11.8 Exiting the T4128MDA program

Select the **eXit to dos** option to terminate the current session and exit to the PC/MS-DOS operating system. The T4128MDA program will return to the command prompt.

T4128 PIN NUMBERING FORMAT

The format of the pin numbering of the T4128's Scanner inputs depends on whether the T4128 is being used in **Live** or **Test Program** mode, the package type selected and the number of pins on the device under test.

All illustrations show the instrument viewed from the front.

The position of pin #1 is always the same (in the upper right corner when the instrument is viewed from the front).

Live mode for the T4128 is a *dual-channel* mode. In **Live** mode Channels A and B can accommodate up to 64 pins each.

The T4128 **Test program** mode is a *single-channel* mode of up to 128 pins.

T4128 Live Mode

Pin numbering on the T4128 connectors (40-pin DIP and SIP formats)

The illustrations opposite show the **Live** mode T4128 Scanner connector formats for 40-pin DIP and SIP devices.

Pin numbering on the T4128 connectors (64-pin DIP and SIP formats)

The illustrations opposite show the **Live** mode T4128 Scanner connector formats for 64-pin DIP and SIP devices.

T4128 Program/Test Modes

Pin numbering on the T4128 connectors (40-pin DIP and SIP formats)

The illustrations opposite show the Program/Test mode T4128 Scanner connector formats for 40-pin DIP and SIP devices.

Pin numbering on the T4128 connectors (64-pin DIP and SIP formats)

The illustrations opposite show the **Program/Test** mode T4128 Scanner connector formats for 64-pin DIP and SIP devices.

Pin numbering on the T4128 connectors (128-pin DIP and SIP formats)

The illustrations opposite show the **Program/Test** mode T4128 Scanner connector formats for 128-pin DIP and SIP devices.

APPENDIX A — EXAMPLES OF ANALOG SIGNATURES

INTRODUCTION AND INDEX

The following pages have been produced from a selection of components and include comparisons of integrated circuits from different vendors.

Signatures produced in your circuits may not appear exactly similar to these examples since manufacturers can change their processes (which could alter the signatures).

This section includes an overview of typical defective signatures. This should prove helpful when comparing integrated circuits from different vendors that produce different signatures.

A sheet of blank screens is included which may be freely photocopied and used for recording special signatures unique to your boards.

Capacitor	A-4,5
Capacitor/Resistor	A-8,9
Defective Signatures	A-42
Digital CMOS 4001B	A-32,33
Digital HCMOS 74HC00	A-34,35
Digital LSTTL 74LS00	A-28–31
Digital TTL 7400	A-24–27
Diode	A-10
Diode/Resistor	A-12,13
FET, N Channel	A-18
FET, P Channel	A-19
Inductor	A-6,7
LED	A-11
Operational amplifier (dual) MC1458	A-38
Operational amplifier (quad) LM324	A-39
Opto isolator	A-22,23
Resistor	A-2,3
Resistor/Capacitor	A-8,9
Resistor/Diode	A-12,13
Schottky diode	A-11
SCR	A-21
Timer 555	A-40,41
Transistor, Darlington	A-15
Transistor, NPN	A-14,15
Transistor, PNP	A-16,17
Triac	A-20
Voltage Regulator 7805	A-36
Voltage Regulator 7905	A-37
Zener diode	A-10

APPENDIX C – TEST PROGRAM STORAGE

The approximate amount of memory required to store the test parameters and signatures is displayed on the Edit screen (for a single device) and the Program screen (for a complete program.)

If it is desired to calculate the memory requirements, the following formula may be used:

$$\text{Total memory required } M = \sum_{1}^n M_n$$

where M_n = the memory required for device n .

$$M_n = 50 [3 + 2r_n(p_n + 1)] \text{ bytes}$$

where r_n = the number of ranges for which signatures are stored,
and p_n = the number of pins on the device.

In addition, the Instructions File for each test program will require a further i bytes, where i is the number of characters in the file.

APPENDIX D – T4000 SERIES PIN NUMBERING FORMATS

This appendix includes Scanner input pin numbering details for the T4040, T4080 and T4128/T4000 instruments – refer to the T4040, T4080 or T4128/T4000 sections as appropriate.

T4040 PIN NUMBERING FORMAT

The format of the pin numbering of the T4040's Scanner inputs depends on whether the T4040 is being used in **Live** or **Test Program** mode, the package type selected and the number of pins on the device under test.

All illustrations in this appendix show the instrument viewed from the front.

The position of pin #1 is always the same (in the upper right corner when the instrument is viewed from the front).

Live mode for the T4040 is a *dual-channel* mode. In **Live** mode Channels A and B can accommodate up to 20 pins each.

The T4040 **Test program** mode is a *single-channel* mode of up to 40 pins.

T4040 Live Mode

Pin numbering on the T4040 connectors (20-pin DIP format)

This format is suitable when testing DIP ICs, e.g. when using DIP IC Test Clips. The example below shows the format for 20 pin DIPs.

The connectors are viewed from the front of the instrument.

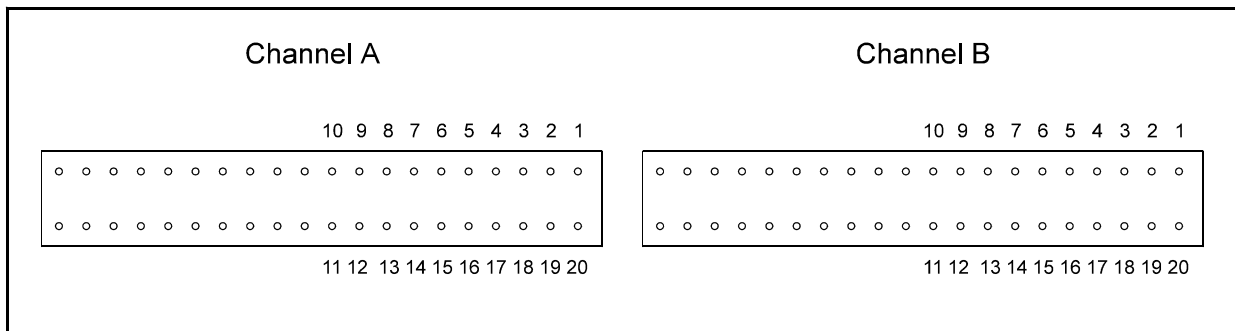


Fig D-1. T4040 Scanner Connectors — Live mode DIP Format – 20 pins

Pin numbering on the T4040 connectors (20-pin SIP format)

This format is suitable when testing SIP packages or IDC cables, e.g. when using the Polar SMD Probes.

The example below shows the format for 20 pins.

The connectors are viewed from the front of the instrument.

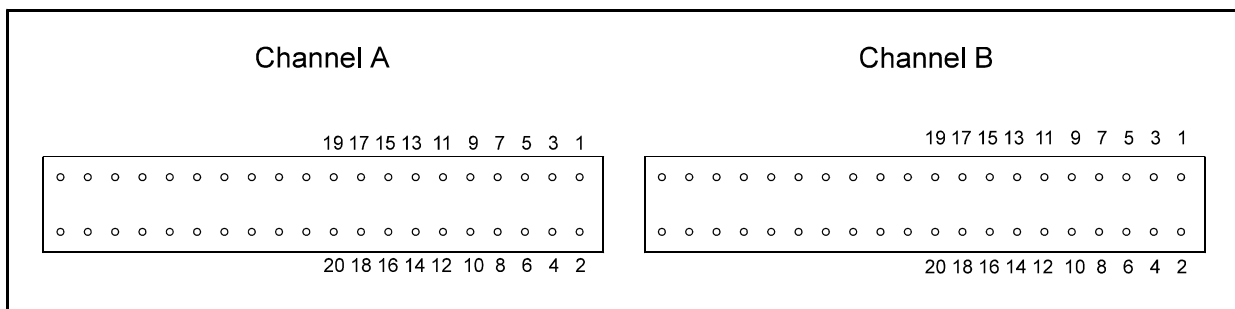


Fig D-2. T4040 Scanner Connectors – Live mode SIP Format – 20 pins

T4040 Program And Test Modes**Pin numbering on the T4040 connectors (40-pin DIP format)**

This format is suitable when testing DIP ICs, e.g. when using DIP IC Test Clips. The example below shows the format for 40 pin DIPs.

The connectors are viewed from the front of the instrument.

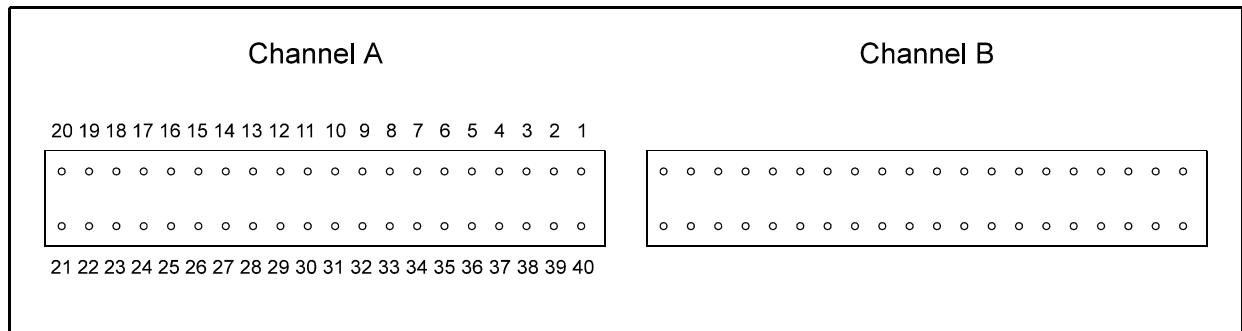


Fig D-3. T4040 Scanner Connectors – Program/Test modes DIP Format – 40 pins

Pin numbering on the T4040 connectors (40-pin SIP format)

This format is suitable when testing SIP packages or IDC cables, e.g. when using the Polar SMD Probes.

The example below shows the format for 40 pins.

The connectors are viewed from the front of the instrument.

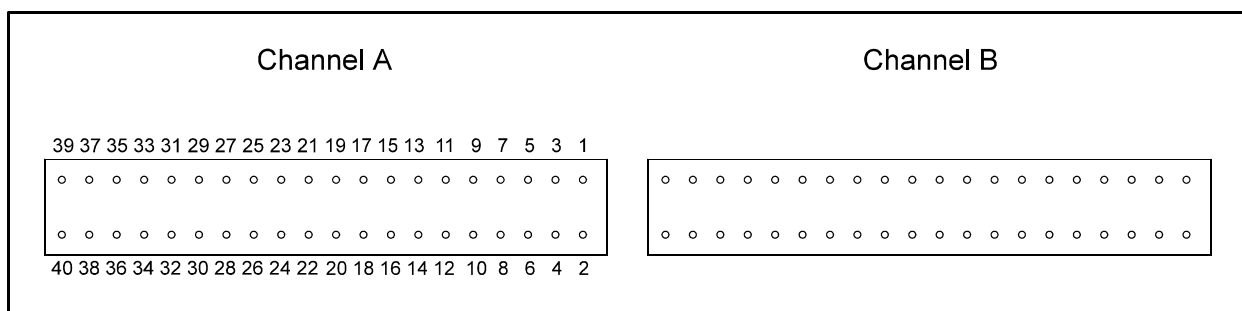


Fig D-4. T4040 Scanner Connectors – Program/Test modes SIP Format – 40 pins

T4080 PIN NUMBERING FORMAT

The format of the pin numbering of the T4080's Scanner inputs depends on whether the T4080 is being used in **Live** or **Test Program** mode, the package type selected and the number of pins on the device under test.

All illustrations show the instrument viewed from the front.

The position of pin #1 is always the same (in the upper right corner when the instrument is viewed from the front).

Live mode for the T4080 is a *dual-channel* mode. In **Live** mode Channels A and B can accommodate up to 40 pins each.

The T4080 **Test program** mode is a *single-channel* mode of up to 80 pins.

T4080 Live Mode

Pin numbering on the T4080 connectors (40-pin DIP format)

This format is suitable when testing DIP ICs, e.g. when using DIP IC Test Clips. The example below shows the format for 40 pin DIPs.

The connectors are viewed from the front of the instrument.

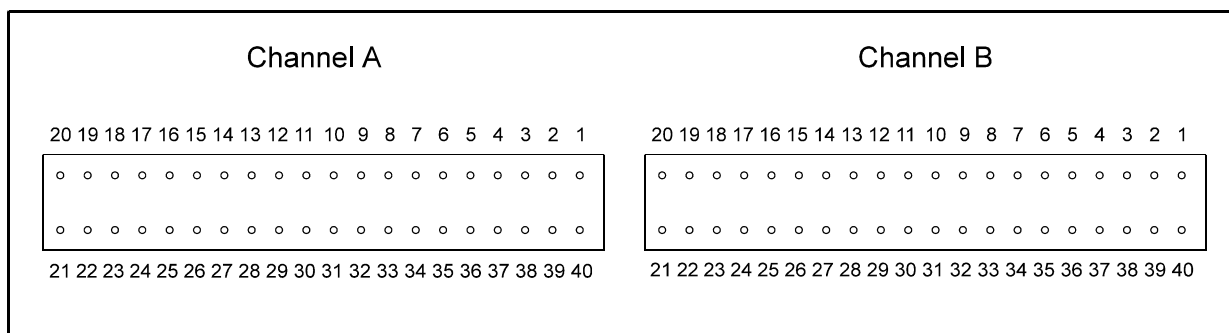


Fig D-5. T4080 Scanner Connectors — Live mode DIP Format – 40 pins

Pin numbering on the T4080 connectors (40-pin SIP format)

This format is suitable when testing SIP packages or IDC cables, e.g. when using the Polar SMD Probes.

The example below shows the format for 40 pins.

The connectors are viewed from the front of the instrument.

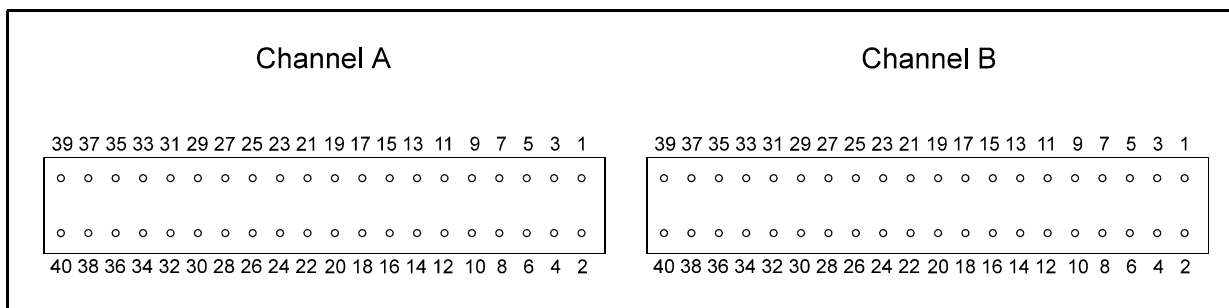


Fig D-6. T4080 Scanner Connectors — Live mode SIP Format – 40 pins

Pin numbering on the T4080 connectors (20-pin DIP format)

This format is suitable when testing DIP ICs, e.g. when using DIP IC Test Clips.

The example below shows the format for 20 pin DIPs.

The connectors are viewed from the front of the instrument.

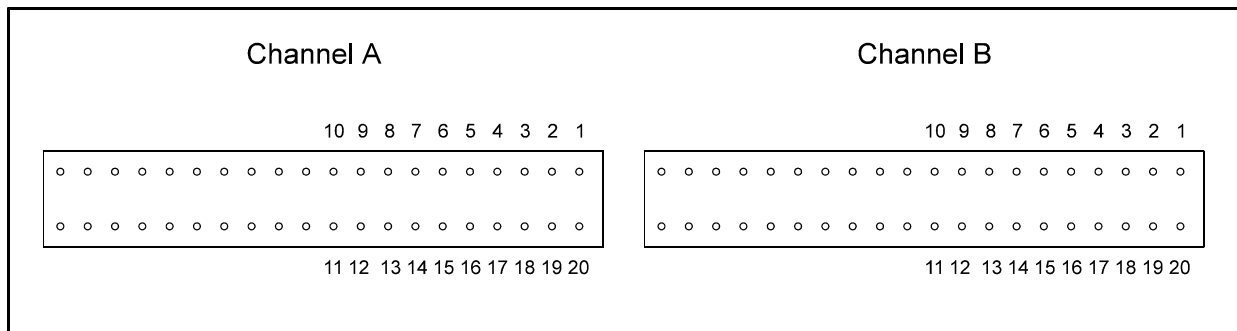


Fig D-7. T4080 Scanner Connectors — Live mode DIP Format – 20 pins

Pin numbering on the T4080 connectors (20-pin SIP format)

This format is suitable when testing SIP packages or IDC cables, e.g. when using the Polar SMD Probes.

The example below shows the format for 20 pins.

The connectors are viewed from the front of the instrument.

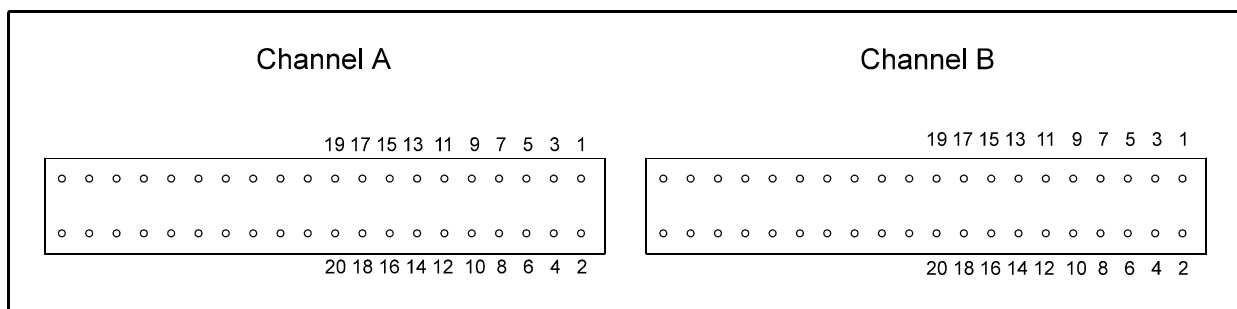


Fig D-8. T4080 Scanner Connectors – Live mode SIP Format – 20 pins

T4080 Program And Test Modes

Pin numbering on the T4080 connectors (40-pin DIP format)

This format is suitable when testing DIP ICs, e.g. when using DIP IC Test Clips.

The example below shows the format for 40 pin DIPs.

The connectors are viewed from the front of the instrument.

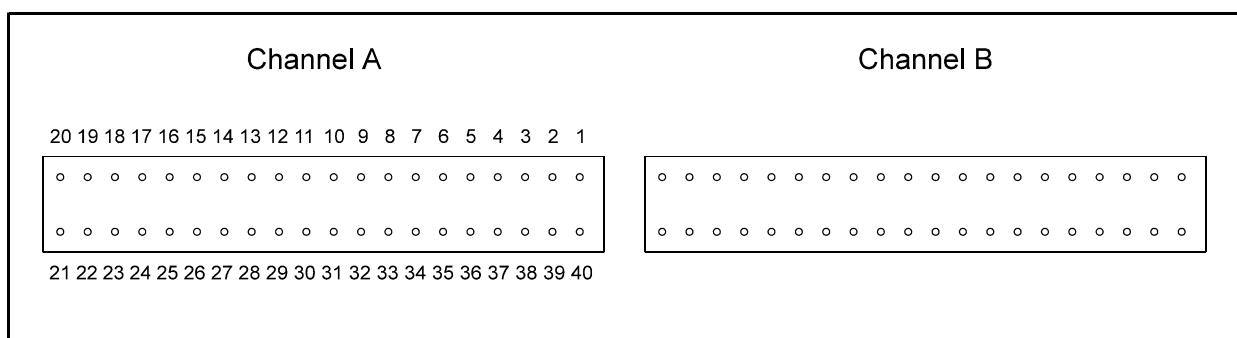


Fig D-9. T4080 Scanner Connectors – Program/Test modes DIP Format – 40 pins

Pin numbering on the T4080 connectors (40-pin SIP format)

This format is suitable when testing SIP packages or IDC cables, e.g. when using the Polar SMD Probes.

The example below shows the format for 40 pins.

The connectors are viewed from the front of the instrument.

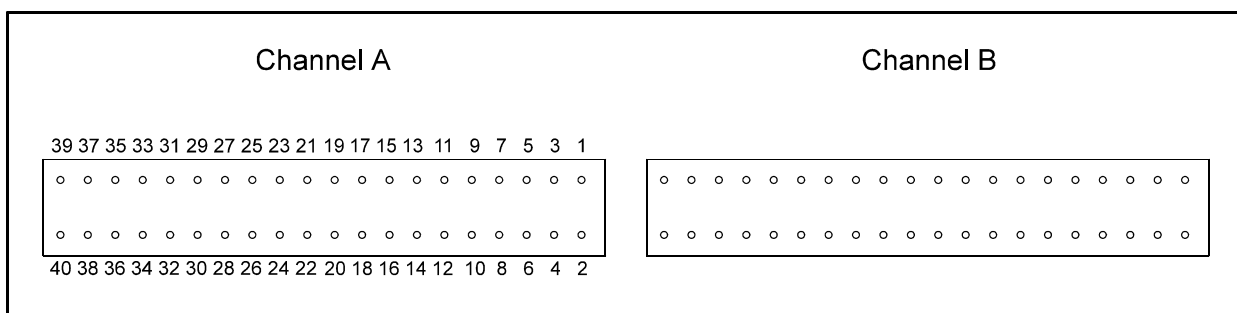


Fig D-10. T4080 Scanner Connectors – Program/Test modes SIP Format – 40 pins

Pin numbering on the T4080 connectors (80-pin DIP format)

This format is suitable when testing DIP ICs, e.g. when using DIP IC Test Clips.

The example below shows the format for 80 pin DIPs.

The connectors are viewed from the front of the instrument.

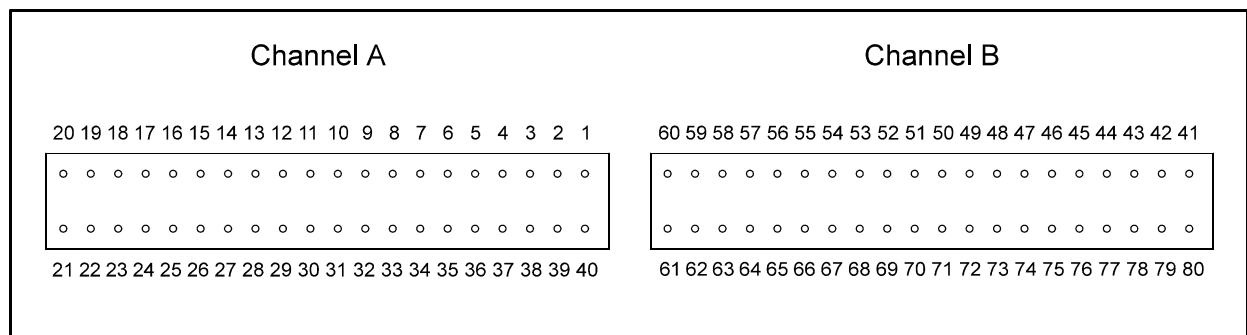


Fig D-11. T4080 Scanner Connectors – Program/Test modes DIP Format – 80 pins

Pin numbering on the T4080 connectors (80-pin SIP format)

This format is suitable when testing SIP packages or IDC cables, e.g. when using the Polar SMD Probes.

The example below shows the format for 80 pins.

The connectors are viewed from the front of the instrument.

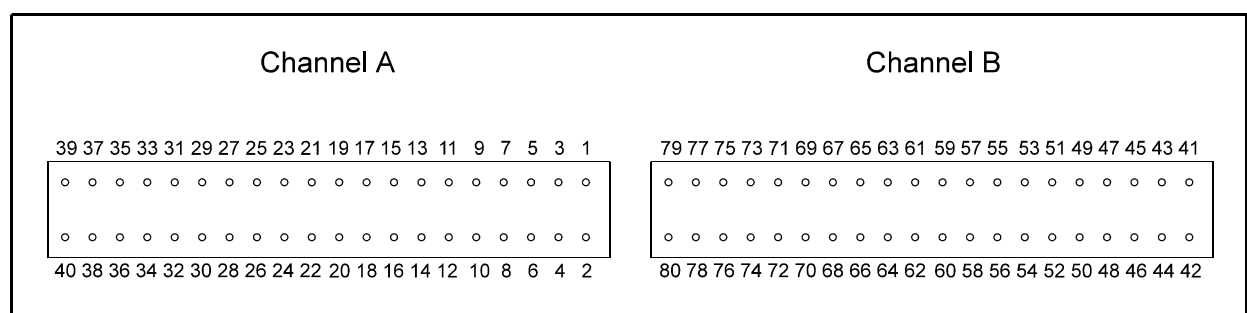


Fig D-12. T4080 Scanner Connectors – Program/Test modes SIP Format – 80 pins

APPENDIX E – T4000 PROGRAMMING EXAMPLE.

RUNNING THE T4000 CONTROL PROGRAM.

This appendix is included to help the new user to write and run a simple T4000 test program.

The example is written around the NCL Disk Controller demo board, but a board of your choice may be substituted if preferred.

Each numbered section denotes the user input required to select the appropriate function.

When the PC has completed its boot up process and finished its self test it should display the command prompt:

C: >

1. Type **T4040**, **T4080** or **T4128** as appropriate after this prompt and press <Enter>.

The T4000 control program will display the Main menu.

Writing a test program

2. At the main menu type **P** to select the Program option.

Note: All T4000 menus are selectable by pressing "hotkeys" - these are highlighted in green on the menu areas; pressing the hotkey will select the appropriate menu option.

At the bottom of this screen a number of menu selections are displayed; the **File** option allows the user to select or create a test file.

Creating a test file.

3. Type **F** – the file screen will display the available test files.

On a new system UNTITLED and NCL_DISK will be the only ones available at this stage.

4. Type a file name, e.g. **EXAMPLE1**

5. Press <Enter>.

Provided a file of that name does not already exist, the T4000 will create a file named **EXAMPLE1**.

EXAMPLE1 will now appear at the top of the **Program** screen.

6. To add some more description to the name, select the **Name** menu entry by pressing the associated hotkey.

Type in a more detailed name for the test file,
e.g. **NCL Disk Controller** (up to 25 characters are allowed) - press <Enter>.

The top line of the screen should now display the file name and description:

Polar T4000 EXAMPLE1 NCL Disk Controller.

The T4000 is now ready to begin programming.

Inserting a component.

7. To add the first component to the file select the **Insert** hotkey.

The control program will enter the program Edit mode.

Note: The initial T4000 Settings (i.e. device test parameters) on this screen are provided by default as a starting point, any alterations are easily made by selecting the appropriate field with the up or down cursor keys and using hotkeys to turn selections On or Off.

Example:

The first component to test is U1

8. At the **Ref:** location type: **U1**

9. Use the arrow keys or press <Enter> to move the cursor down to **Type:** and type: **SN75189N**

Check the other entries:

PACKAGE Pins [14]

Dip

RANGE loGic

These settings are correct for this component.

10. Select the **User Instructions** box (use the up/down arrows) and type in the following two lines :—

Connect COM clip to GND. Place 16 pin IC clip over U1 (brown lead to Pin 1 end).

Ignore the other settings for the present – the defaults are OK for most tests.

Use the <Delete> and <Backspace> keys to correct any typing errors or press the <F9> key to clear the whole entry.

Press the function key <F7> to save the settings – the control program will return to the Main \ Program screen and show the component just added to the program list.

U1 SN75189N is displayed as the only entry in the program list.

Note the text for this component is grey. This means the signatures for this device have not been learnt.

(For this example we shall learn the signatures now. However when developing a full program it is advisable to enter all the components into the list and then learn them.)

Check the RS232 cable is connected to the T4000 and the PC, and plug the foot pedal into the jack on the rear of the T4000.

Learning Signatures.

11. Select **Learn** on the program screen, this may be accomplished by the hotkey or pressing the foot pedal (ensure that the *END* entry is not highlighted or the **Learn** function will be disabled).

The **User Instructions** text will automatically be displayed on screen. Follow the user instructions, then press the foot pedal or any key as instructed.

The PC will now load the signatures from the T4000 and once complete displays the "Saving" message on screen and changes the **Device Data** window to reflect that the signatures have been stored.

Before proceeding, it is good practice to have a quick look at the signatures.

12. **View** the signatures – the PC will display the first 8; scroll through the signatures using the up and down arrow keys. Pressing the PgUp, PgDn and arrow keys will show more signatures.

If the signatures indicate open circuit (e.g. if all show a horizontal line) check the clip is located correctly and the COM clip is connected to the GND side of C20.

13. When satisfied with that the signatures are correct, press the <Esc> key on the PC keyboard to exit from the View screen.

14. Select **Verify**. This will continuously acquire signatures and compare them with the signatures just saved. Since both sets of signatures are for the same device, the variations between them should be very small (0–2%). If significant differences are detected this would suggest instability of the signatures, or charging effects - see "Hints". Press <Esc> to terminate **Verify**.

15. Press the <Esc> to exit from the **Learn** screen and note the U1 entry in the list has turned white to indicate the device has been "Learnt".

The test for U1 is now written; to write more tests, repeat the procedure from step 4.

Hints:

Template

Insert always inserts test parameters from the Template.

To set a new template, highlight the component you wish to use and select **Template**.

Reset device templates as often as necessary to speed programming. On entry to a file the template is set to a default setting.

Charging effects

When comparing acquired signatures on the PC with real-time signatures, note any loops that are significantly larger or smaller, which may indicate a charging effect.

Edit the test and try reducing the STEP RATE to 80% and look for a better match.

Unstable signatures

Some signatures may display a "fuzzy" area, due to inherent device characteristics. For repeatable test results the signatures must be stable.

If a CMOS IC is being tested, try connecting the Vcc and ground pins together. If **High** range is being used, try **loGic** or **Low** instead.

If this fails, **Edit** the test parameters to set the Filter **On**. (This will increase test time so ONLY use when necessary.)

Testing a board.

1. At the main menu type **T** for Test.

Loading a Test File.

Select **File** (type **F**) to select a test file.

2. The **File** screen will display the available test files.

On a new system UNTITLED and NCL_DISK (and EXAMPLE1 if it was created as described earlier) will be the only ones available at this stage.

3. Use the cursor arrows to highlight NCL_DISK and press <Enter>.

The top line of the screen should now display:

Polar T4000 NCL_DISK Demo Disk Controller.

The T4000 is now ready to begin testing. Press **Instructions** to display the Instructions file associated with this test program.

Testing a Component.

4. Set the T4000 to REMOTE mode (press the key at the bottom right of the instrument.)

Check the foot pedal is plugged in.

The User Instructions text for U1 will be displayed in the centre of the screen.

4. Follow the user instructions.
5. To test the first component press **T** or the foot pedal.
6. If the test fails check the clip and the common lead are correctly connected.
8. Press **T** to test again. See **Hints** for further help.
9. Once the test passes try the **Loop** function; remove the clip during the test and observe the effect; this feature may be used for locating intermittent faults.
10. View the results when the device passes the test.

Hints

If the test fails and the system displays the message:

Warning Communication Aborted any key to continue
--

Check the cable between PC and T4000.

Check the COM port setting (see SECTION 5 – *UTILITIES*.)

If the test fails and Shorts test, or 1 or more pins fail:

View the signatures; the worst error will be displayed first.

Check that the test clip is not reversed or one location out.

(If only one pin fails) reattach the clip and test again.

Scroll to the pin displayed as worst on the PC screen. The signature should be the same as the Ref signature on the PC display.