Premier

OPERATION MANUAL

for SYSTEM 8 and BoardMaster Ranges

abi

System overview

The SYSTEM 8 Premier software is designed to support a range of high specification hardware modules containing a wide variety of test and measurement facilities including fault-finding instruments, component test instruments and general test and measurement instruments. The hardware modules are supported by a comprehensive software package which allows different combinations of instruments to be used concurrently to satisfy the most demanding fault-finding or test applications. Each module is the same size as a CD ROM drive, allowing a variety of mechanical mounting options. A module can be mounted directly in your PC and controlled via an internal interface card, or it can be mounted in an external case and controlled via a serial or parallel cable. In addition, fully integrated systems (the BoardMaster range) are available which include a PC controller and colour LCD display.

The range of modules available follows: -

ATM (Advanced Test Module). The ATM will identify and locate faulty ICs, broken tracks, short circuits, floating inputs, mid level outputs, dry joints and leaking nodes on PCBs with analogue, digital and hybrid components from discrete diodes and transistors to complex VLSI in DIL, PLCC and SOIC packaging. It has the added advantage of being compatible with all logic families including TTL, CMOS, LVTTL, ECL, DTL, LSI, PECL and LVPECL.

The following instruments are included in the ATM: -

Advanced IC Tester
Advanced IC Identifier
Advanced Short Locator
Advanced Graphical Test Generator
Advanced Board Checker

MIS (Multiple Instrument Station) module. The MIS module contains a comprehensive range of test and measurement instrumentation resources which can be used to implement most of the test instruments found on any electronics workbench. The basic instrument readings can be processed with the built in calculator and used to calculate more complex results. The Instrument Design Manager allows any combination of instruments to be designed and modified by the user and saved in a design file, even to the extent of adding instrument titles and on-screen prompts. Built-in instrument design files emulating standard bench instrumentation (e.g. DSO, DMM, function generator, frequency counter) are included.

The following instruments are included in the MIS module: -

Digital Storage Oscilloscope:	2 channel, 100MHz, 50MS/s to 5GS/s
Universal Inputs/Outputs:	4 channel analogue I/O, 4 channel digital I/O
Frequency Counter:	2 channel 50Ohm/150MHz and 1MOhm/100MHz
Function Generator:	0.1Hz to 10MHz square, sine, triangle, pulse, plus modulation
Digital Multimeter:	2 channel DC/AC 0 to 400V, DC/AC 0 to 1A, 0 to 10MOhms
Auxiliary Power Supply:	5V and +/-9V low current for test interface power

VPS (Variable Power Supply) module. The VPS module provides a programmable power supply with a logic output (2.5V to 6V at 5A) and dual medium voltage outputs (0 to +/-24V at 1.5A). The logic supply is equipped with programmable over-voltage protection, and the dual supplies have programmable current limit. The voltage and current for each rail are displayed on-screen. The VPS is fully compatible with the Instrument Design Manager.

The following instrument is contained in the VPS module: -

Variable Power Supply

BFL (Board Fault Locator) module. The BFL module will identify and locate faulty ICs, broken tracks, short circuits, floating inputs, mid level outputs, dry joints and leaking nodes on PCBs with analogue, digital and hybrid components from discrete diodes and transistors to complex VLSI in DIL, PLCC and SOIC packaging.

The following instruments are included in the BFL module: -

IC Tester
IC Identifier
IC Live Comparison instrument
Short Locator
Graphical Test Generator instrument
EPROM Verifier
Output Driver

AICT (Analogue IC Tester) module. The AICT module allows analogue devices (discrete and ICs) to be functionally tested and also the signatures of ICs and discrete components to be acquired and compared without removing them from the printed circuit board (PCB).

The **ATS** module is another version of the AICT that offers analogue signature acquisition only.

The following instruments are included in the AICT module: -

Analogue IC Tester
Analogue V-I Tester

What's new in SYSTEM 8 Premier

Thank you for updating your SYSTEM 8 Premier software to the latest version. We aim at constantly improving our software package by taking on feedback from our customers all around the world and ensuring that we supply a solution that is powerful, accessible and suitable to users.

Please read below the summary of the changes and improvements brought to you by ABI Electronics.

New product: the Advanced Test Module

The Advanced Test Module (ATM) is a new solution that offers high test capabilities and comprehensive fault diagnosis with a high degree of flexibility. The ATM is suitable for all logic families including TTL, CMOS, LVTTL, ECL, DTL, LSI, RTL, PECL and LVPECL. Components can be checked in-circuit and out-of-circuit or a complete PCB assembly can be tested with a fixture. Click here for more details.

Five new instruments were added to the SYSTEM 8 Premier software with the introduction of the Advanced Test Module. Further details can be found in this help file.

New instrument: the BFL output driver

The 64 channels of the BFL module can be controlled individually to be set to a high or low logic level (or off if unused). This opens a new range of applications where the BFL channels can control equipment outside the SYSTEM 8 range (a power supply for instance) or can control an external multiplexer to route signals through various paths. Please click here for more details.

Integration with third party solutions

It is now possible to integrate third party equipment (non SYSTEM 8 equipment) to work smoothly within the TestFlow environment. External applications can be launched from SYSTEM 8 Premier, run tests until they are complete and return to SYSTEM 8 with information (test results, measurements etc…). This information can be used to set the result of a step (pass or fail). Products such as JTAGMaster for instance can be run from SYSTEM 8 Premier.

The integration of third party solutions is introduced thanks to Python, a powerful and dynamic programming language. For more information, visit www.python.org.

Database management

New keywords have been added to the calculator to enable the storing of results in databases. This allows data to be stored consecutively every time the same TestFlow is run. This is particularly useful in an environment where multiple assemblies need to be tested consecutively and results need to be recorded for traceability. The new commands (STARTLOGDB and WRITELOGDB) are compatible with a SQLite3 database type.

TestFlow documentation

Documents such as videos, Word, Excel, PowerPoint, PDF and others can now easily be added to TestFlows to make the test procedure more interactive. A simple "Add Media" button was added to quickly integrate information within a particular step. This could be a video explaining how to test a board, a device datasheet, a spreadsheet of expected values etc…

Short links to Windows utilities

These shortcuts allow users to quickly launch *Paint*, *Calculator* and *Notepad* from within SYSTEM 8 Premier. This is particularly useful to take screenshots or write information down.

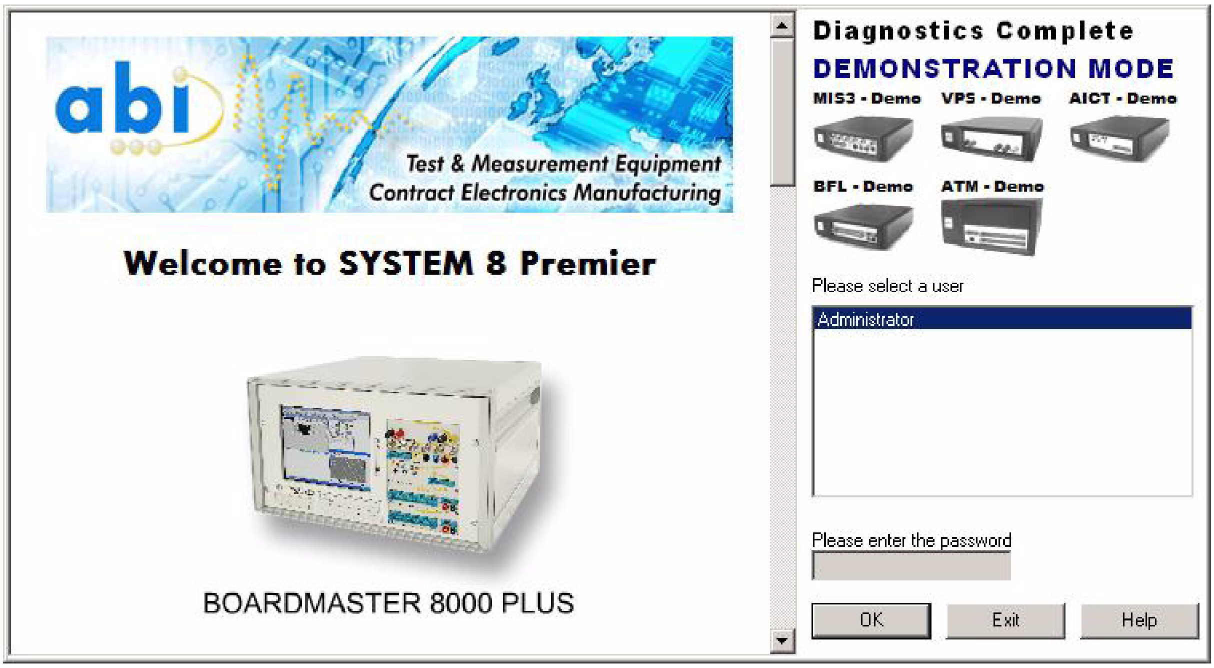
New TestFlows for training

In order to get familiar with the new features of the SYSTEM 8 Premier, a range of short TestFlows is available from ABI Electronics. Please contact us for more information.

Starting the SYSTEM 8 Premier software

SYSTEM 8 Premier operates under Windows XP or above. To start the software, select **Programs** > **SYSTEM 8 Premier** > **SYSTEM 8 Premier** from the **Start** button on your desktop.

When the software launches you will be presented with the login screen:



Pressing the **OK** button will log you into SYSTEM 8 Premier as the selected user.
Pressing the **EXIT** button will ask you whether you wish to exit the software.
Pressing a module icon will show the complete Self Test Diagnostic Results for that module

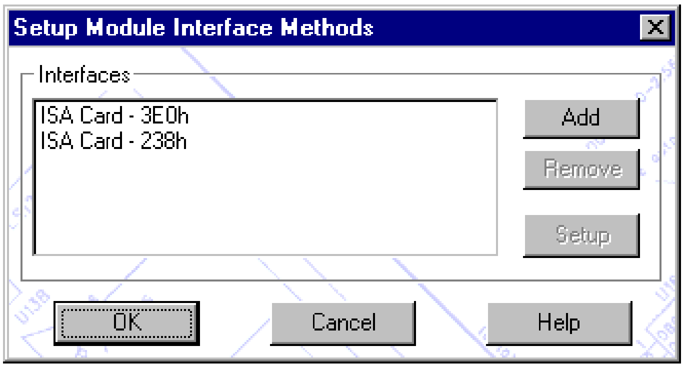
Initially, all instruments and settings will be in their default configuration. A self diagnostic routine is invoked upon running the system to verify that all the hardware is correctly installed and fully functional. The results of the diagnostics are show in the upper right corner where each of the module types is given a PASS or FAIL. If no physical module of a particular type is connected, DEMO will be displayed indicating that this module will be only available in Demonstration Mode.

Quitting the SYSTEM 8 Premier Software

Quit the software by selecting **File** > **Exit** from the menu, or by double clicking on the icon at the top left of the main window. Alternatively you can click on the ☒ symbol at the top right of the main window.

Setup Interface Method

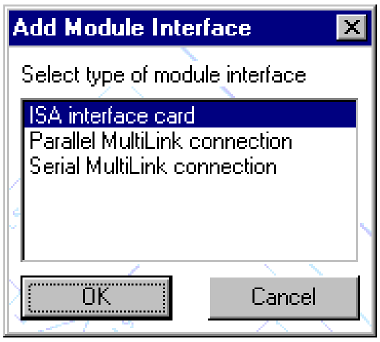
Select **Tools** > **Setup Module Interface Methods** from the menu. This opens the dialog box show below:



The following interface methods are available: -

ISA Card:	This is a card which is installed in an ISA slot in your PC and has an internal connection to the SYSTEM 8 module(s) installed in your PC. Alternatively, an external connection to a SYSTEM 8 External Case may be used.
PCI Card:	This is a card which is installed in a PCI slot in your PC and has an internal connection to the SYSTEM 8 module(s) installed in your PC. Alternatively, an external connection to a SYSTEM 8 External Case may be used.
Parallel MultiLink:	This is a MultiLink case with a built-in interface card which contains your SYSTEM 8 module. The MultiLink case connects to your PC LPT port via a parallel cable.
Serial MultiLink:	This is a MultiLink case with a built-in interface card which contains your SYSTEM 8 module. The MultiLink case connects to your PC COM port via a serial cable.
USB MultiLink:	This is a MultiLink case with a built-in interface card which contains your SYSTEM 8 module. The MultiLink case connects to your PC USB port via a USB cable.

To add a new interface method click on the **Add** button. This opens the dialog box shown below:



Select the interface type you wish to add and click on the **OK** button, which will return you to the original dialog box.

To setup the interface method you have just created, see the following sections:

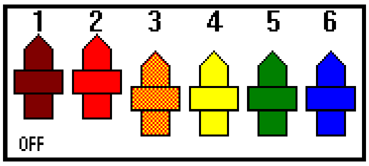
- Setting up the ISA Card
- Setting up the PCI Card
- Setting up the Serial MultiLink Interface
- Setting up the Parallel MultiLink Interface
- Setting up the USB MultiLink Interface

When you are happy with your changes, click the **OK** button, otherwise click the **Cancel** button to leave your settings unchanged.

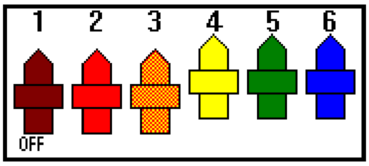
Interface Card Address Setup

The interface card contains a bank of numbered DIP switches which determine the I/O address of the card. The MIS, ATS and VPS can share a common interface card. The BFL module(s) use a separate interface card. The switches on each card must be set to an address which does not clash with any other card on the motherboard. The address range is from 208h to 3E8h. The default addresses below are compatible with the majority of PC cards.

The default address for the **BFL** is **3E0h**:



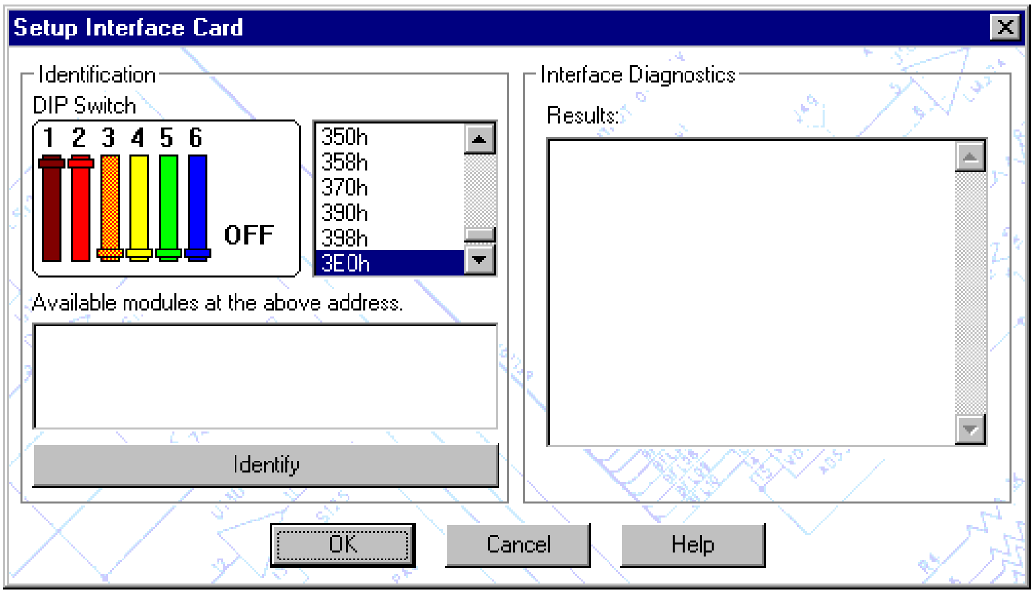
The default address for the **MIS, ATS & VPS** is **238h**:



Changing the Interface Card Address

If the default address does not work for either card, another address can be configured by selecting from the **Tools > Setup Modules Interface Methods** menu. This utility allows you to add/remove interface methods, and setup which port/address to use.

Select the ISA interface that you want to change then click the **Setup** button. This opens a dialog box, similar to the following, which allows you to change the interface card address.



It is important to select a unique address for the interface card to avoid conflict with any other cards on the motherboard. Select a new address from the pick list and the switch settings diagram will change, indicating the new switch settings (remember this configuration). Clicking on the Identify button will tell you whether or not the ISA PC interface card is detected at that address or not.

Once the new address has been selected, press **OK** and then exit the software, and Windows, and switch off. The switches on the appropriate interface card must now be set to the new settings which were displayed during the above operation.

PCI Card Setup

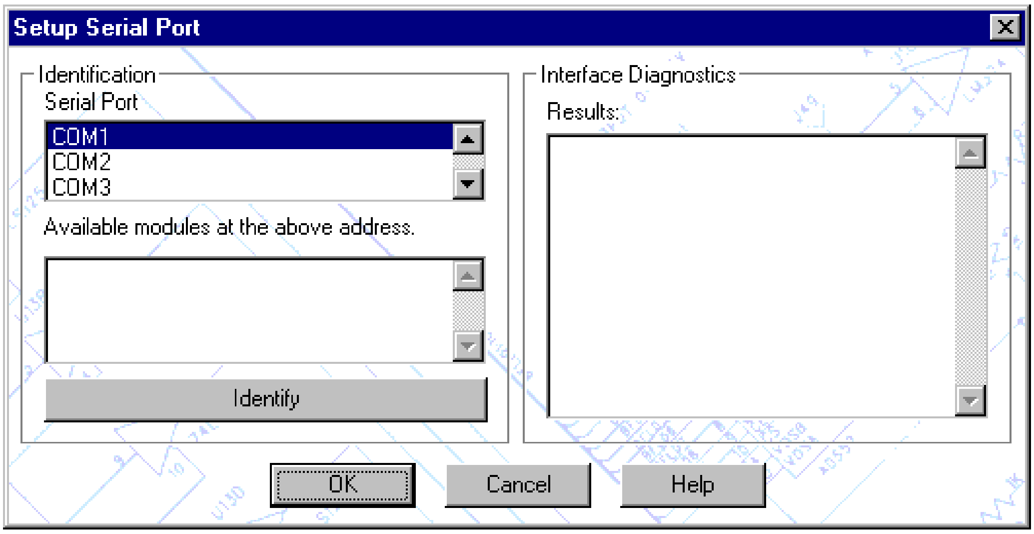
The PCI card is Plug & Play compatible, and will be setup automatically as part of the installation process.

MultiLink Serial Port Setup

If you have an ABI module in a MultiLink case, you can communicate with it using either the serial or parallel port. We recommend the parallel interface because it is faster, and more than one unit can be attached at a time. If you wish to use the serial port you will require an optional serial cable which is available from ABI Electronics Ltd.

Connect the MultiLink case mini DIN serial connector to the PC COM port using a serial cable.

See the Setup Interface Method topic about how to select the Serial Port, and then click the **Setup** button. A dialog box similar to the following will be displayed:-



Select the port that the MultiLink serial cable is connected to. Click **Identify** button to display the MultiLink module that is connected to the specified serial port.

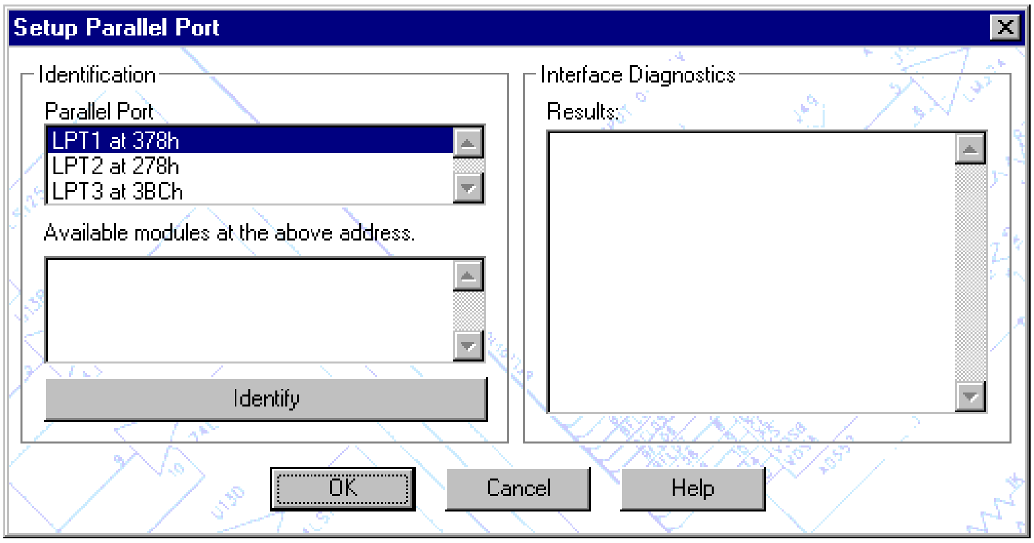
Clicking on the **Cancel** will leave the serial port unchanged.

MultiLink Parallel Port Setup

If you have an ABI module in a MultiLink case, you can communicate with it using either the serial or parallel port. We recommend the parallel interface because it is faster, and more than one unit can be attached at a time by daisy chaining the modules.

Connect the MultiLink case lower connector to the PC LPT port using a parallel cable. Further modules can be connected with further parallel cables from the upper connector of the first module to the lower connector of the next. Up to 7 modules in total can be connected, but no more than 1 of each type.

See the Setup Interface Method topic about how to select the Parallel Port then click the **Setup** button. A dialog box similar to the following will be displayed:-



Select the port that the MultiLink parallel cable is connected to. Click **Identify** to display all MultiLink modules that are connected to the specified parallel printer port.

Clicking **Cancel** will leave the parallel port unchanged.

MultiLink USB Port Setup

The USB Multilink is Plug & Play compatible, and will be setup automatically as part of the installation process.

Contact ABI Electronics Ltd

ABI can be contacted in one of the following ways:

Post:

ABI. Electronics Limited
Dodworth Business Park
Dodworth
BARNSLEY
South Yorkshire
S75 3SP
United Kingdom

Telephone:

Outside UK: +44 1226 207420
UK only: 01226 207420
UK Office hours: 08:00 to 17:00 Monday to Thursday, 08:00 to 12:00 Friday, closed Saturday and Sunday

Fax:

Outside UK: +44 1226 207620
UK only: 01226 207620

Internet & E-mail:

If you would like to visit our Internet web site, the address is http://www.abielectronics.co.uk

Our E-mail address is support@abielectronics.co.uk

ABI Products and accessories

ABI has been designing, manufacturing and selling leading edge solutions in the fields of test, measurement and fault diagnosis since 1983 and has established a world-wide reputation in its field for innovative solutions to real world test and fault diagnosis problems. ABI are the acknowledged leaders in the field of affordable, easy to use, powerful test and diagnosis products with thousands of products installed in around 86% of the world's industrialised countries. The following descriptions detail some of the outstanding products and accessories available:

BoardMaster 8000 Plus.
The BoardMaster 8000 Plus is the ultimate in fault-finding and general purpose test and measurement systems. Completely self contained, with a built-in high performance PC and colour LCD display, the BoardMaster 8000 Plus contains 128 digital and 24 analogue test channels for component level fault diagnosis, a programmable power supply for the board under test, and the state of the art MIS 3 instrumentation module for general test and measurement.

SYSTEM 8 Diagnostic Solution.
The SYSTEM 8 Diagnostic Solution is the solution to board fault-finding problems. Equally at home with analogue or digital PCBs, the system's 64 digital and 24 analogue test channels provide a variety of fault-finding techniques to track down the most elusive faults. The in-circuit IC test is the heart of the digital fault-finding system - look into an IC, and check that it functions correctly, look outside, and confirm that it is correctly wired. Use the analogue V-I tester, with selectable test frequencies and voltages, to check discrete analogue components. Compare the results with a known good board, automate fault-finding procedures with TestFlow, and fault diagnosis becomes truly effortless!

SYSTEM 8 IC Test Solution.
For testing digital components, the IC Test Solution provides the user with the ability to functionally test common digital ICs in- and out-of-circuit. A combination of industry recognised test techniques provides a high level of fault coverage. Additional tools are provided by the software to further enhance the wide range of applications for the unit. The system can be upgraded to include up to 256 channels (in 64 channel steps) which enables live comparison of good and bad boards.

SYSTEM 8 Analogue V-I Solution and Analogue IC Test Solution.
For testing all analogue components, the Analogue IC Test Solution is the answer. The key feature of the Analogue IC Test Solution is its ability to functionally test common analogue ICs in-circuit. It is also capable of identifying and testing all other analogue devices by means of the well-known V-I test technique. For users requiring only the latter function, the Analogue V-I Solution is a lower cost option.

SYSTEM 8 Measurement Solution.
The Measurement Solution contains the MIS instrumentation module providing no less than 6 high specification test and measurement instruments in one compact module. Ideal for design or education, or for general purpose work bench use, the system really is a complete laboratory on your PC. The Measurement Solution is fully compatible with other SYSTEM 8 Solutions.

SYSTEM 8 Power Supply Solution.
The SYSTEM 8 Power Supply Solution contains the VPS module and provides the necessary supply voltages to the unit under test to allow other SYSTEM 8 modules to be utilised in fault-finding. The three output voltages are variable in both voltage and current

making the Power Supply Solution suitable for a wide variety of applications.

LinearMaster Compact.

A hand held out of circuit analogue IC tester

ChipMaster Compact.

A hand held out of circuit digital IC tester

For further details of these and other ABI products and accessories visit our Website, contact your local distributor or contact ABI as detailed above.

Self Test Diagnostic Results

The self test diagnostic results provide information on the status of the hardware. To run the self test diagnostics, select Self Test Diagnostics from the Tools menu. This will run a self test on all hardware and display any errors that occur.

In the event of a fault occurring with any hardware it will be highlighted on one of the diagnostic screens. A summary of the diagnostic results is shown below. Note that further information about any indicated fault can be displayed by clicking the Extended Diagnostic Fault Information button.

MIS 3

System Status Information

Diagnostic result:	Displays the overall self test diagnostic result (PASS / FAIL)
Software version:	Displays the currently installed software version
Number of MIS 3 modules:	Displays the number of MIS modules detected (0 or 1)
Interface method:	Displays the currently selected interface method together with its selected address
Firmware version:	Displays the version number of the firmware installed in the interface card
Firmware test:	Displays the firmware checksum test result (PASS / FAIL)
RAM test:	Displays the interface card RAM test result (PASS / FAIL)

MIS 3 Instrument Test Results

LCAs:	Displays the LCA configuration results for both boards (PASS / FAIL)
EEPROMs:	Displays the EEPROM checksum test results for both boards (PASS / FAIL)
Universal I/O:	Displays the universal I/O test result (PASS / FAIL)
Auxiliary PSU:	Displays the auxiliary PSU test result (PASS / FAIL)
Digital multimeter:	Displays the digital multimeter test result (PASS / FAIL)
Frequency counter:	Displays the frequency counter test result (PASS / FAIL)
Function generator:	Displays the function generator test result (PASS / FAIL)

Digital storage oscilloscope:	Displays the DSO test result (PASS / FAIL)

All the above results will be displayed as **UNDEFINED** if the software is in Demonstration Mode. The software will enter demonstration mode if no MIS 3 hardware is detected.

BFL

System Status Information

Diagnostic result:	Displays the overall self test diagnostic result (PASS / FAIL)
Software version:	Displays the currently installed software version
Number of BFL modules:	Displays the number of BFL modules detected (BFL = 0, 1, 2, 3, 4)
Interface method:	Displays the currently selected interface method together with its selected address
EPROM version:	Displays the version number of the EPROM installed in the interface card
EPROM test:	Displays the EPROM test result (PASS / FAIL)
RAM test:	Displays the RAM test result (PASS / FAIL)

BFL Instrument Test Results

Drive Channel test:	Displays the drive channels test result (PASS / FAIL)
BDO test:	Displays the BDO test result (PASS / FAIL)
Primary PSU test:	Displays the primary PSU test result (PASS / FAIL) where fitted
Secondary PSU test:	Displays the secondary PSU test result (PASS / FAIL) where fitted
Number of channels:	Displays the number of installed channels
Multiplexer:	Displays Installed or Not Found. Note that the Multiplexer is now obsolete.

All the above results will be displayed as **UNDEFINED** if the software is in Demonstration Mode. The software will enter demonstration mode if no BFL hardware is detected.

ATS

System Status Information

Diagnostic result:	Displays the overall self test diagnostic result (PASS / FAIL)
Software version:	Displays the currently installed software version
Number of ATS modules:	Displays the number of ATS modules detected (0 or 1)
Interface method:	Displays the currently selected interface method together with its selected address
EPROM version:	Displays the version number of the EPROM installed in the

	interface card
EPROM test:	Displays the result of the EPROM test (PASS / FAIL)
RAM test:	Displays the result of the RAM test (PASS / FAIL)

ATS Instrument Test Results

LCA 0:	Indicates whether LCA 0 has successfully programmed or not (PASS / FAIL)
EEPROM test:	Displays the result of the EEPROM checksum test (PASS / FAIL)
High voltage power supply test:	Displays the result of the high voltage power supply test (PASS / FAIL)
Analogue V-I probe test:	Displays the result of the V-I probe test (PASS / FAIL)
Pulse generator test:	Displays the result of the pulse generator test (PASS / FAIL)
Number of analogue V-I channels:	Display the number of analogue V-I channels
Analogue IC tester:	PASS/FAIL or NOT FOUND if no IC tester module (AICT) detected

Note: The Analogue IC tester is an option and therefore may not be present even if the ATS V-I Solution is installed. All the above results will be displayed as **UNDEFINED** if the software is in Demonstration Mode. The software will enter demonstration mode if no ATS hardware is detected.

VPS

System Status Information

Diagnostic result:	Displays the overall self test diagnostic result (PASS / FAIL)
Software version:	Displays the currently installed software version
VPS modules detected:	Displays the number and type of VPS modules detected (A, B or A+B)
Interface method:	Displays the currently selected interface method together with its selected address
EPROM version:	Displays the version number of the firmware installed in the interface card
EPROM test:	Displays the firmware checksum test result (PASS / FAIL)
RAM test:	Displays the interface card RAM test result (PASS / FAIL)

VPS Instrument Test Results

Lattice:	Displays the Lattice IC test result (PASS / FAIL)
EEPROM test:	Displays the EEPROM checksum test result (PASS / FAIL)
+HT supply test:	Displays the high voltage supply test result (PASS / FAIL) where fitted
+V supply test A:	Displays the positive supply A test result (PASS / FAIL) where fitted

-V supply test A:	Displays the negative supply A test result (PASS / FAIL) where fitted
Logic supply test:	Displays the logic supply test result (PASS / FAIL) where fitted
+V supply test B:	Displays the positive supply B test result (PASS / FAIL) where fitted
-V supply test B:	Displays the negative supply B test result (PASS / FAIL) where fitted

All the above results will be displayed as **UNDEFINED** if the VPS is in Demonstration Mode. The software will enter demonstration mode if no VPS hardware is detected.

ATM

System Status Information

Diagnostic result:	Displays the overall self test diagnostic result (PASS / FAIL)
Software version:	Displays the currently installed software version
Number of ATM modules:	Displays the number of ATM modules detected (0 or 1)
Interface method:	Displays the currently selected interface method together with its selected address
EPROM version:	Displays the version number of the firmware installed in the interface card
EPROM test:	Displays the firmware checksum test result (PASS / FAIL)
RAM test:	Displays the interface card RAM test result (PASS / FAIL)

ATM Instrument Test Results

Drive Channel test:	Displays the drive channels test result (PASS / FAIL)
BDO test:	Displays the BDO test result (PASS / FAIL)
Number of channels:	Displays the number of installed channels

All the above results will be displayed as **UNDEFINED** if the ATM is in Demonstration Mode. The software will enter demonstration mode if no ATM hardware is detected.

Software Support

ABI believes that it has a duty to support users who have invested in our equipment, and we also believe it is unfair to regard support as a means of generating income. That is the reason we provide all our customers with a two year hardware parts and labour warranty.

If you purchase an ABI product you will receive support free of charge for your two year warranty period. During this time you may send us product support queries via e-mail or fax detailing the nature of your problem. We will do our best to help you get the best from your purchase, but please remember that support is not the same as training. Should you require training we will be happy to arrange training courses for you and your staff on request.

While SYSTEM 8 Premier is a quality piece of software, it will occasionally be necessary to release service releases. Where a service release is necessary the release will be available free of charge from our Internet site. As part of ABI's commitment to innovation, new software will be developed which enhances existing produces and incorporates any new product developments. These innovations will be available for a reduced upgrade fee to existing users of SYSTEM 8 Premier.

Hardware Support

All ABI products are supplied with a 2 year parts and labour return to base warranty. If the event of a problem with your product, to upgrade your hardware to the latest version, or to take advantage of our calibration service, contact ABI Electronics Limited or your local distributor for help and advice.

Calibrating Instruments

Calibration of the system should be performed by ABI or an authorised distributor, who has the necessary equipment and software to ensure that your system is calibrated correctly. In particular, the precision instruments in the MIS module require special high accuracy equipment for calibration and cannot be calibrated by the user. Contact ABI Electronics Ltd or your dealer for details of calibration services.

Safety Notice

All SYSTEM 8 hardware modules with the exception of the VPS module are designed to be installed in a standard 5.25 inch drive bay in your PC and powered from your PC supply, or in an external case supplied by ABI. The VPS module requires a mains transformer and can only be mounted in a special version of the external MultiLink case.

Operation in any other configuration or with any other form of power supply is not supported and will invalidate your warranty.

The BoardMaster range is designed to be operated from 240V AC, 50/60Hz power supply with safety ground but is also available in 110V AC, 50/60Hz when specified at time of order. Please check that the rating label on the back of the unit is compatible with your local supply before connecting. The power cable colour codes are as follows:-

Europe:

Live:	Brown
Neutral:	Blue
Earth (ground):	Green/Yellow

USA:

Live:	Black
Neutral:	White
Ground:	Green

Mains Fuse - mains power cord fused plug - 13A fuse to BS 1362.

Instrument Design Manager

The **Instrument Design Manager** allows you to design your own instrument layouts, or to modify the appearance of the built in layouts. You can design your own instruments using drag and drop editing of the extensive library of instrument controls, readouts and displays. You can edit instrument captions, titles and labels, and add bitmaps for meaningful layouts. You can simplify screen layouts by eliminating unnecessary channels and controls and by combining measurement resources in one window. For example, if your application uses only one channel of the DSO, you can design a special version of the DSO instrument with the other channel removed.

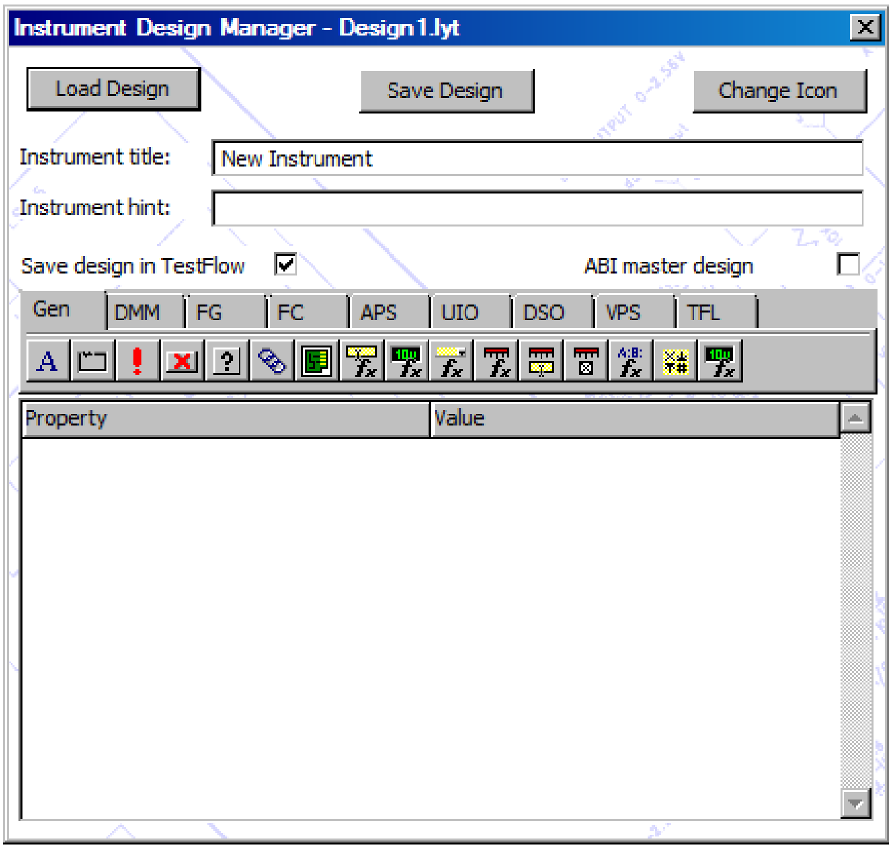
The **Instrument Design Manager** allows instruments in the MIS (Multiple Instrument Station) and VPS (Variable Power Supply) modules to be designed and modified. Instruments in the BFL, ATS and ATM modules use fixed designs and cannot be edited.

With the **Instrument Design Manager** you can Design a New Instrument from scratch, or you can Edit an Existing Instrument. You can also Copy an Existing Instrument to customise it to your own requirements. The SYSTEM 8 Premier software is supplied with a standard range of instrument layouts covering most test and measurement requirements.

When you have designed a new instrument, you can use the Customising the Instruments Menu function to include it in the Instruments menu and the tool bar. Your customised instrument can then be used in the same way as the built-in instruments.

Designing a New Instrument

To design a new SYSTEM 8 Premier instrument, select **Instruments > Design New Instrument** from the menu.



An empty instrument window appears together with the **Instrument Design Manager** window. Enter the title for your instrument in the **Instrument title** entry box. The title will be used as the caption for the instrument when you open it. If you wish, you can also enter **Instrument hint** text which will display when your mouse cursor hovers over the instrument menu commend or icon (see Customising the Instrument Menu for further details). The two check boxes are for internal use only; we recommend that you do not change these settings.

Click **Save Design** to save your new instrument design using a file name of your choice with the **lyt** extension.

In the **Instrument Design Manager** window you will see several control tabs, each containing different types of instrument controls. A summary of the types of control follows: -

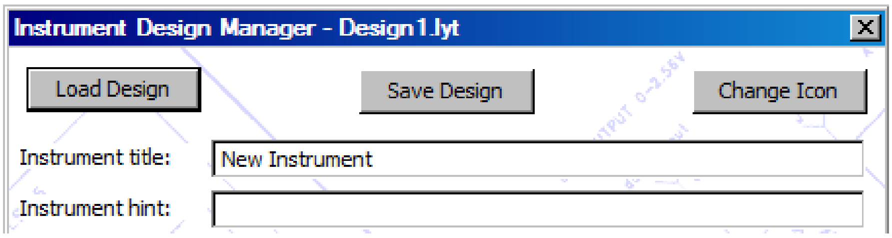
Gen: Contains generic controls such as a text box, group box and action buttons to enhance the appearance of your layout.
DMM: Contains instrument controls and displays for the digital multimeter.
FG: Contains instrument controls and displays for the function generator.
FC: Contains instrument controls and displays for the frequency counter.
APS: Contains instrument controls and displays for the auxiliary power supply.
UIO: Contains instrument controls and displays for the universal inputs/outputs.
DSO: Contains instrument controls and displays for the digital storage oscilloscope.

VPS: Contains instrument controls and displays for the variable power supply.
TFL: Contains instrument controls and displays for the TestFlow.

If you select a control by clicking it, you can place it on your new instrument by clicking on the blank instrument window. You can then Move, Resize, Delete or Edit the control.

Copying an Existing Instrument

To copy an existing SYSTEM 8 Premier instrument, select **Instruments > Design New Instrument** from the menu.



An empty instrument window appears together with the **Instrument Design Manager** window. Click **Load Design** and select the file name of the instrument you wish to edit. Click **Open** to open the file you wish to copy and display the instrument on the screen.

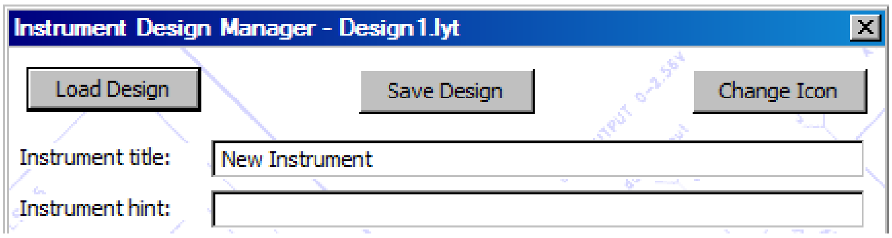
Click **Save Design** to save the instrument design using a *new* file name of your choice with the **.lyt** extension.

If the instrument you wish to copy is already open, right click anywhere on the background of the instrument. When the pop-up menu appears left click **Design Instrument** to open the **Instrument Design Manager**, and then follow the instructions given above.

To make changes to the instrument, follow the instructions given in Designing a New Instrument.

Editing an Existing Instrument

To edit an existing SYSTEM 8 Premier instrument select **Instruments > Design New Instrument** from the menu.



An empty instrument window appears together with the **Instrument Design Manager** window. Click **Load Design** and select the file name of the instrument you wish to edit. Click **Open** to open the file and display the instrument on the screen.

If the instrument you wish to edit is already open, right click anywhere on the background of the instrument. When the pop-up menu appears left click **Design Instrument** to open the **Instrument Design Manager**.

To make changes to the instrument, follow the instructions given in Designing a New Instrument.

Editing Controls

You can only edit, move, resize or delete a control on a SYSTEM 8 Premier instrument if you are in **Design instrument** mode. If you have just loaded or created an instrument, you will already be in **Design instrument** mode. If not, enter **Design instrument** mode by right-clicking anywhere on the background of the instrument. When the pop-up menu appears, left click **Design instrument** to open the **Instrument Design Manager**.

Moving Controls

To move a control on a SYSTEM 8 Premier instrument, click it and drag to a new position using the mouse. A grid of 4 pixels will be used to aid alignment of controls. You can make fine adjustments to the position by using the cursor keys. Alternatively, you can edit the **Top** and **Left** Properties in the window to specify the new position of the control.

Resizing Controls

To change the size a control on a SYSTEM 8 Premier instrument, select it by clicking with the mouse. Point to an edge or corner of the control with the mouse until a grab handle (a double ended arrow symbol) appears. Click and drag the drag handle to resize the control. A grid of 4 pixels will be used to aid alignment of controls. To make fine adjustments edit the **Height** and **Width** Properties.

Deleting Controls

To delete a control from a SYSTEM 8 Premier instrument, select it by clicking with the mouse. Press the **Delete** key to permanently remove it from the instrument.

Editing Controls

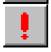
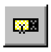
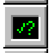
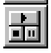
When you select a control by clicking on it, you will then see a table of Properties which you can change to alter the behaviour and/or appearance of your instrument design. The name of the property is shown in the left hand column, and the value in the right hand column. You can click in the value column to change the value of the property only, either by typing in a new value or by selecting from a pick list.

If a control overlaps another control, you can specify the **Z order** (the order in which the controls are viewed) by right-clicking on the control and clicking with **Send to Back** or **Bring to Front** from the pop-up menu. For example, if you place a group box control on your layout, it might hide other controls which were already present. To correct this, right-click on the group box and select **Send to Back** to make the previous controls visible again

Instrument Designer TestFlow Controls

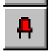
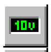
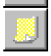
The following controls and a summary of their common Properties are available on the TestFlow tab of the **Instrument Design Manager**.

Control **Function**

	A control that displays a list of all records in a test flow.
	A button used to perform some action associated with manipulating records in a TestFlow.
	An edit box used to display the instructions associated with the current TestFlow record.
	A group of buttons used to set the mode of execution of a TestFlow.
	A control that displays the result of the TestFlow comparison.
	A control that displays a specified webpage or HTML file.
	A control that displays a specified document file e.g. PDF.
	A control that displays a specified video file e.g. AVI, WMV.
	A control that changes the Play/Pause/Stop state of a video which it is assigned to.
	A control that displays the current position within the video to which it is assigned.
	A control which opens a browse window allowing files to be opened in a control to which it is assigned.

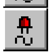
Instrument Designer VPS Controls

The following controls and a summary of their common Properties are available on the VPS (Variable Power Supply) tab of the **Instrument Design Manager**.

Control	**Function**
	A button to switch the supply on or off.
	An indicator, representing an LED, which displays whether the supply is on or off.
	A control used to set values associated with the VPS, such as current limits.
	A display used to indicate the value of a VPS measurement.
	An indicator, displaying text, which shows whether the supply is on or off.
	Text describing the specification of the VPS.

Instrument Designer Universal Inputs/Outputs Controls

The following controls and a summary of their common Properties are available on the UIO (Universal Inputs/Outputs) tab of the **Instrument Design Manager**.

Control	**Function**
	A scrollbar control used to set the value of an analogue channel.
	An indicator, representing an LED, which displays the state of an analogue channel.
	An entry box control used to set the value of an analogue channel.
	A group of buttons used to determine whether an analogue channel is an input or an output.
	A group of buttons used to determine whether an analogue channel is setting/measuring volts or amps.

A display used to indicate the value of an analogue channel.

An entry box control used to set the value of an analogue channel by entering a number, or by using up / down arrow buttons.

An indicator, representing an LED, which displays the state of a digital channel.

A group of buttons used to determine whether a digital channel is set high / low, or whether it is set to be an input.

An indicator, displaying text, which shows the settings for an analogue channel.

Instrument Designer Auxiliary Power Supply Controls

The following controls and a summary of their common Properties are available on the APS (Auxiliary Power Supply) tab of the **Instrument Design Manager**.

Control	Function
	A button to switch the supply on or off.
	An indicator, representing an LED, which shows whether the supply is on or off.
	A display used to indicate the value of an APS measurement.
	An indicator, displaying text, which shows whether the supply is on or off.
	Text describing the specification of the APS.

Instrument Designer Generic Controls

The following controls and a summary of their common Properties are available on the Generic tab of the **Instrument Design Manager**.

Control	Function
	A text box containing free text to annotate your layout.
	A button used to perform some action on a calculator, such as open or run a FormulaPlus program, or perform a user definable action.
	A group box used to group related controls on your layout.
	A button used to close an instrument and return to the previous one.
	A button associated with a help file and context number.
	A button used to open another instrument from the current one.
	A viewer that displays a picture on your layout.
	An edit box where a FormulaPlus program can be entered.
	A display used to indicate the result of a FormulaPlus program.
	A control that allows a predefined FormulaPlus program to be selected.
	A bar graph display indicating the value calculated by FormulaPlus in analogue form, and also used for comparing the value with a target.
	An entry control used for setting the target value and tolerances for the bar graph control.
	A checkbox control to enable a comparison within a TestFlow.

	A label for a calculator entry box.
	A display used to indicate the minimum, maximum and average values of the measurement.

Instrument Designer Function Generator Controls

The following controls and a summary of their common Properties are available on the FG (Function Generator) tab of the **Instrument Design Manager**.

Control	Function
	A scrollbar used to set various FG values, such as the frequency, amplitude etc.
	A display used to indicate the value of a FG setting, such as the frequency, amplitude etc.
	A group of buttons used to set the wave shape.
	A checkbox control used to set whether frequency locking should be used.
	A control used to set the impedance of the externally connected circuit.
	A display used to indicate the FG settings.
	A control used to set the frequency range in use.
	A display used to measure the actual frequency output.
	A button used to trigger a pulse.
	A group of buttons used to set the modulation type.
	A button used to perform some action on the FGEN, such as setting to a predefined duty cycle, a sweep setting, etc.
	Text describing the specification of the FGEN.

Instrument Designer Frequency Counter Controls

The following controls and a summary of their common Properties are available on the FC (Frequency Counter) tab of the **Instrument Design Manager**.

Control	Function
	A display used to indicate the value of a FC measurement.
	A control to select the frequency measurement range.
	A bar graph display indicating the measured value in analogue form, and also used for comparing the measured value with a target.
	A control to select the measurement mode, such as frequency, RPM etc.
	A display used to indicate the minimum, maximum and average values of the measurement.
	A button used to clear the statistics.
	A control used to select frequency or event mode.
	A control used to select between level or pulses when in event mode.
	A control used to select the event mode polarity.
	A control used to select the event mode duration.

	An entry control used for setting the target value and tolerances for the bar graph control.
	A button to start/stop the FC when in event mode.
	A button to zero the counters when in event mode.
	A checkbox control to enable a comparison within a TestFlow.
	Text describing the specification of the FC.

Instrument Designer Digital Storage Oscilloscope Controls

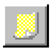
The following controls and a summary of their common Properties are available on the DSO (Digital Storage Oscilloscope) tab of the **Instrument Design Manager**.

Control	Function
	A display showing the waveform measured by the DSO.
	A scrollbar used to adjust the value of a DSO setting, such as the offset on channel 1.
	A group of buttons used to select the acquisition mode.
	A group of buttons used to set the channel coupling.
	A control used to select the volts per division for a channel.
	A control used to select the trigger source.
	A group of buttons used to select the trigger edge.
	A control used to select the timebase.
	A grid control used to display measurements taken from the DSO.
	A button used to store / clear comparison waveforms.
	A control that displays the result of a comparison with a stored waveform.
	Text describing the specification of the DSO.
	A control to set whether an item on the DSO, such as the trace on channel 1, is visible or not.

Instrument Designer Digital Multimeter Controls

The following controls and a summary of their common Properties are available on the DMM (Digital Multimeter) tab of the **Instrument Design Manager**.

Control	Function
	A display used to indicate the value of a DMM measurement.
	A group of buttons used to select the measurement mode.
	A bar graph display indicating the measured value in analogue form, and also used for comparing the measured value with a target.
	A display used to indicate the minimum, maximum and average values of the measurement.
	A button used to clear the statistics.
	An entry control used for setting the target value and tolerances for the bar graph control.
	A checkbox control to enable a comparison within a TestFlow.

 Text describing the specification of the DMM.

TestFlow Automatic Test Manager

The **TestFlow Automatic Test Manager** allows you to design your own step by step test procedures for automatic PASS/FAIL testing of boards or complete assemblies. You can use a combination of the built-in instruments, or even design your own instruments with the Instrument Design Manager, to develop a test and measurement procedure for almost any application. Measurements and waveforms can be compared against target values, with programmable tolerances, and a PASS/FAIL result obtained. On-screen operator instructions, including pictures, can be used to guide the operator through the procedure.

For each step, all instrument settings, target measurement values, tolerances, user instructions, pictures and screen layouts are saved in a single record in a TestFlow file. The file can contain an unlimited number of records to enable complex tests to be developed. As all the test parameters are stored, repeatability and consistency of test results is assured.

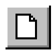
To produce a TestFlow, you perform the following steps: -

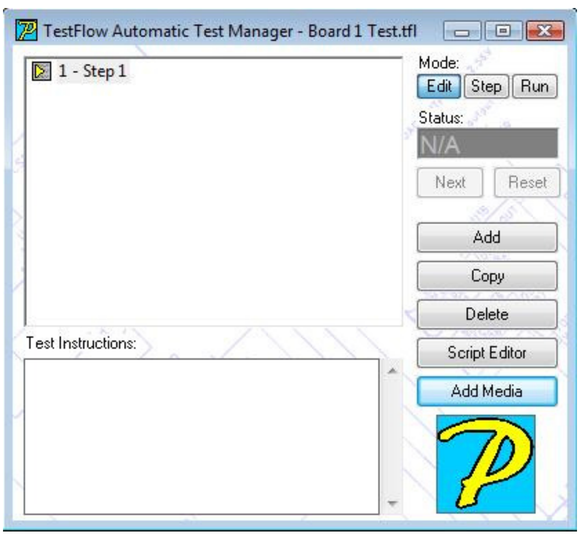
1. Create a New TestFlow by opening the TestFlow Automatic Test Manager.
2. Edit an existing TestFlow to add, copy or delete records, or to amend the settings in a record.
4. Single Step or Run the TestFlow to debug the test flow.

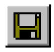
When you have finished editing or running your TestFlow procedure, close the TestFlow window to revert to normal operation.

Once a TestFlow has been created it can be run again and again.

Creating a New TestFlow Procedure

To create a new TestFlow, select **File > New TestFlow** from the menu, or click on the  icon. Enter a suitable filename for your new TestFlow and click **Save**. A TestFlow Automatic Test Manager window will appear containing one record: -



1. The **Edit** button on the **Edit**/**Step**/**Run** control should already be selected.
2. Select **Step 1** by clicking on it and click again to enter rename mode (do not double-click), then type in a name for the first test step.
3. Fill in the **Test Instructions** field with free format text to guide the operator through the test procedure for this step.
4. Open the instruments you wish to use for this test step, resize them and position them where you want on the screen. Or use the **Add Media** button to quickly add videos, images, document and web pages to this step.
5. Set all instrument controls to the required settings and ranges, depending on the nature of the tests you wish to perform.
6. Set all target measurement values. For example, you can use Compare Measurement Results to save multimeter and frequency counter measurements, and you can use the DSO Waveform Comparison function to store DSO waveforms.
7. Select **File > Save TestFlow As** from the menu, or click the  icon, to save the TestFlow procedure under a new filename. Enter a filename for your TestFlow and click **Save**.
8. Use the Edit an Existing TestFlow function to add additional records, delete records or re-order records in your TestFlow procedure.

Editing an Existing TestFlow

To open a TestFlow file for editing select **File > Open TestFlow** from the menu or use the  icon on the toolbar.

Select the file you wish to edit and click Open. After opening the TestFlow file, you can make changes to it by editing. The following editing functions are provided:-

Re-ordering TestFlow records

In the TestFlow Automatic Test Manager window, each TestFlow record is represented by an icon and the test step name. The currently selected record is highlighted. To select a record, click on it, and the instruments contained in the record will automatically open and restore the previously saved control settings. To change the order of the records with the TestFlow procedure, you can click and drag the record to its new position with the mouse.

Adding and deleting records

To add a new TestFlow record, click the **Add** button. A new blank record will be added to the end of the file, regardless of the position of the currently selected record. Click **Delete** to remove a record. Note that you can insert a record anywhere in the file by adding it at the end and then dragging it to the desired position with the mouse.

Copying a new record

To copy a TestFlow record, click the **Copy** button. An exact copy of the currently selected record will be inserted immediately after it. All instrument settings, screen layouts and text will be identical.

Editing an individual record

You can change the instrument settings or screen layouts at any time by operating the instrument controls in the normal way. You can also rename the record name and test instructions by typing in new text.

Saving the modified file

After changing the TestFlow file, select **File > Save** from the menu, or use the icon on the toolbar to save the file on your hard disk. We recommend that you save the file regularly to avoid losing data, particularly if you are making a large number of changes.

Running a TestFlow Procedure

To open a TestFlow file for running select **File > Open TestFlow** from the menu or use the icon on the toolbar.

Select the file you wish to edit and click **Open**. After opening the TestFlow file, you can make run it manually using single stepping, or automatically.

Single Stepping a TestFlow

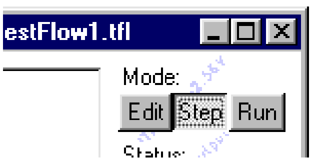
When user intervention is required (for example to change test clips), the TestFlow should be run in **step** mode.

1. Click on the **step** button to place the TestFlow into single stepping mode.
2. If the test passes, a **green tick** appears next to the TestFlow record. If the test fails, a **red cross** appears next to the TestFlow record.
3. Click on the **next** button to move to the next record.

To navigate to a specific record in the TestFlow, click on the record number to select it.

Running a TestFlow Automatically

When user intervention is not required (except at the start and end of the test), the TestFlow should be run in automatic mode. This allows the TestFlow to run unattended.



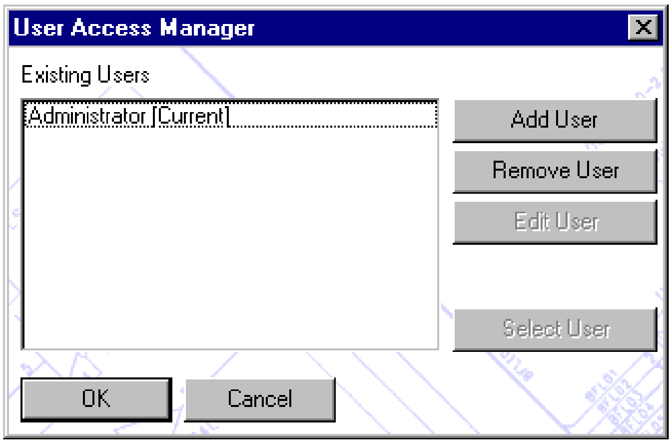
1. Click on the run button to start running the TestFlow.
2. If the test passes, a **green tick** appears next to the TestFlow record. If the test fails, a **red cross** appears next to the TestFlow record.
3. The TestFlow will move onto the next step as soon as a result is available.

User Access Manager

SYSTEM 8 Premier introduces the concept of *users*, each with different *access levels,* to control access to the different functions of the software. For example, you can set up a user who can use the system to carry out tests, but who is not allowed to edit or modify files.

When the software is installed there is only a single user, the Administrator. The Administrator has access to all software features. If you wish, you may continue to use the software in this way without setting up any additional users. If you intend to add users we recommend that you set a password for the Administrator.

To add, remove, change, or edit a user select **Tools > User Access Manager** from the menu.

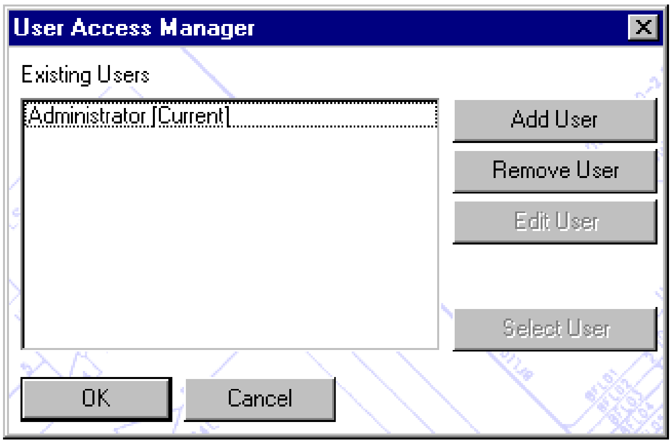


From this dialog box, you can perform the following operations:

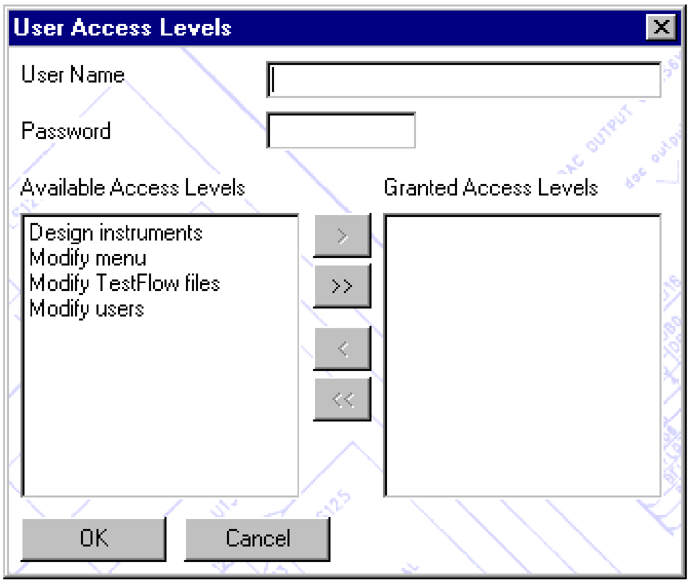
Add a New User
Remove an Existing User
Edit the Settings for an Existing User
Change the Currently Active User

Creating a New User

To manage users you need to select **Tools > User Access Manager** from the menu:



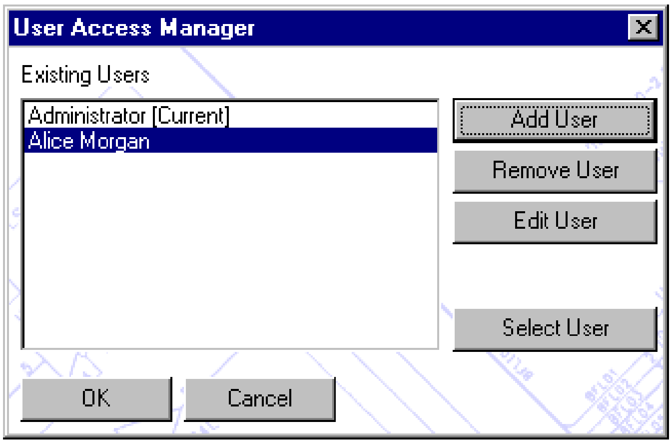
To add your new user, click on the **Add User** button. This opens the *User Access Levels* dialog box:



Type in the desired name for the user, and a password. If you do not wish to use a password, leave the Password edit box blank.

Removing an Existing User

To manage users you need to select **Tools** > **User Access Manager** from the menu:

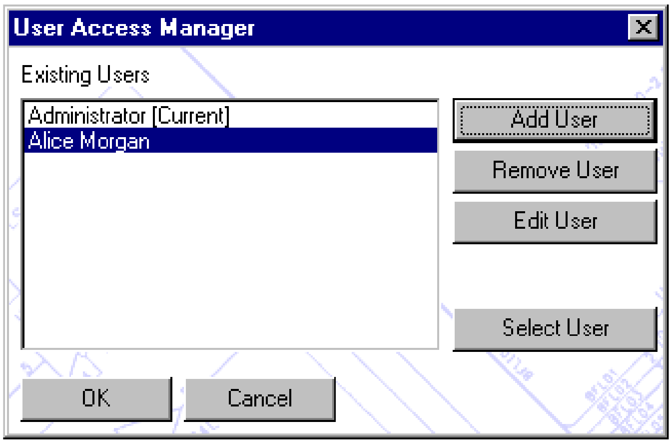


To remove a user, select the user you wish to remove (their user name is highlighted against a blue background), and press the **Remove User** button. You will be asked whether you really wish to remove this user. If you do, click the **Yes** button, otherwise click the **No** button.

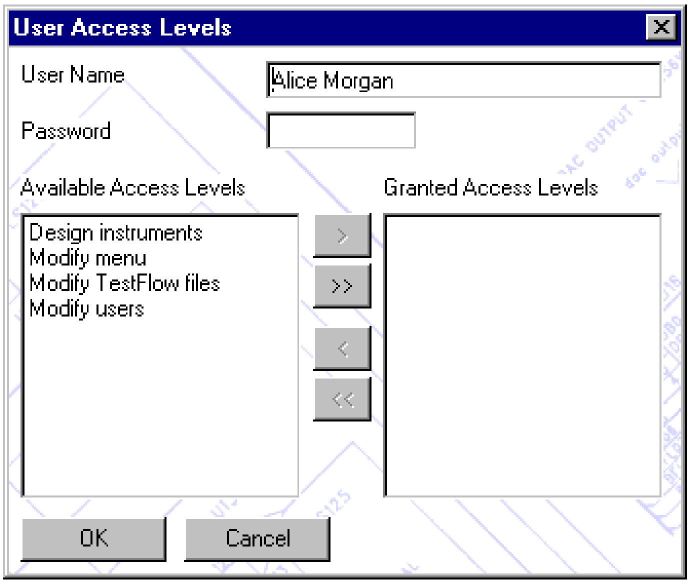
Note: The current user must have the *Modify Users* privilege in order to edit users. If the current user does not have this privilege the **Edit User** button will be greyed out.

Editing an Existing User

To manage users you need to select **Tools** > **User Access Manager** from the menu:



To edit an existing user, select the user you wish to edit (their username is highlighted against a blue background), and press the **Edit User** button. This opens the *User Access Levels* dialog box:



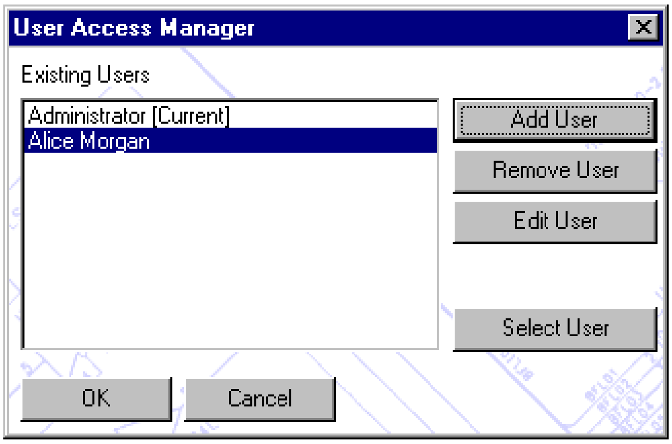
From this dialog box you can modify the *User Name*, *Password*, and *Granted Access Levels*.

The list of available access levels is displayed on the left, while the privileges the user actually has is displayed on the right. To change the access levels granted to this user, use the following controls to move access levels between the two lists:

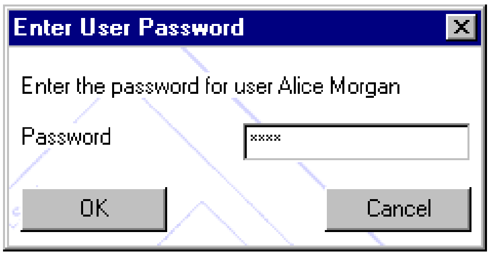
>	Add the *selected* function to the Granted Access Levels list
>>	Add all functions to the Granted Access Levels list
<	Remove the *selected* function from the Granted Access Levels list
<<	Remove all functions from the Granted Access Levels list

Selecting a Different User

To manage users you need to select **Tools > User Access Manager** from the menu:



To change to a different user, select the user you want to change to and click on the **Select User** button. If a password has not been assigned to that user, the user will automatically be made current, otherwise a password entry dialog box will open:

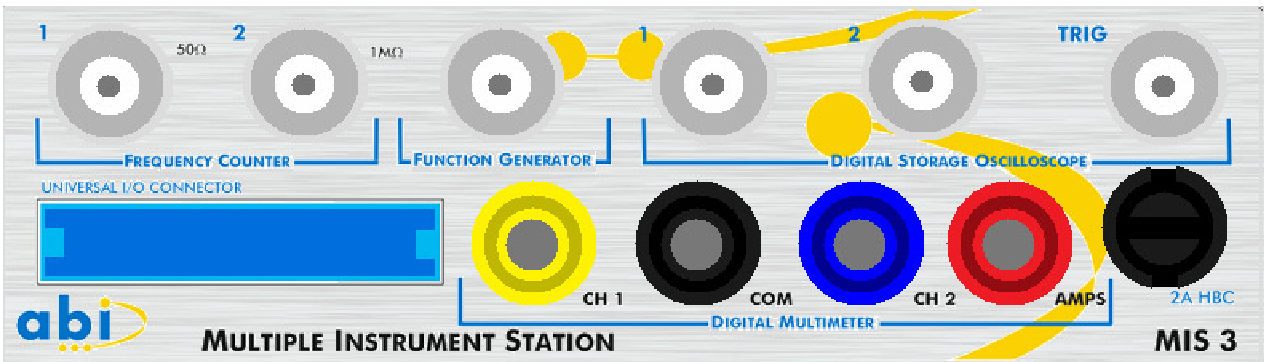


If, when you click the **OK** button, the password is not correct, you will be informed and given the opportunity to enter it again.

The current user is indicated by the text ***[Current]*** being appended after the user name. Click the **OK** to accept these changes, or **Cancel** to leave the current user unchanged.

MIS Front Panel

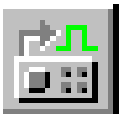
This is the MIS front panel:



All of the connectors on the front panel are industry standard connectors and accommodate standard probes and test cables.

The MIS Function Generator

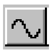
The MIS Function Generator produces sine, square, triangle or single pulse waveforms between 0.1Hz to 10MHz via a 50 ohm output impedance BNC connector on the front panel. The amplitude, DC offset and duty cycle can all be adjusted. AM, FM and PWM types of modulation are also included, with variable modulation level. The function generator contains a built in frequency counter, which can be used to display the actual frequency and to synthesize accurate frequencies. A preview display gives a general impression of the selected waveform.

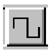


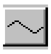
To open this instrument, click on the **Function Generator** icon, or select **Instruments > Function Generator** from the menu.

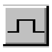
Setting the waveform and frequency

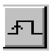
Use the following buttons to select the type of waveform: -

 Click to select sine wave output.

 Click to select square wave output.

 Click to select triangle wave output.

 Click to select single pulse output.

 Click to trigger single pulse output.

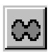
Use the following controls to adjust the frequency and duty cycle of the waveform: -

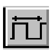
Range Select the desired frequency range with this selector.
Set Frequency Adjust the scroll bar to set the desired output frequency for the chosen range.
Set Duty Cycle Adjust the scroll bar to set the desired duty cycle.
Phase Lock Select this check box to enable closed loop frequency synthesis mode. Note that phase locking takes an appreciable amount of time with low frequencies.

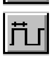
Use the following controls to adjust the amplitude and offset of the waveform: -

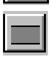
Amplitude Adjust the scroll bar to set the output amplitude.
DC Offset Adjust the scroll bar to set the output amplitude.

Select the modulation mode with the following buttons: -

 Click to select amplitude modulation (AM) mode.

 Click to select frequency modulation (FM) mode.

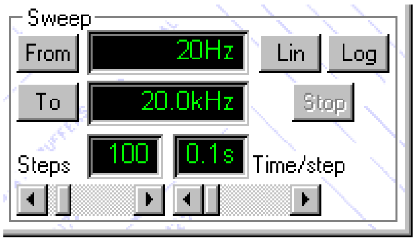
 Click to select pulse width modulation (PWM) mode.

 Click to select normal mode (no modulation).

Modulation Level Adjust the scroll bar to set the modulation level.

Sweeping the Frequency

The Function Generator is capable of sweeping a frequency between two frequency limits in a linear or logarithmic fashion. The controls to perform this action are located in the bottom right hand corner of the Function Generator instrument.



Select the frequency to start sweeping from then click the **From** button, then select the end frequency and click the **To** button. Set how many steps are to be used to reach the final frequency using the scrollbar, and the time to spend between steps using the Time/step scrollbar.

To perform a linear sweep click the **Lin** button, or run a logarithmic sweep by clicking on the **Log** button. To interrupt the Function Generator mid-sweep, click on the **Stop** button.

For more complex sweeps the FormulaPlus calculator can be used.

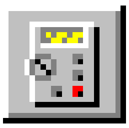
Function Generator Connector

This is a standard BNC connector that outputs waveforms of varying frequency, amplitude and shape.

DC Offset: -7.5V to +7.5V
Amplitude: 0V to 5V
Frequency: 0.1Hz to 10MHz

The MIS Digital Multimeter

The MIS Digital Multimeter is a fully isolated 2 channel multimeter providing AC and DC voltage, current and resistance measurement functions.

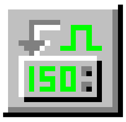


To open this instrument, click on the **Digital Multimeter** icon, or select **Instruments > Digital Multimeter** from the menu.

The multimeter provides DC and AC Voltage Measurement on channels 1 and 2, and channel 2 provides in addition Current Measurement and Resistance Measurement. All ranges are switched automatically. The inputs use shrouded connectors for operator safety, and share a common ground connection. Directly beneath each display is an analogue bar meter which is used for Comparing Measurement Results, and a Measurement Statistics display for monitoring drift and stability of measurements.

The MIS Frequency Counter

The MIS Frequency Counter is a 2 channel frequency counter providing frequency counting from 2Hz to 150MHz, in addition to event counting and RPM measurement. Reciprocal mode measurement ensures accurate measurement of low frequencies without the need to use long gate times.



To open this instrument, click on the **Frequency Counter** icon, or select **Instruments > Frequency Counter** from the menu.

Channel 1 is a 50 ohm high frequency input providing Frequency Measurement up to 150MHz, while the 1M ohm input impedance channel 2 is designed for lower frequencies and covers the full range from 2Hz to 100MHz.

In Event Mode, channel 2 provides the gate input for the event counter, while channel 1 is used for counting events.

Directly beneath each display is an analogue bar meter which is used for Comparing Measurement Results, and a Measurement Statistics display for monitoring drift and stability of measurements.

Frequency Measurement

To measure frequency, set the **Mode** selector to **Frequency** and connect the input signal to either channel 1 or channel 2 as required. Select a suitable range with the **Range** switch.

Channel 1 is a 50 ohm input impedance high frequency channel optimised for frequencies between 1MHz and 150MHz. Channel 2 is a 1M ohm input impedance channel that allows frequencies from 2Hz to 100MHz to be measured.

The result can be displayed either as a **Frequency**, **Period** or **RPM** using the **Display** switch. The measurement is displayed in both digital form and on the analogue bar graph below the digital readout. The bar graph can also be used for Comparing Measurement Results by setting target values with adjustable tolerances.

Below the bar graph the Measurement Statistics for the measurement are displayed, which give an indication of the stability of the measurement.

Event Counting

To count events, set the **Mode** selector to **Event** and connect the signal to be counted to channel 1. The gate signal to time the count is connected to channel 2. The **Range** and **Display** switches are disabled.

To start counting events, click the **Start** button. You can stop at any time by clicking **Stop**, and clicking Zero can clear the count.

In event mode, channel 1 of the frequency counter will count external events when the TTL level external gate signal is in the active logic state. The Trigger On and Edge selectors set this active state. The edge polarity can be set to **Positive** or **Negative** and can trigger on a **Pulse** or logic **Level**.

Channel 2 will display the total time, in seconds, during which the external gate signal is active.

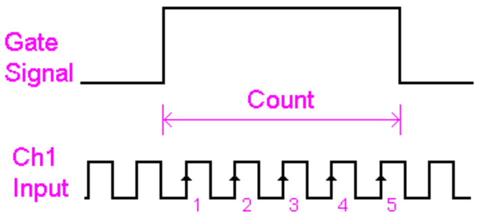
The event count and time are displayed in both digital form and on the analogue bar graphs below the digital readouts. The bar graph can also be used for Comparing Measurement Results by setting target values with adjustable tolerances.

Below the bar graph the Measurement Statistics for the measurement are displayed, which give an indication of the stability of the measurement.

Below are examples of the signals to further explain the operation of event mode:

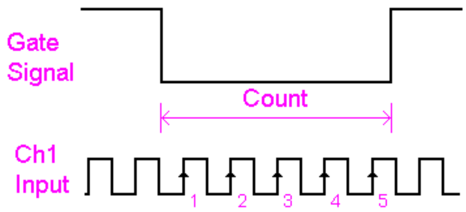
Trigger on Pulse, Positive Polarity

If **Positive** is selected in **Pulse** mode, channel 1 starts counting pulses when the external gate signal goes to a high logic level. When the external gate signal eventually goes to a low logic level, pulse counting is stopped. Even if the external gate signal goes to a high logic level again, no more pulses will be counted.



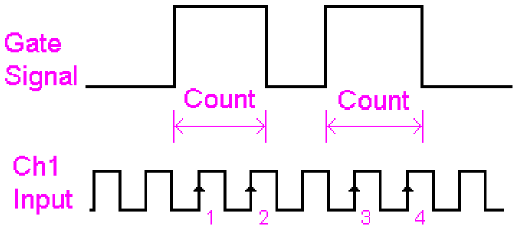
Trigger on Pulse, Negative Polarity

If **Negative** is selected in **Pulse** mode, channel 1 starts counting pulses when the external gate signal goes to a low logic level. When the external gate signal eventually goes to a high logic level, pulse counting is stopped. Even if the external gate signal goes to a low logic level again, no more pulses will be counted.



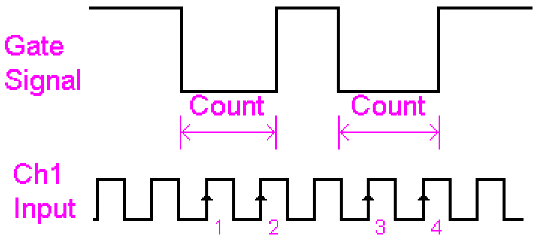
Trigger on Level, Positive Polarity

If **Positive** is selected in **Level** mode, channel 1 counts pulses when the external gate signal is at a high logic level. When the external gate signal goes to a low logic level, pulse counting is stopped. If the external gate signal goes to a high logic level again, pulses will continue to be counted.



Trigger on Level, Negative Polarity

If **Negative** is selected in **Level** mode, channel 1 counts pulses when the external gate signal is at a low logic level. When the external gate signal goes to a high logic level, pulse counting is stopped. If the external gate signal goes to a low logic level again, pulses will continue to be counted.



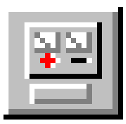
Frequency Counter Connectors

There are 2 channels for measuring frequency and both have standard BNC connectors.

Channel 1: impedance = 50 ohm, max input voltage = 5V peak to peak
Channel 2: impedance = 1M ohm, max input = 200V peak to peak

The MIS Auxiliary Power Supply

The MIS Power Supply provides a fixed triple rail power supply intended for external test interfaces or accessories. The power supply provides +5V at 0.5A, +9V at 0.1A and -9V at 0.1A. The outputs are brought out to the Analogue Outputs Connector on the Front Panel of the MIS module.

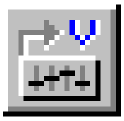


To open this instrument, click **Power Supply** icon, or select **Instruments >Auxiliary Power Supply** from the menu.

The output voltages and currents for each of the three rails are displayed on the digital readouts.

The MIS Universal Inputs/Outputs

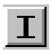
The Universal Inputs/Outputs are designed for controlling external test interfaces. Four bidirectional multi-mode analogue channels and four digital channels are provided. The outputs are brought out to the Analogue Outputs Connector on the Front Panel of the MIS module.



To open this instrument, click on the **Universal I/O** icon, or select **Instruments > Universal I/O** from the menu.

Each analogue channel can be programmed to be either an input or output, and can be further programmed in voltage or current mode. To configure the analogue channels, click the following buttons: -

Configures the analogue channel in **Voltage** mode. The digital readout shows the voltage at the external pin. In output mode, the voltage in the edit box is output to the external pin.



Configures the analogue channel in **Current** mode. In output mode, the current in the edit box is output to the external pin, and the digital readout shows **-.--**. In input mode, an active clamp is used to clamp the external circuit to 0V, and the resulting current is shown on the digital readout.

Configures the channel as an **Output**. In voltage mode, the voltage in the edit box is output to the external pin. In current mode, the current in the edit box is output to the external pin.

Configures the channel as an **Input**. In voltage mode the digital readout shows the voltage at the external pin. In current mode, an active clamp is used to clamp the external circuit to 0V, and the resulting current is shown on the digital readout.

To adjust the analogue output voltage or current to the required setting, click the spin box arrows or enter the value directly. The output voltage can be varied from +9.0V to -9.0V in 0.1V steps, the current from +20mA to -20mA in 100uA steps.

Each digital channel can be programmed to be either an input or output. To configure the digital channels, click the following buttons: -

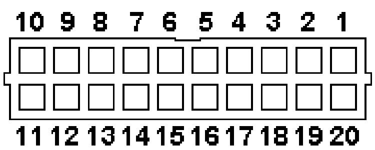
Configure the channel as an input. The LED indicates the logic level **high** (LED on) or **low** (LED off).

Configure the channel as a **high** output.

Configure the channel as a **low** output.

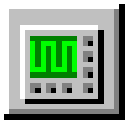
MIS Universal Inputs/Outputs Connector

This connector contains:
4 Analogue input/output channels (pins 1 to 4)
4 Digital input/output channels (pins 5 to 8)
Auxiliary PSU +5V 0.5A output (pins 15 to 16)
Auxiliary PSU +9V 0.1A output (pins 17 to 18)
Auxiliary PSU -9V 0.1A output (pins 13 to 14)
Digital ground (pin 10)
Analogue ground (pins 11 to 12, and pins 19 to 20)



MIS Digital Storage Oscilloscope

The MIS Digital Storage Oscilloscope (DSO) provides two input channels each with a bandwidth of 100MHz and one external trigger. The sampling rate is 50MS/s for single-shot signals, and an Extended Resolution Sampling mode (ERS mode) is available which extends the sampling rate to 5GS/s for repetitive signals.



To open this instrument, click on the **Oscilloscope** icon, or select **Instruments > Oscilloscope** from the menu.

Acquisition

The Acquisition buttons determine the way in which the input signal is acquired when a Trigger occurs. There are four alternatives available:

Single: Single mode. Data is acquired until a trigger occurs. Acquisition then continues for a time set by the Trigger Delay control, before the acquisition stops and the data is plotted.

Normal: Normal mode. Data is acquired as for Single mode, but after the data is plotted further acquisitions take place while ever a valid trigger occurs. This continues until the user presses the Stop button.

Auto: Automatic mode. Data is acquired as for Normal mode, but if no trigger occurs within a preset time a trigger is generated internally.

Stop: Stop acquisition. An acquisition in progress will be abandoned.

Trigger

The Trigger signal is used to produce a stable waveform on the display. The Trigger Source, Trigger Edge, Trigger Level, Trigger Coupling and Trigger Delay controls are used to configure the trigger.

Timebase

The Timebase control sets the time per horizontal (i.e. x-axis) division which will be used during an oscilloscope acquisition.

Channel Controls

The Channel Sensitivity, Channel Coupling and Channel Offset controls are used to configure the vertical (i.e. y-axis) parameters which will be used during an oscilloscope acquisition.

Channel Maths

The Channel Maths controls are used to perform mathematical operations on the acquired waveforms and to compare a waveform with a previously stored version.

Measurements

The Measurements grid can be used to automatically calculate and display a wide range of measurements on the displayed waveform for either channel.

DSO Acquisition Modes

In **Single** mode, data acquisition continues indefinitely until a valid trigger condition occurs (as determined by the Trigger settings and trigger signal). When a valid trigger condition occurs, data acquisition continues until a time set by the Trigger Delay control has elapsed. The resultant data is plotted on the display for examination. The acquired data may be either 100% pre-trigger data, 100% post trigger data, or a combination of both depending on the trigger delay setting. Further acquisitions only take place if the Single button is pressed again.

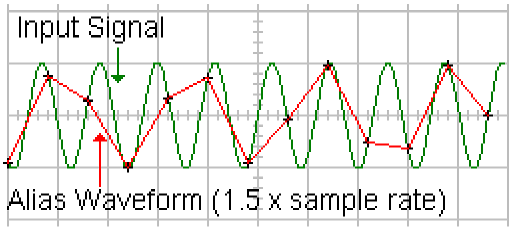
In **Normal** mode, the acquisition sequence is identical to that of single mode described above, except that a further acquisition is started after the data is displayed. After each normal acquisition, the display is updated with the latest data.

In **Auto** mode, the acquisition sequence is identical to that of normal mode described above, except that if a valid trigger does not occur within a preset time a trigger will be automatically generated internally to ensure that a display is possible. Note that in ERS mode auto acquisition is disabled, because a trigger is required from the signal to build the acquisition.

Finally, the **Stop** button stops all acquisitions that are in progress.

DSO Aliasing

Aliasing is a term used to describe a sampling phenomenon that can occur with Digital Storage Oscilloscopes. Nyquist sampling theory suggests that the sampling rate must be at least twice the frequency of the highest frequency in the input signal in order for it to be reproduced in sampled form with the correct frequency. A high frequency signal which violates this sampling criterion (under sampled) can result in a lower frequency signal being displayed (see diagram below). This can fool even the most experienced user. Note that as the sweep speed (timebase) is reduced the sampling rate starts to reduce, which means that even low frequency signals can cause aliasing if the timebase setting is set too low.



It is important that the user has some idea about what the signal being displayed is, and what frequency content to expect. Setting the timebase appropriate to the expected waveform will help eliminate problems with aliasing.
Try turning the timebase to a faster setting (increasing the sampling rate) to check if a higher frequency signal is present. Often, aliased waveforms appear to drift across the screen as if they are not triggered properly, and this is another way of assessing if a waveform is aliased. Finally, measuring the frequency of the input waveform (if repetitive) using the frequency counter will enable the user to determine if the Nyquist criteria is being violated, resulting in aliasing.

DSO Automatic Measurements

The Measurements grid can be used to select a wide range of automatic measurements that are performed on the displayed waveform. Click on the word Select in column 1 on the grid and select the desired parameter to measure from the displayed pick list. Next, click on the channel in column 2 and select the desired channel to measure. The result will be displayed in column 3. To remove a measurement that you no longer require, select None from the measurement pick list.

Note that for some measurements a certain type of waveform is required. For example, to measure the period requires a waveform with at least one full cycle, and to measure rise time requires a waveform above a certain minimum amplitude. If, for some reason, a particular measurement cannot be calculated, the symbol "---" is displayed on the measurement grid.

The following is a list of the available automatic measurements together with a brief description and formula showing how they are calculated. Note that some measurements are directly measured from the waveform (e.g. Base, RMS), while others (e.g. Amplitude, Peak to Peak) are calculated from other measurements:

Base:	The dominant low voltage of a pulse or square waveform, ignoring undershoot. For waveforms with no dominant level (e.g. sine or triangle waveforms) this is the same as the Base Peak.
Top:	The dominant high voltage of a pulse or square waveform, ignoring overshoot. For waveforms with no dominant level (e.g. sine or triangle waveforms) this is the same as the Top Peak.
Base Peak:	The lowest voltage of the waveform, regardless of its shape.
Top Peak:	The highest voltage of the waveform, regardless of its shape.
Amplitude:	Top - Base.
Peak to Peak:	Top Peak - Base Peak.
Mean:	Sum of all voltages / 250 (There are 250 points per acquisition).
Cyclic Mean:	Sum of all voltages within an integral number of cycles / Total number of points within this number of cycles (provided that a periodic waveform is detected).
RMS:	Square root of the sum of the squares of all voltages / 250 (There are 250 points per acquisition).
Cyclic RMS:	Square root of the sum of the squares of all voltages within an integral number of cycles / Total number of points within this number of cycles (provided that a periodic waveform is detected).
Overshoot:	100 % * (Top Peak - Top) / Amplitude.
Undershoot:	100 % * (Base - Base Peak) / Amplitude.
Crest Factor:	Peak to Peak / 2 * Cyclic RMS (provided that a periodic waveform is detected).
V Resolution:	Resolution of voltage measurements on this V/div range.
Cycle Count:	Number of complete cycles detected in the acquisition.
Period:	Total time between 50% amplitude points on successive rising or falling edges of a cyclic waveform / Cycle Count (provided that a periodic waveform is detected).
Frequency:	1/ Period.
Rise Time:	Total time between 10% and 90% amplitude points on rising edges /

Number of rising edges.

Fall Time: Total time between 10% and 90% amplitude points on falling edges / Number of falling edges.

Positive Width: Total time between 50% amplitude points on positive pulses (rising then falling edge) / Number of positive pulses.

Negative Width: Total time between 50% amplitude points on negative pulses (falling then rising edge) / Number of negative pulses.

Positive Slew: Voltage difference between 10% and 90% amplitude points on rising edge / Time difference between these points.

Negative Slew: Voltage difference between 10% and 90% amplitude points on rising edge / Time difference between these points.

Bandwidth: 0.35 / Rise Time. This formula is valid only for a first order system (i.e. with no overshoot on a rising edge) and can be used to give a VERY approximate estimate of the system bandwidth.

Duty Cycle: 100% * High Pulse Width / Period.

T Resolution: Resolution of time measurements on this time/div range.

DSO Channel Coupling

The **Channel Coupling** switch determines the way in which the input signal to the oscilloscope is coupled. There are three positions:

DC Coupling. The input signal is DC coupled.

AC coupling. The input signal is AC coupled. Frequency components below about 10Hz will be attenuated, and DC components will be blocked altogether.

Ground. The signal is internally connected to ground. The input BNC connector becomes open circuit.

DSO Channel Maths

The Channel Maths controls allow you to perform a range of mathematical operations on the acquired waveform(s). There are two sets of controls, one for each channel, allowing independent maths functions for each channel:

Waveform Comparison: This allows a waveform from a known good circuit to be stored as a reference. Another waveform can then be compared against it using programmable tolerances.

DSO Channel Offset

The Channel Offset control adds an adjustable DC offset to the input signal to allow it to be moved vertically on the display. The range of adjustment is +/- 4 divisions, so on the 1V/div range, for example, the ground position of the trace can be adjusted in the range of +/- 4V.

This control allows waveforms which are not symmetrical about ground (e.g. digital signals which switch in the range 0V to 5V) to be displayed with the maximum resolution possible.

DSO Channel Sensitivity

The Channel Sensitivity control sets the vertical sensitivity of the oscilloscope in volts per vertical division. If you are using a x1 probe, the vertical sensitivity can be adjusted from 20mV per division to 2V per division. Using a x10 probe will extend this range up to 20V per division.

DSO ERS Mode

For timebase settings of 0.2us/div and faster, the oscilloscope uses Extended Resolution Sampling to acquire a high speed waveform with more resolution than the normal single-shot sampling rate (50MS/s) will allow. This is achieved by taking repeated samples of a repetitive waveform and interleaving the samples using proprietary hardware and software to reconstruct the original waveform. With this technique, effective sampling rates of up to 5GS/s are possible with timing resolution of 200ps.

For a stable waveform display in ERS mode, a highly stable trigger is necessary, and the waveform must itself be highly stable with minimum timing jitter or noise. If any of these conditions are not met, the reconstructed ERS waveform will appear noisy. The waveform average facility can be used to recover some information.

Note that an ERS acquisition of a low frequency signal will take a long time to construct, because a large number of acquisitions are necessary before the resulting waveform can be displayed.

DSO Timebase

The **Timebase** control sets the time per horizontal division that will be used during the acquisition. A fast timebase allows information around the trigger point to be displayed in detail, whereas a slow timebase allows a larger portion of the waveform to be displayed but in less detail. Normally, a fast timebase is used to acquire high frequency signals since higher sampling rates (more points) are required in order to reconstruct the waveform on the display.

The timebase control sets the time per division for both channels. The time base can be set can be set between 5ns and 5 seconds per division.

The sampling rate for single shot acquisitions is 50MS/s, but for timebase settings of 0.2us/div or faster ERS mode is selected to give better resolution for examining high speed signals. Note that the timebase control also determines, indirectly, the sampling rate. The sampling rate must be high enough to suit the waveform being acquired, otherwise Aliasing will occur.

DSO Trigger

The **Trigger** function is used to control the acquisition to ensure that a stable display is obtained showing the desired part of the waveform on the screen. This is achieved by triggering on a particular voltage level of the trigger input signal, and using this point in time as a reference to control the acquisition

Use the Trigger Source control to select the source of the trigger signal, and the Trigger Edge to specify the active edge to trigger on. The trigger signal coupling can be adjusted with the Trigger Coupling control. Finally, use the Trigger Level and Trigger Delay controls to complete the trigger setup.

DSO Trigger Coupling

The **Trigger Coupling** control is used to select one of four options to improve triggering on noisy or composite waveforms, or on waveforms with large DC offsets. The four coupling options are:

The DC filter leaves the trigger signal unchanged and is the most commonly used setting.

The AC filter is designed to remove the DC component of the trigger signal, for example a waveform that has a DC offset such as ripple on a DC power supply.

The **Low Frequency Reject** filter attenuates low frequency components (below about 3.5kHz), including DC, from the trigger signal. For example, this could be used to trigger on a high frequency signal, which also contains mains (50/60Hz) ripple.

The **High Frequency Reject** filter attenuates high frequency components (above about 3.5kHz) from the trigger signal. For example, this could be used to trigger on mains (50/60Hz) ripple on a signal that also contains high frequency noise.

DSO Trigger Delay

The **Trigger Delay** control sets the amount of pre-trigger data (i.e. data acquired before the trigger) which is shown on the display. Setting the trigger delay to zero (extreme left) causes data only after the trigger point being displayed (100% post-trigger data). Setting maximum trigger delay (extreme right) results in data only before the trigger point to be displayed (100% pre-trigger data). Setting the delay to an intermediate value results in a combination of both depending on the trigger delay setting.

DSO Trigger Edge

The **Trigger Edge** control allows the oscilloscope to trigger on either a rising (positive) or falling (negative) edge. The actual position on the edge can be adjusted in combination with the Trigger Level control. The Trigger Edge can be either of the following:

Triggers on a rising (positive) edge.

Triggers on a falling (negative) edge.

DSO Trigger Level

The **Trigger Level** control sets the voltage level on the trigger waveform at which the trigger occurs. The trigger will occur when the waveform makes a transition through this voltage level in the direction set by the Trigger Edge control. The trigger level voltage is shown on the display next to the trigger level control.

For DC trigger (DC, HF reject) and CH1/CH2 source trigger settings, a marker is shown on the display to show the approximate position of the trigger on the waveform.
For AC trigger (AC, LF reject) or EXT source trigger settings, the marker is not displayed because the waveform may have an unknown DC offset.
For the FG trigger source setting, the trigger level is internally fixed and can not be adjusted.

DSO Trigger Source

The **Trigger Source** is usually set to either **CH1** or **CH2**. The **External** trigger is most often used when you wish to use both channels of the oscilloscope to look at signals which are intermittent or difficult to trigger on. For example, when looking at microprocessor data lines that are not repetitive and difficult to observe, the system clock or read/write line could be used as a trigger by connecting it to the EXT input. If you are using the function generator, you can set the trigger source to **FG** to automatically trigger the DSO from the function generator.

Note that when using the FG trigger source the trigger level is fixed internally and cannot be adjusted.

DSO Waveform Comparison

With this function a known good waveform can be stored and used as a reference. An acquired waveform can then be compared with it and a pass/fail result, using adjustable voltage and time tolerances, can be displayed.

The following buttons are used to control the comparison function:

Click this button to store the waveform for the channel you want. The currently displayed waveform will be saved in the internal memory, and an envelope will be displayed on the display representing the saved waveform with the programmed tolerances.

Click this button to adjust the comparison tolerances. You can then adjust the voltage tolerance, time tolerance and the pass/fail percentage comparison threshold. The envelope adjusts to show the effect of the changes to the tolerances.

Click this button to clear the waveform and disable the comparison.

The percentage (measured in terms of the total length of the trace) of the waveform which lies within the envelope is calculated and displayed. The result is displayed in either red (fail) or green (pass) depending on the setting of the pass/fail tolerance.

MIS Digital Storage Oscilloscope Connectors

The DSO has 2 input channels and an external trigger, all with standard BNC connectors.

MIS Digital Multimeter

DMM Current Measurement

To measure current, select either DC or AC as required and attach your probes in series with the current to be measured to the **Amps** socket and common. The current meter allows currents up to 1A AC or DC to be measured. The system is protected by a fuse accessible from the front panel.

The current is displayed in both digital form and on the analogue bar graph below the digital readout. The bar graph can also be used for Comparing Measurement Results by setting target values with adjustable tolerances.

Below the bar graph the Measurement Statistics for the measurement are displayed, which give an indication of the stability of the measurement.

AC measurements are true RMS but the maximum accuracy is obtained with sine waveforms. True RMS converters have a slow discharge characteristic which can cause errors when measuring a small AC current immediately after measuring a large one. Ensure that you allow enough time, in these circumstances, for the reading to stabilise.

Warning: Do not leave your probe connected to the **Amps** socket after making a measurement. You may inadvertently cause damage if you later try to measure voltage with the probe in the **Amps** socket.

DMM Resistance Measurement

To measure resistance, attach your probes to the channel 2 and common. The multimeter has seven ranges as follows. All ranges are switched automatically:

Range	Maximum	Resolution
1	10R	10mR
2	100R	100mR
3	1k	1R
4	10k	10R
5	100k	100R
6	1M	1k
7	20M	10k

The resistance is displayed in both digital form and on the analogue bar graph below the digital readout. The bar graph can also be used for Comparing Measurement Results by setting target values with adjustable tolerances.

Below the bar graph the Measurement Statistics for the measurement are displayed, which give an indication of the stability of the measurement.

DMM Voltage Measurement

To measure voltage, select either DC or AC as required and attach your probes to the desired channel and common. The multimeter has three ranges as follows. All ranges are switched automatically:

Range	Maximum	Resolution
1	2V	100uV
2	20V	1mV
3	400V	10mV

The voltage is displayed in both digital form and on the analogue bar graph below the digital readout. The bar graph can also be used for Comparing Measurement Results by setting target values with adjustable tolerances.

Below the bar graph the Measurement Statistics for the measurement are displayed, which give an indication of the stability of the measurement. AC measurements are true RMS but the maximum accuracy is obtained with sine waveforms. True RMS converters have a slow discharge characteristic that can cause errors when measuring a small AC voltage immediately after measuring a large one. Ensure that you allow enough time, in these circumstances, for the reading to stabilise.

MIS Digital Multimeter Connectors

These 4mm shrouded connectors accept shrouded test leads.

Measurement Statistics

The statistics information provides information regarding stability, drift and trends for the digital multimeter or frequency counter measurement values. The following functions are provided:

The highest value measured since the statistics were cleared

The average value measured for the number of samples taken since the statistics were cleared

The lowest value measured since the statistics were cleared

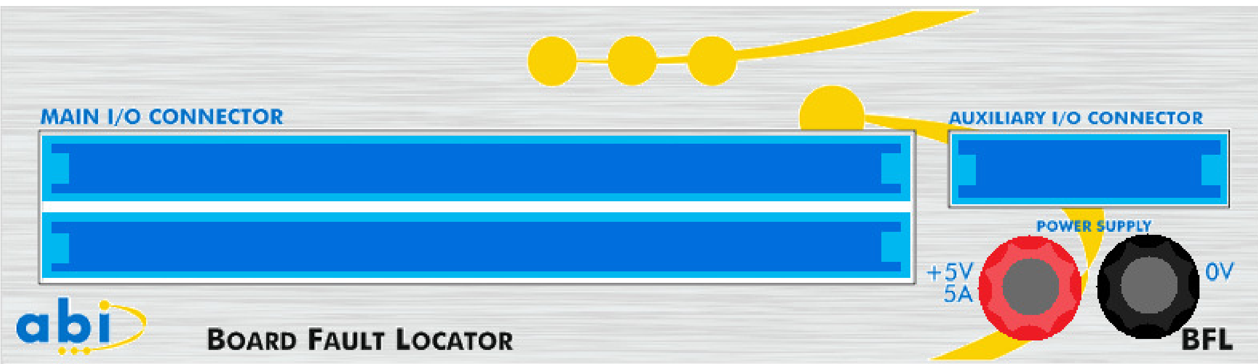
The number of measurements taken since the statistics were cleared

#0 Clicking this button will reset the statistics. They will also be reset automatically when changing measurement mode.

If an invalid value is measured (e.g. voltage above 400V, resistance above 20M or frequency out of range), the statistics will suspend updating and will resume once a valid measurement is obtained.

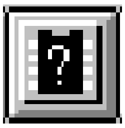
The BFL Front Panel

This is the BFL front panel:



The BFL IC Identifier

The BFL IC Identifier allows unknown ICs to be identified without typing in a part number.



To open this instrument, click on the **Digital IC Identifier** icon, or select **Instruments > Digital IC Identifier** from the menu.

IC Size

The user must select the size of the IC to be identified. This is achieved using the **IC Size** list box. The list box contains the sizes of all ICs in the identifier library.

Circuit Types

The user may select an **in-circuit** or **out-of-circuit** test. The out-of-circuit test requires a special out-of-circuit adapter (contact your dealer for details)

Start/Stop Buttons

Pressing the **Start** button will begin the identification process. Pressing the **Stop** button will abort the identifier instrument at any time during the test.

Identifier Test Result

Any identified devices and their function are listed in the result list box. Also, equivalent devices are listed.

ICs Found

The total number of devices identified during the test is displayed in the IC's Found box. This is continually updated as the test proceeds.

Identifier Progress

Due to the large size of the identifier library, the identifier test can be in progress a considerable time. The extent to which the test has searched through the library is indicated in a percentage status bar at the bottom of the screen. Initially this will indicate 0% complete. As the test progresses, the displayed figure will increase toward 100% (indicating completion). This is also indicated graphically by a blue bar which moves towards the right of the screen as the test progresses.

Identifier Status

The status of the identifier instrument is indicated as follows:

Ready:	The instrument is ready to start
Searching:	The instrument is searching
Complete:	The identification is complete
Stopped:	The instrument has been stopped

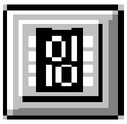
More than one part may be found to be equivalent to the device under test. This is usually due to PCB configuration and IC pin compatibility.

If no parts are identified, the device under test may not be in the identifier library or the device may be faulty. Alternatively factors such as test clip connection, lack of a ground clip and failure to disable connecting circuitry may cause parts not to be identified.

Note: The IC Identifier instrument can cause prolonged backdriving of components. Please take steps to prevent this by disabling connected devices by removal or by using BDO outputs to disable them. Linear ICs are particularly susceptible; therefore ensure that the IC Identifier instrument is only used on digital ICs.

The BFL Graphical Test Generator

The BFL **Graphical Test Generator** allows the BFL digital channels to be used to output a timing sequence and monitor responses.



To open this instrument, click on the **Digital Graphical Test Generator** icon, or select **Instruments > Digital Graphical Test Generator** from the menu.

The number of channels (256 maximum), the number of patterns (230 maximum) and the signal type are all configurable. Each channel is represented by a number which is displayed down the left hand side of the instrument. These numbers relate to the actual physical channel number on the front connector. The pattern number is displayed at the top of the display, under the instrument buttons.

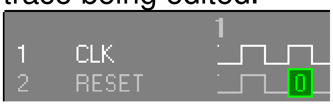
Changing Channel Numbers, Names & Types

To change a channel number, name or type, click the mouse cursor on the appropriate channel name. A green box will then highlight that channel.

If the mouse is double-clicked on a channel, a channel edit box will be displayed. This allows the user to change the number, name and type of the channel. If two channels contain the same number, an error message will be displayed when attempting to run the sequence.

Creating a Timing Sequence

Any timing sequence can be simulated by using high and low levels. The high and low levels are generated either by using the mouse cursor and double-clicking on a trace pattern or by using the keyboard keys "**0**" (Drive Low), "**1**" (Drive High),"**X**" (Don't care), "**L**" (Sense Low), "**M**" (Mid Level) and "**H**" (Sense High). A green box will then highlight the part of the trace being edited.



The existing state of the trace will be displayed as a **0** (Drive Low), **1** (Drive High), **X** (Don't care), **L** (Sense Low), **M** (Mid Level) and **H** (Sense High). Double-clicking on this level will toggle it to the next state.

Channels defined as outputs from the system (inputs to the unit under test) can be programmed as either **0** (Drive Low) or **1** (Drive High). Channels defined as inputs to the system (outputs from the unit under test) can be programmed as L (Sense Low), **M** (Mid Level), **H** (Sense High) or **X** (Don't care). Channels defined as bidirectional can be programmed to any of the states.

Save Button

Once a trace has been set up, it can be saved to a file by pressing the **Save** button. A window will appear, prompting for a filename. Enter a filename and the sequence will be saved under that name, with the extension **.PAT**.

Learn Button

Once the required outputs from the system have been programmed, it is possible to learn the response of the inputs by pressing the **Learn** button.

Open Button

The **Open** button opens and loads a previously saved file. A box will appear and all available .PAT files will be displayed. Choose a file and press OK to load it.

Run Button

The **Run** button begins the logic sequence as defined by the traces. The sequence of high and low pulses is output to the front connector on the BFL module. The PSU and Outputs indicators show when the BFL power supply is turned on and when the output channels are being driven.

Clear Button

The **Clear** button will clear any changes made to the traces, and will set all traces back to a low state. All the channel names and numbers are set back to their original (default) state.

Setup Button

The **Setup** button allows the user to configure the number of usable channels, patterns, test threshold levels and whether the power supply and outputs should be turned off at the end of the test.

Delete Button

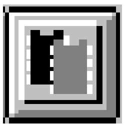
The **Delete** button will delete a row or column, depending on which part of the trace is highlighted. If a channel name is highlighted and the delete button is pressed, the entire selected channel is deleted. If a particular point on a trace (a cell) is highlighted and the delete button is pressed, then that column on every channel will be deleted.

Insert Button

The **Insert** button will insert a row or column, depending on which part of the trace is highlighted. If a channel name is highlighted and the insert button is pressed, a new channel and trace will be inserted directly before the selected channel. If a particular point on a trace (a cell) is highlighted and the insert button is pressed, a new column is inserted on every channel directly before the selected cell.

The BFL IC Live Comparison

The BFL **IC Live Comparison** function allows two identical boards to be powered and compared at the same time.



To open this instrument, click on the **Digital IC Live Comparison** icon, or select **Instruments > Digital IC Live Comparison** from the menu.

One of the most efficient methods to repair a PCB is to compare a suspect board with a known good board. Highlighted differences between the boards can quickly lead to fault diagnosis. The IC Live Comparison instrument allows a suspect board to be compared directly with a known good board or Golden Board. In a 128 channel system, the suspect device is clipped by channels 1 to 64 and the master by channels 65 to 128. In a 256 channel system, the suspect device is clipped by channels 1 to 128 and the master by channels 129 to 256.

Part Button

The **Part** button is used for selecting the part you wish to test. When pressed, you are presented with a box allowing you to select the part you wish to test for the appropriate library. For more information on selecting a part, see Selecting Part to Test.

Setup Button

The **Setup** button is used to configure the test parameters. In the Setup Test Parameters box it is possible to configure a particular test to the requirement of the IC under test. The tolerances used in the comparison of the V-I characteristic and the voltage tests may also be selected.

Start Button

The **Start** button will execute the tests which have been enabled in the Setup Test Parameters box using the configured parameters. If no part has been loaded, the message No Part Loaded is displayed and no test will be executed. When the ‘IC Live Comparison has started, the master device and suspect device are both tested and their resulting test signatures are compared. Any differences between the two test signatures will be highlighted.

Stop Button

The **Stop** button will stop any test which is currently running. This will only usually apply when running tests in one of the loop modes.

Analysis Button

The **Analysis** button displays the Analysis Information dialogue box which includes extended test result information (if no test has been executed this button will be greyed).

IC / DV-I Button

This button toggles (switches) between the truth table test display (IC diagram) and the Digital V-I (DV-I) test display. The text on the button indicates which result display is currently shown. All colours corresponding to the DV-I trace can be configured using the Select DV-I Trace Colours function.

Actual / Master Button

The **Actual** button is used to toggle the current result display between the actual (device under test) and the master (golden device). The expected Master signature of the device can be viewed by toggling the ‘Actual/Master’ button to show 'Master’. The package display of the master and the actual result must be viewed separately. The package pin names will be highlighted in red if there are comparison differences on individual pins. The master DV-I characteristic will be displayed in green and superimposed onto the actual trace of the current board, which is displayed in yellow. All colours corresponding to the DV-I trace can be configured.

The << and < Buttons

When viewing DV-I traces the **<<** and **<** buttons will be active. If there are many DV-I traces on the screen (up to 8) then the **<<** button can be used to view the previous set of traces. If you have zoomed into a single trace, the **<** button can be used to select the previous full trace.

The >> and > Buttons

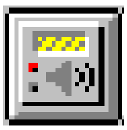
When viewing DV-I traces the **>>** and **>** buttons will be active. If there are many DV-I traces on the screen (up to 8) then the **>>** button can be used to view the next set of traces. If you have zoomed into a single trace, the **>** button can be used to select the next full trace.

V-I Result Comparison

In each of the DV-I display boxes, a percentage figure is displayed which indicates the result of the DV-I comparison for each particular pin. The figure denotes the degree of similarity between all of the points on the master characteristic and those on the corresponding pin of the device under test. A percentage figure of below 95% is considered a bad comparison, and the percentage result will be displayed in red to indicate this. The tolerance of this comparison can be selected from the setup dialogue box. Selecting the **Actual** / **Master** button to Master will display both the master DV-I characteristic (in green), and the DV-I characteristic obtained from the board under test (in yellow). All colours corresponding to the DV-I trace can be configured.

The BFL Short Locator

The BFL **Short Locator** allows short circuits to be located to a very close proximity.



To open this instrument, click on the **Short Locator** icon, or select **Instruments > Short Locator** from the menu.

This instrument requires a separate probe set containing red and black probes. This connects into the 10 way BDO connector on the BFL Front Panel. The instrument uses a 4 wire low resistance measuring technique to enable the location of a short circuit on a PCB to be found.

<u>**Note:**</u> The presence of the Short Locator probes will interfere with the test results of the IC Tester, IC Live Comparison and IC Identifier instruments. Ensure that the probes are removed when not using the Short Locator instrument.

When a low resistance is measured between the two probes, a tone is generated by the PC speaker and the on-screen probes move toward the right of the screen. As the probes become closer to the source of the short circuit, the measured resistance decreases. This is indicated by a higher pitch, and also by the displayed probes moving further to the right of the screen.

Range

This selects the full scale sensitivity of the resistance measurement. The ranges are:

0.1 Ohm: 0.0 ohms to 0.1 ohms
1.0 Ohm: 0.0 ohms to 1.0 ohms
2.0 Ohm: 0.0 ohms to 2.0 ohms

Tone

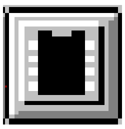
This provides an audio indication of the measured resistance between the Short Locator probes. This allows the user to concentrate on following tracks on the PCB without needing to look at the display. The tone may be turned **On** or **Off** by moving the control slider. The tone status is indicated in both text and picture to the side of the control.

Error Messages

If the measured resistance is greater than the full scale of the selected range the message **OVERFLOW** will be displayed. If the probe leads are not connected or damaged, the message **PROBES!** will be displayed.

The BFL IC Tester

The BFL IC Tester allows ICs to be tested in various ways without removing them from the printed circuit board (PCB).



To open this instrument, click on the **Digital IC Tester** icon, or select **Instruments > Digital IC Tester** from the menu.

Before an IC can be tested, a part must be selected. The currently loaded part will be displayed in the box directly to the left of the Part button. If the message No Part Loaded is displayed here, you will be unable to run any tests. You must select a part before a test can be performed. The board under test will need to be powered from the BFL external supply (if power is required by the test). If a separate power supply is used, the ground **MUST** be linked to the BFL ground terminal.

Part Button

The **Part** button is used for selecting the part you wish to test. When pressed, you are presented with a box allowing you to Select Part to Test and the Test Type for the appropriate library.

Setup Button

The **Setup** button is used to configure the test parameters. In the Setup Test Parameters box it is possible to configure a particular test to the requirement of the IC under test.

Start Button

The **Start** button will execute the tests which have been enabled in the Setup Test

Parameters box using the configured parameters. If no part has been loaded, the message **No Part Loaded** is displayed and no test will be executed.

Stop Button

The **Stop** button will stop any test which is currently running. This will only usually apply when running tests in one of the loop modes.

Analysis Button

The Test Types button displays the Analysis Information dialogue box which includes extended test result information (if no test has been executed this button will be greyed).

IC / DV-I Button

This button toggles (switches) between the truth table test display(IC diagram) and the digital V-I (DV-I) test display. The text on the button indicates which result display is currently shown. All colours corresponding to the digital DV-I trace can be configured using the Select DV-I Trace Colours function.

Rotate Button

When a truth table test is performed on a QFP or PLCC IC it displays only 2 sides of the IC. The rotate button rotates the IC to view the pins which were not initially displayed. Pressing the **Rotate** button again displays the initial pins which were displayed.

Actual / Master Button

The **Actual** button is only active when in BFL IC Live Comparison mode. In normal operation of the IC Tester, this button will be greyed.

The << and < Buttons

When viewing DV-I traces the **<<** and **<** buttons will be active. If there are many DV-I traces on the screen (up to 8) then the **<<** button can be used to view the previous set of traces. If you have zoomed into a single trace, the **<** button can be used to select the previous full trace.

The >> and > Buttons

When viewing DV-I traces the **>>** and **>** buttons will be active. If there are many DV-I traces on the screen (up to 8) then the **>>** button can be used to view the next set of traces. If you have zoomed into a single trace, the **>** button can be used to select the next full trace.

Also, the currently selected **MODE** is displayed beneath the **>>** button.

The BFL Logic Trace

The BFL **Logic Trace** is an integrated part of the BFL IC Tester. If enabled, it will display the logic trace for each pin of an IC under test.

Enable / Disable Logic Trace

The Logic Trace can be enabled and disabled in the Setup Test Parameters window. If a truth table test is performed and the logic trace is disabled, the analysis window will appear giving details of that test. If the test is performed and the logic trace is enabled, the analysis window appears again but also the logic trace window appears.

Understanding the Display

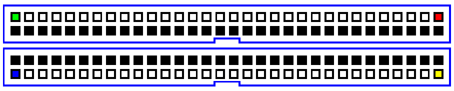
The logic trace window displays all the IC pin names down the left side, the number of clock cycles taken to test the IC at the top and the logic traces for each pin. Each trace is displayed in either white or grey. If the test fails, a red bar will be displayed on the appropriate trace to highlight the fault.

Finding the Voltage

To examine the actual voltages measured in a test, move the mouse cursor to the point of the test to be examined and click the left mouse button. The measured voltages will then be displayed on the left of the screen, between each pin name and logic trace. A green highlight bar will indicate which clock cycle is being displayed.

BFL Main IO Connector

The main I/O connector is where the test cable is inserted. This is used for IC testing and for the Graphical Test Generator. You must ensure the cables are inserted in the correct orientation. The yellow dot on the pin diagram below shows pin 1 (channel 1) of the connector, the blue dot shows pin 32, the green dot shows pin 33 and the red dot shows pin 64. The two rows of black dots are all ground pins.



(See Test Clips for more details).

BFL Pin Conversion Table

The pin conversion table allows the user to define which pin numbers on the test clip connect to which physical BFL channel numbers. This allows the user to make custom PLCC and QFP package clips and cables.

Note: The following pin conversion file format must be complied with to enable this utility to work correctly.

File Format

The file is a non-document pure ASCII file. Each line contains the user test clip pin number and the corresponding physical channel number, separated by a comma and terminated with a CR/LF. The file must contain the same number of lines as the number of pins on the test clip. Each line should follow this format:

nnn,pppCRLF
nnn device clip pin number (3 chars) must start at pin 1 and increment consecutively
ppp physical channel number (3 chars)
CR Carriage return (1 char)
LF Line feed (1 char)

Example

Here is an example where a 20 pin PLCC test clip has all pins mapped one to one, except for pins 19 and 20. Pins 19 and 20 are mapped to physical channel numbers 59 and 60 respectively.

001,001

002,002
003,003
004,004
005,005
006,006
007,007
008,008
009,009
010,010
011,011
012,012
013,013
014,014
015,015
016,016
017,017
018,018
019,059
020,060

Note: The numbers must be padded to three digits by use of zeros (as above).

Pin Conversion Filename

The user defined pin conversion files must be placed in the directory where the software was installed. The following filenames have been allocated for user PLCC/QFP packages.

Package Type	Filename
PLCC20	PLCC20.CON
PLCC28	PLCC28.CON
PLCC32	PLCC32.CON
PLCC44	PLCC44.CON
PLCC52	PLCC52.CON
PLCC68	PLCC68.CON
PLCC84	PLCC84.CON
QFP44	QFP44.CON
QFP48	QFP48.CON
QFP64	QFP64.CON
QFP80	QFP80.CON
QFP100	QFP100.CON
QFP120	QFP120.CON
QFP128	QFP128.CON
QFP132	QFP132.CON
QFP144	QFP144.CON
QFP160	QFP160.CON
QFP168	QFP168.CON
QFP184	QFP184.CON
QFP196	QFP196.CON
QFP208	QFP208.CON

BFL Power Supply Connectors

The 4mm power supply connectors supply 5V @ 5A to the PCB under investigation.

Black : 0V **Red** : +5V

Note: if you are using an external power supply, its ground terminal **MUST** be linked to the black socket on the BFL.

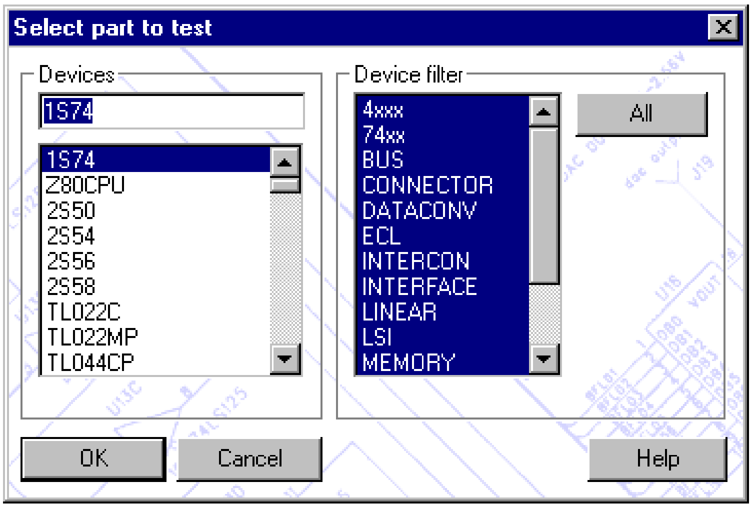
BFL Result Analysis Information

Each enabled test type will have either a tick or a cross beside it indicating a good or bad comparison for that test. Also shown will be the result of the truth table tests if applicable. Any information regarding circuit conditions and pre-test information will also be shown in the list box. Any notes applicable to the part under test will also be displayed in the notes box at the bottom of the dialog.

If the logic trace is enabled and the Analysis button is pressed, the logic trace window will appear as well as the Analysis Information window.

BFL Selecting Part to Test

After the **Part** button has been pressed, you are presented with the new part dialogue box:



The device filter allows multiple libraries to be selected, displaying their contents in the left hand Devices list.

Holding the <control> key while selecting a library allows multiple individual selections to be made, while clicking on the All button highlights all the libraries. To select a range of libraries hold down the <shift> key and click on the first and last libraries in the desired range.

You can also type the IC number directly into the **Devices** box. Simply start typing the number of the IC you wish to test and the IC is automatically found in the list. If the IC cannot be found then either the wrong library has been loaded or the IC does not exist. The easiest way to check this is to enter the IC number with all the libraries selected.

The currently installed library version is displayed underneath the filter box.

Standard Libraries

Each part in the standard **BFL** library has associated attributes which specify which of the test types are valid for the particular part. As an example, the part DIL 8 (Dual in Line, 8 pin package) cannot have an associated truth table test.

Linear Library

When testing linear devices the VCC+ and VCC- supply rails must not be powered up. Testing a linear device with the PCB powered up may cause damage to your system.

BFL Setup Test Parameters

The tests and parameters that are applied to the ICs can be modified as necessary. If any parameters are changed and the **Cancel** button is clicked, none of the changes will be saved or used. If the **Ok** button is click, the changes will be stored and used thereafter.

Test Types

The **BFL** uses a variety of Test Types or test methods to diagnose faults on a PCB. These consist of:

Truth Table Test:	Applies the selected truth table to the IC under test
Connections Test:	Checks for open circuit pins, links between pins, floating pins and shorts to 5V and 0V
Voltage Test:	Measures the voltage on every pin of the IC under test

In addition, the **BFL** contains the following test methods:

Thermal Test:	Detects the thermal value of each individual pin (or node) on the IC under test
DV-I Test:	Performs a V-I test on the IC under test

The user may enable any test type from the setup menu. However, if an enabled test type is not valid for a particular selected part, the system will simply miss out that test. The test setup configuration will not be changed. If the setup configuration has enabled only in-valid test types, an error message will be displayed when the user attempts to perform a test.

Note: Some ICs do not have a Truth Table Test.

To enable/disable a particular test type, click the mouse button on the particular test you wish to enable/disable. If the box by the side of the text contains an **X** then the test is enabled. If the box is empty then the test is disabled.

Test Modes

An IC test can be executed once, continuously or until certain conditions are met. This is highlighted by the following:

Single:	Executes the tests once only.
Loop:	Executes the tests continually.
True Loop:	Executes the tests while ever the tests are true.
False Loop:	Executes the tests while ever the tests are false.

Circuit Types

The IC under test can be tested in-circuit or out-of-circuit. This can be chosen by highlighting one of the following:

In: The IC under test is in-circuit (on a PCB).
Out: The IC under test is out-of-circuit (using the external IC Adapter).

DV-I Range

The DV-I range can be changed by adjusting the LOW and HIGH scroll bars to the required value. Each scroll bar step is 2.5V. A graphical representation of the range is displayed adjacent to the scroll bars. Pressing the **Restore Default** button will set the DV-I range settings to -10.0V and +10.0V respectively. The **Colours** button allows the user to Select DV-I Trace Colours.

Thresholds

The threshold levels are a defined set of parameters that determine whether the output voltage of an IC is High, Low or Mid-Level. While a test is being run, the output voltage from each pin of the IC is compared against the LOW, SWITCH and HIGH threshold settings to determine the logic state of that pin. On the BFL, these threshold settings can be adjusted using the LOW, SWITCH and HIGH scroll bars. Pressing the **Restore Default** button will set the threshold settings to: LOW: 0.5V, SWITCH: 1.2V, HIGH: 2.4V.

The **Swept** option is for the swept threshold test. If the checkbox contains **X** then the test is enabled. If the box is empty then the test is disabled. The swept threshold test identifies the extreme operating thresholds of a particular IC. The swept threshold test uses the truth table test but sweeps the threshold voltages until all mid-level outputs (mid-high and mid-low) are eliminated. The initial test threshold levels are as follows:-

Low threshold:	0.1V
Switch threshold:	1.7V
High threshold:	4.9V

The truth table test will be applied to the IC, and the high threshold levels used will be reduced until all mid-high pin conditions are eliminated. Similarly, the low threshold used will be increased until all mid-low pin conditions are eliminated. When all of the mid level conditions have been eliminated the swept threshold test will stop. The last threshold voltages used will then be displayed.

The swept threshold test is useful if the user wishes to test an IC beyond its normal specification. In this circumstance, the test can be used to quickly identify the tightest thresholds at which the test will pass.

Note: The swept threshold test can only be selected if setup is configured for a single, truth table test only.

Power Supply

The internal power supply can be delayed before switching on when a test is run. The delay time is set by the scroll bar and the delay time is displayed directly above the scroll bar. Pressing the **Restore Default** button sets the delay to its default value of 250mS.

Messages

Various messages can be displayed when running tests. These can be enabled by selecting the appropriate option.

Auto Clip:	Displays the "No automatic clip positioning" message if appropriate to that test
Notes:	Displays any notes associated with the IC under test
Test Results:	Displays the results of all tests performed on the IC under test
Logic Trace:	Enables / disables the logic trace facility

Connection Tol.

This option is only available when using comparison mode. It defines how to treat **floating** and **open circuit** pins when using comparison mode. The options are:

Same:	Floating and open circuit pins are treated as the same when comparing
Different:	Floating and open circuit pins are treated as different when comparing
Off:	Floating and open circuit pins are completely ignored for comparison purposes

Voltage Tol.

This option is only available when using comparison mode. The voltages found on the board under test are compared with those on the master board or in the master file. The **Voltage tolerance** can be adjusted to ensure that correct results are obtained even if the voltages being compared are slightly different from each other due to normal component value variations.

DV-I Tol.

This option is only available when using comparison mode. The DV-I performed on the board under test is compared with that on the master board or in the master file. The **DV-I tolerance** can be adjusted to ensure that correct results are obtained even if the DV-I being compared is slightly different from the other due to normal component value variations.

Thermal Tol.

This option is only available when using comparison mode. The thermal test performed on the IC under test is compared with that on the master board or in the master file. The **Thermal tolerance** can be adjusted to ensure that correct results are obtained even if the thermal test being compared is slightly different from the other due to normal component value variations.

BFL Pin Conditions

When a test has been performed, a number of test messages may be displayed beside the IC pins displayed on the screen. One or more of the following could be displayed:

CFLT (CONFLICT)
The output pin of a tri-state IC is not floating or high impedance when switched off. This indicates a Conflict between this pin and another output on the PCB.

FLOT (FLOATING)

It was found that the pin was not driven by any valid logic level, but the system has detected the small IC input current. This may be due to a PCB fault such as a broken track or dry joint, or a faulty output on the driving IC. This type of condition is closely related to an OPEN CCT pin condition, in particular for high impedance inputs such as CMOS ICs.

OPCT (OPEN CCT)
It was found that the pin had no connection and no input current could be detected. This may be due to a PCB fault such as a broken track or dry joint, a faulty output on the driving IC, or a bad test clip connection. This type of condition is closely related to a FLOATING pin condition, in particular for high impedance inputs such as CMOS ICs.

GND
The pin is connected to the 0V rail, and the voltage is valid (less than 0.5V) when under load.

HIGH
The output on this pin was detected at a high logic level, with respect to the SWITCHING threshold, at a point during the test at which a low logic level was expected.

IPML (INPUT MID-LOW)
The input signal on this pin was found to be between the LOW and SWITCHING threshold settings.

IPMH (INPUT MID-HIGH)
The input signal on this pin was found to be between the SWITCHING and HIGH threshold settings.

L *n* (LINK *n*)
The pin was found to be linked to other pins on the same IC. The connected pins are indicated by a number n.

LD0V (LOAD 0V)
The pin presents an excessive Load (low impedance) to the 0V or GROUND rail. The system is unable to drive this pin with a valid logic high voltage.

LD5V (LOAD 5V)
The pin presents an excessive Load (low impedance) to the 5V or VCC rail. The system is unable to drive this pin with a valid logic low voltage.

LOW
The output on this pin was detected at a low logic level, with respect to the SWITCHING threshold, at a point during the test at which a high logic level was expected.
MDHI (MID HIGH)
The output on this pin was found to be at an invalid logic level at a point during the test. The voltage was measured at a level in between the voltages specified by the SWITCHING and HIGH threshold voltage setup.

MDLO (MID LOW)
The output on this pin was found to be at an invalid logic level at a point during the test. The voltage was measured at a level in between the voltages specified by the LOW and

SWITCHING threshold voltage setup.

NGND (NO GND)
The system was unable to detect a valid 0V supply.

NVCC (NO VCC)
The system was unable to detect a valid +5V supply.

SH0V (SHORT 0V)
The pin is connected directly to the 0V rail.

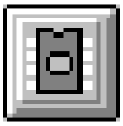
SH5V (SHORT 5V)
The pin is connected directly to the +5V rail.

SIG (SIGNAL)
A changing voltage Signal has been detected on the pin that may interfere with the test results.

VCC
The pin is connected to the +5V rail, and the voltage is valid (greater than 4.5V) when under load.

The BFL EPROM Verifier

The BFL EPROM Verifier allows the users to read, load and save EPROMs for verification purposes.



To open this instrument, click on the **EPROM Verifier** button, or select **EPROM Verifier** from the **Instruments** menu.

The EPROM Verifier can read EPROMs in-circuit and out-of-circuit (if using out-of-circuit mode, a special Adapter is required). The contents of the EPROM are read and the data and checksum are then displayed on the screen. This is then said to be the **Master** data. The master data can then be saved to a file in a binary format, or compared against another EPROM.

The task currently being performed will be displayed under the **Status** box. For example, it will display the word "**Reading...**" when reading and EPROM. Once the data has been read and the checksum is being calculated, the message will change to "**Calculating...**"

EPROM Type

The drop-down list of EPROM types allows EPROMs of different sizes to be selected. These can be:

2k by 8: 16k bit EPROM
4k by 8: 32k bit EPROM
8k by 8: 64k bit EPROM
16k by 8: 128k bit EPROM

32k by 8: 256k bit EPROM
64k by 8: 512k bit EPROM
128k by 8: 1M bit EPROM
256k by 8: 2M bit EPROM

Before a file is opened or an EPROM is read, the appropriate EPROM type **must** be selected.

In Circuit / Out Circuit

The **In Circuit** and **Out Circuit** radio buttons allow the user to specify whether the EPROM to be read or verified is in-circuit or out-of-circuit.

Read Button

The **Read** button will read the contents of an EPROM and display the data on the screen. The scroll bar allows all the data to be viewed by scrolling up or down as necessary.

Verify Button

The **Verify** button will compare the master data (displayed on the screen) against another EPROM. This EPROM can be in or out-of-circuit. If the comparison is good, the message **Verify OK** is displayed. If the comparison is bad, an error message will appear displaying the first address where the comparison was different and the actual and master data. For example, the following message could appear:

Error: 00000 F3 FF

This is interpreted as follows:

Error: <address> <actual data> <master data>

where the master data is the data displayed on the screen and the actual data is the data just read from the EPROM.

Open Button

The **Open** will open a window to allow the user to choose a file to be loaded. The files have the extension **.EPR** and are in a binary format. Once the file is loaded, this will become the master data. The filename of the loaded file will be displayed at the bottom left of the instrument.

Save Button

The **Save** button will open a window to allow the user to enter a filename to be saved. The saved files will have the extension **.EPR** and are in a binary format. Once the file is saved the filename will be displayed at the bottom left of the instrument.

Checksum

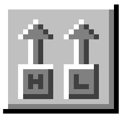
When an EPROM is read or a file is opened (loaded) the data will be displayed on the screen. The checksum will then be calculated and displayed at the bottom right of the instrument in the checksum box.

Status

After an EPROM has been read or a file has been opened (loaded), the status of that EPROM is displayed in the status box. This will show if the EPROM is blank or not blank.

The BFL Output Driver

The BFL Output Driver allows the drive state of each of the BFL channels to be changed individually. This can be useful for communicating with or controlling external hardware from within SYSTEM 8.



To open this instrument, click on the **Advanced Board Checker** icon, or select **Instruments > Advanced Board Checker** from the menu.

Update BFL Button

The Update BFL button is used to send the drive states of each of the channels in the in the channel list to the BFL.

Send Settings on Open Checkbox

The send settings on open check box is used to determine if the BFL should be updated when the BFL Output Driver instrument is opened. This is useful if the BFL is required to be setup upon entering a TestFlow step.

Channel

The BFL channel number associated with a row in the channel list.

Test Point

The name of the channel. This is user definable text which can be used to identify a channels function.

Drive State

The drive state of each of the BFL channels can be set as follows:

Off:	The channel is turned off
Drive Low:	The channel is driving low
Drive High:	The channel is driving high

BFL Auxiliary I/O Connector

The auxiliary I/O connector is mainly used for the BDO (Bus Disable Output) cable. It provides two outputs providing a LOW logic level during a test (green clips), two providing a HIGH logic level during a test (red clips) and one to provide a 0V link with the PCB (black clip). For information on BDO usage, see Test Techniques. This connector is also used for the **DV-I Single Probe** and the **Short Locator Cable**.

BFL Backdriving

When functionally testing ICs in-circuit it is necessary to apply stimulus to the device inputs. However, under normal circumstances these inputs will also be connected to the outputs of other devices on the board. It is only possible to test the IC by momentarily forcing the inputs to the required state by a technique known as backdriving or node forcing. This technique works by applying a higher source or sink current output than that provided by the device being backdriven. The output of the device being backdriven is forced out of saturation to the required level. This is a widely used technique for in-circuit testing.

BFL Conflicts Explained

Consider a tri-state IC, e.g. a device whose output may be logic high, logic low, or high impedance (off). These devices are usually found on bus (data / address / etc.) lines and their outputs will invariably be in common (or parallel) with the outputs of other tri-state devices.

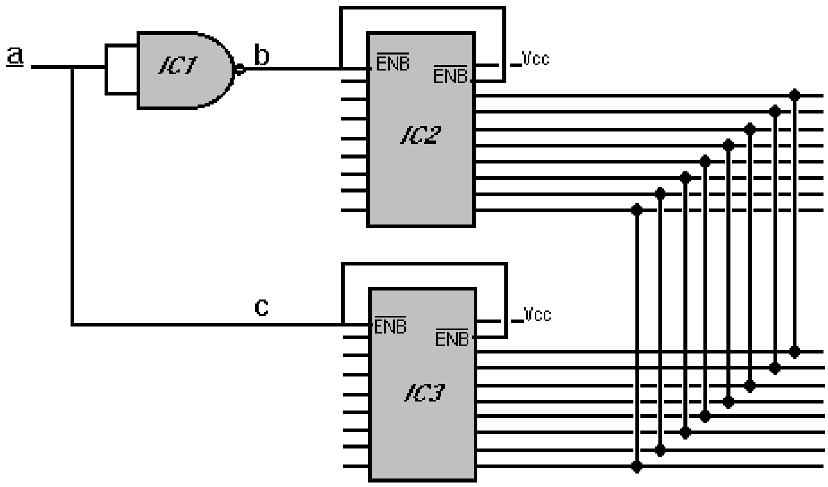
Before testing a tri-state device, BFL checks that the outputs of these devices are in the high impedance condition. Only by ensuring that the outputs are in the high impedance condition before test, can you be certain that, when the test is run, BFL is seeing the outputs of the device under test and not some other device on the same bus which may be enabled.

Should the outputs of a tri-state device not be in the high impedance condition, BFL will report an output CONFLICT by the appropriate pin(s) of the device. At this point the conflict should be removed, this often being done by the application of a BDO to the chip enable (CE) or output enable (OE) pin(s) of the offending device(s) (see Test Techniques). Other ways of removing conflicts include enabling the write enable (WE) pins of a memory, changing the direction of a transceiver, removing the processor and or the memory. Again do the test in the FALSE LOOP. When the point(s) for removal of the conflict have been located a note to this effect can be inserted in the TestFlow file when saving an IC test).

In the example below (***Figure 1***), IC2 and IC3 are tri-state devices such as a 74244. Let us assume that point **a** is at a logic 0. This will cause a logic 1 at point **b** and so IC2 will be disabled and its outputs will be tri-state. Point **c** will be at logic 0 and so IC3 will be enabled. IC3 can therefore be tested without problem. However it is when we try to test IC2 that the problems occur. To test IC2 it must be enabled but IC3 is still enabled by the logic low at point **a.** This will cause a CONFLICT because the outputs of IC2 and IC3 are now connected together. To test IC2 its outputs must go low and high but the outputs of IC3 will be in one state. As they are connected together they cannot be high and low at the same time and so you have a conflict.

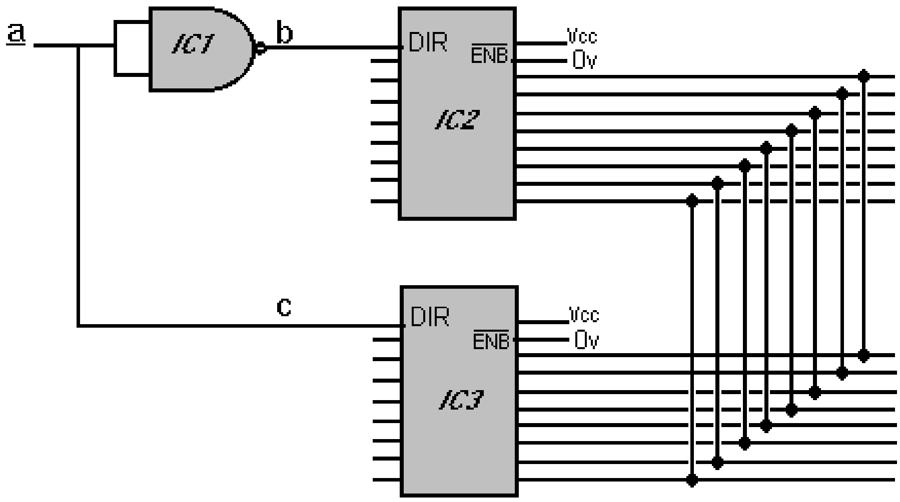
So how do you get rid of the CONFLICT? Simply disable IC3 by either connecting a high BDO to points **a** or **c**.

Figure 1



Note: Notice that the device that was the source of the conflict actually passed the test without the need of BDOs. This is a very important point to remember when trying to detect the source of BUS CONFLICTS on large PCBs. Not all devices that cause a conflict to occur will actually be affected by conflict themselves.

Figure 2



In ***Figure 2*** we have a similar problem to ***Figure 1*** but with one slight difference. Both devices are permanently enabled by a hard wired connection to 0 volts. Therefore it is not possible to get rid of the conflict by disabling one of the devices. However as well as being tri-state these devices are also bi-directional. Therefore, this time the conflict is removed by changing the direction of one of the devices. This can be done by again clipping a BDO to point **a**, though this time either a high or low BDO will work. This problem is common with CONFLICTS on memory devices were the chip select pin is hard wired and you must 'BDO' the read/write pin.

How Do I Find The Conflict Source?

This usually takes practice and experience; use the SPLIT LEAD cable to detect outputs linked to outputs. Check the 20 pin devices (they are usually on bus lines) and any memory devices on the PCB under test. Remember to use the FALSE LOOP mode and probe likely points with the both high and low BDOs.

What If I Cannot Find The Conflict Source?

If there is a BUS conflict on a PCB and it is not possible to get rid of it, then there may be a fault on that PCB. If it is not possible or if you do not have enough time to find the conflict source then you may simply accept that the result you have got is the correct one, <u>whether the device passes the test or not.</u>

<u>Figure 3</u>

	1	20	VCC
CONFLICT	2	19	
CONFLICT	3	18	CONFLICT
CONFLICT	4	17	CONFLICT
CONFLICT	5	16	CONFLICT
	6	15	CONFLICT
CONFLICT	7	14	
CONFLICT	8	13	CONFLICT
CONFLICT	9	12	CONFLICT
GND	10	11	CONFLICT

The diagram in ***Figure 3*** is an example of a test result on a faulty 74245, but it is not the pins with the conflict that are faulty but the two pins (6 & 14) without a conflict. This seems strange until you think about it. As we have seen it is perfectly normal for a device to fail the IC test because of conflict. Therefore, which result is most likely to be correct - the fourteen identical pins or the two that are different from all the rest? It is unusual for one channel of an octal device to be connected differently from the other seven. The evidence suggests then that either this device or another on the BUS is faulty.

BFL Loads Explained

At the start of a test the BFL checks that it is possible to drive each input pin of the device under test (with the exception of VCC and GND pins). Input pins which appear to be excessively loaded towards 5V or 0V are indicated as LOAD 5V or LOAD 0V respectively. This can be caused by various situations such as RC (resistor/capacitor) networks on the inputs, damaged input pins and high current source devices driving the device under test.

A LOAD on an input pin is not necessarily an indication of a faulty device, but simply an indication of a condition that is not typical of a normal input.

BFL Signals Explained

Signals can come from various sources; they could come from an oscillator, a processor and various other sources. Sometimes, the system will detect the signal and warn you of its presence. However it will be unable to do this for frequencies of approximately 4MHz or greater.

How Can I Tell If An External Signal Is Affecting The Test?

Test the device in FALSE LOOP and look for an INPUT SIGNAL CHANGING warning on screen. The device may fail in a slightly different way every time as it is tested. Links, open circuits or floating may appear and disappear.

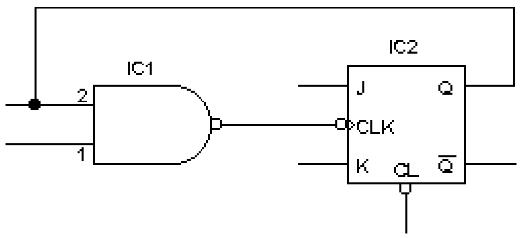
How Do I Stop The Signal?

Try connecting a low BDO to one leg of the crystal or remove the crystal, remove the processor or EPROMS etc. Run the test in FALSE LOOP.

In ***Figure 1*** below, the **Q** output from the JK flip-flop is fed back to its own clock input via a NAND gate. This can cause a problem when testing either device. When testing the NAND gate, a signal may appear on pin 2, caused by the feedback from the Q output of the flip flop. This would not usually cause the device to fail the test but it may cause a bad comparison if comparing boards. To avoid this, simply connect a BDO clip to the CLEAR pin of the flip flop, thus holding its outputs in a fixed state. Use a low or high BDO as appropriate, depending on whether the CLEAR is a low or high enable.

When testing a flip flop in this configuration the device is very likely to fail due to a changing input signal. This is again caused by the feedback line from the **Q** output. To solve the problem this time simply connect a LOW BDO to pin 1 of the NAND gate, then no matter what pin 2 does, the output will always be a steady logic high.

Figure 1



BFL Special Tests

There are many special function tests that can be performed. These are listed below:

Interconnections Tests

The interconnections test is a derivative of the connections test. This enables the user to determine interconnections between different ICs on a PCB by using an optional split cable and two IC clips.

This feature is particularly useful if no circuit diagrams are available for the PCB under test.

Test names: DIL 14x2, DIL 16x2, DIL 20x2, DIL 24x2, DIL 32x2, DIL 40x2

DV-I Probe Test

The Digital V-I (DV-I) probe test performs a DV-I test on a single pin or circuit node by use of the discrete DV-I probe cable. The cable connects into the 10 way blue BDO connector on the BFL Front Panel. The black ground clip on the cable is for use as a reference point (alternatively use the power supply black terminal as a ground reference). The red probe is used to connect to the desired pin or circuit node. The DV-I Probe test is best used in LOOP mode, although SINGLE mode can be used for one-shot acquisitions. The display shows the DV-I characteristic obtained from the red probe with respect to the 0V black clip. The V-I voltage sweep range used will be the range defined in the setup menu (see Setup Test Parameters).

WARNING: The black test clip on the DV-I probe cable provides a hard 0V reference for the DV-I test. If this clip is not connected to the PCB 0V (or ground), the user must ensure that no power is supplied to the PCB whilst the clip is connected. Failure to comply could result in damage to the PCB.

Test names: VI PROBE

EPROM Socket Analysis

These tests are designed so the user can examine the BUS on a PCB. This is done by removing an EPROM and plugging a special cable directly into the EPROM socket, then selecting the appropriate test (according to the EPROM size). All the selected tests (except Truth Table test) are all performed and the appropriate information is displayed. The types of tests performed are user configurable in the Setup Test Parameters menu.

Test names: BUS 2Kx8, BUS 4Kx8, BUS 8Kx8, BUS 16Kx8, BUS 32Kx8, BUS 64Kx8, BUS 128Kx8, BUS 256Kx8

Microprocessor BUS Analysis

These tests are designed so the user can examine the BUS on a PCB. This is done by removing the appropriate microprocessor and plugging a special cable directly into the microprocessor socket, then selecting the appropriate microprocessor test. All the selected tests (except Truth Table test) are all performed and the appropriate information is displayed. The types of tests performed are user configurable in the Setup Test Parameters menu.

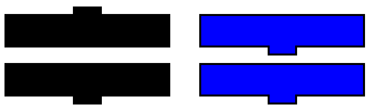
Test names: BUS Z80, BUS 6502, BUS 8085, BUS 8088

BFL Test Clips and Cables

BFL can utilize many types of test clip, from 8 pins and upwards. **DIL** (Dual in Line), **SOIC** (Small Outline Integrated Circuit), **QFP** (Quad Flat Pack) and **PLCC** (Plastic Leaded Chip Carrier) ICs can all be tested using the appropriate test cable.

Connection to the PCB under Test

Connection to the board under test is made by use of a ribbon cable and an appropriate test clip. The blue connectors on the ribbon cable connect into the blue 128 way connector on the front of the BFL unit. It is important to connect the cable in the correct manner.

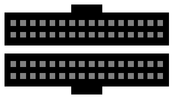


You should position the two black connectors so that their polarization notches are on the outside, (i.e. away from each other), with the cables running parallel. Now install the blue connectors into BFL. The two cables should still be parallel, and the black polarization notches should still be on opposite sides.

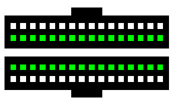
DIL Test Clip Insertion

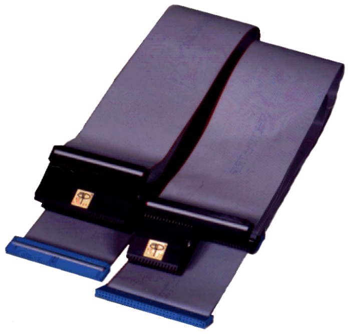
Conventional test clips insert into the black connectors on the test cable in the following manner:

1) Position the two black connectors so that their polarization notches are on the outside, (i.e. away from each other), with the cables running parallel.



2) The test clip inserts into the inner rows of pins (shown in green on the diagram), on the black connector.



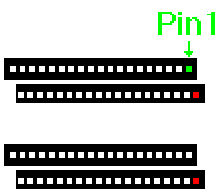


The clip may be inserted in any position along the row. However, inserting the clip toward the end of the ribbon cable with the red stripe, will ease interpretation of results in some cases, and is mandatory in cases where automatic clip positioning is disabled. In these circumstances, pin 1 of the test clip is the left side corner pin nearest the red stripe on the ribbon cable. The test clip itself is not polarized and therefore it does not matter which way round the test clip is inserted into the cable (see diagram).

SOIC Test Clip Insertion

a) AP Test Clips

Some AP SOIC test clips have staggered pins and require a special test cable. This cable can be used for any size SOIC test clip (from 8 to 28 pins). However, when inserting the test clip into the cable there will often be a spare hole that is not used. For example, the red dots on the diagram below show the holes in the test clip connector which do not have a test clip pin inserted in them. The pin in green denotes pin 1.



20 pin and 28 pin SOIC clips will utilize the holes shown in red (above), but 8 pin, 14 pin, 16 pin and 24 pin SOIC clips will not use these holes.

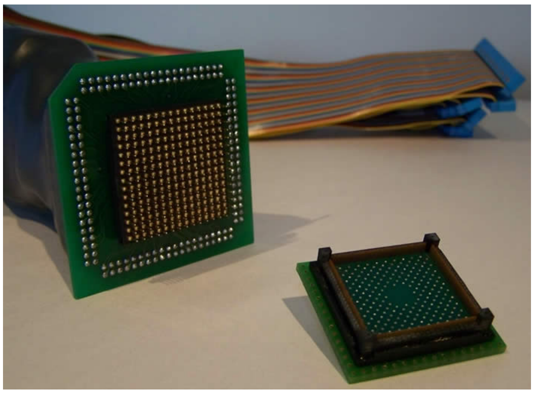
b) Pomona Test Clips

The Pomona test clips are an alternative to the AP clips. They are fitted into their own cable in the same way as the DIL test clips. However, it is important to use the appropriate cable for the correct test clips:

- For DIL test clip, use the **grey** flat cable (for BFL and AICT modules)
- For SOIC Pomona clips, use the **multi-coloured** cable (for BFL and AICT)

QFP and PLCC Test Clip Insertion

QFP and PLCC test clips are similar in that they have 4 sides. Each QFP and PLCC test clip has a unique test cable that will only fit that particular size clip. When the clip is inserted into the test cable, all of the holes must be utilized. Usually, a red dot on one side of the test cable will denote pin 1.



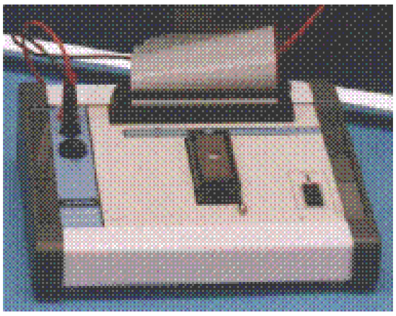
Custom Test Clips and Cables

Custom cables and clips can be made by the user. To enable the custom cables and clips to be used with the system, a Pin Conversion utility is available for PLCC and QFP devices. This will enable the physical test channels to be mapped to the logical test clip numbers. For more information, see Pin Conversion Table.

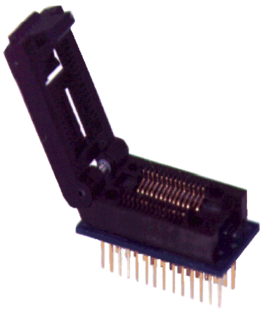
Connections to plugs and sockets (e.g. a 9 pin D-type) should ensure that pins 1, 2, 3… of the device connect to pins 1, 2, 3… of the BFL test cable.

Adapters and Probes

An **automatic out-of-circuit adapter** is available for the BFL and the ATM which enables the user to test ICs out-of-circuit. This attaches to the BFL/ATM Front Panel in the test cable connector. This will allow up to 40 pin ICs to be tested with the BFL and more pins with the ATM. The ICs should be inserted at the bottom of the ZIF socket with pin 1 facing upwards. The mode should be changed from in-circuit to out-of-circuit in the setup menu. The operation of the software is then identical to in-circuit mode testing.



SOIC adapters are also available. This can be inserted in to the ZIF socket of the out-of-circuit adapter and will then allow the user to test SOICs out of circuit.



ABI also have **MultiProbe Range**, designed as a more flexible alternative to standard test clips. The **MultiProbes** allow voltage, connection, V-I and thermal testing on almost any type of device including connectors. The range includes 0.050"/1.27 mm pitch, 10 pin for SOIC and most PLCC devices, and 0.100"/2.54mm pitch, 8 pin for DIL devices

The SOT **PenProbe** is an accessory for the Analogue IC Test Solution which allows in-circuit functional testing of transistors and diodes in tiny SOT-23 packages.

For price information on all of the above adapters and probes, please contact your distributor.

BFL Test Techniques

The **BFL** uses a variety of test methods to diagnose faults on a PCB. The **BFL** can power the board under test from its own power supply, but it a separate power supply is used the GND (ground) **MUST** be linked to the **BFL** GND terminal.

Connection to the PCB under Test

It is important to connect the test cable in the correct manner. For more information, see Test Clips.

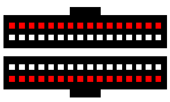
Test Clip Installation

There are different types of test clips available from ABI to cover conventional ICs, surface mount IC, quad flat pack ICs and PLCC ICs. Different types of IC clip use different cables and are inserted in a different way. For more information, see Test Clips.

Using the Ground Clip

The actual in circuit IC test can cause noise spikes to be generated on the Ground line of the PCB under test. This can cause some devices to fail, flip-flops, dynamic RAMs, timer/counters and especially processors are all prone to failing because of ground noise. The ground clip is used to provide a local ground connection to the device under test and thus improve test reliability. For example, when backdriving ICs that are connected to the device under test, the current required can be quite high. The high current can cause transient voltage spikes. If the grounding is not adequate, the IC under test may well respond to these spikes and may appear to fail the test. The solution is usually to use the Ground Clip to provide a low impedance return path for the high backdrive current. In nearly all cases this will cure the problem, but if it persists, one of the BDO signals may be used to disable the IC which is being backdriven.

The ground clip is inserted into the end pair of holes in the outer rows of the black connector (shown in red on the diagram).



Not all tests require the ground clip to be connected.

Automatic Clip Positioning

AUTOMATIC CLIP POSITIONING establishes the position of the IC within the test clip. This allows the clip to be applied in any desired position or orientation. The technique works by locating the VCC (+5V) and GND (0V) pins prior to commencement of a test. **Note:** Automatic clip positioning is not possible under some circumstances. The software will issue a warning to this effect when appropriate. In these circumstances, pin 1 of the test clip must connect to pin 1 of the IC..

Powering the PCB under Test

The **BFL** provides a 5Vdc, 5A power supply output to power the PCB under test. The supply is connected to two terminals at the front of the module. Connect the PSU leads to the appropriate power supply terminals on the PCB under test as follows:

Black: PCB 0V or GND (ground)
Red: PCB +5V or VCC

If the PCB under test has a current consumption greater than 5A a separate power supply must be used. In such cases the ground or 0V supply of the power supply **MUST** be linked to the **BFL/DCS** module ground terminal (black connector). The DV-I test does not require the PCB to be powered during test. However, the PCB 0V power rail must be connected to the **BFL** module black ground terminal.

Cleaning

For reliable test results the test clip must make good contact with the device under test. To facilitate this, it may be necessary to clean the PCB under test to remove dirt, oxidation and flux from IC pins. There are many cleaning solvents available which will safely do this.

Clocks

Clocks and oscillators on the PCB under test should be disabled to ensure static test conditions. Failure to do so may result in interference and invalid or unreliable test results. Well designed boards usually have the facility to disable clocks and oscillators using links or jumpers. Alternatively, a BDO output can be used for this purpose (see **BDO Usage**).

The BDOs

Each BFL module provides four **B**us **D**isable **O**utput (**BDO**) signals. These are also sometimes referred to as guards. The BDO cable consists of five clips connected to a blue 10 way connector. The connector should be attached to the 10 way connector on the front of each BFL module. Two of the BDO outputs, identified by green clips, provide a low logic level during a test. Two of the BDO outputs, identified by red clips, provide a logic high level during a test. An additional black clip is used to provide a 0V link with the PCB. The output specification of the BDO signals is identical to that of the other drive channels.

BDO Usage

BDO clips are used to backdrive nodes on the board under test to selectively disable circuitry. Clip the BDO clips to the appropriate nodes on the PCB. The BDO clips will only be active for the duration of a test. Examples of the use of BDOs would be:

1) Disabling a microprocessor by forcing the RESET, HOLD or DMA REQUEST to the appropriate logic level.
2) Disable clock signals to prevent test interference.
3) Disable tri-state outputs on a common bus to prevent contention with the outputs of the particular IC under test.

BFL Test Types

The **BFL** (Board Fault Locator) can use a variety of test methods to diagnose faults on a PCB.

Truth Table Test

The **Truth Table** test tests the functionality of an IC by applying the appropriate truth table stimulus to the IC under test. While this defined sequence of signals is being applied to the IC, the outputs of the IC are checked to ensure that they comply with the expected levels. If the IC responds at all times to the input stimulus, the test result is regarded as good and a green tick will be displayed in the result analysis box. If the test fails, the faulty logic level will be displayed next to the relevant pin on the IC diagram and a red cross will be displayed in the result analysis box.
On the BFL, the low, high and switching voltage thresholds may be defined by the user in the Setup Test Parameters menu.

Connections Test

The **Connections** test examines the connectivity of the device under test. The information displayed can include any of the following:

Link: Pins on the same device that are connected together
Short: Pins that are connected directly to 0V or 5V
Float: Pins that are not being driven by a valid logic level
Open circuit: Pins that are completely open circuit

The above information provided by this test is sometimes termed **Manufacturing Defect Analysis** (MDA) since it can often highlight defects caused by the manufacturing process. For more information on pin conditions, see Pin Conditions.

Voltage Test

The **Voltage** test measures the voltage on every pin of the IC under test before any stimulus is applied, and displays it as an actual voltage beside the appropriate pin on the IC diagram. This can be useful when testing analogue ICs and also when comparison testing. The voltages are also translated to logic levels. This identifies mid-level logic states which are a classic fault symptom on digital boards.

Thermal Test

The **Thermal** test exploits the thermal characteristic of a digital device's static protection diodes to provide a relative measure of the temperature of the IC in the vicinity of that pin. The precise temperature is not known, but the relative number can be used to compare a good and faulty board.

The test detects the thermal value of each individual pin (or node) on the IC under test, provided that pin has a valid diode characteristic. The value displayed is not a valid temperature reading but merely a relative measure of temperature. If a thermal test is performed and the IC under test does not display a thermal value, this means that the pin (or node) does not have a diode characteristic.

Even though the thermal test applies no power to the IC under test, it can detect overloaded outputs, over dissipation (hot ICs) and is a useful feature in comparison testing.

DV-I Test

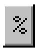
The **Digital V-I Test** is a long established test technique commonly used for examining the pin (input/output) characteristic of ICs. The result is in a graphical form and an experienced user can identify common faults such as leaky static protection diodes, blown bond wires, shorted outputs or open inputs. Alternatively, the characteristic can be stored and compared with a known good board for fault diagnosis. The test is conducted with the power off and is, therefore, appropriate for boards which cannot be powered up due to severe faults.

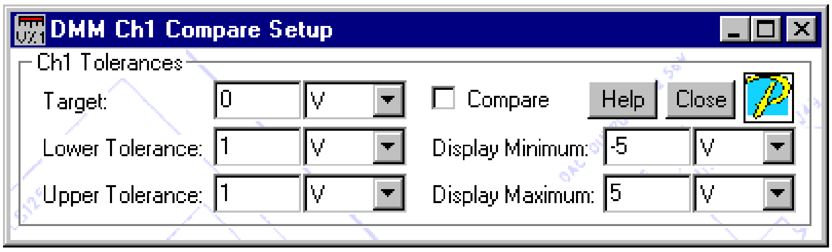
The Digital V-I (DV-I) display depicts the Voltage (V)-Current (I) characteristic of a node with respect to ground. The DV-I characteristic is obtained by applying a varying voltage to a device pin from a current limited source. A graph of voltage against current is then displayed. The resultant curves are analogous to an analogue signature of a device pin. The technique may thus be used to build up a profile of a board containing both digital and analogue components. Differences in characteristic curves of components on a saved good board and those of the corresponding component on a suspect board can lead to diagnosis of the fault. No power is applied to the board or device under test when performing a DV-I but a ground connection to the BFL module must be present.

The BFL digital V-I test has been optimised for testing digital ICs. The source impedance and frequency are fixed. The voltage limits are user adjustable in the range +/- 10V.

Comparing Measurement Results

The results of a measurement or calculation can be compared with a target value for pass/fail testing. The results are displayed in the form of a bar graph, which displays green (pass) for readings inside the programmed tolerance, red otherwise.

To setup measurements click on the  icon on the instrument. A typical example of a setup comparison dialog box is given below (a calculator comparison box will also include an area for entering a FormulaPlus program).



Enter the target value of the measurement in the **Target** box, and set the appropriate units by clicking on the drop down box. Similarly adjust the **Lower Tolerance**, **Upper Tolerance**, **Display Minimum** and **Display Maximum** values.

The display minimum and display maximum figures refer to the range displayed on the associated bar graph. A measured (or calculated) value will be indicated as a pass (provided the compare checkbox is set) if the value is greater than or *equal to target - lower tolerance*, or less than or *equal to target + upper tolerance*.

BFL Select DV-I Trace Colours

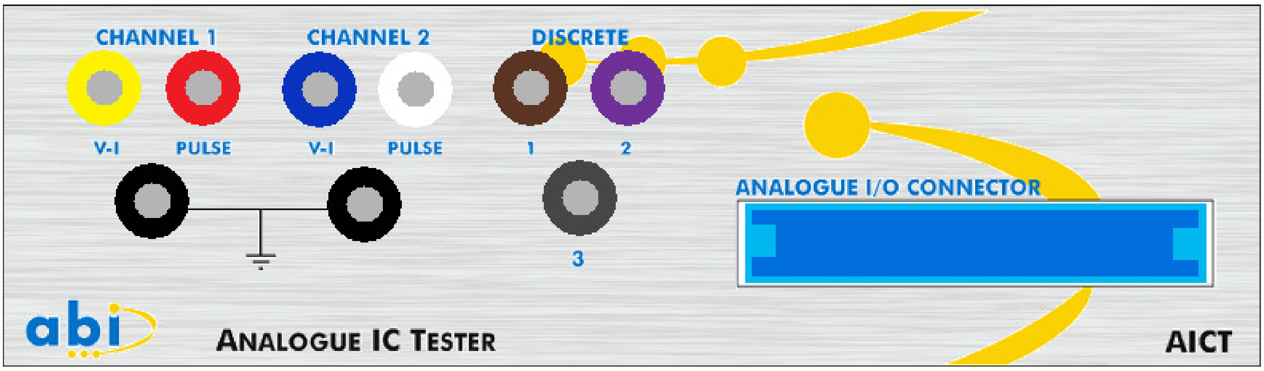
The colours of various parts of the digital V-I display can be configured. These are:

Actual Colour:	Sets the colour of the actual trace
Master Colour:	Sets the colour of the master trace
Name, Range:	Sets the colour of the text on the display
Grid Colour:	Sets the colour of the grid
BkGnd Colour:	Sets the background colour of the display

The Default Colours button restores the factory default colour scheme.

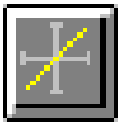
The AICT Front Panel

This is the AICT front panel.



AICT Analogue V-I Tester

The AICT **Analogue V-I Tester** allows the analogue signatures of ICs and discrete components to be acquired and compared without removing them from the printed circuit board (PCB). As voltages are applied and measured by the V-I Tester, there should be no external power supplied to the unit being tested. In addition, when matrix V-I testing is being performed there should also be no ground reference lead connected. For more information on using the V-I Tester, see Using Analogue V-I.



To open this instrument, click on the **Analogue V-I Tester** icon, or select **Instruments > Analogue V-I Tester** from the menu.

Note: When using source impedances above 1k or waveform frequencies above 300Hz the capacitance of the probes being used will start to become significant. This will exhibit itself as an elliptical analogue V-I characteristic under open circuit conditions. The software can compensate for this, under user control, using the **Probe Compensate** button in the Analogue V-I Setup dialogue box.

Size Box

The Size box is a drop down list box containing several settings for selecting the size of component. This may be a discrete probe or an IC. The options are as follows:

Probe 1: Single trace using the single V-I probe in Channel 1
Probe 2: Single trace using the single V-I probe in Channel 2
Probe Dual: Channel 1 and Channel 2 traces together on the same screen

Clip 4: Displays four separate traces via the Analogue I/O Connector
Clip 6: Displays six separate traces via the Analogue I/O Connector
Clip 8: Displays eight separate traces via the Analogue I/O Connector
Clip 10: Displays ten separate traces via the Analogue I/O Connector
Clip 14: Displays fourteen separate traces via the Analogue I/O Connector

Clip 16: Displays sixteen separate traces via the Analogue I/O Connector
MultiProbe 8: Displays eight separate traces via the Analogue I/O Connector
MultiProbe 10: Displays ten separate traces via the Analogue I/O Connector
MultiProbe 16: Displays sixteen separate traces via the Analogue I/O Connector

Frequency Selector

The **Frequency** selector is a drop down list box which is used to select the frequency of the output waveform. The selected frequency can be in the range of 38Hz to 12kHz.

Impedance Selector

The **Impedance** selector is a drop down list box which is used to select the source impedance of the output waveform. The selected impedance can be in the range of 100R to 1M.

Voltage Selector

The **Voltage** selector is a drop down list box which is used to select the amplitude of the output waveform. The selected voltage can be in the range of 2V to 50V peak to peak.

Curve Selector

The **Curve** selector is a drop down list box which is used to select the type of output waveform. This can be one of the following:

- Sine: sets a sine wave as the output waveform
- Ramp: sets a ramp as the output waveform
- Triangle: sets a triangle wave as the output waveform

Axis Selector

The **Axis** selector is a drop down list box which is used to select the plotting axis. This can be one of the following:

- V-I: sets the plotting axis to V-I (Voltage against current)
- V-T: sets the plotting axis to V-T (Voltage against time)
- I-T: sets the plotting axis to I-T (Current against time)

Setup Button

The Analogue V-I Setup button is used to configure the test parameters.

Start Button

The **Start** button will start the test, using the selected parameters.

Stop Button

The **Stop** button will stop any test which is currently running.

Store Button

The **Store** button stores the currently active waveform. The trace of the current device under test and the stored trace will both be displayed on the screen. The waveforms are only stored until store is pressed again or one of the options (such as clip type, impedance, wave shape etc.) is changed. It is not operational in dual probe mode as comparison is performed between the two probes in this mode.

Matrix Button

Matrix V-I testing is a powerful technique that allows connections between pins on an IC to be measured and compared. This allows ICs to be tested out of circuit as well as finding shorts between pins that would otherwise not have been found. It is only available when the AICT Analogue IC Test Solution is installed. When performing Matrix testing there should be no ground reference connected to the unit under test.

V-I Result Comparison

When comparing stored traces/signatures, a percentage figure is displayed in the bottom left-hand-side of each display. This represents the result of the V-I comparison for each particular pin. The figure denotes the degree of similarity between all of the points on the master characteristic and those on the corresponding pin of the device under test. A percentage figure of below 95% is considered a bad comparison, and the percentage result will be displayed in red to indicate this. The tolerance of this comparison can be selected from the Analogue V-I Setup box. The colours of the traces are configurable using the Select Analogue V-I Trace Colours function.

Tone Box

Clicking the tone box toggles an audible indicator of the match between the current trace and the stored trace. This works for both information stored using the store button, and within a test sequence.

The < and > Buttons

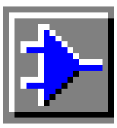
A single trace can be more accurately examined by positioning the mouse cursor over the desired V-I curve. When the mouse cursor becomes a magnifying glass symbol, a single mouse click will expand the curve. A second mouse click will restore the normal display. If you have zoomed into a single trace, the **<**; and **>** buttons are enabled, and can be used to view the previous (**<**) / next (**>**) full trace.

The Pulse Generator

The pulse generator (when enabled) will continuously produce a pulse or DC level according to the attributes set by the user in the Analogue V-I Setup box. The pulse length, amplitude and type can all be changed to suit a particular test. The main use is for testing 3 terminal devices where the pulse generator would switch on/off the device under test.

AICT Analogue IC Tester

The AICT **Analogue IC Tester** is an analogue equivalent of the BFL IC Tester - it allows analogue ICs to be tested in-circuit, without removing them from the printed circuit board (PCB).



To open this instrument, click on the **Analogue IC Tester** icon, or select **Instruments** > **Analogue IC Tester** from the menu.

To test an IC select the part from the appropriate library using the drop down list boxes to the left of the instrument. The currently loaded part will be displayed in the box in the left hand top corner. The board under test will need to be powered from an external supply (if power is required by the test). The ground of the external power supply **MUST** be linked to the ground (black) terminal of the AICT module.

Setup Button

The **Setup** button is used to configure the test parameters, using the Setup AICT IC Tester

Test Parameters window.

Start Button

The **Start** button will execute the test(s) which have been enabled using the configured parameters.

Stop Button

The **Stop** button will stop the currently executing test when running in loop mode.

Actual / Master Button

The **Actual** button is only active when in AICT IC Comparison mode. In normal operation of the AICT IC Tester, this button will be greyed.

Library Window

The **Library** window allows a device to be selected - an image of its package type is displayed to the right.

Notes Button

The **Notes** button will display any notes which are relevant to the test which is currently selected.

Analysis window

The **Analysis** window displays extended Analysis Information after the test.

Result window

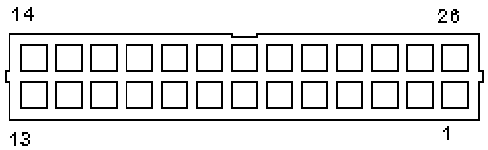
The **Result** window displays a picture of the device under test and any Pin Conditions detected during the last test.

Trace window

The **Trace** window displays the voltages present at each of the pins during the test.

AICT Analogue I/O Connector

A cable is inserted into this connector which will contain a clip of the appropriate size to perform functional and V-I tests on multiple pins, using the Clip 4 to Clip 24 or MultiProbe options. The pin numbers of the connector are as follows:



If using Clip 4 to Clip 24 or MultiProbe cables, pin 1 of the cable will attach to pin 1 of the connector. The actual V-I channels are pins 1 to 12 and pins 15 to 26.

Example: If using the Clip 14 option, pins 1 to 7 of the connector would be pins 1 to 7 of the clip, but pins 20 to 26 of the connector would be pins 8 to 14 of the clip.

AICT Analogue V-I Setup

This box contains the following parameters that are used when running the analogue V-I test:

Enable Pulse

This is a check box that enables and disables the pulse generator. If the check box is empty, the pulse generator is disabled.

Positive Pulse

The waveform from the V-I pulse generator can be configured and is output to the Pulse connectors on the ATS Front Panel. The start position, stop position and output voltage can be set using the 3 scroll bars. These controls will be disabled and will appear greyed unless the **Enable Pulse** option is selected (enabled). Once enabled, the user can set up the following parameters:

Start: sets the start position of the positive pulse (0.0us to 26.21ms)
Stop: sets the stop position of the positive pulse (103.2us to 26.32ms)
V+: sets the amplitude of the positive pulse (0V to +10V)

Negative Pulse

The waveform from the V-I pulse generator can be configured and is output to the Pulse connectors on the ATS Front Panel. The start position, stop position and output voltage can be set using the 3 scroll bars. These controls will be disabled and will appear greyed unless the **Enable Pulse** option is selected (enabled). Once enabled, the user can set up the following parameters:

Start: sets the start position of the negative pulse (0.0us to 26.21ms)
Stop: sets the stop position of the negative pulse (103.2us to 26.32ms)
V-: sets the amplitude of the negative pulse (0V to -10V)

Pulse Type

The Pulse Type box is a drop down list box that is used to select the type of pulse output from the V-I pulse generator.

Positive: selects a positive pulse
Negative: selects a negative pulse
Bipolar: selects a bipolar pulse
DC: selects a DC level

DC

This is a scroll bar that sets the DC voltage level that is output from the V-I pulse generator. This voltage can be in the range of **+10V** to **-10V**.

Comp. Tol.

This is a scroll bar that selects the **comparison tolerance** when using the V-I tester to compare the trace with a stored trace. A low number in the Points box would make the comparison sensitive (e.g.: The traces would have to be almost identical to indicate a good comparison). As the number of points is increased, the sensitivity of the comparison is decreased.

Colours Button

The Colours button allows the colours of various parts of the display can be configured. See Select Analogue V-I Trace Colours.

Dot Join

This check box enables and disables the interpolation of points during plotting. If the check box is empty, dot join is disabled.

Probe Compensation

When using source impedances above 1k or waveform frequencies above 300Hz the capacitance of the probes being used will start to become significant. This will exhibit itself as an elliptical analogue V-I characteristic under open circuit conditions. The software can compensate for this, under user control, using the 'Probe Compensate' button in the Analogue V-I Setup dialogue box. Pressing this button will calibrate out the stray capacitance of the probes. It is important that the user should insert all probes on all channels that will be used before the button is pressed, otherwise the stray capacitance of the probe on that channel cannot be calibrated out. If the probe on a particular channel is changed at any time, the 'Probe Compensate' button must be pressed to calibrate the system for the new probe. At the test setup extremes (1M source or towards 12kHz) the compensation will not be perfect. However, when using the main application of comparison mode, this will have little effect on the performance. Probe compensation can take up to 30 seconds to perform.

The AICT Analogue IC Tester Analysis Information

The analysis text window contains information regarding the IC test that has been performed.

If the test is running in loop mode, the total number of passes and failures is displayed. Some functional tests return additional information regarding the test being performed and this will also be displayed in the analysis window. For example, a bipolar transistor test is capable of approximating the Hfe of the device under test (at a single operating condition) and determining which pins are connected to the Base, Emitter and Collector of the device under test. Any information regarding circuit conditions and pre-test information will also be shown in the analysis window.

The AICT IC Tester Comparison

One of the most efficient methods to repair a PCB is to compare a suspect board with a known good board. Highlighted differences between the boards can quickly lead to fault diagnosis. SYSTEM 8 allows the profile of a known good board or **Golden Board** to be saved in a TestFlow file. A suspect board can then be compared with the profile of the Golden Board.

The **Actual** button is used to toggle the current result display between the actual (device under test) and the master (golden device). The expected Master signature of the device can be viewed by toggling the **Actual**/**Master** button to show **Master**. The package display of the master and the actual result must be viewed separately. The package pin names will be highlighted in red if there are comparison differences on individual pins.

AICT IC Tests Types

The Analogue IC Tester uses several test methods to diagnose faults on a PCB.

Functional Test

This tests the basic functionality of a device by applying the appropriate stimulus to the device under test (DUT). Analogue currents or voltages are applied to the DUT and the analogue responses are checked to ensure that they comply with the expected responses. If the DUT responds at all times to the input stimulus, the test result is regarded as good and a green tick will be displayed in the result analysis box. If the test fails, a fault code will be displayed next to the relevant pin on the IC diagram and a red cross will be displayed in the result analysis box.

A representation of the stimulus and response waveforms can also be displayed graphically in the form of a timing diagram.

Connections Test

The connections test examines the connectivity of the device under test. The information displayed can include any of the following:

Link: Pins on the same device which are connected together
Short: Pins which are connected directly to a power rail

The above information provided by this test is sometimes termed Manufacturing Defect Analysis (MDA) since it can often highlight defects caused by the manufacturing process. For more information on pin conditions, see Pin Conditions.

Voltage Test

The voltage test measures the voltage on every pin of the device under test before any stimulus is applied, and displays it as an actual voltage beside the appropriate pin on the diagram. This can be useful when testing analogue ICs and also when comparison testing.

AICT Pin Conditions

When a test has been performed, a number of test messages may be displayed beside the IC pins displayed on the screen. One or more of the following could be displayed:

GND
This pin is the ground pin of the IC and has the correct voltage on it.

HI V
The voltage measured exceeded the maximum allowable positive voltage (+15.5V). The test will not proceed under these conditions. Ensure the board power supply ground is linked to the ATS black terminal.

I>>
The output current on this pin was found to be too high at a point during the test at which a lower current was expected.
I<<
The output current on this pin was found to be too low at a point during the test at which a higher current was expected.

L *n* (LINK *n*)
The pin was found to be linked to other pins on the same IC. The connected pins are indicated by a number n.

LO V
The voltage measured exceeded the minimum allowable negative voltage (-15.5V). The test will not proceed under these conditions. Ensure the board power supply ground is linked to the ATS black terminal.

NGND (NO GND)
The system was unable to detect a valid 0V supply. Ensure the board power supply ground is linked to the ATS black terminal and the clip is properly located.

NV+ (NO V+)
The system was unable to detect a valid positive supply. Ensure the board power supply ground is linked to the ATS black terminal and the clip is properly located.

NV- (NO V+)
The system was unable to detect a valid negative supply. Ensure the board power supply ground is linked to the ATS black terminal and the clip is properly located.
SH0V (SHORT 0V)
The pin is connected directly to the 0V rail.

SV+ (SHORT V+)
The pin is connected directly to the positive supply rail.

SV- (SHORT V-)
The pin is connected directly to the negative supply rail.

V+
This pin is the positive supply pin of the IC.

V-
The pin is the negative supply pin of the IC.

V>>
The output voltage on this pin was found to be too high at a point during the test at which a lower voltage was expected.

V<<
The output voltage on this pin was found to be too low at a point during the test at which a higher voltage was expected.

HI V
The voltage on this pin is too high for the test.

LO V
The voltage on this pin is too low for the test.

SVx+
This pin is shorted to an unspecified positive voltage.

SVx-
This pin is shorted to an unspecified positive voltage.

AICT Selecting Analogue V-I Trace Colours

The colours of various parts of the display can be configured. These are:

Actual Colour 1:	The colour of the actual trace 1 (Actual Probe 1, pins 1 to 16)
Actual Colour 2:	The colour of the actual trace 2 (Actual Probe 2)
Master Colour 1:	The colour of the master trace 1 (Master Probe 1, pins 1 to 16)
Master Colour 2:	The colour of the master trace 2 (Master Probe 2)
Name, Range:	The colour of the text on the display
Grid Colour:	The colour of the grid
BkGnd Colour:	The background colour of the display

Default Colours Button

This button restores the factory default colour scheme. This is:

Actual Colour 1	:	Light Yellow
Actual Colour 2	:	Light Blue
Master Colour 1	:	Light Green
Master Colour 2	:	Light Red
Name, Range	:	White
Grid Colour	:	Black
BkGnd Colour	:	Grey

AICT Setup Test Parameters

The tests which are applied to the ICs under test and the messages which appear are modified as necessary. If any parameters are changed and the CANCEL button is pressed, none of the changes will be saved or used. If the OK button is pressed, the changes will be stored and used thereafter.

Test Types

The ATS IC Tester uses a variety of test types or test methods to diagnose faults on a PCB. These consist of:

Functional:	Applies a go/no go test to the selected device under test
Connections test:	Checks for open circuit pins, links between pins, floating pins and shorts
Voltage test:	Measures the voltage on every pin of the IC under test

The user may enable any test type from the setup menu. However, if an enabled test type is not valid for a particular selected part, the system will simply miss out that test. The test setup configuration will not be changed. If the setup configuration has not enabled any valid test types, an error message will be displayed when the user attempts to perform a test.

Test Modes

An IC test can be executed once, continuously or until certain conditions are met. This is highlighted by the following:

Single:	Executes the tests once only
Loop:	Executes the tests continually
True loop:	Executes the tests while ever the test result is true
False loop:	Executes the tests while ever the test result is false

Test Functions
This group configures various test functions as described below:

Analogue trace:	Enables/disables the analogue trace facility
Auto clip function:	Enables/disables the automatic clip positioning function. If disabled, the IC test clip must be applied with pin 1 of the clip to pin 1 of the IC under test.

Messages
Various messages can be displayed when running tests. These can be enabled by selecting the appropriate option:

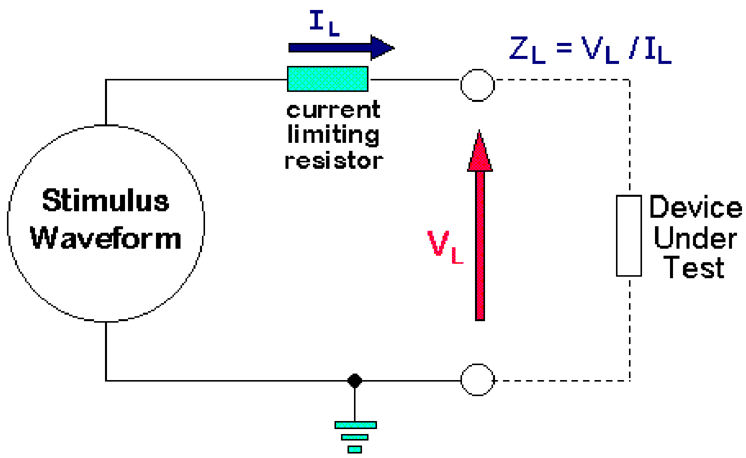
Auto clip warning:	Enables/disables the "No automatic clip positioning" message if appropriate to that test
Notes:	Displays any notes associated with the device under test

Voltage Tolerance
This allows adjustment of the voltage tolerance on each pin in regard to comparing Master/Actual results. This is used when the Master/Actual test results are always failing due to small voltage variations, i.e. tolerance of components or slightly different test conditions.

AICT Using Analogue V-I

About V-I Testing
V-I testing (also known as Analogue Signature Analysis) is a technique which is excellent for fault finding on PCBs, and is ideal when diagrams and documentation are minimal. When testing a board with the V-I Tester, no power is applied to the device under test. Therefore, this technique is an extremely effective test for so called dead boards which cannot safely be powered up. A current-limited, ac signal is applied to the device under test and the characteristic impedance is displayed by plotting voltage against current on an X-Y graph (the X axis representing voltage and the Y axis representing current).

Analogue V-I testing is a very simple technique, as will be detailed. However, this does not mean that it is not also a powerful fault diagnosis tool. The basic technique is depicted below. A stimulus waveform is applied through a current limiting resistor across the device under test (DUT). The voltage across the DUT is plotted (on the horizontal axis) against the current through it (on the vertical axis).



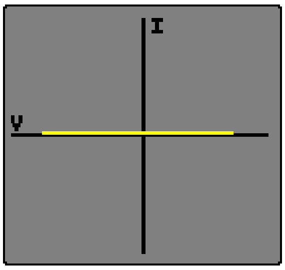
From ohms law, (Z = V/I) it can be seen that the resulting characteristic represents the impedance of the DUT. The stimulus waveform is usually a sine wave. For frequency dependent components such as capacitors and inductors, the impedance is frequency related. Thus a variable frequency stimulus source is required for these types of components. It can also be seen that the current limiting resistor and the DUT form a potential divider. To achieve a reasonable trace the current sense resistor should be the same order of magnitude as the impedance of the DUT at the test frequency. Thus, in order to use this technique on a wide range of DUTs, a wide range of current limiting (*or source*) resistors are required.

It is not necessary to understand the above technique to be able to use analogue V-I testing for fault diagnosis. Most applications use analogue V-I testing in a comparative manner where understanding the displayed characteristic is not important. Indeed, in real board fault diagnosis situations, many components will be connected to a particular node and the resulting analogue V-I characteristic will be a complex composite of the individual components analogue V-I characteristics making it extremely difficult to completely understand it.

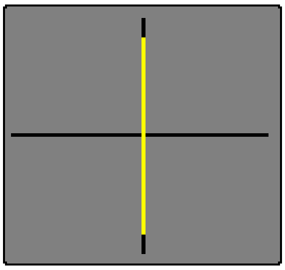
Understanding the Display

The V-I display plots the voltage across the device under test (V) on the horizontal axis, and the current through the device under test (I) on the vertical axis as shown below. Different devices in different configurations produce different signatures, depending on the current flow through the device as the applied voltage changes. A short circuit, for example, would be displayed as a vertical line, because the current flow for any applied voltage would be theoretically infinite (see below), whereas an open circuit would display a horizontal line because the current is always zero irrespective of the applied voltage (see below). A pure resistor would give a diagonal line whose slope is proportional to the resistance, because the current is proportional to the applied voltage. More complex curves are obtained with frequency dependent components such as capacitors and inductors, and also for non-linear devices such as diode and transistor junctions.

Open Circuit:



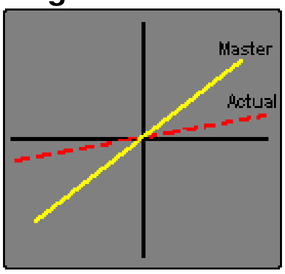
Short Circuit:



Even though the curves can sometimes be quite complex, it is not necessary to understand them in order to use the V-I test technique. The comparison of the curves for a known good board and a suspect board can often identify faults with a minimum of knowledge. Bear in mind that in a typical circuit the displayed V-I curve would normally be for a number of components in parallel. A better understanding of the operation of the analogue V-I tester can be gained by using the system with known components out of circuit.

The signatures of resistors are straight lines (see **Diagram 1**). The value of the resistor under test affects the slope of the line, the higher the value, the closer the line gets to the horizontal (open circuit). The source impedance of the V-I tester should be selected so the slope of the line, for a good resistor, is as close as possible to 45 degrees. A difference in the slope of the curve when comparing a good and suspect board would indicate a difference in the resistor values on the two boards.

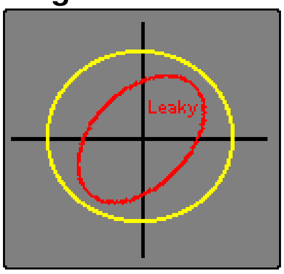
Diagram 1:



820 Ohm Resistor
<u>SETTINGS</u>

Frequency :	*1.2kHz*
Source Impedance :	*1k Ohms*
Curve :	*sine wave*
Voltage :	*10V peak to peak*

Diagram 2:



0.47uF Capacitor
<u>SETTINGS</u>

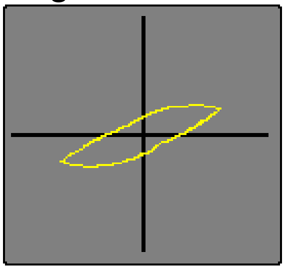
Frequency :	*4.8kHz*
Source Impedance :	*100 Ohms*
Curve :	*sine wave*
Voltage :	*2V peak to peak*

Capacitors with relatively low values have flattened, horizontal, elliptical signatures and capacitors with relatively high values have flattened, vertical, elliptical signatures. The optimal signature is a nearly perfect circle (see **Diagram 2**) which can be obtained by selecting the appropriate test frequency and source impedance. Typically, the higher the capacitance, the lower the test impedance and frequency. A leaky capacitor would give a sloping curve due to the effective resistance in parallel with the capacitor.

The signature of an inductor is elliptical or circular, sometimes showing hysteresis (see **Diagram 3**). Inductors with relatively high values have flattened, horizontal, elliptical signatures similar to those of capacitors. The optimal signal is a perfect circle. Inductors may have ferrite, iron, brass or air cores, which may or may not be adjustable. Inductors with the same value may have very different signatures if they use different core materials or if the core is positioned differently. Inductors usually require a low source impedance and higher test frequencies to exhibit an elliptical signature.

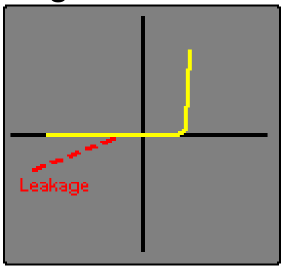
An open circuit inductor (a common fault with small PCB mounting devices) can easily be detected by the sharply contrasting V-I curves when comparing two boards.

Diagram 3:



10mH Inductor
SETTINGS
Frequency : *1.2kHz*
Source Impedance : *100 Ohms*
Curve : *triangle wave*
Voltage : *4V peak to peak*

Diagram 4:



1N4148 Diode
SETTINGS
Frequency : *60Hz*
Source Impedance : *1k Ohms*
Curve : *sine*
Voltage : *6V peak to peak*

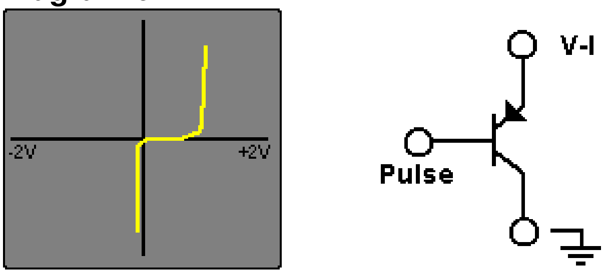
The signature of a silicon diode can be identified easily (see **Diagram 4**). The vertical part of the curve shows the forward bias region, and the turn-on voltage and the forward voltage drop can be easily identified. The curved area of the trace shows the changeover from fully off to fully on as the applied voltage increases. The horizontal part of the curve is the reverse voltage region where the diode is non-conducting and is effectively an open-circuit. Faulty diodes can easily be identified by a deviation from this characteristic, for example a diode which exhibits significant reverse leakage would have a diagonal curve in the reverse region, similar to a resistor.

Zener diodes conduct in both directions. The forward current characteristic is similar to that for a diode (see above). The characteristic in the reverse direction is also similar to a diode until the breakdown or Zener voltage is reached, at which point the current increases rapidly and the diode voltage is clamped.
This gives rise to the curve in **Diagram 5**. The test voltage should be chosen to be higher than the Zener voltage for this curve to be obtained. A suspect Zener diode may not have a well-defined "knee" and the horizontal part of the curve in the reverse region may exhibit leakage effects in a similar way to a normal diode.

Diagram 5:

BZX55C5V1 Zener Diode
SETTINGS
Frequency : *60Hz*
Source Impedance : *1k Ohms*
Curve : *sine*
Voltage : 20V peak to peak

Diagram 6:



PNP Transistor
SETTINGS
Frequency : *120Hz*
Source Impedance : *1k Ohms*
Voltage : *4V peak to peak*
Pulse Type : *Bipolar : (V+ 0.12) (V- -0.7V)*
Positive start : *0us stop : 4.18ms*
Negative start : *4.18ms stop : 8.33ms*

NPN and PNP bipolar transistors have a signature similar to that of the diode (see **Diagram 4**) when tested between the base-collector and base-emitter junctions. If tested between the collector-emitter terminals the signature would appear to be open circuit. The pulse generator can be used to apply a bias voltage, via a suitable resistor, to the base of the transistor, so that the switching action can be observed (see **Diagram 6**). The pulse generator can also be used to trigger devices such as triacs and thyristors, so that again the switching action can be observed. Transistors with open circuit or leaky junctions can easily be identified by the marked differences between curves.

Summary

In order to employ the V-I tester to its full potential as a fault diagnosis tool, it is important to focus on differences between curves for good and suspect boards, rather than analysing in great detail the meaning of the curves. The majority of nodes on a PCB will contain parallel and series combinations of components, making exact analysis difficult. The majority of faults on failed boards are gross failures such as short or open circuits, which are easy to detect with the V-I technique without complex analysis.

Suggested V-I Test Parameters

There are numerous combinations of Analogue V-I test parameters which can be chosen by the operator. This flexibility allows the widest range of components to be tested but also presents some difficulty to the inexperienced operator. The following table presents typical test parameters for a number of different types of components to be tested. The table may be used to quickly obtain a representative V-I characteristic for a given component. Often, a different combination of test parameters will give the same characteristic. Experienced operators will be able to quickly deduce the appropriate test parameters by observing the obtained V-I characteristic and adjusting the controls.

Capacitors *(Voltage = 4V pk-pk, curve = Sine)*

Range	Test frequency	Source impedance
100uF - 1000uF	37.5Hz	100 ohms
10uF - 100uF	37.5Hz - 300Hz	100 ohms
1uF - 10uF	37.5Hz - 300Hz	1k
10nF - 1000nF	37.5Hz - 2.4kHz	10k
1nF - 10nF	37.5Hz - 2.4kHz	100k
0.1nF - 1nF	37.5Hz - 600Hz	1M

Inductors *(Voltage = 2V pk-pk, curve = Sine)*

Range	Test frequency	Source impedance
10mH - 100mH	2.4kHz - 240Hz	100 ohms
1mH - 10mH	4.8kHz - 2.4kHz	100 ohms
100uH - 1000uH	12kHz - 4.8kHz	100 ohms

Resistors *(Voltage = 4V pk-pk; test frequency = 60Hz, curve = Sine)*

Range	Source impedance
500k - 10M	1M
50k - 500k	100k
5k - 50k	10k
500R - 5k	1k
10R - 500R	100 ohms

Digital ICs: *Voltage = 4V pk-pk;*
Test frequency = 37.5Hz;
Source impedance = 10k

Analogue ICs: *Voltage = 10V pk-pk;*
Test frequency = 37.5Hz;
Source impedance = 10k

Diodes: *Voltage = 2V pk-pk*
Test frequency = 37.5Hz
Source impedance = 10k

Matrix V-I

Matrix V-I testing is a powerful extension to the normal Analogue V-I technique. The Matrix V-I test performs a V-I test, (as described above), between every pair of pins on the device under test. This provides a much more comprehensive test than the standard V-I test. For example if the device under test (DUT) has any links between pins this will immediately be apparent using the Matrix V-I test.

Initially pin 1 is switched to ground to provide the V-I reference, and the V-I characteristic of pin 1 is then captured. Then pin 2 is switched to ground and again the V-I characteristic for pin 1 is captured. This is repeated until all of the pins on the DUT have been switched to ground to provide the reference. The whole process is then repeated by switching each pin in turn to ground and capturing the V-I characteristic of pin 2 relative to the reference pin. When the V-I characteristics for all pins on the DUT have been captured, the test begins once again at pin 1. As an example, an 8 pin test would result in 64 (8x8) V-I characteristics being captured.
The test displays all of the V-I characteristics associated with the selected pin, by clicking on the comparison bar graph next to that pin. Obviously if the characteristics for pin 1 are displayed, the characteristic for pin 1 with reference to pin 1 will be a short circuit, indicated by a vertical line. An individual characteristic can be inspected by clicking on that trace.

Note that the Matrix V-I test is only available when an Analogue IC Test Solution is installed.

Matrix VI Out-Of-Circuit Adapter

In order to carry out Matrix VI tests out-of-circuit, an optional adapter is available and connects directly into the ATS Analogue I/O connector (using cable provided). Note that no ground reference is required for this test.

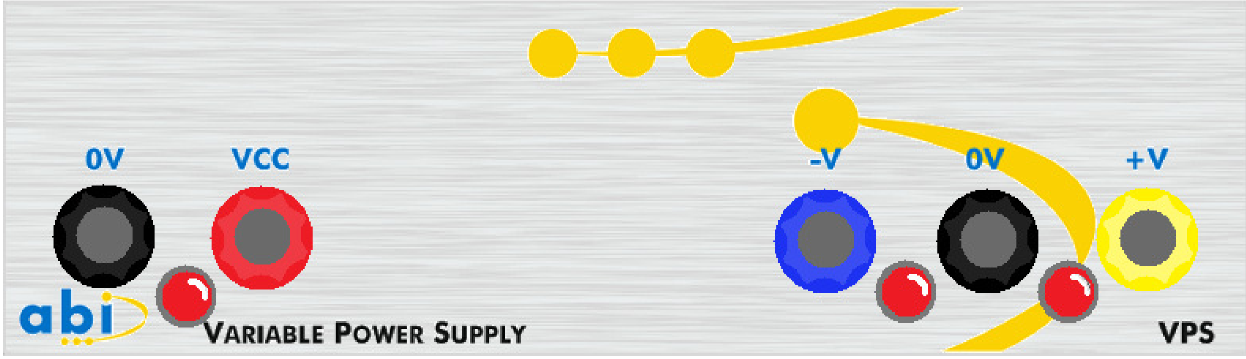
The Matrix VI adapter offers the following sockets:

- 24 pin SOIC socket (wide gauge)
- 14 pin SOIC socket (narrow gauge)
- 24 pin DIL socket

Please note that, in order to enable Matrix VI out-of-circuit, the tick box in the setup window needs to be selected.

The VPS Front Panel

This is the VPS (Variable Power Supply) front panel:



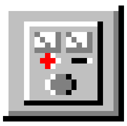
VPS Variable Power Supply

The Variable Power Supply (VPS) is a self contained triple power supply unit designed to work with the existing SYSTEM 8 modules.

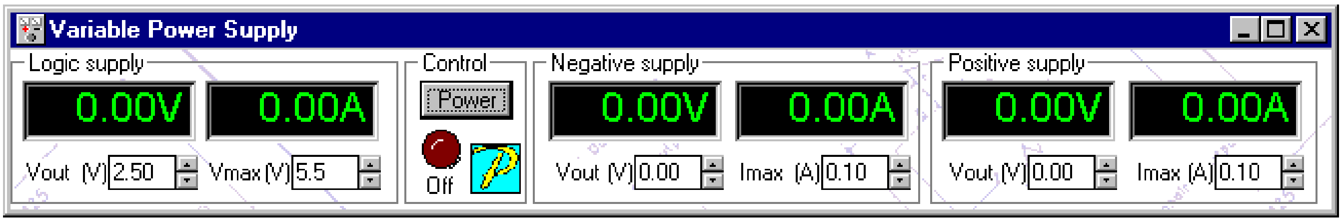
As standard the supply provides the following outputs and features: -

A logic supply (2.5V to 6V at 5A max) supply with adjustable over-voltage protection and fixed over-current protection.

Positive and negative variable supplies covering the range of: -24V to 0V and 0V to +24V each with a maximum current of 1.5A. Both supplies include variable current limiting from 50mA to 1.5A.



To open this instrument, click on the **PSU button** or select **Power Supply** from the **Instruments** menu.



Power Supply Output

The power supply output state can be one of the following:

ON: All three power supplies are ON.
OFF: All three power supplies are OFF.

Voltage Adjustment

The output voltages of all three supplies can be adjusted using the scroll bars.

Over Voltage Protection

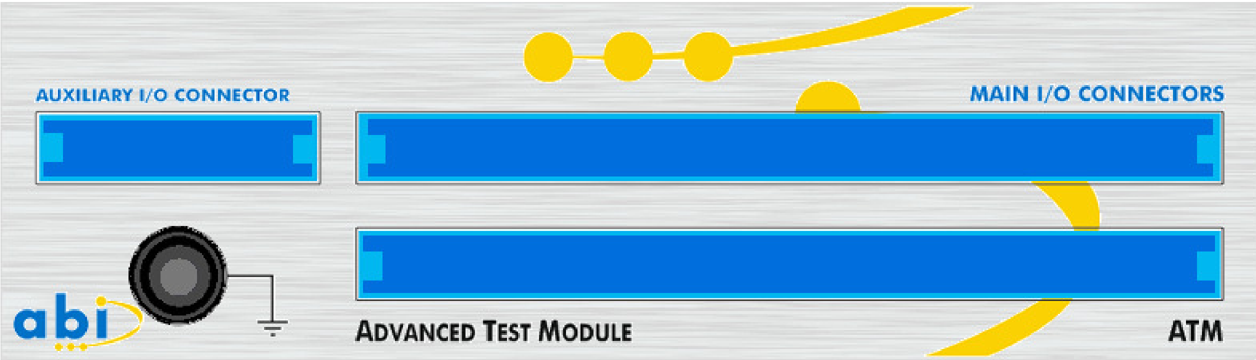
The logic supply has built in over voltage protection which can be set using the scroll bar. If the over voltage state is triggered a **Vmax** message is displayed in the digital readout and the entire power supply switches off.

Over Current Protection

The current limits can be set using the scroll bars underneath the current readings on the instrument. If the current limit activates, the output voltage for this supply will reduce to maintain a constant current. The other supplies will be unaffected. If the over current condition is removed, the output voltage will revert to its original state.

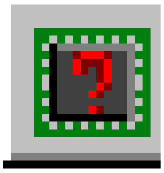
The ATM Front Panel

This is the ATM (Advanced Test Module) front panel:



The ATM Advanced IC Identifier

The ATM Advanced IC Identifier allows unknown ICs to be identified without typing in a part number.



To open this instrument, click on the **Advanced IC Identifier** icon, or select **Instruments > Advanced IC Identifier** from the menu.

IC Size

The user must select the size of the IC to be identified. This is achieved using the **IC Size** list box. The list box contains the sizes of all ICs in the identifier library.

Family

Once an IC Size has been selected the family lost box will display all the families that contain parts of the selected size. By selecting one or more families from the list the time taken of identify the device can be reduced.

Start / Stop Button

Pressing the **Start** button will begin the identification process.

Pressing the **Stop** button will abort the identifier instrument at any time during the test.

Identifier Test Result

Any identified devices and their function are listed in the result list box. Also, equivalent devices are listed.

ICs Found

The total number of devices identified during the test is displayed in the IC's Found box. This is continually updated as the test proceeds.

Identifier Progress

Due to the large size of the identifier library, the identifier test can be in progress a considerable time. The extent to which the test has searched through the library is indicated in a percentage status bar at the bottom of the screen. Initially this will indicate 0% complete. As the test progresses, the displayed figure will increase toward 100% (indicating completion). This is also indicated graphically by a blue bar which moves towards the right of the screen as the test progresses.

Identifier Status

The status of the identifier instrument is indicated as follows:

Ready:	The instrument is ready to start
Searching:	The instrument is searching
Complete:	The identification is complete
Stopped:	The instrument has been stopped

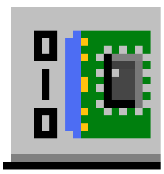
More than one part may be found to be equivalent to the device under test. This is usually due to PCB configuration and IC pin compatibility.

If no parts are identified, the device under test may not be in the identifier library or the device may be faulty. Alternatively factors such as test clip connection, lack of a ground clip and failure to disable connecting circuitry may cause parts not to be identified.

Note: The IC Identifier instrument can cause prolonged backdriving of components. Please take steps to prevent this by disabling connected devices by removal or by using BDO outputs to disable them. Linear ICs are particularly susceptible; therefore ensure that the IC Identifier instrument is only used on digital ICs.

The ATM Advanced Graphical Test Generator

The ATM **Advanced Graphical Test Generator** allows the ATM channels to be used to output a timing sequence and monitor responses.



To open this instrument, click on the **Advanced Graphical Test Generator** icon, or select **Instruments > Advanced Graphical Test Generator** from the menu.

The number of channels (256 maximum), the number of patterns (999 maximum) and the signal type are all configurable. Each channel is represented by a number which is displayed down the left hand side of the instrument. These numbers relate to the actual physical channel number on the front connector.

Part Selection

The family filter allows a specific family to be selected, displaying its contents in the **Parts** list below.

You can also type the IC number directly into the **Parts** box. Simply start typing the number of the IC you wish to test and the IC is automatically found in the list. If the IC cannot be found then either the wrong library has been loaded or the IC does not exist. The easiest way to check this is to enter the IC number with the **All** families option selected. Once a part is selected its pin names are loaded and its power pins defined.

Changing Channel Numbers, Names & Types

To change a channel number, name or type, click the mouse cursor on the appropriate channel name. A green box will then highlight that channel.

If the mouse is clicked on a channel, a channel edit box will be displayed. This allows the user to change the number, name and type of the channel. If two channels contain the same number, an error message will be displayed when attempting to run the sequence.

Creating a Timing Sequence

Any timing sequence can be simulated by using high and low levels. The high and low levels are generated by using the mouse cursor and clicking on a trace.

The existing state of the trace will be displayed as a Drive Low, Drive High, Don't care, Sense Low and Sense High. Clicking on this level will toggle it to the next state.

Channels defined as outputs from the system (inputs to the unit under test) can be programmed as either Drive Low or Drive High. Channels defined as inputs to the system (outputs from the unit under test) can be programmed as either Sense Low, Sense High or Don't care. Channels defined as bidirectional can be programmed to any of the states.

Save Button

Once a trace has been set up, it can be saved to a file by pressing the **Save** button. The trace is then saved internally against its part.

Learn Button

Once the required outputs from the system have been programmed, it is possible to learn the response of the inputs by pressing the **Learn** button.

Import Button

The **Import** button opens and loads a previously saved file. A box will appear and all available .APAT files will be displayed. Choose a file and press OK to load it.

Export Button

The **Export** button opens saves a pattern to an external file. A box will appear and all available .APAT files will be displayed. Choose a file name and press OK to save it.

Run Button

The **Run** button begins the logic sequence as defined by the traces. The sequence of high and low pulses is output to the front connector on the ATM module.

Setup Button

The **Setup** button allows the user to configure the number of usable channels, patterns, test threshold levels, whether auto clip positioning is to be used and the output drive levels can be defined.

Delete Button

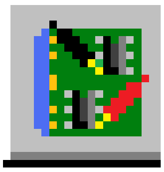
The **Delete** button will delete a saved trace.

Edit Button

The **Edit** button will allow the name of a saved trace to be changed.

The ATM Advanced Short Locator

The ATM **Advanced Short Locator** allows short circuits to be located to a very close proximity.



To open this instrument, click on the **Advanced Short Locator** icon, or select **Instruments > Advanced Short Locator** from the menu.

This instrument requires a separate probe set containing red and black probes. This connects into the main IO connector on the ATM Front Panel. The instrument uses a 4 wire low resistance measuring technique to enable the location of a short circuit on a PCB to be found.

<u>**Note:**</u> The presence of the Advanced Short Locator probes will interfere with the test results of the other Advanced instruments. Ensure that the probes are removed when not using the Advanced Short Locator instrument.

When a low resistance is measured between the two probes, a tone is generated by the PC speaker and the on-screen probes move toward the right of the screen. As the probes become closer to the source of the short circuit, the measured resistance decreases. This is indicated by a higher pitch, and also by the displayed probes moving further to the right of the screen.

Range

This selects the full scale sensitivity of the resistance measurement. The ranges are:

0.5 Ohm: 0.0 ohms to 0.5 ohms
1.0 Ohm: 0.0 ohms to 1.0 ohms
2.0 Ohm: 0.0 ohms to 2.0 ohms

Tone

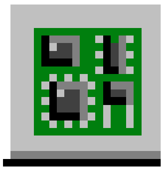
This provides an audio indication of the measured resistance between the Short Locator probes. This allows the user to concentrate on following tracks on the PCB without needing to look at the display. The tone may be turned **On** or **Off** by moving the control slider. The tone status is indicated in both text and picture to the side of the control.

Error Messages

If the measured resistance is greater than the full scale of the selected range the message **OVERFLOW** will be displayed. If the probe leads are not connected or damaged, the message **PROBES!** will be displayed.

The ATM Advanced IC Tester

The ATM Advanced IC Tester allows ICs to be tested in various ways without removing them from the printed circuit board (PCB).



To open this instrument, click on the **Advanced IC Tester** icon, or select **Instruments > Advanced IC Tester** from the menu.

Before an IC can be tested, a part must be selected. The currently loaded part will be displayed in the box directly to the left of the Start button. If the message No Part Loaded is displayed here, you will be unable to run any tests. You must select a part before a test can be performed. The board under test will need to be powered from an external supply (if power is required by the test) and the ground **MUST** be linked to the ATM ground terminal.

Part Selection

The family filter allows a specific family to be selected, displaying its contents in the **Parts** list below.

You can also type the IC number directly into the **Parts** box. Simply start typing the number of the IC you wish to test and the IC is automatically found in the list. If the IC cannot be found then either the wrong library has been loaded or the IC does not exist. The easiest way to check this is to enter the IC number with the **All** families option selected.

Run Modes

An IC test can be executed once, continuously or until certain conditions are met. This is highlighted by the following:

Single: Executes the tests once only.
Loop: Executes the tests continually.
True Loop: Executes the tests while ever the tests are true.
False Loop: Executes the tests while ever the tests are false.

Setup Button

The **Setup** button is used to configure the test parameters. In the Setup Test Parameters box it is possible to configure a particular test to the requirement of the IC under test.

Start / Stop Button

The **Start** button will execute the tests which have been enabled in the Setup Test Parameters box using the configured parameters. If no part has been loaded, the message **No Part Loaded** is displayed and no test will be executed.

The **Stop** button will stop any test which is currently running. This will only usually apply when running tests in one of the loop modes.

Results

The results are displayed at the bottom of the instrument. Each enabled test type will have either a tick or a cross beside it indicating a good or bad comparison for that test. Also shown will be the result of the truth table tests if applicable. Any information regarding circuit conditions and pre-test information will also be shown in the list box. Any notes applicable to the part under test will also be displayed in the notes box at the bottom of the dialog.

IC / V-I / Logic Trace Tabs

These tabs toggle between the truth table test display(IC diagram) the digital V-I (DV-I) test display and the Logic Trace test display.

All colours corresponding to the digital DV-I trace can be configured using the Select DV-I Trace Colours function.

For more information on the logic trace feature see Logic Trace.

Rotate Button

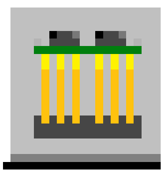
When a truth table test is performed on a QFP or PLCC IC it displays only 2 sides of the IC. The rotate button rotates the IC to view the pins which were not initially displayed. Pressing the **Rotate** button again displays the initial pins which were displayed.

Actual / Master Button

The **Actual** / **Master** button toggles between displaying the results that have be acquired after the last test or the results which were stored as the master in a TestFlow.

The ATM Advanced Board Checker

The ATM Advanced Board Checker allows a printed circuit board (PCB) to be tested in various ways without the need for multiple pieces of test equipment.



To open this instrument, click on the **Advanced Board Checker** icon, or select **Instruments > Advanced Board Checker** from the menu.

Update All Button

The Update All button is used to send the actions for each of the channels in the in the available channel list to the ATM. The results for all of the channels will also be updated.

Send Settings on Open Checkbox

The send settings on open check box is used to determine if the ATM should be updated when the Board Checker instrument is opened. This is useful if the ATM is required to be setup upon entering a TestFlow step.

Channel Name

Each channel can be assigned a name this is user definable text which can be used to identify a channels function.

Action to Perform

The action of each of the ATM's channels can be set as follows:

Off:	The channel is turned off and set to a user specified off voltage
Measure:	The channel is setup to measure a voltage with user definable tolerances
Drive:	The channel is driving on and set to a user specified drive voltage
VI Check:	The channel is setup to perform a VI test and compare against a stored mask with user definable tolerances

Available Channels List

The available channels list shows all ATM channels and their actions. The list can be filtered to **Show All**, **Show Passes** or **Show Failures** using the radio buttons.

Channel Results

Each channel has its own result. Once all measurements are completed the Board Checker instruments overall result is updated.

Calculator

The SYSTEM 8 Premier software contains 9 user programmable calculators, four that are general purpose, and five that are related to individual instruments. Each calculator has its own readout display, comparison and statistics functions.

Calculators allow basic measurements obtained from the measurement hardware to be used to perform further calculations and display or log the results.

The calculator formulae are text files that contain simple commands, mathematical operators and expressions, variables and functions. You can use the built-in formula files for commonly used functions, or develop your own application specific equations.

The calculator uses the simple, but flexible, programming language FormulaPlus. To find out more about FormulaPlus consult the following *Conceptual Topics* and *Language References:*

Conceptual Topics

Commenting your FormulaPlus Programs
Declaring Variables
Looping Through Code
Understanding FormulaPlus Syntax
Writing Data to Files

Language Reference

Error Messages
Keywords
Operators
System Variables
Functions

Commenting your FormulaPlus Programs

While the FormulaPlus syntax is easy to understand we recommend that all FormulaPlus programs are commented. Comments make your code easier to understand and help you to maintain your code.

The FormulaPlus language uses the // symbols (two forward slashes) to indicate that the text following it is a comment. The comment ends with either a new line character, or another set of // symbols.

Examples of Comments:

```
// This is a comment that ends with a new line character.
// The display command that follows will be executed, as this comment ends here //
display "Hello World"
```

Declaring Variables

A variable is a named storage location that contains data that may be modified during the execution of a FormulaPlus program.

Variables must be defined before they are used by assigning a value to them. For example, the statement ***x = 1***, creates a variable ***x***, and assigns the value ***1*** to it.

Each variable must be unique within a calculator, and must begin with an alphabetic character. Variables are not case sensitive, but can contain only alphabetic characters, numbers and may include the underscore character.

Examples of legal variable identifiers:

volts_1_of_200
new_resistance

Examples of illegal variable identifiers:

1_of_200_voltages
new-resistance

Attempting to use an illegal variable identifier will cause the FormulaPlus program to stop with an error message.

Looping Through Code

Looping allows a block of statements to be executed repeatedly. Some loops repeat blocks of statements depending upon the result of a conditional expression, while others loop repeatedly.

WHILE Loops

WHILE loops repeat the block of statements while the condition evaluates to true.

These loops are especially useful when you want to loop while you wait for a given situation to occur. For example, suppose you want to only begin logging values measured on the DMM Channel 1 when its voltage exceeds 5.0V, and then you only want to log the next 10 readings. You could do this using the following program:

```
Run
WHILE DMM_CH1 < 5.0
{
      WAIT DMM_CH1
}
count = 0
STARTLOG "My Log.csv"
WHILE count < 10
{
      WAIT DMM_CH1
      WRITELOG DMM_CH1
      count = count + 1
}
```

The first WHILE statement loops round the block until DMM_CH1 has a value of 5.0V or above. The second WHILE loop writes the value of DMM_CH1 to "*My Log.csv*" and increments the count. When the count equals 10 it stops repeating the block, having written 10 values to the file.

REPEAT Loops

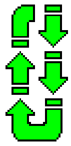
REPEAT loops repeat the block of statements while the calculator is running.

These loops are especially useful when a display must be continuously updated for the lifetime of a calculator. A calculator lifetime begins when you press the RUN button, or when a TestFlow record begins. The calculator lifetime ends when the STOP button is pressed, or when the TestFlow moves to the next record.

For example, suppose you want to create a display that continuously displays the voltage measured on DMM_CH1 divided by the voltage measured on DMM_CH2. The FormulaPlus program on the ***right*** shows the ***correct*** way to do this.

```
Run
DISPLAY DMM_CH1 / DMM_CH2
```

```
Run
REPEAT
```



```
{
        DISPLAY DMM_CH1 / DMM_CH2
}
```

The program on the left runs the DISPLAY command exactly once, and then the program ends. The program on the right repeatedly runs the DISPLAY command while the calculator is running, continuously updating the value displayed in the calculator display box as the values of DMM_CH1 and DMM_CH2 change.

Understanding FormulaPlus Syntax

The Language Reference help text shows how to use the FormulaPlus language correctly. The examples in this topic explain how to interpret the most common elements. You should note that, unlike some other programming languages, there is no need to delimit a new line of code using a semicolon.

Keywords

KEYWORD *parameter1*, *parameter2*, ..., *parameterN*

A keyword has one or more parameters, examples include:

DISPLAY "Hello World"
WRITELOG DMM_CH1, DMM_CH2

Functions

FUNCTION (*parameter1*, *parameter2*, ..., *parameterN*)

A function has zero or more parameters, examples include:

PI()
MIN(1, 2)

Writing Data to Files

When working with large amounts of data, for example when you want to log results, it is convenient to write data to a file. FormulaPlus allows you to write data to files using the STARTLOG and WRITELOG or STARTLOGDB and WRITELOGDB keywords.

Each calculator can only have one file open at any time.

Before data can be written to a file, the file must be created by using the STARTLOG or STARTLOGDB keyword. Data can then be written to the file using the WRITELOG or WRITELOGDB keyword. The WRITELOG keyword opens the file created by STARTLOG, writes data to it, then closes the file again. In the event a poorly written application program crashes your machine, preventing Premier from running, you should not lose your logged data. The WRITELOGDB keyword adds a new entry to the database created by STARTLOGDB.

Comma Separated Variable Files

FormulaPlus writes data to files in the "*.csv*" file format. Comma separated variable files are an industry standard file format for importing into spreadsheets such as Microsoft Excel™.

Writing to the Same File

Two or more calculators can write to the same file, although the order in which data is added to the file ***cannot be guaranteed***.

Example:

```
// DMM Calculator

STARTLOG "C:\My Documents\My Log File.csv"
count = 0
WHILE (count < 5) {
    WAIT DMM_CH1
    WRITELOG "DMM", DMM_CH1
}
```

```
// FC Calculator

STARTLOG "C:\My Documents\My Log File.csv"
count = 0
WHILE (count < 5) {
    WAIT FC_CH1
    WRITELOG "FC", FC_CH1
}
```

Result:

```
"FC",100.0
"DMM",1.0
"FC",100.0
"FC",100.0
"DMM",1.2
```

Database Files

FormulaPlus writes data to databases in the "SQLite3" file format. Comma separated variable files are an industry standard file format for importing into spreadsheets such as Microsoft Excel™.

Writing to the Same File

Two or more calculators can write to the same file, although the order in which data is added to the file ***cannot be guaranteed***.

Example:

```
// DMM Calculator

STARTLOGDB "C:\My Documents\My Log File.db"
count = 0
WHILE (count < 5) {
    WAIT DMM_CH1
    WRITELOGDB "DMM", DMM_CH1
}
```

```
// FC Calculator

STARTLOGDB "C:\My Documents\My Log File.db"
count = 0
WHILE (count < 5) {
    WAIT FC_CH1
    WRITELOGDB "FC", FC_CH1
}
```

Result:

ResultID	TestFlowID	TestFlowStep	ResultName	ResultValue
1	7	1	StepName	Step 1
2	7	1	FC	100.0
3	7	1	DMM	1.0
4	7	1	FC	100.0
5	7	1	FC	100.0
6	7	1	DMM	1.2

Conditional Expressions

Conditional expressions evaluate to either true (any value other than zero) or false (zero).

List of Error Messages

The following error conditions can occur in FormulaPlus programmes. For detailed information about an individual error message, see below: -:

Vars > 20

More than 20 variables defined. The FormulaPlus language allows up to 20 user defined variables. If more than 20 user defined variables are created this error is generated.

Missing =

Missing equals sign in assignment statement. FormulaPlus is expecting an assignment (e.g. ***X = 100***) but hasn't found the ***=*** symbol.

Var syntax

Variable name contains invalid character(s). FormulaPlus has encountered a variable name that contains invalid characters. For examples of valid names see the "Declaring Variables" section.

Var undef

Variable name not defined. FormulaPlus requires that variables are defined before they are used. For more information on declaring variables, see the "Declaring Variables" section.

Syntax

Syntax error. FormulaPlus cannot match the program code to any known command, function, variable name or operator.

Missing (

Missing opening bracket in expression. FormulaPlus expected to find an open bracket at this point, but didn't find one.

Missing)

Missing closing bracket in expression. FormulaPlus expected to find a closing bracket at this point, but didn't find one.

Too complex

Expression has too many nested brackets. FormulaPlus allows up to 5 levels of bracket nesting. If there are more than 5 levels of brackets, this error will be displayed.

Divide 0
Divide by zero. Numbers cannot be divided by zero - attempting to do so causes this error.

Missing "
Missing opening or closing quotation mark in string. FormulaPlus is expecting a string, but either cannot locate the opening quotation mark, or the closing quotation mark.. A string must start and end on the same line of code.

Decimals
Invalid expression for decimal places. FormulaPlus allows formatted numbers to have up to six decimal places using the FORMAT keyword. See the FORMAT keyword for more information.

Power arg
Invalid argument for power operator. FormulaPlus generates this error whenever an attempt is made to generate a mathematically incorrect power, or raise the power by more than 50.

1. If ***x*** is raised to the power ***y***, and ***x*** is a negative number, ***y*** must be a whole number.
   e.g. ***(-2)^2*** is valid, ***(-2)^(0.5)*** gives an error.

2. If ***x*** is raised to the power ***y***, and ***x*** is 0, ***y*** must be greater than 0.
   e.g. ***0^(0.5)*** is valid, ***0^(-1)*** gives an error.

Sq root arg
Invalid argument for square root function. FormulaPlus generates this error whenever an attempt is made to generate the square root of a negative number. *(FormulaPlus does not allow complex numbers.)*

Log arg
Invalid argument for logarithm function. FormulaPlus gives this error if an attempt is made to take the log of a value of 0 or less.

Missing ,
Missing comma. FormulaPlus gives this error when it is expecting another parameter but can't find a comma.

Exp arg
Invalid argument for exponential function. FormulaPlus does not allow exponentials of greater than 50 to be calculated. If an attempt is made to calculate the exponential of a value greater than 50, then this error is generated.

Var read only
System variable is read only. This error is generated if an attempt is made to write to a read only system variable.

File error
Cannot create log file. If the file specified with the STARTLOG keyword cannot be created,

FormulaPlus will give this error. There are a number of possible reasons why a file may not be created:

1. An attempt was made to overwrite a file that cannot be overwritten.
2. An attempt was made to create a file in a location that does not exist.
3. An attempt was made to write to a read only device (such as a CD-ROM).

Stck ovfl
Stack overflow. FormulaPlus allows up to 50 ***WHILE*** / ***REPEAT*** / ***IF*** blocks to be nested within each other. Any attempt exceed this limit generates a stack overflow.

A block is the code placed between the opening brace symbol ***{*** and the closing brace symbol ***}***.

```
X=0
Y=0
WHILE (X < 100)
{
	// This is the first block
	WHILE (Y < 50)
	{
		// This is a second block.
		// In FormulaPlus you can have up to 50 of
		// these nested blocks before you get an
		// error message.
		Y=Y+1
	}
	X=X+1
}
```

Stk undfl
Stack underflow. If there are more closing brace symbols } than opening brace symbols {, then FormulaPlus will display this error message.

For example, the following would display the error message:

```
X=0
WHILE (X<10)
{
	X=X+1
}
// The following extra brace causes a "Stk undfl" error message.
}
```

Maths
Unknown error in mathematical operation. While every attempt has been made to ensure that all mathematical errors are caught and that meaningful error messages are given, there may be occasions where this does not happen,. On these rare occasions FormulaPlus generates an Unknown error in mathematical operation error.

Error?
Unknown error, contact product support. This error should never occur. If this error does occur, please contact Product Support giving as much detail about how it happened as you possibly can.

List of Keywords

For detailed information about individual keywords, see below.

BLEEP
Bleep emits a user definable sound based on a series of parameters.

Syntax:
BLEEP *pitch1*, *time1*, *pitch2*, *time2*, *repeat*

Parameters:
pitch1 : Pitch of first note
time1 : Duration of first note in milliseconds
pitch2 : Pitch of second note
time2 : Duration of second note in milliseconds
repeat : Number of repetitions of first and second notes.

Example:
```
BLEEP 4000, 250, 8000, 250, 2
```

Result:
```
// Produces a low note, followed by
// a high note, followed by a low note
// and then a final high note.
//
// Each note is played for 0.25
// seconds.
```

DISPLAY
Displays a number or some text in the associated calculator readout control.

Syntax:
DISPLAY *expression*
DISPLAY *string*

Parameters:
expression: A number to be displayed.
string: A string to be displayed.

Example:
```
voltage = 2.0
resistance = 1000.0
FORMAT 1, "A", E
```

Example:
```
DISPLAY "Hello World"
```

DISPLAY voltage / resistance

Result:
2.0mA

Result:
Hello World

EXECUTE
Executes a given record in the test flow.

Syntax:
EXECUTE *NEXT*
EXECUTE *FIRST*
EXECUTE *LAST*
EXECUTE *expression*

Parameters:

NEXT:	Evaluates to the next record in the TestFlow.
FIRST:	Evaluates to the first record in the TestFlow.
LAST:	Evaluates to the last record in the TestFlow.
expression:	Expression evaluates to a number that refers to a particular record number.

Example:
EXECUTE NEXT

Result:
// Executes the next record in the
// test flow sequence

Example:
EXECUTE 5

Result:
// Executes the 5th record in the
// test flow sequence

FORMAT
Allows the format of a readout to be changed. The number of decimal places, the units of measurement, and the style of number can be changed.

Syntax:
FORMAT *decimal-places*, *units*, *number-format*

Parameters:

decimal-places:	Number of decimal places to display. The number of decimal places must not exceed 6.
units:	Units to display, e.g. "V", "mV" etc.
number-format:	Number format (if the format isn't specified, N is assumed): N for normal, e.g. 0.0001. S for scientific, e.g. 100e-6. E for engineering, e.g. 100u.

Example:
FORMAT 3, "V", N
DISPLAY 0.001

Result:

Example:
FORMAT 3, "V", S
DISPLAY 0.001

Result:

Example:
FORMAT 3, "V", E
DISPLAY 0.001

Result:

0.001V	1.000e-3V	1.000mV

IF

Only executes the given instructions if the condition evaluates to true (any non-zero value).

Syntax:

IF *conditional_expression* { *true_statements* }
IF *conditional_expression* { *true_statements* } ELSE { *false_statements* }

Parameters:

conditional_expression:	Evaluates to false (0), or true (any value other than 0).
true_statements:	Statements that are executed if the *conditional-expression* evaluates to true.
false_statements:	Statements that are executed if the *conditional-expression* evaluates to false.

Example:

```
IF temperature > 100 {
    PAUSE "Too Hot!"
    }
ELSE {
    PAUSE "Safe"
    }
```

Result:

```
// If temperature is greater than 100
// pause to display "Too Hot!",
// otherwise display "Safe".
```

LABEL

Set the text displayed in the in the calculator's associated *calculator entry box label* control. Strings for both the *A* and *B* controls must be provided, even if only one of the controls is visible.

Syntax:

LABEL *stringA*, *string*B

Parameters:

stringA: A string to be displayed in *calculator entry box label* control *A*.
stringB: A string to be displayed in *calculator entry box label* control *B*.

Example:

LABEL "One", "True"

PAUSE

Pauses execution, either displaying a prompt or waiting for a given number of milliseconds.

Syntax:

PAUSE *string*
PAUSE *expression*

Parameters:

string: The string displayed to the user while the software is paused.

expression: Evaluates to the number of milliseconds to wait for before continuing execution.

Example:

```
PAUSE "Click OK to continue..."
```

Result:

```
// Opens a dialog box that displays
// the text "Click OK to continue...".
//
// Execution will not continue until
// the user clicks on the 'OK' button.
```

Example:

```
PAUSE 1000
```

Result:

```
// The calculator's execution is
// paused for 1 second.
```

REPEAT

Continuously executes the statements within its braces while the calculator is running.

Syntax:

REPEAT { *statements* }

Parameters:

statements: Statements that are executed each iteration.

Example:

```
resistance = 100
REPEAT {
    WAIT DMM_CH2
    voltage = DMM_CH2
    DISPLAY voltage / resistance
    }
```

Result:

```
// When the program is executed it
// enters the repeat block.
//
// Within the block the program waits
// for the system variable DMM_CH2
// to be updated, then displays the
// result of a calculation.
//
// The block of code is then repeated
// indefinitely, updating the display
// whenever DMM_CH2 is updated.
```

STARTLOG
Create a new file for logging operations. Overwrites any data that already exists in the file.

Syntax:
STARTLOG *filename*

Parameters:
filename: String representing a file name.
The filename is relative to the current working directory, unless a full path name is given.

Examples:
STARTLOG "results.csv"

Results:
// Creates a new file called
// "results.csv" in the current directory
// (normally the directory that Premier
// was installed in).

Examples:
STARTLOG
"c:\mydocu~1\results.csv"

Results:
// Creates a new file called
// "results.csv" in directory
// "mydocu~1" on the "C:\" drive.

STARTLOGDB
Create an SQLite3 database file for logging operations. A new TestFlowLog entry is added marked with the current user, date and time. If the database already exists, add a new TestFlowLog entry is added to the existing database.

Syntax:
STARTLOGDB *filename*

Parameters:
filename: String representing a file name.
The filename is relative to the current working directory, unless a full path name is given.

Examples:
STARTLOGDB "results.db"

Results:
// Creates a new file called
// "results.db" in the current directory
// (normally the directory that Premier
// was installed in) and creates a new
// TestFlowLog entry.

Examples:
STARTLOGDB
"c:\mydocu\results.db"

Results:
// Creates a new file called
// "results.db" in directory
// "mydocu" on the "C:\" drive and
// creates a new TestFlowLog entry.

TestFlowLog Entry:

	TestFlowID	Date	Time	User
1	1	16/09/2009	12:56:29	Administrator

Notes:

This function stores data in a format that can be understood by any SQLite3 database viewer.

SYSTEM

Executes a program, or opens a file if the extension for that file has been registered with windows.

Syntax:

SYSTEM *filename*

Parameters:

filename: String representing a file name.
The filename is relative to the current working directory, unless a full path name is given.

Examples:

SYSTEM "http://www.abielectronics.co.uk"

Results:

// Opens the given web page.

Examples:

SYSTEM "C:\Program Files\Microsoft Office\Microsoft Excel", "test.csv"

Results:

// opens the file "test.csv" in Excel

SYSTEMWAIT

Executes a program, or opens a file if the extension for that file has been registered with windows. Then waits for the program to return a result.

Syntax:

result = SYSTEMWAIT *filename*

Parameters:

filename: String representing a file name.
The filename is relative to the current working directory, unless a full path name is given.

result: A variable to contain the result of the executed program (normally an integer).

Examples:

Result = SYSTEMWAIT "http://www.abielectronics.co.uk"

Results:

// Opens the given web page.

Examples:

Result = SYSTEMWAIT "C:\Program Files\Microsoft Office\Microsoft Excel", "test.csv"

Results:

// opens the file "test.csv" in Excel

// Programs return value stored in result

// Programs return value stored in result

WAIT
Waits for a system variable to be updated.

Syntax:

WAIT *system_variable*

Parameters:

system_variable: Any system variable.
When that system variable updates (even if the updated value is the same as the previous value), execution continues.

Example:

```
WAIT DMM_CH1
```

Result:

```
// The calculator does not continue
// executing the program until the
// value of DMM_CH1 is updated.
```

WHILE
Continuously executes statements while the condition is true.

Syntax:

WHILE *conditional_expression* { *statements* }

Parameters:

conditional_expression: Evaluates to false (0), or true (any value other than 0).
statements: Statements that are executed if the *conditional-expression* evaluates to true.

Example:

```
COUNT = 0
STARTLOG "DMM_CH1.csv"
WHILE COUNT < 100 {
    WAIT DMM_CH1
    WRITELOG COUNT, DMM_CH1
    COUNT = COUNT + 1
    }
```

Result:

```
// A log file is opened.
//
// Each time the DMM_CH1 reading is
// updated its value is appended to
// the .csv file.
```

```
//
// When count reaches 100,
// COUNT < 100 evaluates to false
// (non-zero), and the while loop is
// exited.
//
// The log file contains 100 results.
```

WRITELOG
Appends data to the current log file (which is created by using the STARTLOG keyword).

Syntax:

WRITELOG *expression1*, *expression2*, ..., *expressionN*.

Parameters:

expression1 : An expression that evaluates to either any real number, or a string.
expression2 : An expression that evaluates to either any real number, or a string.
...
expressionN : An expression that evaluates to either any real number, or a string.

Example:

```
STARTLOG "volts.csv"
count = 1
volts = 1.5
WRITELOG count, ":", volts, "V"
```

Result:

```
// A log file called "volts.csv" is
// created in the current directory.
//
// The contents of the file will be:
//      1,":",1.5,"V"
```

Notes:

WRITELOG has access to special functions that are not available to any other FormulaPlus keyword at this time.

TIME() returns the current time (with a minimum resolution of 1 second).
DATE() returns the current date.

These functions return data in a format that can be understood by Microsoft Excel™ when imported as a "*.csv*" file.

WRITELOGDB
Appends data to the current log database (which is created by using the STARTLOGDB keyword).

Syntax:

WRITELOGDB *result1_name*, *result1_value*, *result2_name, result2_value,* ..., *resultN_name, resultN_value*.

Parameters:

*result1*_name : A string to be the name of the result.
*result1*_value : An expression that evaluates to either any real number, or a string.
*result2*_name : A string to be the name of the result.
*result2*_value : An expression that evaluates to either any real number, or a string.
...
*resultN*_name : A string to be the name of the result.
*resultN*_value : An expression that evaluates to either any real number, or a string.

Example:

```
STARTLOG "volts.db"
Resistance = 0.515034
WRITELOG "Status", "PASS", "Resistance (Ohms)", Resistance
```

Result:

```
// A log file called "volts.db" is
// created in the current directory.
//
// Then a TestFlowResult entry for each expression pair is created.
```

TestFlowResult Entry:

	ResultID	TestFlowID	TestFlowStep	ResultName	ResultValue
1	1	1	1	Status	PASS
2	2	1	1	Resistance (Ohms)	0.515034

Notes:

This function stores data in a format that can be understood by any SQLite3 database viewer.

List of Operators

For detailed information about individual operators, see below:

*** Operator**
Used to multiply two numbers.

+ Operator
Used to add two numbers.

- Operator
Used to subtract one number from another.

/ Operator
Used to divide one number by another.

^ Operator
Used to raise one number to the power of another.

List of System Variables

System variables are pre-defined variables which can be used in FormulaPlus programmes for extracting readins, measurements or for controlling the operation of a programme. For detailed information about individual system variables see below:

Advanced Board Checker System Variables

BC_CH_RESULT(Channel Number) (read-only)
Returns the status of the specified channel on the Advanced Board Checker.

0	Incomplete	*The channel is waiting for its measurement to complete.*
1	Pass	*The channel's measurement has completed, and the result was a pass.*
2	Fail	*The channel's measurement has completed, and the result was a fail.*
3	None	*The channel is off.*

BC_CH_VOLTAGE(Channel Number) (read-only)
Returns the last voltage measured by the specified channel on the Advanced Board Checker.

Digital Multimeter System Variables

DMM_ACTION (read-only)
Returns the value of the last DMM user button that was last pressed.

DMM_CH1, DMM_CH2 (read-only)
Returns the last value read from the specified channel on the Digital Multimeter.

DMM_ENTRY_A, DMM_ENTRY_B
Returns/sets the value displayed in *Calculator Entry Box A/B* for the DMM calculator.

Digital Storage Oscilloscope System Variables

DSO_ACQUISITION (read-only)
This system variable is updated whenever a DSO acquisition has completed. This system variable is useful for waiting for a DSO acquisition to finish. For example:

```
Run
STARTLOG "C:\My Documents\Oscilloscope.csv"
REPEAT
{
    WAIT DSO_ACQUISITION
    WRITELOG "DSO", DSO_CH1_AMPLITUDE, DSO_CH1_PERIOD
}
```

This example opens a file "Oscilloscope.csv" in directory "C:\My Documents". It then enters the repeat loop and waits for the DSO acquisition to complete. When the acquisition is complete it logs the amplitude and period of the waveform displayed on channel 1 to the open file. It then loops around again and waits for the next acquisition to complete.

DSO_ACQUIRE_STATUS (read-only)

Returns the current acquisition state of the Digital Storage Oscilloscope as follows: -

Values	0	Starting acquisition
	1	Waiting for trigger
	2	Completed acquisition
	3	Completing acquisition
	4	Building ERS acquisition
	5	Auto zero calibration

DSO_ACQUIRE_MODE
Returns/sets the acquisition mode for the Digital Storage Oscilloscope as follows: -

Values	0	Automatic acquisition
	1	Normal acquisition
	2	Single acquisition
	3	Stop

DSO_TIMEBASE_INDEX
Returns/sets the timebase index for the Digital Storage Oscilloscope as follows: -

Values	0	5s / Division
	1	2s / Division
	2	1s / Division
	3	0.5s / Division
	4	0.2s / Division
	5	0.1s / Division
	6	50ms / Division
	7	20ms / Division
	8	10ms / Division
	9	5ms / Division
	10	2ms / Division
	11	1ms / Division
	12	0.5ms / Division
	13	0.2ms / Division
	14	0.1ms / Division
	15	50us / Division
	16	20us / Division
	17	10us / Division
	18	5us / Division
	19	2us / Division
	20	1us / Division
	21	0.5us / Division
	22	0.2us / Division
	23	0.1us / Division
	24	50ns / Division
	25	20ns / Division
	26	10ns / Division
	27	5ns / Division

DSO_TRIG_COUPLING
Returns/sets the trigger coupling setting used by the Digital Storage Oscilloscope as follows: -

Values	0	DC triggering

	1	AC triggering
	2	Low frequency rejection
	3	High frequency rejection

DSO_TRIG_DELAY
Returns/sets the trigger delay for the Digital Storage Oscilloscope.

DSO_TRIG_EDGE
Returns/sets the edge used to trigger off on the Digital Storage Oscilloscope as follows: -

Values	0	Positive edge
	1	Negative edge

DSO_TRIG_LEVEL
Returns/sets the trigger level voltage for the Digital Storage Oscilloscope.

DSO_TRIG_SOURCE
Returns/sets the trigger source setting used by the Digital Storage Oscilloscope as follows: -.

Values	0	Channel 1 triggering
	1	Channel 2 triggering
	2	External triggering
	3	FG triggering

DSO_CH1_ACTION, DSO_CH2_ACTION (read-only)
Returns the value of the DSO user button for the specified channel that was last pressed.

DSO_CH1_AMPLITUDE, DSO_CH2_AMPLITUDE (read-only)
Returns the amplitude of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_BANDWIDTH, DSO_CH2_BANDWIDTH (read-only)
Returns the value of 0.35 divided by the measured rise time for the specified channel. This formula is valid only for a first order system (i.e. with no overshoot on a rising edge) and can be used to give a VERY approximate estimate of the system bandwidth.

DSO_CH1_COUPLING, DSO_CH2_COUPLING
Returns/sets the coupling settings for the specified channel of the Digital Storage Oscilloscope as follows: -

Values	0	Ground
	1	DC
	2	AC

DSO_CH1_BASE, DSO_CH2_BASE (read-only)
Returns the base voltage of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_BASE_PEAK, DSO_CH2_BASE_PEAK (read-only)
Returns the base peak (lowest point) of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_CREST_FACTOR, DSO_CH2_CREST_FACTOR (read-only)
Returns the crest factor of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_CYCLIC_MEAN, DSO_CH2_CYCLIC_MEAN (read-only)
Returns the cyclic mean of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_CYCLIC_RMS, DSO_CH2_CYCLIC_RMS (read-only)
Returns the cyclic RMS of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_CYCLES, DSO_CH1_CYCLES (read-only)
Returns the number of complete cycles detected in the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_DUTY_CYCLE, DSO_CH2_DUTY_CYCLE (read-only)
Returns the value of "100% * high pulse width divided by the period for the waveform on the specified channel of the Digital Storage Oscilloscope.".

DSO_CH1_ENTRY_A, DSO_CH1_ENTRY_B, DSO_CH2_ENTRY_A, DSO_CH2_ENTRY_B
Returns/sets the value displayed in *Calculator Entry Box A* or B for the specified channel of the DSO calculator.

DSO_CH1_FALL_TIME, DSO_CH2_FALL_TIME (read-only)
Returns the total time between the 10% and 90% amplitude points on the falling edges of the specified channel divided by the number of falling edges.

DSO_CH1_FREQUENCY, DSO_CH2_FREQUENCY (read-only)
Returns the frequency of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_GAIN_INDEX, DSO_CH2_GAIN_INDEX
Returns/sets set the volts/division setting for the specified channel on the Digital Storage Oscilloscope as follows: -

Values	0	2.0V / Division
	1	1.0V / Division
	2	0.5V / Division
	3	0.2V / Division
	4	0.1V / Division
	5	50mV / Division
	6	20mV / Division

DSO_CH1_MEAN, DSO_CH2_MEAN (read-only)
Returns the mean of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_NEG_SLEW, DSO_CH2_NEG_SLEW (read-only)

Returns the voltage difference between the 10% and 90% amplitude points on falling edge divided by the time difference between these points on the specified channel.

DSO_CH1_NEG_TIME_CONSTANT, DSO_CH2_NEG_TIME_CONSTANT (read-only)
Returns the falling time constant (time from the top to 37% of the amplitude) of an exponential falling edge on the specified channel of the DSO.

DSO_CH1_NEG_WIDTH, DSO_CH2_NEG_WIDTH (read-only)
Returns the total time between 50% amplitude points on falling pulses (falling then rising edge) divided by the number of negative pulses on the specified channel.

DSO_CH1_OFFSET, DSO_CH2_OFFSET
Returns/sets the offset for the specified channel on the Digital Storage Oscilloscope.

DSO_CH1_OVERSHOOT, DSO_CH2_OVERSHOOT (read-only)
Returns the overshoot of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_PEAK_TO_PEAK, DSO_CH2_PEAK_TO_PEAK (read-only)
Returns the peak to peak voltage of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_PERIOD, DSO_CH2_PERIOD (read-only)
Returns the period of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_POS_SLEW, DSO_CH2_POS_SLEW (read-only)
Returns the voltage difference between the 10% and 90% amplitude points on rising edge divided by the time difference between these points on the specified channel.

DSO_CH1_POS_TIME_CONSTANT, DSO_CH2_POS_TIME_CONSTANT (read-only)
Returns the rising time constant (time from the base to 63% of the amplitude) of an exponential rising edge on the specified channel of the DSO.

DSO_CH1_POS_WIDTH, DSO_CH2_POS_WIDTH (read-only)
Returns the total time between 50% amplitude points on positive pulses (rising then falling edge) divided by the number of positive pulses on the specified channel.

DSO_CH1_RISE_TIME, DSO_CH2_RISE_TIME (read-only)
Returns the total time between the 10% and 90% amplitude points on the rising edges of the specified channel divided by the number of rising edges.

DSO_CH1_RMS, DSO_CH2_RMS (read-only)
Returns the RMS voltage of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_TIME_RESOLUTION, DSO_CH2_TIME_RESOLUTION (read-only)
Returns the resolution of time measurements for the current timebase.

DSO_CH1_TOP, DSO_CH2_TOP (read-only)
Returns the top voltage of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_TOP_PEAK, DSO_CH2_TOP_PEAK (read-only)
Returns the top peak voltage of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_UNDERSHOOT, DSO_CH2_UNDERSHOOT (read-only)
Returns the amount of undershoot of the waveform displayed on the specified channel of the Digital Storage Oscilloscope.

DSO_CH1_VOLTAGE_RESOLUTION, DSO_CH2_VOLTAGE_RESOLUTION (read-only)
Returns the resolution of voltage measurements on the current V/div range for the specified channel.

Frequency Counter System Variables

FC_ACTION (read-only)
Returns the value of the last frequency counter user button that was last pressed.

FC_CH1, FC_CH2 (read-only)
Returns the last value read from for the specified channel on the Frequency Counter.

FC_ENTRY_A, FC_ENTRY_A
Returns/sets the value displayed in *Calculator Entry Box A/B* for the Frequency Counter calculator.

Function Generator System Variables

FG_SWEEP_STEP
Returns/sets the frequency step through which the function generator output sweeps.

FG_SET_FREQUENCY
Returns/sets the function generator output frequency.

FG_DUTY_CYCLE
Returns/sets the function generator duty cycle.

FG_DC_OFFSET
Returns/sets the function generator DC offset.

FG_ACTUAL_FREQUENCY (read-only)
Returns the function generator frequency as measured internally by the frequency counter.

FG_AMPLITUDE
Returns/sets the function generator amplitude.

Miscellaneous System Variables

USER1_ACTION, USER2_ACTION, USER3_ACTION, USER4_ACTION (read-only)
Returns the value of the user button that was last pressed for the specified user calculator.

USER1_ENTRY_A, USER1_ENTRY_B, USER2_ENTRY_A, USER2_ENTRY_B
USER3_ENTRY_A, USER3_ENTRY_B, USER4_ENTRY_A, USER4_ENTRY_B
Returns/sets the value displayed in the *Calculator Entry Box A/B* for user calculators 1 to 4.

TestFlow System Variables

TFL_ACTION (read-only)
Returns the value of the TestFlow user button that was last pressed.

TFL_ENTRY_A, TFL_ENTRY_B
Returns/sets the value displayed in the *Calculator Entry Box A/B* for the TestFlow calculator.

TFL_STATUS (read-only)
Returns the status of the current TestFlow record as follows: -

0	Incomplete	*The TestFlow is waiting for the record's tests to complete.*
1	Pass	*All the record's tests have completed, and the result was a pass.*
2	Fail	*All the record's tests have completed, and the result was a fail.*
3	None	*The TestFlow record doesn't have any associated tests.*

Universal Input/Outputs System Variables

UIO_ACH1_VALUE_OUT, UIO_ACH2_VALUE_OUT
UIO_ACH3_VALUE_OUT, UIO_ACH4_VALUE_OUT
Returns/sets the voltage output by the specified UIO analogue channel.

UIO_ACH1_VALUE_IN, UIO_ACH2_VALUE_ IN
UIO_ACH3_VALUE_ IN, UIO_ACH4_VALUE_ IN (read-only)
Returns the voltage measured on the specified UIO analogue channel.

UIO_ACH1_DIRECTION, UIO_ACH2_DIRECTION
UIO_ACH3_DIRECTION, UIO_ACH4_DIRECTION
Returns/sets the direction of the specified UIO analogue channel, i.e. whether it is an output or an input, as follows: -

Values	0	Output
	1	Input

UIO_ACH1_MODE, UIO_ACH2_ MODE
UIO_ACH3_ MODE, UIO_ACH4_ MODE
Returns/sets the mode of the specified UIO analogue channel, i.e. whether it is in voltage or current mode, as follows: -

Values	0	Voltage
	1	Current

UIO_ACH1_RESTRICT, UIO_ACH2_ RESTRICT
UIO_ACH3_ RESTRICT, UIO_ACH4_ RESTRICT
Returns/sets the restrict state of the specified UIO analogue channel, i.e. whether it is enabled ir disabled, as follows: -

Values	0	Disabled
	1	Enabled

UIO_DCH1_STATE, UIO_DCH2_STATE, UIO_DCH3_STATE, UIO_DCH4_STATE
Returns/sets the value of the specified digital channel on the UIO as follows: -

Values	0	Low
	1	High

UIO_DCH1_DIRECTION, UIO_DCH2_ DIRECTION
UIO_DCH3_ DIRECTION, UIO_DCH4_ DIRECTION
Returns/sets the logic level and direction of the specified UIO digital channel as follows: -

Values	0	Output low
	1	Output high
	2	Input

Variable Power Supply System Variables

VPS_STATUS
Returns/sets the power status of connected VPS modules as follows: -

Values	0	VPS Off
	1	VPS On

Notes: All connected VPS modules will be affected by changes to this variable.

VPS_LOGIC1_VOLTAGE_SETTING, VPS_LOGIC2_ VOLTAGE _ SETTING
VPS_NEG1_ VOLTAGE _ SETTING, VPS_NEG2_ VOLTAGE _ SETTING
VPS_POS1_ VOLTAGE _ SETTING, VPS_POS2_ VOLTAGE _ SETTING
Returns/sets the voltage setting for the specified VPS output. The logic output range is 0 to +6.0V, negative output -24.5V to 0V, and positive output 0V to +24.5V

VPS_LOGIC1_VOLTAGE_READING, VPS_LOGIC2_ VOLTAGE _READING
VPS_NEG1_ VOLTAGE _READING, VPS_NEG2_ VOLTAGE _READING
VPS_POS1_ VOLTAGE _READING, VPS_POS2_ VOLTAGE _READING (read-only)
Returns the measured voltage reading for the specified VPS output

VPS_LOGIC1_CURRENT_READING, VPS_LOGIC2_CURRENT_READING
VPS_NEG1_CURRENT_READING, VPS_NEG2_CURRENT_READING
VPS_POS1_CURRENT_READING, VPS_POS2_CURRENT_READING (read-only)
Returns the measured current reading for the specified VPS output

VPS_LOGIC1_CURRENT_TRIP, VPS_LOGIC2_CURRENT_TRIP
Returns/sets the current trip value for the specified VPS logic output from 0 to 5A.

VPS_LOGIC1_ENABLE_TRIP, VPS_LOGIC2_ENABLE_TRIP
Returns/sets the state of the current trip for the specified VPS logic output as follows: -

Values	0	Trip Off
	1	Trip On

VPS_LOGIC1_OVP_SETTING, VPS_LOGIC2_ OVP_SETTING
Returns/sets the over voltage protection setting for the specified VPS logic output from 0 to 6.5V.

VPS_LOGIC1_OVP_TRIG, VPS_LOGIC2_ OVP_TRIG

Returns/sets the state of the over voltage protection trigger for the specified VPS logic output as follows: -

Values	0	OVP off
	1	OVP on

VPS_NEG1_CURRENT_LIMIT, VPS_NEG2_CURRENT_ LIMIT
VPS_POS1_CURRENT_ LIMIT, VPS_POS2_CURRENT_ LIMIT
Returns/sets the current limit setting for the specified VPS output from 0.00A to 1.50A

List of Functions

For detailed information about individual functions see below: -

ABS()
This function returns the absolute value (or magnitude) of an expression, providing that expression evaluates to a number. For example, a negative number is returned as a positive number with the same magnitude as the original negative number.

Syntax:
ABS (*expression*)

Parameters:
expression: Numerical expression whose magnitude is to be returned.

Example:
FORMAT 0, "", N
DISPLAY ABS(-100)

Result:
100

Example:
FORMAT 0, "", N
DISPLAY ABS(100)

Result:
100

COS()
This function calculates the cosine of an expression, providing that expression evaluates to a number.

Syntax:
COS (*angle*)

Parameters:
angle: Numerical expression representing an angle (in radians) whose cosine is to be returned.

Example:
FORMAT 3, "", N
DISPLAY COS(PI()/2)

Result:
0.000

E()
This function returns the value of the mathematical constant E (which is equivalent to taking the exponential of 1).

Syntax:
E()

Parameters:

Example:
```
FORMAT 3, "", N
DISPLAY E()
```

Result:
2.718

E12(), E24()
This function evaluates expression, providing that expression evaluates to a number, and determines the nearest preferred E12/E24 resistor value.

Syntax:
E12 (*expression*)
E24 (*expression*)

Parameter:
expression: Value for which the preferred E12/E24 resistor value is found.

Example:
```
FORMAT 0, "", N
DISPLAY E12(302.5)
```
Result: 330

EXP()
This function calculates the exponential of the expression, providing that expression evaluates to a number.

Syntax:
EXP (*expression*)

Parameters:
expression: Numerical expression for which the exponential will be returned. If the value is greater than 50, an error will be given.

Example:
```
FORMAT 3, "", N
DISPLAY EXP(1)
```

Result:
2.718

Example:
```
FORMAT 3, "", N
DISPLAY EXP(51)
```

Result:
Exp arg

INT()
Returns the integer value of the expression given, providing that expression evaluates to a number.

Syntax:
INT (*expression*)

Parameters:
expression: Numerical expression whose integer part will be returned.

Example:
FORMAT 1,"",N
DISPLAY INT(1.5)

Result:
2.0

Example:
FORMAT 1,"", N
DISPLAY INT(-1.5)

Result:
-2.0

LOG()
This function evaluates the expression, and providing it evaluates to a number, returns its natural logarithm.

Syntax:
LOG (*expression*)

Parameters:
expression: Numerical expression whose natural logarithm will be returned.
If the value is 0.0 or less, an error message is given.

Example:
FORMAT 1,"",N
DISPLAY LOG(1.0)

Result:
0.0

Example:
FORMAT 1,"", N
DISPLAY LOG(0.0)

Result:
Log arg.

MAX()
This function returns the larger of the two values in its parameter list.

Syntax:
MAX (*expression1, expression2*)

Parameters:
expression1: Value to compare against.
expression2: Value to compare against.

Example:
FORMAT 1,"",N
DISPLAY MAX(1, 2)

Result:
2.0

Example:
FORMAT 1,"", N
DISPLAY MAX(2, 1)

Result:
2.0

MIN()
This function returns the smaller of the two values in its parameter list.

Syntax:
MIN (*expression1, expression2*)

Parameters:
expression1: Value to compare against.
expression2: Value to compare against.

Example:
FORMAT 1,"",N
DISPLAY MIN(1, 2)

Result:
1.0

Example:
FORMAT 1,"", N
DISPLAY MIN(2, 1)

Result:
1.0

PI()
This function returns the value of the mathematical constant PI.

Syntax:
PI()

Parameters:

Example:
FORMAT 3, "", N
DISPLAY PI()

Result:
3.142

ROUND()
This function rounds the value given as its first parameter to the nearest multiple of its second parameter.

Syntax:
ROUND (*expression1, expression2*)

Parameters:
expression1: Value to round.
expression2: Nearest value to round to a multiple of.

Example:
FORMAT 0,"",N
// Round to the nearest hundred
DISPLAY ROUND(123, 100)

Result:
100

Example:
FORMAT 0,"", N
// Round to an even number
DISPLAY ROUND(13, 2)

Result:
14

SIN()
This function calculates the sine of an expression, providing that expression evaluates to a number.

Syntax:
SIN (*angle*)

Parameters:
angle: Numerical expression representing an angle (in radians) whose sine is to be returned.

Example:
FORMAT 3, "", N
DISPLAY SIN(PI()/2)

Result:
1.000

SQRT()
This function evaluates the square root of the given expression.

Syntax:
SQRT (*expression*)

Parameters:
expression: Numerical expression whose square root is to be returned.
If the value is negative, an error occurs.

Example:
FORMAT 1,"",N
DISPLAY SQRT(4.0)

Result:
2.0

Example:
FORMAT 1,"", N
DISPLAY SQRT(-4.0)

Result:
Sq root arg

TAN()
This function calculates the tangent of an expression, providing that expression evaluates to a number.

Syntax:

TAN (*angle*)

Parameters:

angle: Numerical expression representing an angle (in radians) whose tangent is to be returned.

Example:

FORMAT 3, "", N
DISPLAY TAN(0)

Result:

0.000

TICK()

This function returns the time, in seconds, that the calculator program has been running.

Syntax:

TICK()

Parameters:

Example:

FORMAT 0,"",N
PAUSE 5000
DISPLAY TICK()

Result:

5

What Is Python?

Python is an object-oriented programming language, which combines remarkable power with very clear syntax. There are interfaces available to many system calls and libraries, as well as to various windowing systems. New modules can be easily written in C or C++.

Python has been fully integrated into the SYSTEM 8 FormulaPlus calculator description language.

Full support and documentation on the Python language is available from www.python.org

Installing Python

It is necessary to download and install python 2.7 on your computer before you can you any of its features from within SYSTEM 8.

Python 2.7 is available as a free download directly from www.python.org, install the latest version available for the windows operating system. Once installed all of Python's feature will be available from within the SYSTEM 8 FormulaPlus calculator description language.

Python DMM

The Digital Multimeter instrument can be accessed from Python using the Premier library. All of the DMM system variables from FormulaPlus are available in Python.

Usage Example

```
python
{
	# Include talking to Premier in this script
	import premier

	# Get access to the digital multimeter
	DMM = premier.dmm()

	# Print the DMM Channel readings
	print "Channel 1 reading is" + str(DMM.ch1)
	print "Channel 2 reading is" + str(DMM.ch2)
}
```

Property	Description	Equivalent FormulaPlus Variable
ch1	DMM channel 1 reading	DMM_CH1
ch2	DMM channel 2 reading	DMM_CH2

Python DSO

The Digital Storage Oscilloscope instrument can be accessed from Python using the Premier library. All of the DSO's system variables from FormulaPlus are available in Python.

Usage Example

```
python
{
	# Include talking to Premier in this script
	import premier

	# Get access to the digital storage oscilloscope
	DSO = premier.dso()

	# Set some DSO properties
	DSO.ch1_offset = 2
	DSO.timebase_index = 3 # 0.5s / Division

	# Print some DSO properties
	print "DSO channel 1 amplitude is" + str(DSO.ch1_amplitude)
	print "DSO channel 1 frequency is" + str(DSO.ch1_frequency)
}
```

Property	Description	Equivalent FormulaPlus Variable
acquire_mode	DSO Acquire mode	DSO_ACQUIRE_MODE
acquire_status	DSO Acquisition status	DSO_ACQUIRE_STATUS
trig_coupling	DSO trigger coupling	DSO_TRIG_COUPLING
trig_source	DSO trigger source	DSO_TRIG_SOURCE
trig_edge	DSO trigger slope	DSO_TRIG_EDGE
trig_level	DSO trigger level	DSO_TRIG_LEVEL
trig_delay	DSO trigger delay	DSO_TRIG_DELAY
timebase_index	DSO timebase	DSO_TIMEBASE_INDEX
ch1_offset	DSO channel 1 vertical offset	DSO_CH1_OFFSET
ch1_amplitude	DSO channel 1 amplitude	DSO_CH1_AMPLITUDE
ch1_peak_to_peak	DSO channel 1 peak to peak	DSO_CH1_PEAK_TO_PEAK
ch1_top	DSO channel 1 top	DSO_CH1_TOP
ch1_top_peak	DSO channel 1 top peak	DSO_CH1_TOP_PEAK
ch1_base	DSO channel 1 base	DSO_CH1_BASE
ch1_base_peak	DSO channel 1 base peak	DSO_CH1_BASE_PEAK
ch1_mean	DSO channel 1 mean value	DSO_CH1_MEAN
ch1_cyclic_mean	DSO channel 1 cyclical mean	DSO_CH1_CYCLIC_MEAN
ch1_rms	DSO channel 1 RMS	DSO_CH1_RMS
ch1_cyclic_rms	DSO channel 1 cyclical RMS	DSO_CH1_CYCLIC_RMS
ch1_overshoot	DSO channel 1 overshoot	DSO_CH1_OVERSHOOT
ch1_undershoot	DSO channel 1 undershoot	DSO_CH1_UNDERSHOOT
ch1_crest_factor	DSO channel 1 crest factor	DSO_CH1_CREST_FACTOR
ch1_period	DSO channel 1 period	DSO_CH1_PERIOD
ch1_frequency	DSO channel 1 frequency	DSO_CH1_FREQUENCY
ch1_cycles	DSO channel 1 number of cycles	DSO_CH1_CYCLES
ch1_rise_time	DSO channel 1 rise time	DSO_CH1_RISE_TIME
ch1_fall_time	DSO channel 1 fall time	DSO_CH1_FALL_TIME
ch1_pos_width	DSO channel 1 positive width	DSO_CH1_POS_WIDTH
ch1_neg_width	DSO channel 1 negative width	DSO_CH1_NEG_WIDTH
ch1_pos_slew	DSO channel 1 positive slew rate	DSO_CH1_POS_SLEW
ch1_neg_slew	DSO channel 1 negative slew rate	DSO_CH1_NEG_SLEW
ch1_bandwidth	DSO channel 1 bandwidth	DSO_CH1_BANDWIDTH
ch1_duty_cycle	DSO channel 1 duty cycle	DSO_CH1_DUTY_CYCLE
ch1_pos_time_constant	DSO channel 1 positive time constant	DSO_CH1_POS_TIME_CONSTANT
ch1_neg_time_constant	DSO channel 1 negative time constant	DSO_CH1_NEG_TIME_CONSTANT

ch1_voltage_resolution	DSO channel 1 voltage resolution	DSO_CH1_VOLTAGE_RESOLUTION
ch1_time_resolution	DSO channel 1 time resolution	DSO_CH1_TIME_RESOLUTION
ch2_offset	DSO channel 2 vertical offset	DSO_CH2_OFFSET
ch2_amplitude	DSO channel 2 amplitude	DSO_CH2_AMPLITUDE
ch2_peak_to_peak	DSO channel 2 peak to peak	DSO_CH2_PEAK_TO_PEAK
ch2_top	DSO channel 2 top	DSO_CH2_TOP
ch2_top_peak	DSO channel 2 top peak	DSO_CH2_TOP_PEAK
ch2_base	DSO channel 2 base	DSO_CH2_BASE
ch2_base_peak	DSO channel 2 base peak	DSO_CH2_BASE_PEAK
ch2_mean	DSO channel 2 mean value	DSO_CH2_MEAN
ch2_cyclic_mean	DSO channel 2 cyclical mean	DSO_CH2_CYCLIC_MEAN
ch2_rms	DSO channel 2 RMS	DSO_CH2_RMS
ch2_cyclic_rms	DSO channel 2 cyclical RMS	DSO_CH2_CYCLIC_RMS
ch2_overshoot	DSO channel 2 overshoot	DSO_CH2_OVERSHOOT
ch2_undershoot	DSO channel 2 undershoot	DSO_CH2_UNDERSHOOT
ch2_crest_factor	DSO channel 2 crest factor	DSO_CH2_CREST_FACTOR
ch2_period	DSO channel 2 period	DSO_CH2_PERIOD
ch2_frequency	DSO channel 2 frequency	DSO_CH2_FREQUENCY
ch2_cycles	DSO channel 2 number of cycles	DSO_CH2_CYCLES
ch2_rise_time	DSO channel 2 rise time	DSO_CH2_RISE_TIME
ch2_fall_time	DSO channel 2 fall time	DSO_CH2_FALL_TIME
ch2_pos_width	DSO channel 2 positive width	DSO_CH2_POS_WIDTH
ch2_neg_width	DSO channel 2 negative width	DSO_CH2_NEG_WIDTH
ch2_pos_slew	DSO channel 2 positive slew rate	DSO_CH2_POS_SLEW
ch2_neg_slew	DSO channel 2 negative slew rate	DSO_CH2_NEG_SLEW
ch2_bandwidth	DSO channel 2 bandwidth	DSO_CH2_BANDWIDTH
ch2_duty_cycle	DSO channel 2 duty cycle	DSO_CH2_DUTY_CYCLE
ch2_pos_time_constant	DSO channel 2 positive time constant	DSO_CH2_POS_TIME_CONSTANT
ch2_neg_time_constant	DSO channel 2 negative time constant	DSO_CH2_NEG_TIME_CONSTANT
ch2_voltage_resolution	DSO channel 2 voltage resolution	DSO_CH2_VOLTAGE_RESOLUTION
ch2_time_resolution	DSO channel 2 time resolution	DSO_CH2_TIME_RESOLUTION

Python FC

The Frequency Counter instrument can be accessed from Python using the Premier library. All of the FC's system variables from FormulaPlus are available in Python.

Usage Example

```
python
{
        # Include talking to Premier in this script
        import premier

        # Get access to the frequency counter
        FC = premier.fc()

        # Print the FC Channel readings
        print "Channel 1 reading is" + str(FC.ch1)
        print "Channel 2 reading is" + str(FC.ch2)
}
```

Property	Description	Equivalent FormulaPlus Variable
ch1	Frequency counter channel 1 reading	FC_CH1
ch2	Frequency counter channel 2 reading	FC_CH2

Python FGen

The Function Generator instrument can be accessed from Python using the Premier library. All of the Function Generator system variables from FormulaPlus are available in Python.

Usage Example

```
python
{
        # Include talking to Premier in this script
        import premier

        # Get access to the function generator
        FGen = premier.fgen()

        # Set some FGen properties
        FGen.amplitude = 2
        FGen.set_frequency = 2000

        # Print FGen actual frequency property
        print "FGen actual frequency is " + str(FGen.actual_frequency)
}
```

Property	Description	Equivalent FormulaPlus Variable
amplitude	Amplitude	FG_AMPLITUDE
dc_offset	DC Offset	FG_DC_OFFSET
set_frequency	Set Frequency	FG_SET_FREQUENCY
actual_frequency	Actual Frequency	FG_ACTUAL_FREQUENCY
duty_cycle	Duty Cycle	FG_DUTY_CYCLE
sweep_step	Sweep Step	FG_SWEEP_STEP

Python UIO

The Universal Input/Output instrument can be accessed from Python using the Premier library. All of the UIO system variables from FormulaPlus are available in Python.

Usage Example

```
python
{
	# Include talking to Premier in this script
	import premier

	# Get access to the universal input / outputs
	UIO = premier.uio()

	# Set some UIO properties
	UIO.ach1_direction = 0
	UIO.ach1_value_out = 2
	UIO.ach2_direction = 1

	# Print some UIO properties
	print "UIO channel 1 output is " + str(UIO.ach1_value_out)
	print "UIO channel 2 input is " + str(UIO.ach2_value_in)
}
```

Property	Description	Equivalent FormulaPlus Variable
ach1_direction	UIO analogue channel 1 direction	UIO_ACH1_DIRECTION
ach2_direction	UIO analogue channel 2 direction	UIO_ACH2_DIRECTION
ach3_direction	UIO analogue channel 3 direction	UIO_ACH3_DIRECTION
ach4_direction	UIO analogue channel 4 direction	UIO_ACH4_DIRECTION
ach1_mode	UIO analogue channel 1 mode	UIO_ACH1_MODE
ach2_mode	UIO analogue channel 2 mode	UIO_ACH2_MODE
ach3_mode	UIO analogue channel 3 mode	UIO_ACH3_MODE

ach4_mode	UIO analogue channel 4 mode	UIO_ACH4_MODE
ach1_value_out	UIO analogue channel 1 output value	UIO_ACH1_VALUE_OUT
ach2_value_out	UIO analogue channel 2 output value	UIO_ACH2_VALUE_OUT
ach3_value_out	UIO analogue channel 3 output value	UIO_ACH3_VALUE_OUT
ach4_value_out	UIO analogue channel 4 output value	UIO_ACH4_VALUE_OUT
ach1_value_in	UIO analogue channel 1 input value	UIO_ACH1_VALUE_IN
ach2_value_in	UIO analogue channel 2 input value	UIO_ACH2_VALUE_IN
ach3_value_in	UIO analogue channel 3 input value	UIO_ACH3_VALUE_IN
ach4_value_in	UIO analogue channel 4 input value	UIO_ACH4_VALUE_IN
ach1_restrict	UIO analogue channel 1 restrict enable	UIO_ACH1_RESTRICT
ach2_restrict	UIO analogue channel 2 restrict enable	UIO_ACH2_RESTRICT
ach3_restrict	UIO analogue channel 3 restrict enable	UIO_ACH3_RESTRICT
ach4_restrict	UIO analogue channel 4 restrict enable	UIO_ACH4_RESTRICT
dch1_state	UIO digital channel 1 state	UIO_DCH1_STATE
dch2_state	UIO digital channel 2 state	UIO_DCH2_STATE
dch3_state	UIO digital channel 3 state	UIO_DCH3_STATE
dch4_state	UIO digital channel 4 state	UIO_DCH4_STATE
dch1_direction	UIO digital channel 1 direction	UIO_DCH1_DIRECTION
dch2_direction	UIO digital channel 2 direction	UIO_DCH2_DIRECTION
dch3_direction	UIO digital channel 3 direction	UIO_DCH3_DIRECTION
dch4_direction	UIO digital channel 4 direction	UIO_DCH4_DIRECTION

Python VPS

The Variable Power Supply can be accessed from Python using the Premier library. All of the VPS system variables from FormulaPlus are available in Python.

Usage Example

```
python
{
	# Include talking to Premier in this script
	import premier

	# Get access to the VPS
	VPS = premier.vps()

	# Set some VPS properties
	VPS.logic1_voltage_setting = 3
	VPS.pos1_voltage_setting = 10

	# Print some VPS properties
	print "VPS logic1 voltage reading is " + str(VPS.logic1_voltage_reading)
	print "VPS pos1 current is " + str(VPS.pos1_current_reading)
}
```

Property	**Description**	**Equivalent FormulaPlus Variable**
logic1_voltage_reading	VPS1 Logic Voltage	VPS_LOGIC1_VOLTAGE_READING
pos1_voltage_reading	VPS1 +ve Voltage	VPS_POS1_VOLTAGE_READING
neg1_voltage_reading	VPS1 -ve Voltage	VPS_NEG1_VOLTAGE_READING
logic1_current_reading	VPS1 Logic Current	VPS_LOGIC1_CURRENT_READING
pos1_current_reading	VPS1 +ve Current	VPS_POS1_CURRENT_READING
neg1_current_reading	VPS1 -ve Current	VPS_NEG1_CURRENT_READING
logic1_voltage_setting	VPS1 Logic Set Voltage	VPS_LOGIC1_VOLTAGE_SETTING
pos1_voltage_setting	VPS1 +ve Set Voltage	VPS_POS1_VOLTAGE_SETTING
neg1_voltage_setting	VPS1 -ve Set Voltage	VPS_NEG1_VOLTAGE_SETTING
pos1_current_limit	VPS1 +ve Set Current	VPS_POS1_CURRENT_LIMIT
neg1_current_limit	VPS1 -ve Set Current	VPS_NEG1_CURRENT_LIMIT
logic1_ovp_setting	VPS1 Logic OVP setting	VPS_LOGIC1_OVP_SETTING
logic1_ovp_trig	VPS1 Logic OVP trig	VPS_LOGIC1_OVP_TRIG
logic1_current_trip	VPS1 Logic current trip	VPS_LOGIC1_CURRENT_TRIP
logic1_enable_trip	VPS1 Logic enable trip	VPS_LOGIC1_ENABLE_TRIP
logic2_voltage_reading	VPS2 Logic Voltage	VPS_LOGIC2_VOLTAGE_READING
pos2_voltage_reading	VPS2 +ve Voltage	VPS_POS2_VOLTAGE_READING
neg2_voltage_reading	VPS2 -ve Voltage	VPS_NEG2_VOLTAGE_READING
logic2_current_reading	VPS2 Logic Current	VPS_LOGIC2_CURRENT_READING
pos2_current_reading	VPS2 +ve Current	VPS_POS2_CURRENT_READING
neg2_current_reading	VPS2 -ve Current	VPS_NEG2_CURRENT_READING
logic2_voltage_setting	VPS2 Logic Set Voltage	VPS_LOGIC2_VOLTAGE_SETTING
pos2_voltage_setting	VPS2 +ve Set Voltage	VPS_POS2_VOLTAGE_SETTING
neg2_voltage_setting	VPS2 -ve Set Voltage	VPS_NEG2_VOLTAGE_SETTING

pos2_current_limit	VPS2 +ve Set Current	VPS_POS2_CURRENT_LIMIT
neg2_current_limit	VPS2 -ve Set Current	VPS_NEG2_CURRENT_LIMIT
logic2_ovp_setting	VPS2 Logic OVP setting	VPS_LOGIC2_OVP_SETTING
logic2_ovp_trig	VPS2 Logic OVP trig	VPS_LOGIC2_OVP_TRIG
logic2_current_trip	VPS2 Logic current trip	VPS_LOGIC2_CURRENT_TRIP
logic2_enable_trip	VPS2 Logic enable trip	VPS_LOGIC2_ENABLE_TRIP

Using Python Example

In order to use Python code within the calculator, the code must be contained within a Python code segment.

```
python
{
        ...
        ... Python code here
        ...
}
```

Commenting Python Code

The Python language uses the # symbol to indicate that the text following it is a comment. The comment ends with either a new line character.

```
python
{
     # This is a comment that ends with a new line character.
}
```

Mixing Python and FormulaPlus Example

In this example FormulaPlus and Python code are mixed to write continuous measurements of the DMM channel 1 to the calculator output.

```
// START OF FIRST PYTHON BLOCK
python
{
                import premier                          # Prepare to use the Premier interface
                NumReadings = 0       # No readings taken initially
                Multimeter = premier.dmm()
}
// END OF FIRST PYTHON BLOCK

// START OF CALCULATOR BLOCK
while 1
{
        // Wait for DMM channel 1 to complete
        WAIT DMM_CH1

        // START OF SECOND PYTHON BLOCK
```

```
	python
	{
		# New reading available
		CurrentReading = Multimeter.ch1
		NumReadings += 1

		# Display this reading
		print "Reading {0}: {1:.3f}V".format(NumReadings, CurrentReading)
		}
		// END OF SECOND PYTHON BLOCK
}
// END OF CALCULATOR BLOCK
```

Python Input Example

In this example Python is used to ask the user to enter their name and then write the users name to the calculator output.

```
python
{
	try:
		UserEntry = raw_input("Please enter a name")
		print "\nYou entered: " + UserEntry
	except EOFError:
		print "\nYou pressed cancel"
}
```

Python Output Example

In this example Python is used to write "Hello there" to the calculator output.

```
python
{
	print "Hello there!"
}
```

Python Running an External Program Example

In this example Python is used to launch the Microsoft calculator application and display any response to the calculator output.

```
python
{
		import subprocess

		p = subprocess.Popen(["calc.exe"], stdout=subprocess.PIPE)
		stdout, stderr = p.communicate()
		print stdout
}
```