Fusion
Instruction Manual
Form 150795/A1

©QuadTech, Inc., 2005
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The material in this manual is for informational purposes only and is subject to change, without notice. QuadTech assumes no responsibility for any error or for consequential damages that may result from the misinterpretation of any procedures in this publication.

WARNING

Potentially dangerous voltages may be present on front and rear panel terminals. Follow all warnings in this manual when operating or servicing this instrument. Dangerous levels of energy may be stored in capacitive devices tested by this unit. Always make sure the high voltage indicator is not on when connecting or disconnecting the device under test.

Safety Notices

This product generates high potential as a test stimulus when programmed to do so.

To avoid the risk of shock do not attempt to service the supply beyond the described steps in this documents.

To avoid the risk of shock or personal injury, do not remove the product covers while the unit is operating or connected the AC mains.

Use only a power cord rated greater than the input current rating of the external power supplies. Use only a cord in good condition.

If liquid is spilled on the unit, shut it off immediately and disconnect it from the AC mains.

Ensure the unit is properly grounded using a reliably grounded AC mains input at the external power supplies.

Do not touch any exposed wiring on your product under test (PUT) while the High Voltage lamp is illuminated.

For additional safety it is recommended to use an approved EPO (Emergency Power Off) switch during High Voltage testing.

The Fusion has built-in safety systems:

1. Interlock: EPO (Emergency Power Off) switch connected to the Fusion's I/O can be used as emergency high voltage shut off.
2. Software Safety: The Fusion will not perform a High Voltage test on a product that has failed either continuity or isolation. By default, the software pauses before running a High Voltage test. The operator is prompted to continue.

The operator prompt before High Voltage tests can be disabled, enabling an immediate High Voltage test to follow a passed Low Voltage test. QuadTech does not take responsibility for injury caused by the 'Autohipot' option.

Product marked with this symbol (ISO#3864) when you must refer to the instruction manual in order to prevent injury or equipment damage.

Product marked with this symbol (IEC417) indicates presence of direct current.

Product marked with this symbol (ISO#3864) when voltages in excess of 1000V are present.

Important: Additional user information

Caution: Indicates how to avoid potential damage to parts/components or loss of data.

Warning: Indicates how to avoid potential bodily harm.

Examples of Fusion Script Language

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1 Introduction

1.1 Warranty

QuadTech warrants that products are free from defects in material and workmanship and, when properly used, will perform in accordance with QuadTech's applicable published specifications. If within one (1) year after original shipment it is found not to meet this standard, it will be repaired or, at the option of QuadTech, replaced at no charge when returned to a QuadTech service facility.

Changes in the product not approved by QuadTech shall void this warranty.

QuadTech shall not be liable for any indirect, special or consequential damages, even if notice has been given of the possibility of such damages.

This warranty is in lieu of all other warranties, expressed or implied, including, but not limited to any implied warranty or merchantability of fitness for a particular purpose.

1.2 Service Policy

QuadTech's service policy is to maintain product repair capability for a period of at least five (5) years after original shipment and to make this capability available at the then prevailing schedule of charges.

1.3 Specifications

1.3.1 Resistance

Parameter	Stimulus	Range	Accuracy	Resolution
2-Wire Resistance Measurement	100mA	0.000Ω to 9.999Ω	±1%,±50mΩ	1mΩ
	100mA	10.00Ω to 39.99Ω	±1%,±50mΩ	10mΩ
	1mA	40.00Ω to 99.99Ω	±1%	10mΩ
	1mA	100.0Ω to 399.9Ω	±1%	100mΩ
	1mA	400.0Ω to 999.9Ω	±1%	100mΩ
	1mA	1.000KΩ to 3.999KΩ	±1%	1Ω
	100µA	4.000KΩ to 9.999KΩ	±1%	1Ω
	100µA	10.00KΩ to 39.99KΩ	±1%	10Ω
	10µA	40.00KΩ to 99.99KΩ	±1%	10Ω
	10µA	100.0KΩ to 399.9KΩ	±1%	100Ω
	Auto	400.0KΩ to 999.9KΩ	±3%	100Ω
	Auto	1.000MΩ to 9.999MΩ	±5%	1KΩ
	Auto	10.00MΩ to 50.00MΩ	±10%	10KΩ
4-Wire Resistance Measurement	100mA	0.000Ω to 9.999Ω	±1%,±5mΩ	1mΩ
	100mA	10.00Ω to 39.99Ω	±1%,±5mΩ	10mΩ
	1mA	40.00Ω to 99.99Ω	±1%	10mΩ
	1mA	100.0Ω to 399.9Ω	±1%	100mΩ
	1mA	400.0Ω to 999.9Ω	±1%	100mΩ
	1mA	1.000KΩ to 3.999KΩ	±1%	1Ω
	100µA	4.000KΩ to 9.999KΩ	±1%	1Ω
	100µA	10.00KΩ to 39.99KΩ	±1%	10Ω
	10µA	40.00KΩ to 99.99KΩ	±1%	10Ω
	10µA	100.0KΩ to 399.9KΩ	±1%	100Ω

1.3.2 Capacitance

Range	Accuracy	Resolution
100.0pF to 999.9pF	±2%,±10pF	0.1pF
1.000nF to 9.999nF	±2%	1pF
10.00nF to 99.99nF	±2%	10pF
100.0nF to 999.9nF	±2%	100pF
1.000µF to 9.999µF	±2%	1nF
10.00µF to 99.99µF	±2%	10nF
100.0µF to 999.9µF	±2%	100nF

1.3.3 High Voltage DC

Parameter	Range	Accuracy	Resolution
Voltage (Model QF4)	50VDC to 3000VDC	±1%,±5VDC	1VDC
Voltage (Models QF2 and QF3)	50VDC to 2500VDC	±1%,±5VDC	1VDC
Current	1nA to 3mA	±3%	1nA
Dwell Time	100ms to 600s	±1%,±50ms	10ms
Ramp Time	0s to 100s	±1%,±50ms	10ms
Fall Time	0s to 100s	±1%,±50ms	10ms
Discharge Time	0s to 1200s	±1%,±50ms	100ms
Insulation Resistance	1MΩ to 49MΩ	±3%	1MΩ
	50MΩ to 499MΩ	±5%	1MΩ
	500MΩ to 1.999GΩ	±10%	1MΩ
	2GΩ to 100GΩ	±20%	1MΩ

1.3.4 High Voltage AC

Parameter	Range	Accuracy	Resolution
Voltage (Model QF4)	50VAC to 3500VAC	±1%,±5VAC	1VAC
Voltage (Models QF1 and QF3)	50VAC to 2500VAC	±1%,±5VAC	1VAC
Current	1uA to 25mA	±3%	1uA
Dwell Time	500ms to 600s	±1%,±50ms	10ms
Ramp Time	0s to 100s	±25%	10ms
Fall Time	0s to 100s	±25%	10ms
Discharge Time	0s to 1200s	±1%,±50ms	100ms

1.4 Accessories

Fusion includes the following accessories:

- AC power cord
- Ground probe
- Instruction manual
- Calibration certificate

2 Installing Fusion

2.1 Unpacking the Fusion

As you unpack your system, you will find one or more of the following items. Please refer to your packing slip to ensure all ordered items are present.

- Fusion (two boxes)
- Power supply cable
- Ground probe
- Instruction manual
- Calibration certificate
- Connecting cables
- Digital hand-held probe (if ordered)

Carefully inspect the shipping containers for mishandling or damage due to transit. If visible damage is found, QuadTech suggests that the carrier's representative be present when opening the container. Carefully inspect all items as they are removed from the shipping containers and immediately report any lost or damaged parts to QuadTech or an authorized QuadTech representative.

2.2 Environmental Requirements

2.2.1 Input Voltage

105VAC – 130VAC, 60Hz, 5A

2.2.2 Physical Specifications

2.2.2.1 Dimensions and Weight

Unit	Dimensions	Weight
Main	17" w X 21.5" d X 9" h	35 lbs
Expansion – QF1, QF3, QF4	17" w X 21.5" d X 9" h	55 lbs
Expansion – QF2	17" w X 21.5" d X 9" h	45 lbs

2.2.2.2 Shipping Dimensions and Weight

Model	Dimensions	Weight
QF1, QF3, QF4	27.5" w X 28.5" d X 31.25" h	150 lbs
QF2	27.5" w X 28.5" d X 31.25" h	140 lbs

2.2.3 Environmental Specifications

Ambient Temperature:

Operating	0ºC - 55ºC
Non-Operating	0ºC - 45ºC

Temperature Gradient:

Operating/Non-Operating

30ºC/hr max, without condensation

Relative Humidity:

Operating/Non-Operating

8% - 80% non-condensing

Vibration:

Operating	2.45 m/s2 (0.25G)
Non-Operating	11.76 m/s2 (1.2G)

Shock:

Operating	29.4m/s2 (3G)
Non-Operating	490 m/s2 (50G)

Corrosion Gas:

No Corrosion Gas

2.3 Site Requirements

The installation site must provide a properly wired and grounded power outlet. Circuits connected to air conditioners and devices that generate significant transient electrical noise should be avoided.

Electrostatic discharge in the vicinity should be minimized by avoiding high resistant floor material and carpeting that does not have anti-static properties. The unit should be located away from areas that generate electromagnetic interference (for example, transformers, power distribution panels, and motors). The unit should not be installed where the atmosphere contains corrosive elements that may damage the unit.

The Fusion should be installed on a flat sturdy surface at a comfortable height for operators to work at.

It is not recommended to install the unit on any angle other than horizontal (with all four chassis rubber feet touching the surface) or on a 90 degree angle from that reference.

2.4 Connecting the Fusion

1. Set up the two Fusion boxes so that, when facing the Fusion, the box with the touch screen is on the left, and the box with the switch cards is on the right. For purposes of explanation, we will refer to the box with the touch screen as the “control” box and the box with the switch cards as the “switch” box.

Control box:

Switch box:

Front View

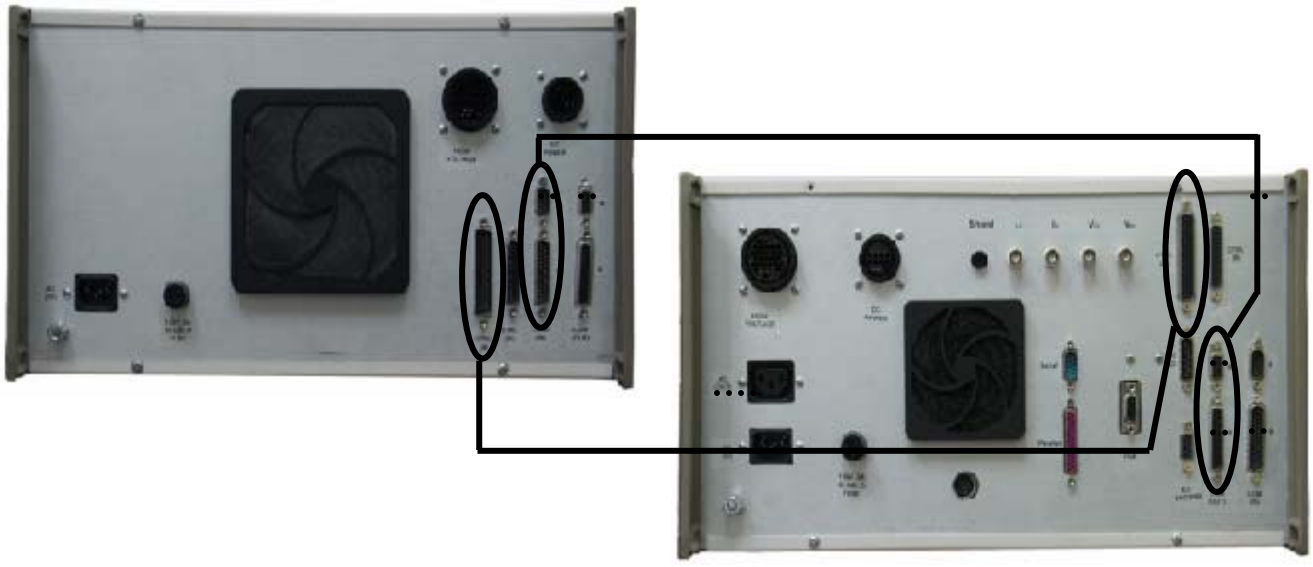
Switch box:

Control box:

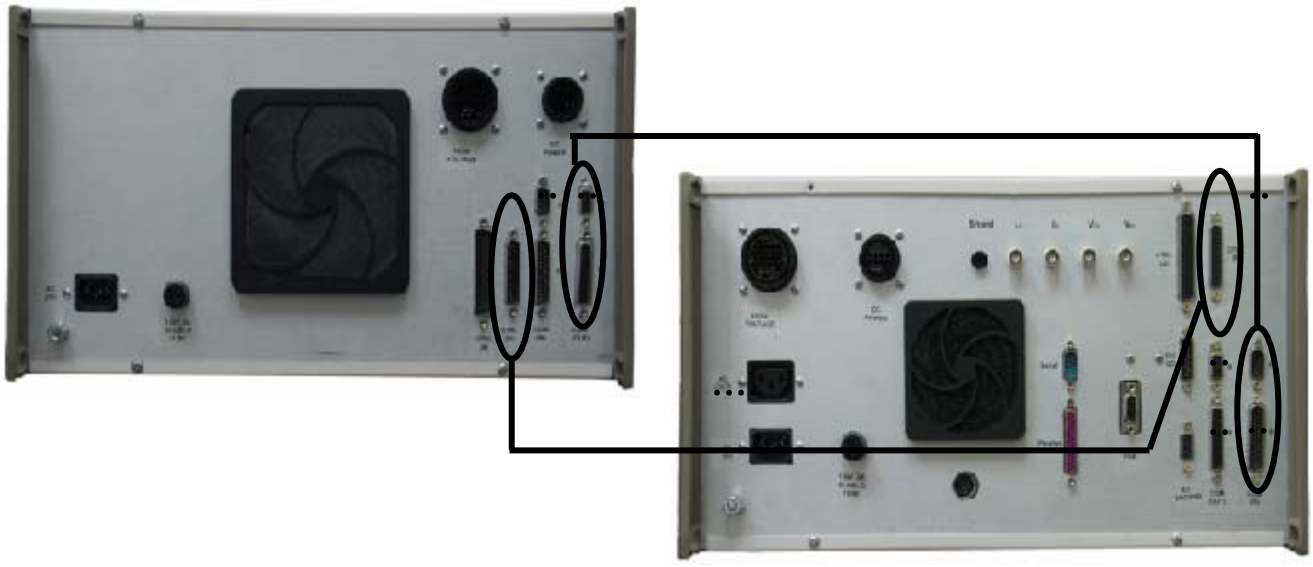
Rear View

2. Connect AC (IN) on the switch box to AC (out) on the control box.
   Connect High Voltage on the switch box to High Voltage on the control box.
   Connect DC power on the switch box to DC power on the control box.

3. Connect CTRL (A) on the switch box to CTRL (A) on the control box.
   Connect COM (IN) and the A plug above it on the switch box to COM (IN) and the A plug above it on the "control" box.



Connect CTRL (B) on the switch box to CTRL (B) on the control box.
Connect COM (Out) and the A plug above it on the switch box to COM (Out) and the A plug above it on the "control" box.

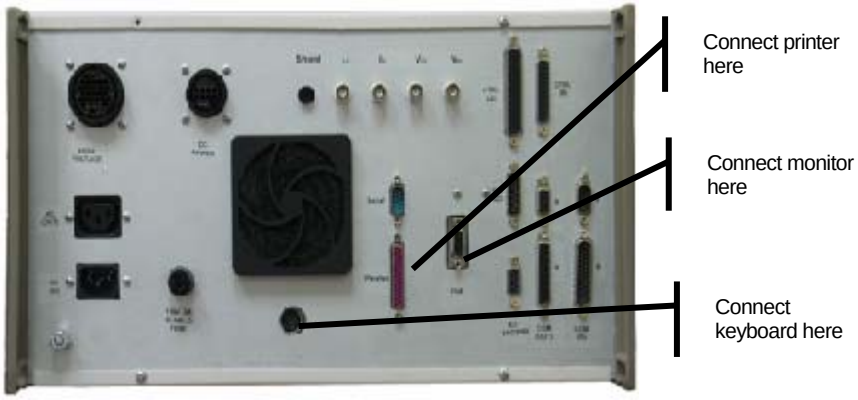


Connect the external power supply (see table below) to an appropriate power supply.

2.5 Connecting Accessories

1. Plug the probe into the plug on the front of the switch box.

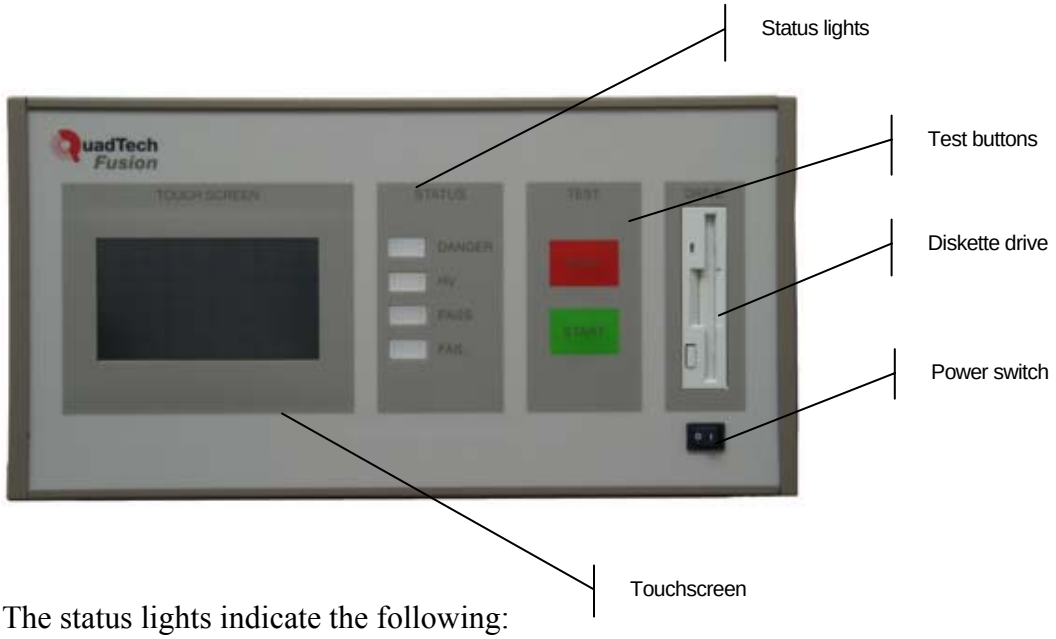
2. If using a printer, connect it to the parallel port on the control box.
   If using a keyboard, connect it to the keyboard port on the "control" box.
   If using a monitor, connect it to the VGA port on the "control" box.



3 Getting Started with Fusion

3.1 About the Front Panels

The Fusion consists of two boxes, each of which has a front panel. One box offers a touch-screen display, set of status lights, pair of test buttons (for starting and stopping tests), diskette drive (for backing up and restoring data), and power switch.



The status lights indicate the following:

- **Fail** is lit when the test has failed
- **Pass** is lit when the test has passed
- **HV** is list when a High Voltage test is being performed
- **Danger** is lit whenever there is the potential for danger, such as during any test

The second box contains the switch cards to which you attach adapters and/or products to be tested, and is where the external probe is attached.

3.2 Powering On and Off

Turn on the Fusion by using the power switch located on the front of the unit, below the diskette drive. Once the system successfully initializes, the Fusion Main Menu appears:

To turn off the Fusion, from the Main Menu, the EST mode Main Menu or the CableTest Mode Main Menu, press **Shut Down**. You will be prompted when it is safe to turn off the power switch (located at the rear of the unit).

3.3 Navigating through the Fusion Screens

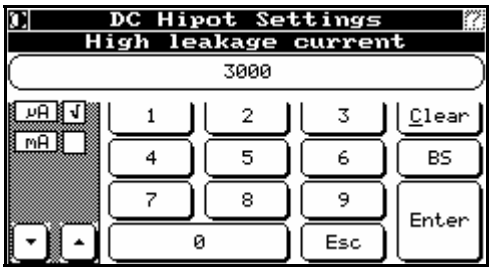
The Fusion has a touch screen that you use to operate the product.

What happens when you press a button on the touch screen varies from screen to screen, but in general, pressing a button does one of the following:

- cycles through the available options
- toggles a checkmark on and off, indicating the feature is enabled Hipot ☑ or disabled Hipot ☐
- opens a new screen

Some buttons have arrows on them, which you press (instead of the button) to increase or decrease a value. ▲ Select ▼

Screens that allow data entry offer an on-screen keyboard.



On this keyboard, watch for these special keys:

- BS is the backspace key
- Esc is the “escape” key, which usually closes the screen
- Arrow keys (on some screens) allow you to choose measurement (e.g. uA or mA)

Some screens allow you to choose items from a list. These screens offer a set of arrow buttons you use to highlight an item in the list (for example, a directory to be opened).

Up in the list

Down in the list

To top or bottom of list

Left or right in display (for example, to display a full line of information)

3.4 About the Fusion Main Menu

The Fusion *Main Menu* allows you to choose from the two Fusion modes (see section 3.5). It also allows you to change the screen contrast (see section 3.6) or shut down the Fusion (see section 3.2).

To return to the Fusion *Main Menu* from one of the modes, press the arrow key on either mode's *Main Menu*.

3.5 About the Modes

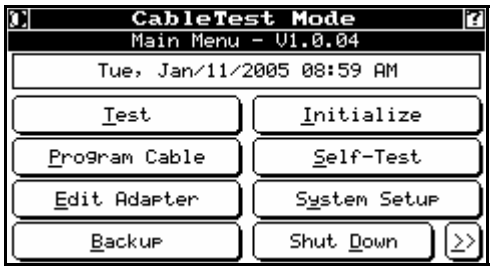
The Fusion includes two modes of operation: CableTest mode and Electrical Safety Testing (EST) mode. Both modes allow you to program and carry out product tests, but the modes differ from each other in some important ways.

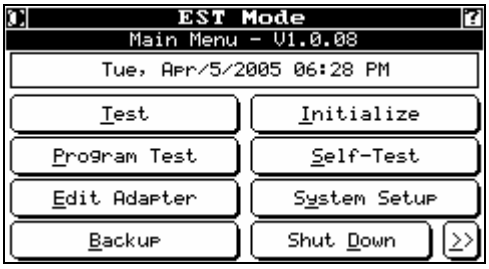
The tests performed in CableTest mode apply to the whole product, while the tests performed in EST mode apply only to a specific element (typically, a wire) in the product. For example, CableTest mode tests an entire cable, while EST mode can test just a few wires in that cable.

The test methodologies used to conduct testing are, in CableTest mode, built-in and cannot be changed. In EST mode you can use automatically-determined methodologies, or customize your own. For example, a high voltage test conducted in CableTest mode will use built-in parameters and methodologies, while the same test conducted in EST mode can run based on customized parameters.

The order of the steps involved in a test is, in CableTest mode, determined by the system. In EST mode you can choose your own order of operations. For example, a high voltage test conducted in CableTest mode will test each of the elements of the cable in an order determined by the system. The same test conducted in EST mode will perform steps in the order you specify.

In essence, if you want highly automated tests, use CableTest mode. If you want to be able to customize your tests, use EST mode.





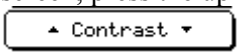
Both modes allow you to:

- Edit adaptors (see chapter 7.0)
- Back up and restore your data (see chapter 9.0)
- Initialize the system, performing a self-diagnosis of the measurement instruments
- Perform a Fusion self-test, verifying the switching system
- Set up the system for your unique needs (see chapter 4)
- Shut down the Fusion (see section 3.2)

For instructions on using CableTest mode, see chapter 5.0. For instructions on using EST mode, see chapter 6.0.

3.6 Changing Screen Contrast

If necessary, you can increase or decrease the contrast of the screen display. From the main screen, press the up or down arrows on the **Contrast** button.



3.7 Levels of Taring (Offset)

With Fusion, you can tare (CableTest mode) or offset (EST mode) at three different levels:

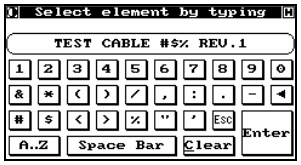
- System level (all of Fusion) — set in system settings (see section 4.0)
- Adapter level (just for a specific adapter) — set in adapter settings (see section 7.0)
- Fixture level (just for a specific product) — set in test program (see chapter 5.0 (CableTest mode) or chapter 6.0 (EST mode).

3.8 About Passwords

Password protection for all but the main menu and test-related screens can be enabled. If it is enabled, you will be prompted for a password when performing any functions other than those related to tests.

3.9 Using Fast Load

The Fast Load function lets you quickly search through long lists of directories or test file names.

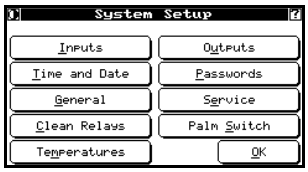


From any test screen that lists items (directories, test names, etc.), press the center of the screen to display the *Select element by typing* screen. Enter the element (directory or file) to be loaded and press **Enter**. You can enter partial names to get a list of matching items.

4 System Setup

4.1 Introduction

Each product-testing environment is unique, incorporating a different set of requirements. Many of these requirements are built around your testing philosophy and the way you have set up your production flow, and have little to do with the actual testing process. The Fusion allows you to make these decisions once for your shop (although you can change them any time the need arises). Once they are set, a password protects them so that they cannot be changed casually.



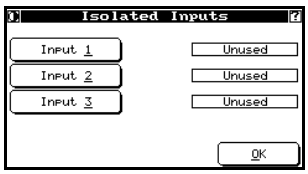
From either the EST Mode or CableTest Mode *Main Menu*, press **System Setup** to access the *System Setup* screen. Settings made in one mode apply to the other.

System Setup allows you to:

- Specify which inputs you want to use and how you want them to behave (see section 4.2)
- Set time and date (see section 4.3)
- Set general customization options, including test-related options (see section 4.4)
- Clean relays immediately (press **Clean Relays**)
- Display temperatures within the two Fusion boxes (press **Temperatures**)
- Specify which outputs you want to use (see section 4.5)
- Set and manage passwords (secure access to functions) (see section 4.6)
- Use services (such as testing the touch screen or isolation of test points) (see section 4.7)
- Set up automatic hipot testing (see section 4.8)

4.2 Inputs

The Fusion has three isolated inputs available through ports on the left side (see chapter 1). Using these isolated inputs, the Fusion can be incorporated into a PLC or automatic tester. Alternatively, these inputs can be used to implement external control. Use this function to implement these inputs.



From *System Setup* (see section 4.1), press **Inputs** to display the *Isolated Inputs* screen.

Press each of the inputs to scroll through the following options:

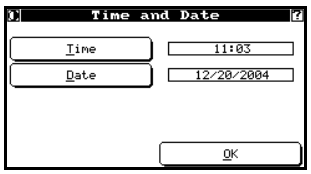
- **Unused** (default value) means the input is disabled.
- **Start Test** means to test this input. In order to start, the control line must be externally activated, usually by applying a 12VDC – 24VDC stimulus.
- **Reset Fail** means to reset this line after the product fails during a test. Reset must be done before further testing can occur. One possible use of this is to verify the test fixture setup.
- **Retest** means to perform the test again (if the product failed the first time).
- **Test Resume** means to not require operator input to resume a paused test.

Make sure that you only choose options for inputs you actually plan to use. Others should remain at the default value of Unused. Failure to set inputs properly could cause your Fusion to "hang" unexpectedly because it might be waiting for one of these inputs to be actuated.

To return to *System Setup*, press **OK**.

4.3 Time and Date

Use this function to set the Fusion's internal clock and calendar.



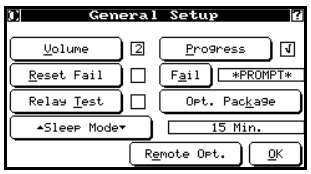
From *System Setup* (see section 4.1), press **Time and Date** to display the *Time and Date* screen.

- To enter the time, press **Time** to display the *Set Time* screen. Press the arrows and then **0..9** to show numbers on the touch screen. Enter the time of day in hh:mm format using the 24 hour clock convention. For example, 2:20 pm would be entered as 14:20. To return to *Time and Date*, press **Enter**.
- To enter the date, press **Date** to display the *Set Date* screen. Dates are entered using the mm/dd/yyyy convention/format. For example, October 16, 1997 would be entered as 10/16/1997. To display numbers on the touch screen, press the arrows and then **0..9**. To return to *Time and Date*, press **Enter**.

To return to *System Setup*, press **OK**.

4.4 General Setup Functions

Use these functions to customize the Fusion for your preferences.



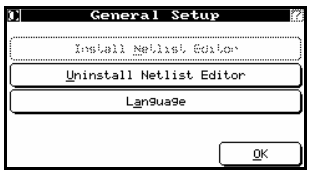
From *System Setup* (see section 4.1), press **General** to display the *General Setup* screen.

- **Volume** —set the internal speaker volume to a value from 0 (softest) to 7 (loudest).
- **Reset Fail**— choose whether, if a product fails, an acknowledgement will have to be entered before testing can proceed. The acknowledgement is the supervisor's password.
- **Relay Test** — choose whether to have the internal relays tested and cleaned as a part of self-test and before every testing session.
- **Sleep Mode** — Choose the amount of time after which, if there is no activity on the Fusion, it will go into power save mode. In this mode, the touch screen is turned off and the front panel lights flash. Simply touching the screen reactivates the system. Use the arrows to increase (up arrow) or decrease (down arrow) the interval in one minute intervals.
- **Progress** — choose whether the progress bar of the test will be displayed on the screen.
- **Fail** — choose one of the following options:
- **Abort**: If a product with multiple states (switches) has a failure, the test will abort and the product will fail.
- **Retry**: If a product with multiple states (switches) has a failure, the operator will be prompted to try the same position again until the position passes or the test is cancelled.
- **Ignore**: If a product with multiple states (switches) has a failure, the failure will be logged and testing can continue on the product.
- **Prompt**: During a test with multiple states (switches), a failure will cause the Fusion to prompt the user to choose whether to abort the test, ignore the error and continue, or retry the test.
- **Opt. Package** — Use for additional packages and language control. See section 4.4.1.
- **Remote Opt.** — Setup options for Fusion Control using RS232. See section 4.4.2.

To return to *System Setup*, press **OK**.

4.4.1 Opt. Package Settings

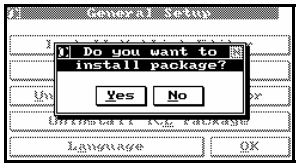
Use these functions to uninstall or reinstall the Advanced NetList Editor, or to change the language used in the interface.



From *General Setup* (see section 4.4), press **Opt. Package** to display a new screen.

4.4.1.1 Installing Advanced NetList Editor

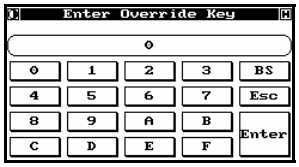
The Advanced NetList Editor is installed by default. This function is only needed if, for some reason, it was un-installed.



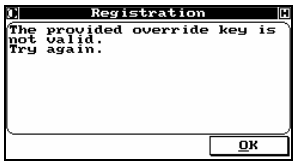
To install the Advanced NetList Editor, from the Opt. Package screen (see section 4.4.1) press **Install Netlist Editor**. You are prompted to confirm the installation.

To continue the installation, you need an override key, for which you must contact QuadTech.

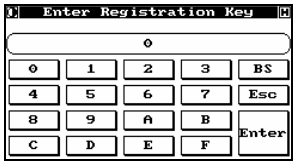
You must provide the unit's serial number as well as the Uninstall Verification Key you recorded when uninstalling the editor (see section 4.4.1.2).



Enter the override key provided by the factory.



If there is an error when entering the override key, this message appears. Press **OK** and try again. If the message persists, call the Fusion Technical Support.

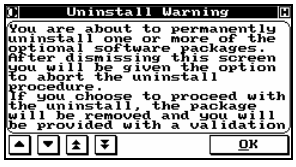


Enter the registration key provided at the time of purchase.

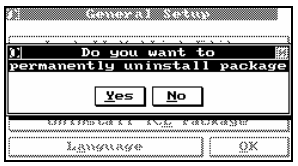
If there was an error when entering the registration key, this message appears. Press **OK** and try again. If the message persists, call the Fusion Technical Support.

4.4.1.2 Uninstall Advanced NetList Editor

The Advanced NetList Editor is installed by default. This function is only needed if, for some reason, you want to uninstall this feature.



To un-install the Advanced NetList Editor, from the Opt. Package screen (see section 4.4.1) press **Uninstall Netlist Editor**. A warning message appears, which you should read carefully. Use the up and down arrows to scroll through the warning message and press **OK** to continue.



When prompted to confirm:

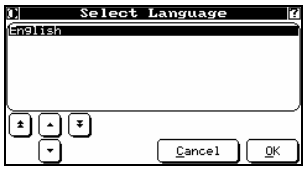
- to permanently uninstall the Editor, press **Yes**
- to abort the uninstall process, press **No**.

Write down the displayed validation key. Fusion support will require this key if the Editor is re-installed.

To return to the Opt. Package screen, press **Enter**.

4.4.1.3 Default Language

This function is for future implementation (currently only English is supported). When implemented, it will allow you to choose a different language for the operator's screens (the main menus and screens within the Test operation).

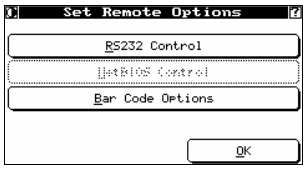


From the Opt. Package screen (see section 4.4.1), press **Language**. A list of available languages appears.

The selected language will only change the operator's screens. All other screens will remain in English.

4.4.2 Remote Opt. Settings

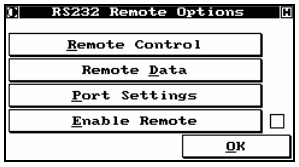
Use these functions to set up external/remote control of the Fusion.



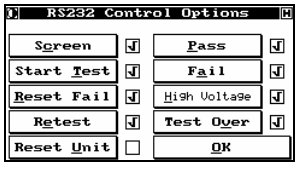
From *General Setup* (see section 4.4), press **Remote Opt.** to display the *Set Remote Options* screen.

NetBIOS is currently unavailable.

4.4.2.1 RS232 Control



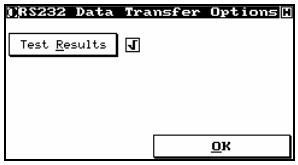
From *Set Remote Options* (see section 4.4.2), press **RS232 Control** to display the *RS232 Remote Options* screen.



Press **Remote Control** to display the *RS232 Control Options* screen. The individual options enable/disable the following functions:

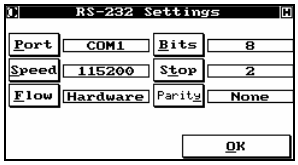
- **Screen:** Controls the *ClickButton* and *TypeButton* commands.
- **Start Test:** Controls the *StartTestON* and *StartTestOff* commands.
- **Reset Fail:** Controls the *ResetFailOn* and *ResetFailOff* commands.
- **Retest:** Controls the *RetestOn* and *RetestOff* commands.
- **Reset Unit:** Controls the *ResetUnitON* and *ResetUnitOff* commands. The reset unit command family requires additional conditions to be enabled.
- **Pass:** Controls the *PassOn* and *PassOff* commands.
- **Fail:** Controls the *FailOn* and *FailOff* commands.
- **High Voltage:** Controls the *HighVoltageOn* and *HighVoltageOff* commands.
- **Test Over:** Controls the *TestOverOn* and *TestOverOff* commands.
- **Test Resume:** Controls the *TestResumeOn* and *TestResumeOff* commands.
- **Test Pause:** Controls the *TestPauseOn* and *TestPauseOff* commands.

To return to *RS232 Remote Options*, press **OK**.



Press **Remote Data** to display the *RS232 Data Transfer Options* screen. Use the **Test Results** option to specify if results are to be returned to the Host PC at the end of a test.

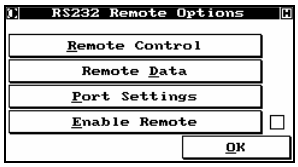
To return to *RS232 Remote Options*, press **OK**.



Press **Port Settings** to display the *RS-232 Settings* screen. Press each button to scroll through its available options.

- **Port:** Choose either COM1 or COM2.
- **Speed**: Choose 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200.
- **Flow**: Choose Hardware (only option).
- **Bits:** Although words of 5, 6, 7 and 8 bits are theoretically supported, only 8 bits is supported at this time.
- **Stop:** Choose 1 or 2 stop bits.
- **Parity**: Choose None, Even, Odd, Zero or One

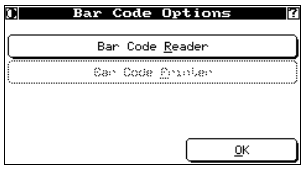
To return to *RS232 Remote Options*, press **OK**.



Press **Enable Remote** to enable or disable the remote function.

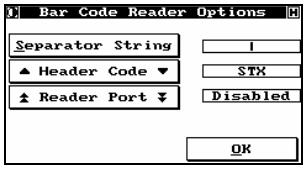
To return to *Set Remote Options*, press **OK**.

4.4.2.2 Bar Code Options



From *Set Remote Options* (see section 4.4.2), press **Bar Code Options**. The *Bar Code Options* screen appears.

Press **Bar Code Reader** (the Bar Code Printer function is for future implementation).

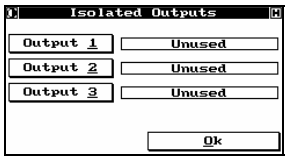


Set:

- **Separator String** (test name separator).
- **Header Code** (barcode reader programmed prefix).
- **Reader Port** (only Keyboard emulators are supported at this time).

4.5 Outputs

The Fusion has three contact closures that are tied to specific internal events and are made available at the port on the side of the box (see chapter 1). As with the inputs, these are designed for use in setting up external indicators, or for incorporating the Fusion into an automatic system.



From *System Setup* (see section 4.1), press **Outputs** to display the *Isolated Outputs* screen. Press each button to cycle through the possible settings for each output:

- **Unused:** None of the outputs are active.
- **Pass:** The product passed all required tests.
- **Fail:** The product failed one or more required tests.
- **HV On:** The high voltage power supply is active.
- **Test Over:** The testing cycle is completed.
- **Test Pause:** The test pauses for operator input.

To return to *System Setup*, press **OK**.

4.6 Passwords

4.6.1 Working with Passwords

The Fusion offers password-protection to restrict access to specific functions, preventing untrained or unauthorized people from inadvertently modifying test programs or vital system parameters. If password protection is enabled, users need a password to access all but the main menu and the test-related screens and password-protected functions are identified by a small key icon on their buttons on the *Main Menu*.

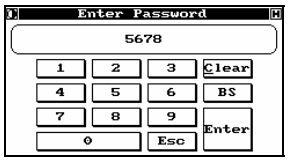
From *System Setup* (see section 4.1), press **Passwords** to display the *Password Settings* screen.

The default password is 1234. It is highly recommended that you change this as soon as you put the Fusion into use on your production floor, if you are using passwords.

To delete a password, highlight it and press **Delete**.

Make sure that you do not delete all passwords. Always leave at least one password active or you will be locked out of password-protected functions.

4.6.2 Adding Passwords



To add a new password, from *Password Settings* (see section 4.6.1), press **Add** to display the *Enter Password* screen. Input a password of four numbers (from 1000 – 9999). Make sure that you either memorize it, or write it down and put it in a safe place. Press **Enter** to display the *Enter Password Type* screen.

Press the type you want for this password (passwords of all types provide the same level of access to Fusion) and the *Password Settings* screen reappears.

Repeat these steps as necessary to set up all the passwords you want. When you are finished, press **OK** to return to *System Setup*.

4.6.3 Disabling Passwords

You can disable password protection, if desired.

To disable password protection, from *Password Settings* (see section 4.6.1), press **Enable** to toggle between enabled and disabled.

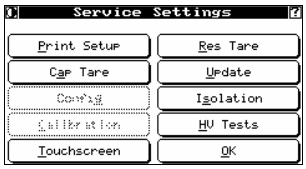
When passwords are disabled, the key symbol is no longer displayed on any of the buttons on the *Main Screen*.

It doesn't matter what password is highlighted when you press **Enable**: the function applies to the whole password-protection scheme, not just the highlighted password.

Press **OK** to return to *System Setup*.

4.7 Service

These functions allow you to perform basic service and maintenance.



From *System Setup* (see section 4.1), press **Service** to display the *Service Settings* screen.

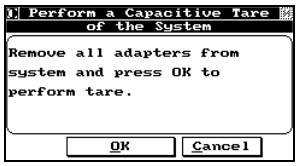
Make certain no Fusion adapters or interface materials are connected to the system.

The **Config** option is reserved for service personnel. Calibration is for future implementation.

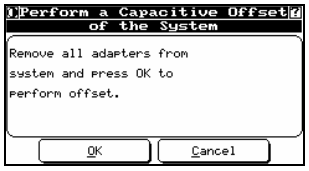
Press **OK** to return to *System Setup*.

4.7.1 Basic Functions

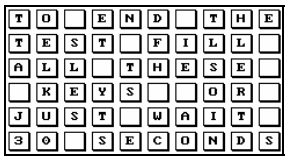
- To print all your system setup settings to the printer attached to the Fusion's LPT port (see chapter 1), from *Service Settings* (see section 4.7), press **Print Setup**.



- For CableTest mode, to tare out the capacitance of the installed switching modules on the Fusion, from *Service Settings* (see section 4.7), press **Cap Tare**. This must be done if cards are changed.



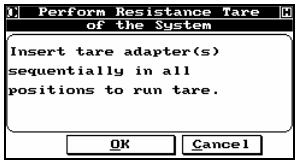
- For EST mode, to offset the capacitance of the installed switching modules on the Fusion, from *Service Settings* (see section 4.7), press **Cap Offset**. This must be done if cards are changed.



- To test each of the possible touch screen positions to make sure they are working correctly, from *Service Settings* (see section 4.7), press **Touchscreen**. A touchscreen display appears.

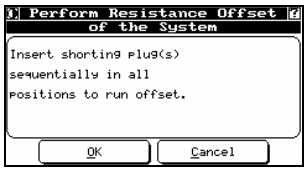
  Touch each of the displayed positions in turn. As you touch it, it goes dark.

  If you have a bad position, or if you wait more than 30 seconds between button pushes, an error message appears. Press the screen to return to *Service Settings*.



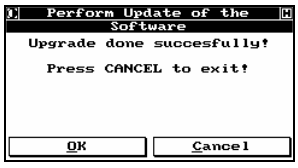
- For CableTest mode, to tare out the resistance of the installed switching modules on the Fusion, from *Service Settings* (see section 4.7), press **Res Tare**. This must be done if cards are changed.

To perform the Resistance Tare, you must have a Positron shorting plug. Contact your sales representative for more details.



- For EST mode, to offset the resistance of the installed switching modules on the Fusion, from *Service Settings* (see section 4.7), press **Res Offset**. This must be done if cards are changed.

To perform the Resistance Offset, you must have a Positron shorting plug. Contact your sales representative for more details.

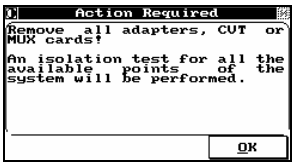


- To update Fusion client software, from *Service Settings* (see section 4.7), press **Update**. You are prompted to confirm. Insert the first of the provided diskettes (labelled 1 of n) and press **OK**.

Once complete, press **Cancel**.

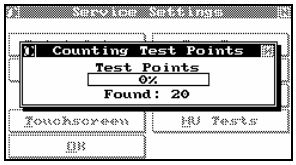
If your system is operating through a network, the update only affects the machine where the Update function was run. You will need to update the files located on the network server manually, or run Update from the network server machine, to have updates apply to all systems in the network.

4.7.2 Testing Isolation



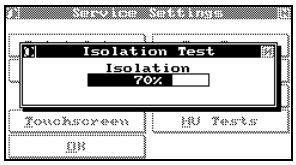
To test the isolation of all installed test points in your Fusion, from *Service Settings* (see section 4.7), press **Isolation**.

Remove all adaptors and products from the Fusion and press **OK**.

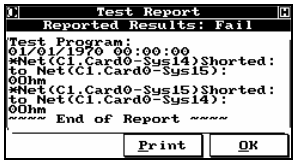


The Fusion learns the number of available test points.

The isolation resistance between points is verified at a default level of 100kΩ. Change this level if desired and press **Enter** to continue.



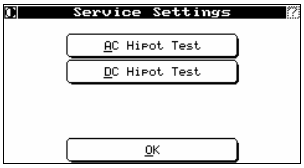
Switchcard isolation is verified.



If a fault is found, the *Test Report* window lists the points that failed.

To return to *Service Settings*, press **OK**.

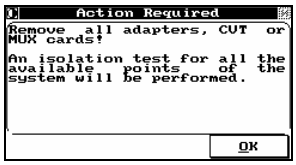
4.7.3 Setting HV Test Defaults



If you suspect a faulty Hipot or High Current Source during testing, use this feature. From *Service Settings* (see section 4.7), press **HV Tests**. A new screen appears.

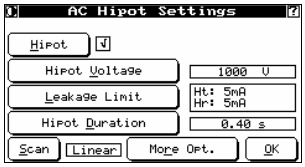
This option will only be enabled if a Hipot is installed in the Fusion.

4.7.3.1 High Voltage Sources: AC Hipot Test

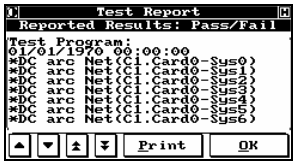


From the HV tests settings screen (see 4.7.3), press **AC Hipot Test**. You are prompted to remove all adapters or products for the Fusion.

You are prompted for the minimum resistance to be used by the safety isolation test.



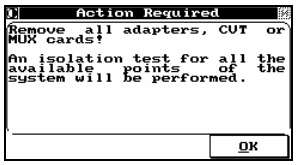
A safety isolation test is done. If the isolation test passes, the *AC Hipot Settings* screen appears. For instructions on using this screen, see section 5.5.3.



To carry out the test, from the HV Tests screen (see 4.7.3), press **OK**.

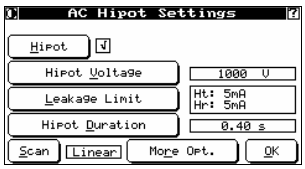
You are prompted to confirm that you want to perform test. During the test, details are shown. If the test fails, contact the Fusion Technical Support

4.7.3.2 High Voltage Sources: DC Hipot Test

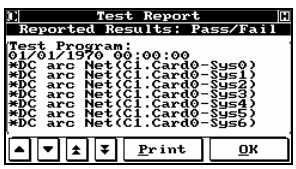


From the HV Tests settings screen (see 4.7.3), press **DC Hipot Test**: You are prompted to remove all adapters or products.

You are prompted for the minimum resistance to be used by the safety isolation test.



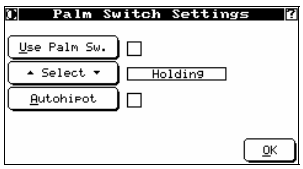
A safety isolation test is done. If the isolation test passes, the DC Hipot Settings screen appears. For instructions on this screen, see section 5.5.2.



To carry out the test, from the HV Tests screen (see 4.7.3), press **OK**.

You are prompted to confirm that you want to perform test. During the test, details are shown. If the test fails, contact the Fusion Technical Support.

4.8 AutoHipot



From *System Setup* (see section 4.1), press **Palm Switch**. The *Palm Switch Settings* screen appears:

- To choose whether hipot testing should start automatically as soon as the product has passed all of the low voltage tests, press **Autohipot**.

Enabling **Autohipot** will cause hipot testing to start automatically as soon as the product has passed all of the low voltage tests – caution should be taken to prevent shock.

Hipot tests will not be performed if any low voltage test fails, regardless of these settings.

Palm switches are reserved for future implementation..

To return to *Service Settings*, press **OK**.

5 Programming and Testing in CableTest Mode

5.1 Introduction

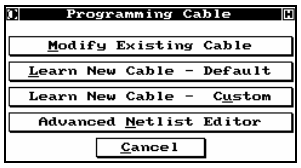
5.1.1 Choosing a Mode

Section 0 explains the difference between the two modes. In essence, if you want highly automated tests, use CableTest mode. If you want to be able to customize your tests, use EST mode.

5.1.2 Choosing a Programming Method

CableTest lets you develop test programs in two main ways: the default method and the custom method. The default method produces results appropriate for most applications (quickly determining whether or not the product has any shorts or opens, or if any wires are connected to the wrong pins, and providing information such as the location of the fault to the operator. The custom method lets you handle special needs such as twisted pair, Kelvin measurement probing and free ends.

Both methods are accessed from the Programming Cable screen:



From the *CableTest Main Menu*, press **Program Cable** to display the *Programming Cable* screen.

- Modify Existing Cable: lets you expand an existing test program with specific test parameters (see section 5.1.4)
- Learn New Cable – Default: lets you quickly develop a basic test
- Learn New Cable – Custom: lets you develop a more complex test (see section 5.2.2.2)
- Advanced Netlist Editor – lets you modify an existing test program using an advanced NetList editor (see section 5.2.5.2)

Some functions may be password-protected. The factory-installed password is “1234”.

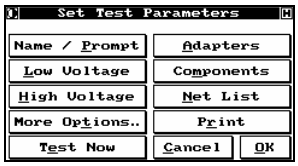
5.1.3 Overview of Steps

The key steps in programming and testing a product are:

1. Add the adapter being used for the product to the adapter library if necessary (see section 5.2).
2. If using the custom method, set the basic test conditions and settings for component-specific testing (see section 5.6.1).
3. “Learn” a known good product to create the test program (see section 5.2.2).
4. Optionally, change test parameters to further refine the test (see section 5.2.4).
5. Test a product using the test program (see section 5.2.2.2).

5.1.4 About Test Parameters

When you learn a new product, you create a basic test program based on that product. This test program lets you perform standard tests. However, the Fusion also allows capabilities such as generating an in-depth capacitance and resistance profile of your product, performing AC or DC Hipot testing, and testing for/with embedded components. It also allows you to perform each or all of these tests on selected nets. These functions are performed from the *Set Test Parameters* screen, which appears when you learn a new product (thereby creating a test program) or modify an existing test program.



The functions on this screen are described throughout this manual:

- Name/Prompt: used to change the test's name and assign an operator prompt to a test (see 5.2.4.2)
- Low Voltage: used to set thresholds for low voltage tests (see section 5.3)
- High Voltage: used to perform DC Hipot tests (see section 5.5.2)
- More Options: used to prevent runaway tests (see section 5.2.4.1)
- Test Now: used to carry out tests based on parameters that have been set, but not necessarily saved (see section 5.2.2.2)
- Adapters: used to add or modify adapters (see section 5.2)
- Components: used for advanced programming (see section 5.6)
- Net List: used to change labels in NetLists (see section 5.2.5.1)
- Print: used to print the NetList of the current test.

5.2 General Instructions

5.2.1 Adding an Adapter

The Fusion includes an adapter library containing a single adapter, called "no adapter", which tests all the points. For most purposes, you will want to add the adapter used for your product to the Fusion adapter library. You add an adapter by learning it, much as you will learn a cable.

On the *CableTest Main Menu*, press **Edit Adapter** to display the *Adapter Library* screen.

Press **Learn New Adapter**.

A series of screens prompts you for:

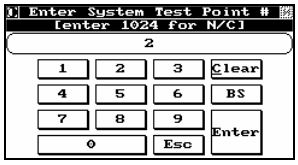
- Name for the adapter.
- Number of connectors mounted on your adapter.
- Name of each connector (it is recommended that you base the name on some easily identifiable feature of the connector, such as its type, color, manufacturer's part number, etc.).
- Number of pins.

The *Edit Connector's Netlist* screen appears.

You now need to map the Fusion's internal pin/switch designators to the connector pin number.

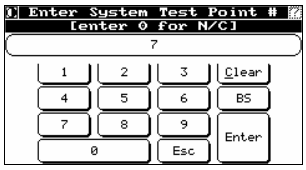
The **Kelvin** toggle is provided for use with Kelvin adapters

Using the provided ground probe, touch the tip to each connector pin in its standard numbering sequence. The Fusion maps the connector pin to its corresponding system pin and displays a pin map similar to the one shown above. The "Sense" column is reserved for the special case, Kelvin adapters (see section 7.4).



The Fusion lets you define the numbering convention needed for your adapter (see section 7.3) or you can edit each individual connector pin name by highlighting the pin and pressing **Edit**. You can also use the edit function to manually enter system pins or define a point as NC (not connected).

To edit a pin, highlight its **Conn. Pin** and press **Edit** to display the *Enter System Test Point #* screen.



Enter the associated system pin number and press **Enter.** Enter 0 for N/C (not connected) pins.

If the Kelvin toggle is enabled, pressing **Edit** will prompt you to enter values for both the Sys. Pin and Sense pins. If your adapter is not a Kelvin adapter, the default 0 (NC) should be present in the Sense column. With Kelvin disabled you are prompted only for the Sys. Pin value. Kelvin requires odd and even consecutive pairs (for example, 7, 8).For more about Kelvin adapters, see section 7.4.

To continue, press **Enter** to display the *Edit Pin's Name* screen.

Enter a new name for the pin and press **Enter**.

The option to name pins at this level is limited since no lower case letters are available. To properly set a numbering convention you should use the conventions features described in section 7.3.

Repeat the above steps for any and all remaining connectors.

To print the completed pin map, press **Print**.

After you have programmed all the connectors, press **OK** to display the *Edit Adapter* screen.

From *Edit Adapter*, you can edit any of the adapter's properties. See section 0 for details.

- **Label** – enter a label for the adapter.
- **Connectors** – edit connector names and pin mapping of an adapter, as described above.
- **Cap Tare** – For increased capacitance measurement accuracy, the capacitance of the adapter may be learned and utilized as a tare value. Pressing this button takes you through the steps of learning the capacitive tare.
- **Res Tare** – For increased resistance measurement accuracy, the resistance of an adapter can by learned and utilized as a tare value. In order to perform this function, you must short all points together that are contained on each connector. Pressing this button takes you through the steps of learning the resistance tare.

To tare a connector you must have a minimum of three (3) test points.

For more information on working with the adapters in the adapter library, see chapter 0.

Adapter as ADP File

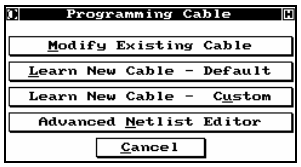
\datab\adapters\special.adp For syntax information, see chapter 0

```
*ADAPTER*,SPECIAL
*CONNECTOR*,DB9 #1,
12,1,,,,
11,2,,,,
10,3,,,,
9,4,,,,
8,5,,,,
13,6,,,,
14,7,,,,
15,8,,,,
0,9,,,,
*CONNECTOR*,DB9 #2,
7,1,,,,
5,2,,,,
1,3,,,,
2,4,,,,
3,5,,,,
6,6,,,,
4,7,,,,
28,8,,,,
24,9,,,,
```

5.2.2 Learning the Product

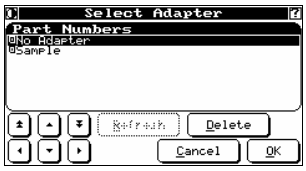
We refer to the process of programming the Fusion to test a product as “learning” the product, since this is almost literally what you do. Starting with a known good, or “golden”, product, you are guided through a series of simple steps during which a parametric profile is made of the product. The resulting test program is then stored as a simple ASCII file. After that, any time you want to test an identical product, the parameters are loaded from the file and used as the basis for the test.

5.2.2.1 Default Method

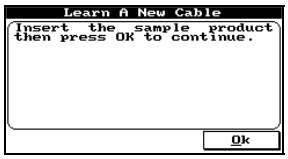


On the *CableTest Main Menu*, press **Program Cable** to display the *Programming Cable* screen.

Press **Learn New Cable – Default** to display the *Select Adapter* screen.

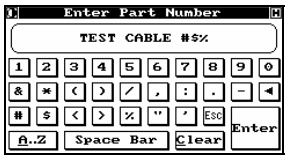


Choose the appropriate adapter.



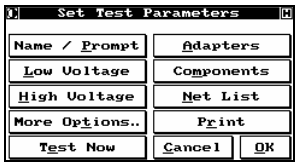
Insert your "golden" product and press **OK** to begin the learning process.

As the Fusion learns your product, a status screen keeps you informed about its progress. The NetList for the product is learned and stored in a file.



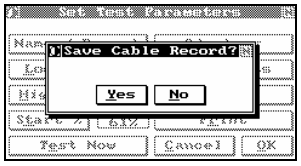
After the NetList has been learned, you are asked to enter a test name to be used to label this product's test record. You can use any combination of up to 32 alpha and numeric characters as well as other valid ASCII symbols, such as parentheses, *, &, ^, etc., for your test name.

Press **Enter** to display the *Set Test Parameters* screen.



At this point, you have a test program that will test all standard low voltage tests (shorts, opens, and mis-wires). You do not need to specify anything else. However, the Fusion has significantly greater capabilities as well. For an overview of these different test parameters, see section 5.1.4.

Press **Net List** to view the resulting NetList. See section 5.2.5.



Press **OK** and the *Save Cable Record* screen appears. Press **Yes** to save your test program and display the *Open Directory* screen.

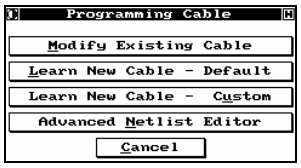
Highlight the directory in which you want to save the test program, then press **OK**. The test program is saved, and you are returned to the *Programming Cable* screen. (If you want to store your test program in a new directory, press **New**, and you are prompted to enter the new name. Press **Enter** when done.) You can use any combination of up to 32 characters for directory or test program names.

You can continue the learning process and program as many products as you like by simply repeating these steps. When you have finished, press **Cancel** to return to the *Main Menu*.

Test Program as CBL File

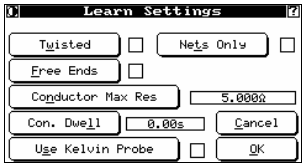
```
\datab\cables\main\testcabl.cbl      For syntax information, see chapter 0.

*CABLE*,TEST CABLE #$%,1
*STAR*
 *THRESHOLD*,61
 *ADAPTER*,HA 116,
  *POSITION*,J1
 *ADAPTER*,HA 116,
  *POSITION*,J3
 *NET*,,
  J1.C1.1,,
  J3.C1.1,,
 *NET*,,
  J1.C1.2,,
  J3.C1.2,,
 *NET*,,
  J1.C1.3,,
  J3.C1.3,,
 *NET*,,
  J1.C1.4,,
  J3.C1.4,,
 *NET*,,
  J1.C1.5,,
  J3.C1.5,,
 *NET*,,
  J1.C1.6,,
  J3.C1.6,,
 *NET*,,
  J1.C1.7,,
  J3.C1.7,,
 *NET*,,
  J1.C1.8,,
  J3.C1.8,,
 *NET*,,
  J1.C1.9,,
  J3.C1.9,,
 *NET*,,
  J1.C1.10,,
  J3.C1.10,,
 *NET*,,
  J1.C1.11,,
  J3.C1.11,,
 *NET*,,
  J1.C1.12,,
  J3.C1.12,,
 *NET*,,
  J1.C1.13,,
  J3.C1.13,,
 *NET*,,
  J1.C1.14,,
  J3.C1.14,,
 *NET*,,
  J1.C1.15,,
  J3.C1.15,,
 *NET*,,
  J1.C1.16,,
  J3.C1.16,,
 *NET*,,
  J1.C1.17,,
  J3.C1.17,,
 *NET*,,
  J1.C1.18,,
  J3.C1.18,,
 *NET*,,
  J1.C1.19,,
  J3.C1.19,,
 *NET*,,
  J1.C1.20,,
  J3.C1.20,,
 *NET*,,
  J1.C1.21,,
  J3.C1.21,,
 *NET*,,
  J1.C1.22,,
  J3.C1.22,,
 *NET*,,
  J1.C1.23,,
  J3.C1.23,,
 *NET*,,
  J1.C1.24,,
  J3.C1.24,,
 *NET*,,
  J1.C1.25,,
  J3.C1.25,,
*END*
```

5.2.2.2 Custom Method



On the *CableTest Main Menu*, press **Program Cable** to display the *Programming Cable* screen.

Press **Learn New Cable – Custom** to display the *Learn Settings* screen.

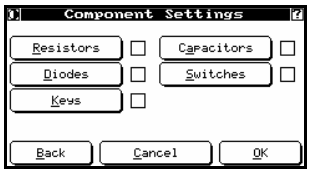


From here you can program or set up a number of test conditions:

- **Twisted**: Enable to have the Fusion detect and test products with twisted pairs. You are prompted for threshold capacitance. See section 5.7.2.
- **Nets Only:** Enable to confine the programmed testing process to complete, multi-point nets. Single point nets, any test points not connected, and free ends/flying leads are ignored.
- **Free Ends:** Enable to have the Fusion test products with non-continuous conductors. Using the standard probe or the digital hand-held probe, you can test products that do not terminate to a connector for continuity. See section 5.7.1.
- **Conductor Max Res.**: Maximum conductor resistance is automatically set to a default value, which you can change if necessary when looking for low ohm resistors or learning a Kelvin fixture. You are prompted for the resistance value.
- **Con. Dwell:** A programmable dwell to lengthen the time the source is held on each net during the learning cycle. This option may improve learning accuracy on very long products. You are prompted to enter a dwell time.
- **Use Kelvin Probe:** Enable to create a probe using two test points for accurate resistance measurements of free end products. The probe is created as an adapter in the adapter library. If you choose this option, you are prompted to select the points where the Kelvin probe is plugged in.

ⓘ Kelvin requires odd and even consecutive pairs (for example, 7, 8).

When these parameters are set appropriately, press **OK** to display the *Component Settings* screen.

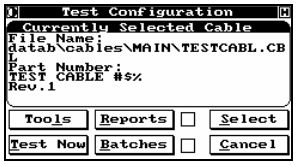


The Fusion will help you detect and program any one or all of the listed embedded components.

The results of choosing each component vary, as explained elsewhere in this chapter. However, the learning process is the same for all components, and identical to that for the default method (see section 5.2.2.1). If you develop a component test, be sure to verify the results by pressing **Components** from the Set Test Parameters screen.

5.2.3 Testing a Product

Note that this function cannot be password-protected since it is a "run-only" function; system and/or test parameters cannot be modified, added or deleted.



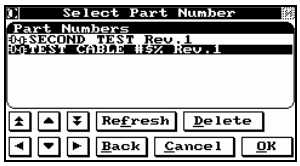
On the *CableTest Main Menu*, press **Test** to display the *Test Configuration* screen.

The screen shows the directory location and test name for the product you just learned or the last test run (whichever happened more recently).

If this screen shows the test you want to run, press **Test Now**; otherwise, you can choose the appropriate test by following the instructions below.

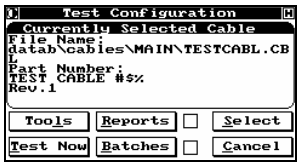
- For information on the Tools function, see section 5.3.2.1.
- For information on the Reports function, see section 8.1.
- For information on the Batches function, see section 8.2.

Press **Select** to display the *Open Directory* screen. Highlight the desired directory and press **Open** to see a list of test names contained in that directory. To quickly find a specific directory, use the Fast Load function described in section 3.9.



Highlight the test name to be tested and press **OK** or, alternatively, use the Fast Load feature described in section 3.9.

- **Refresh** re-loads the directory.
- **Delete** removes highlighted test name from directory.
- **Back** returns you to the *Open Directory* screen.
- **Cancel** returns you to the *Test Configuration* screen.

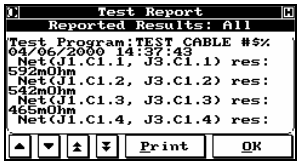


The appropriate test name is now displayed as the *Currently Selected Cable*. Press **Test Now** to start the testing process.

The information for the selected test program is loaded and you are prompted to start the test. Press the Start button on the front of the Fusion.

During the test, the blue "danger" light is lit. If your product passes, the green "pass" light is lit at the end of the test. If it fails, the red "fail" light is lit at the end of the test.

Once the test is complete, if you have set up reports to be printed automatically (see section 8.1.3), they will be sent to the printer.



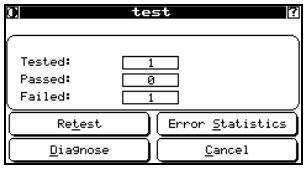
If you enabled the Auto Diagnose option (see section 8.1.3), the Test Report screen appears, showing information on the most recent test. Each time you press the *Test Report* screen you see a different type of display, until you have scrolled through all of them. The choices are:

- None (no results are displayed)
- Fail (shows only failed results)
- Pass (shows only pass results)
- Pass/fail (if the test passed, shows only a statement to that effect; if the test failed, shows details)

Changing the display on-screen also changes it in the test reports setting screen (see section 5.2.3).

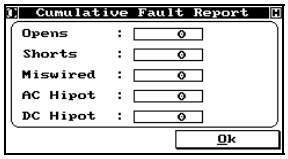
To print an individual test report display, press **Print**.

Press **OK** to display the test summary screen, which appears automatically if you have not enabled Auto Diagnose.



This screen shows the number of products tested, passed and failed.

- To re-test the same product with the same test program, press **Retest**. The number of products tested will not increment.
- To test a new product with the same test program, attach the new product and press the Start button again.
- To display the Test Report screen (see above), press **Diagnose**.
- To view a report of the faults found in all tests done during this session, press **Error Statistics** to display the Cumulative Fault Report screen.
- To stop using this test program, press **Cancel**.

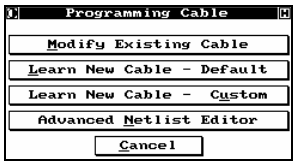


In the example shown, only one test has been performed, and it was good, so the report shows all 0's.

You can also test a program by pressing **Test Now** from *Set Test Parameters* (see section 5.1.4).

5.2.4 Modifying a Test Program

You can modify an existing test program at any time.

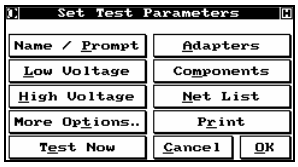


On the *CableTest Main Menu*, press **Program Cable** to display the *Programming Cable* screen.

Press **Modify Existing Cable**.

Highlight the directory and test program you wish to modify and press **OK** or, alternatively, use the Fast Load feature described in section 3.9.

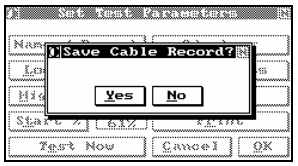
The test program is loaded.



The *Set Test Parameters* screen appears. Make changes to the parameters as necessary (see section 5.1.4 for an overview of the different parameters and where they are described).

Press **Test Now** to test any changes you made to the test program. Changes will be applied, but not saved.

Once you are satisfied with the modifications, press **OK**.

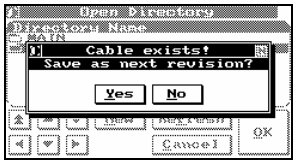


You are prompted to choose whether to save your changes.

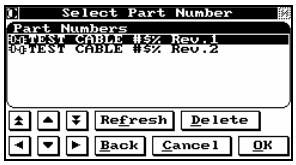
Press **Yes** to continue.

Highlight a directory to save the file in or press **New** to create a new directory.

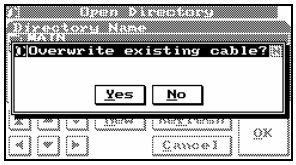
Press **OK** to continue.



If you are saving the file into the same directory it was originally stored in, you can save the file as a next revision or overwrite the existing file.



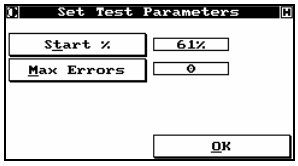
- If you create a next revision, a new record is created with the same test name and an incremented revision number.



- If you do not create a next revision, you are prompted whether you wish to overwrite the existing file.

5.2.4.1 Preventing Runaway Tests: Max Errors

The Fusion's determination to discover all faults in a product can sometimes create long test times while all the faults are diagnosed. One way to prevent this is to specify the number of errors the Fusion should find before aborting the test sequence and failing the product.



To enable this feature, from the *Set Test Parameters* screen (see section 5.1.4) press **More Options → Max Errors**.

Enter the number of maximum number of errors and press **OK** to continue.

5.2.4.2 Changing Test Program Name and Assigning Prompts

From the *Set Test Parameters* screen (see section 5.1.4) press **Name/Prompt**.

Enter the new name for the test program and press **Enter**.

Enter the first line of text that should appear as a prompt for the operator (for example, this could be used as a reminder for specific tasks related to a test).

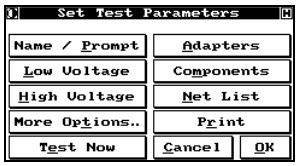
Press **Enter**. The screen re-appears, allowing you to enter a second prompt line. Continue to add lines until complete, then press **Esc** to return to *Set Test Parameters*.

5.2.5 Working with NetLists

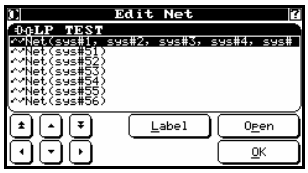
With Fusion, you can edit the labels of nets and their pins in the NetList. If you have a VGA monitor and AT keyboard attached to Fusion, you can use the advanced NetList Editor to actually modify the contents of the NetList.

See chapter 0 for details on NetList syntax and options.

5.2.5.1 Viewing NetLists and Changing Labels

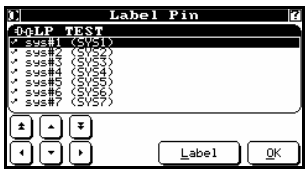


From the *Set Test Parameters* screen (see section 5.1.4), press **Net List** to display the *Edit Net* screen.



To change the label of a net, highlight it and press **Label**. You are prompted for the new label.

To open a net, highlight it and press **Open** to display the *Label Pin* screen.

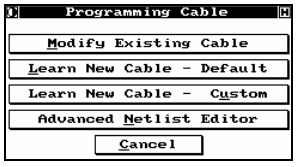


To change the label of a pin, highlight it and press Label. You are prompted for the new label.

Press **OK** to return to *Edit Net*, and **OK** again to return to *Set Test Parameters*.

5.2.5.2 Advanced NetList Editor (Optional)

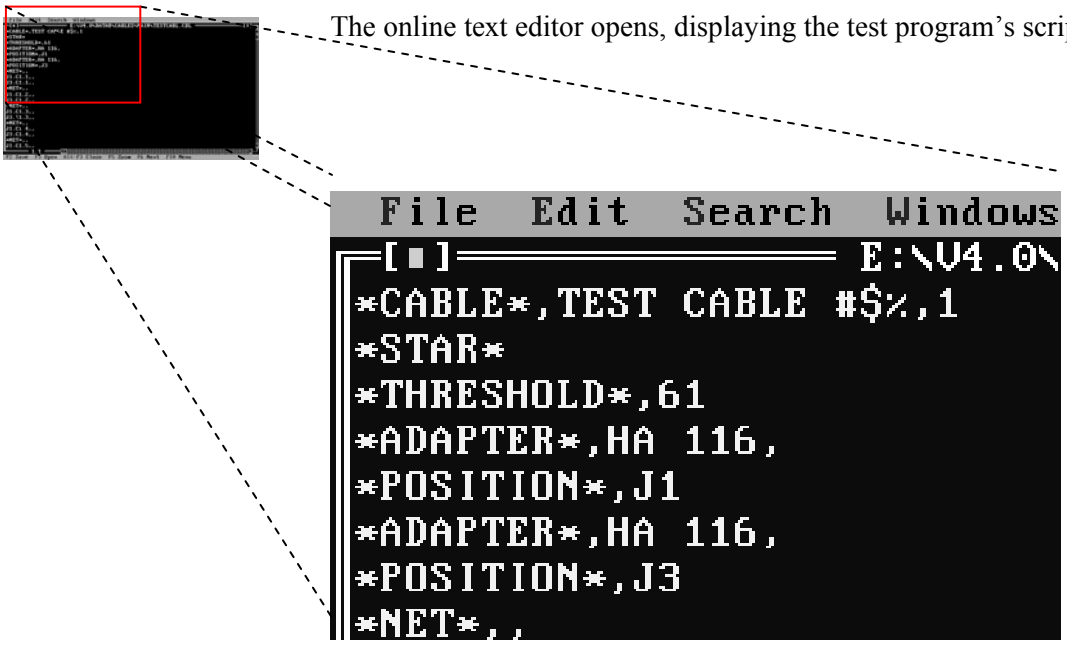
An available option for the Fusion is an onboard script editor. To edit a script from the Fusion you need to have a VGA monitor and an AT keyboard attached to the system.



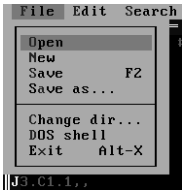
On the *CableTest Main Menu*, press **Program Cable** to display the *Programming Cable* screen or **Edit Adapter** to display the *Programming Adapter* screen

Press **Advanced Netlist Editor** to open the text editor.

Open the desired directory and select the product you wish to edit. Press **OK**.



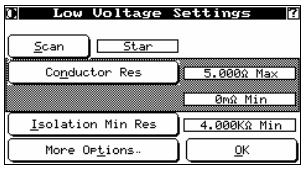
The online text editor opens, displaying the test program's script.



Once you have edited the file as necessary, press **<Alt-F>** to pull down the File menu, then **<S>** or **<F2>** to save and **<Alt-X>** to exit and return to *Programming Cable*.

5.3 Low Voltage Tests

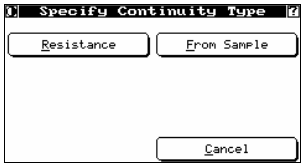
5.3.1 Low Voltage Testing Options



Open *Set Test Parameters* for the test you want to modify (see section 5.1.4) and press **Low Voltage** to display the *Low Voltage Settings* screen.

To enter a measured value for the Isolation test, press **Isolation Min Res**.

Enter the minimum resistance measurement for the Isolation test in kΩ and press **Enter**.



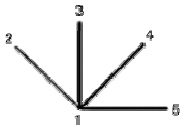
To enter a measured value for the Continuity measurement, press **Conductor Res** and choose the desired continuity type.

- To enter the resistance, press **Resistance** and enter the maximum and then minimum values (the ideal minimum is 0Ω).
- To load the resistance from a sample, press **From Sample.** The MSR is used to measure the maximum resistance, which is displayed to you. You are then prompted to set the maximum and minimum conductor resistance.

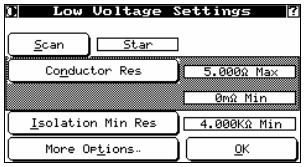
Measurements higher than the maximum value entered will be considered opens. If your test requires a minimum conductor resistance and the test measures lower than the threshold value, the fault will be reported as "wrong gauge".

5.3.1.1 Star or Chain Scan

The Fusion provides two methods for continuity scanning: star and chain. The default method is the **Star** scan. The star scanning method selects the first point in a net and measures continuity from that point to all other points.



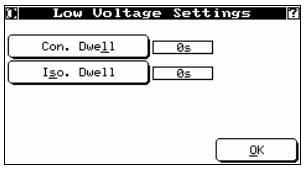
The second method is the **Chain** scan. The chain scanning method selects the first point in a net and measures continuity to the second point in a net. Next, the second point is selected and continuity is measured to the third, etc



From *Low Voltage Settings* (see section 5.3), press **Scan** to toggle between the two scan options.

5.3.1.2 Improving Accuracy with High Capacitive Loads (Long Cables)

In order to improve measurement accuracy it may be beneficial to add a delay to continuity or isolation measurements. .



From *Low Voltage Settings* (see section 5.3). press **More Options** to display a new screen.

To add a delay to the continuity measurement, press **Con. Dwell**.

To add a delay to the isolation measurement, press **Iso. Dwell**.

5.3.2 Low Voltage Testing Examples

5.3.2.1 Opens

Common errors or faults reported by the Fusion for a cable during a low voltage test are opens, shorts, and miswiring faults. Should the low voltage test fail, before removing the product from the adapters, pressing **Diagnose** will report the cause of the cable failing.

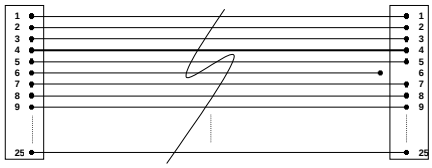
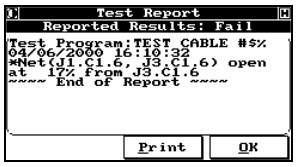


Figure 4-1: PUT with Open J3.C1.6



The first example is an open connection. The Fusion reports that the cause of the fail condition is an open connection located at pin 6 of the first connector on the adapter mounted in the J3 position. Note that the fault is at the adapter level.

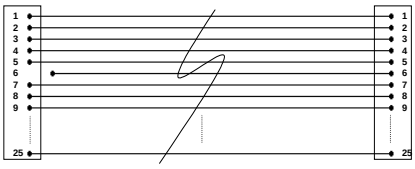
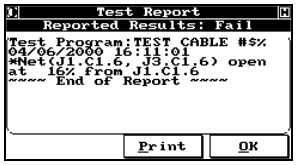


Figure 4-2: PUT with Open J1.C1.6



Reversing the cable with the open connection and re-testing it reveals the Fusion's ability to locate the position of the open net. Note the same fault now appears at J1 instead of J3.

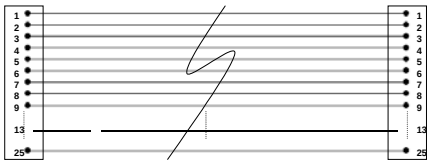
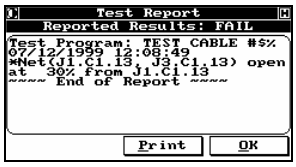


Figure 4-3: Open at 30%.



In this example, the open has occurred at 30% the distance from the first adapter.

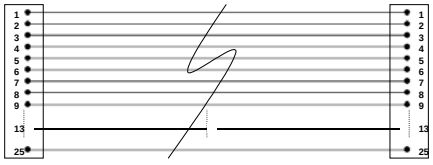
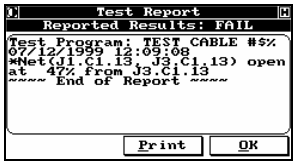


Figure 4-4: Open at 47%.



In this example, the open has occurred at 47% the distance from the first adapter.

5.3.2.2 *Miswires*

Miswire reports are extremely accurate. A miswire error is reported when the Fusion tests a cable and the nets do not match the configuration of the original "golden" sample.

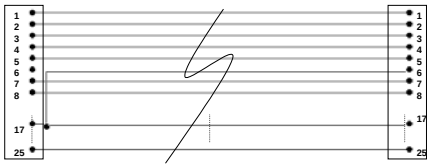
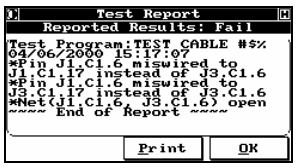


Figure 4-5: PUT Miswired



In the example to the left, the cable is miswired and Fusion notes the current wrong configuration and the correct configuration it expected.

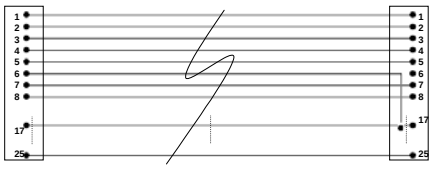
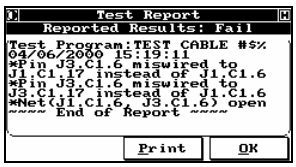


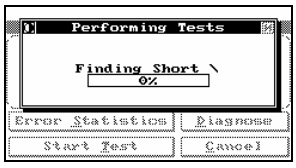
Figure 4-6: PUT Miswired – reversed



Reversing the cable and re-testing, the Fusion reports the same net to be faulty, but points to the correct adapter at which the fault can be located.

5.3.2.3 Shorts

One of the unique features of the Fusion is its ability to pin-point the location of shorts on a test cable. With regards to low voltage tests, shorts can be detected and located by the Fusion.



During the isolation test of a cable, the Fusion can diagnose shorts and the location of the fault relative to its position from the adapters. If a short is detected, the system will display a rotating character next to the "Finding Short" message to tell the operator it is still working and diagnosing faults.

It is important to remember that the Fusion can only detect, and will not pin-point, the location of a short (arc) that is a result of a high voltage test.

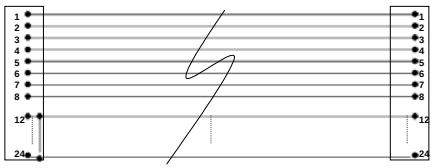
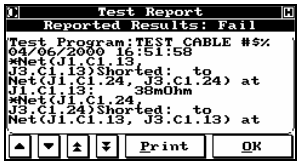


Figure 4-7: Short at J1



In the example above, the cable is tested and failed as a result of a short very close to the adapter at J1. Use the down arrow button to see the remainder of the error message.

Asterisks always precede faults.

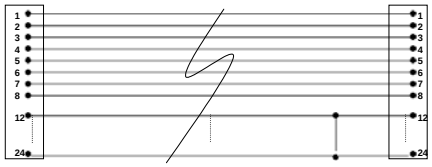
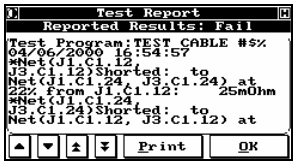
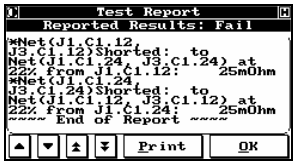


Figure 4-8: Short at 81%



In the next example, the same cable has failed as a result of a short, not at either end of the cable, but 81% of the distance from the first adapter. In this manner, the fault to be dealt with at the re-working station can easily be identified.

Use the down arrow button to see the remainder of the error message.



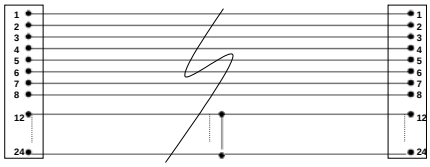
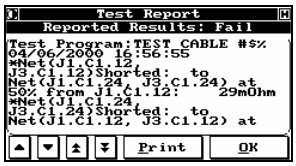
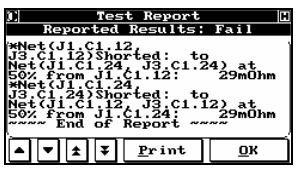


Figure 4-9: Short at 55%



In this example, the short has occurred at 55% the distance from the first adapter.



Use the down arrow button to see the remainder of the error message.

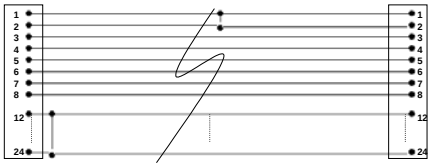
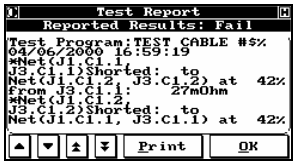
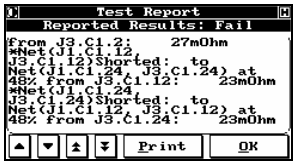


Figure 4-10: Multiple Shorts





It is not unusual to find a product that has more than one fault. The Fusion will report all faults found.

The only exceptions are those cases where one type of fault is masking another type of fault, for example, when an open circuit is sitting behind a short on the same wire. The only other exception is a case in which the product is removed before **Diagnostics** is pressed. In this case, the Fusion simply shows the product as failed and does not retain diagnostics.

Use the down arrow button to see the remainder of the error message.

5.3.2.4 Shorts and Opens with a Test Fixture

If you are using a test fixture, that is, a fixture a particular distance from the adapter level of the Fusion, then the full cable length (100%) will be measured from adapter to adapter unless you perform both a capacitive and resistive tare on the fixture (see section 5.2.1 for details). If you do not wish to do this, the length of cabling from the Fusion to the test fixture is part of the distance calculation.

Consider the following setup:

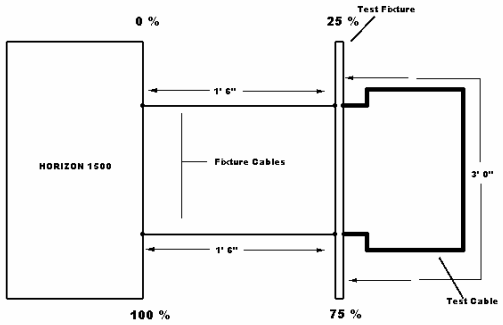


Figure 4-11: Example of a Test Fixture Setup

The above setup demonstrates the notion of faulty end recognition when a test fixture is being used with the Fusion. In the case above, should a short occur on the test cable during a low voltage test, then the short would be reported between 25% and 75%. The front of the cable is located at 25% of the total length and the rear of the cable is located at 75% of the total length.

Adapter level shorts will be reported at 25% or 75%, respectively, from a particular adapter, and a short along the cable would fall in between those two percentages.

5.4 Assembly Aid Tools

Assembly Aid allows you to randomly populate one end of the product, and then use the tool to test and populate the remaining end(s) of the product.

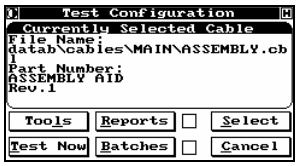
For details on the Fusion's **Build Aid** capabilities, see section 10.1.5.

The following is a step by step example using a cable terminated at one end with a DB50 connector and not terminated at the other.

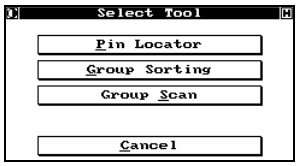
The following example makes use of the standard Fusion ground probe as well as a cup of ordinary unsalted water.

5.4.1 Learn the Open Product

Follow the instructions in section 5.2.2 to learn the open product, then display the *Test Configuration* screen for that product (from the *CableTest Main Menu*, press **Test**).



Press **Tools** to begin the Assembly Aid process and display the *Select Tool* screen.



- For information on the Pin Locator function, see section 5.4.5.
- For information on the Group Sorting function, see section 5.4.3.
- For information on the Group Scan function, see section 5.4.2.

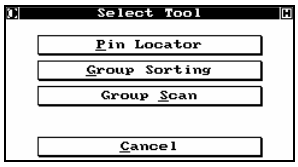
5.4.2 Perform a Group Scan

Before you begin, it is recommended to verify the continuity of all conductors that are terminated within the connector.

To perform group continuity, place the Fusion Probe within the glass of water.

Connect the terminated end of the product to the Fusion.

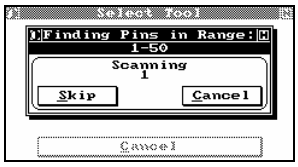
Place the non-terminated end into the glass of water.



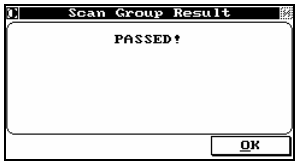
From *Select Tool* (see section 5.4.1), press **Group Scan** to display a new screen.

Enter a range that includes all the conductors and press **Enter** to continue.

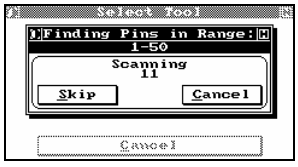
For this example we enter 1-50.



The scan will begin as soon as the conductors are submerged in the grounded water. The results vary depending on the conductor status:



- If all the conductors are continuous, the group scan will pass. Press **OK** to continue.



- If a conductor is open, the scan will pause. Press **Skip** to continue scanning or **Cancel** to exit the scan.

The end of the scan will display the conductor/pin not probed. This conductor is most likely open.

Press **OK** to continue.

To return to *Select Tool*, press **ESC**

5.4.3 Perform Group Sorting

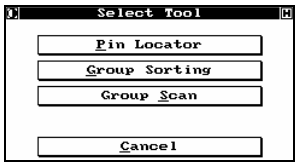
The next step involves separating the loose ends of the product into groups for easy connector assembly.

For the DB50 connector, an ideal method is to separate the conductors into the 3 rows of the DB50 connector.

Group 1: 1 - 17

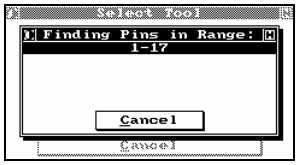
Group 2: 18 - 33

Group 3: 34 - 50



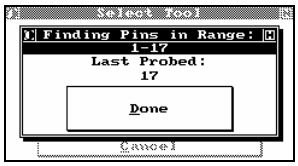
From *Select Tool* (see section 5.4.1), press **Group Sorting** to display a new screen.

Enter the pins that belong to group 1 (1 - 17) and press **Enter** to continue.



Using the ground probe, touch the conductors to isolate group 1.

As you probe the conductors, the pin you last probed is displayed. Conductors that do not belong to the group will not respond to the probe's touch.



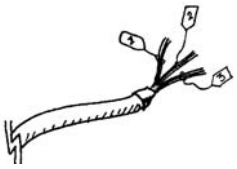
Once you have probed all the conductors, a message is displayed.

At this point you can continue to probe to verify the group.

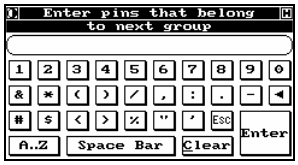
To continue, press **Done**.

Enter the pins for the second group and begin probing the remaining conductors.

Probe until done. To continue, press **Done**.



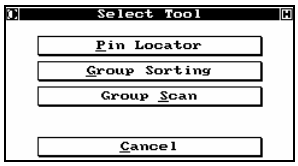
Upon completion of the second group, you will now have three sets of conductors.



To continue, press **Esc**.

5.4.4 Perform Group Verification (Group Continuity)

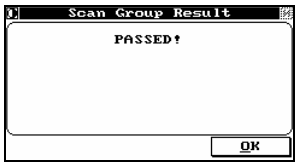
It is highly recommended that, once the groups are separated, you perform a group scan on each of the groups.



From *Select Tool* (see section 5.4.1), press **Group Scan** to display a new screen.

Enter the pins of group 1.

Place the probe and group 1 into the water and press **Enter** to continue.

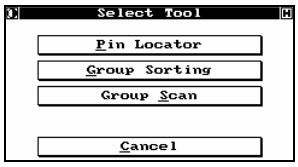


Repeat the scan for group 2 and group 3.

Once all three groups have been verified you can move to connector population.

5.4.5 Assemble the Product

The three verified groups can now be populated within the connector.

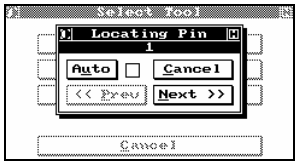


From *Select Tool* (see section 5.4.1), press **Pin Locator** to display a new screen.

Enter the pin range for the first group.

Pin ranges can be ascending or descending depending on your preference or need. If you wish to enter non-sequential pins you can do so by separating them with commas (e.g. 1,3,5,7). You may also enter ranges that are non-sequential by separating them with a comma (e.g. 1-5, 8-20).

To continue, press **Enter**.



Choose from the available methods to sequence through a range of pins.

To have the scan sequence to the next pin once a pin has been successfully probed, enable **Auto**. Be aware this may cause problems should you probe the pin and lose its location: you will then need to press **Prev** to re-scan that pin.

To have to press **Next** to sequence the next pin in the range once a pin has been successfully probed, disable **Auto**.

Once you have probed the final pin in the range, if you press **Next**, or if you are automatically sequencing, you will return to the range entry screen.

Enter the range for the next group of pins you wish to locate and press **Enter** to continue.

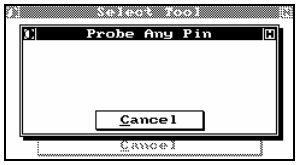
Continue until you have fully assembled the product.

5.4.6 Final Verification

Once all the pins are populated in the connector, it is recommended that you perform a final verification that the product is correctly assembled.

After the last pin is probed, if you press **Next**, or if you are automatically sequencing, you will return to the range entry screen.

If you press **Enter** without entering a range, you will enter the "Probe any Pin" mode.



Probe each pin on the assembled connector, noting the connector position and the pin displayed on the screen.

Probing pins on the newly assembled connector will display the pins as they are populated at the original terminated end.

Verify that the pin and displayed pin match.

5.5 High Voltage Testing

5.5.1 General

The Fusion can be set up to perform a DC or AC Hipot test on any product, provided that it has a high voltage DC or AC source installed. Hipot testing can be done on the entire product, or only on selected nets within the product.

If your product has embedded resistors or diodes and these components are learned when the product is learned, the Fusion will automatically exclude the nets connected to these components. Nets with components connected to them are automatically grouped for isolation and Hipot testing, and the group of nets is treated as a single net while these tests are running. You do not need to worry about manually excluding them.

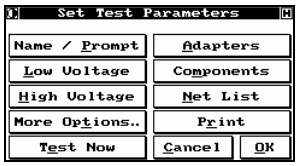
5.5.1.1 Safety

Your Fusion lets you set up a number of safety procedures. Which of these you use depends on local regulations, your philosophies, and the training level of your personnel.

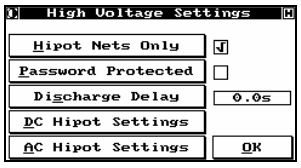
5.5.1.2 Program the Fusion to Hipot the Entire Product or Harness

You can choose to have the Fusion perform a Hipot test only on complete nets. This is done for several reasons:

- to speed up the test, since the system doesn't have to consider open nets
- to prevent the programmed high voltage from possibly being present at open leads. It is important to remember that the Fusion can perform a Hipot test on flying leads; in fact, this is quite common in many applications testing isolation. Just remember not to use this option unless it is needed.



From *Set Test Parameters* (see section 5.1.4), press **High Voltage** to display the *High Voltage Settings* screen.



- Choose whether the Fusion will perform a Hipot test only on complete nets (enable **Hipot Nets Only)**.
- Choose whether an operator-level password must be entered before high voltage testing can proceed (enable **Password Protected**) —this is independent of the normal password protection.
- Set the **Discharge Delay** that controls the discharge of the PUT. This affects both AC and DC Hipot testing. By default the Fusion discharges the PUT as fast as possible, but you can set this to any value between .1s and 1200s.

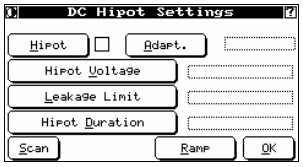
ⓘ This option is only available after an AC or DC Hipot has been programmed.

Press either **DC Hipot Settings** (see section 5.5.2.1) or **AC Hipot Settings** (see section 5.5.3.1).

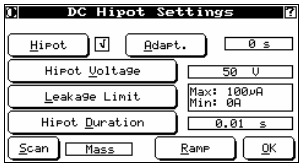
5.5.2 DC Hipot Testing

5.5.2.1 DC Hipot Settings

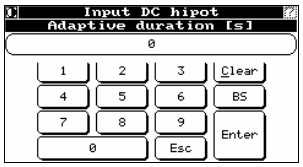
These settings are displayed when you press **DC Hipot Settings** from *High Voltage Settings* (see section 5.5.1.2).



For safety reasons, DC high voltage testing cannot even be set up until the **Hipot** button is pressed, activating the rest of the options.



Now that the Fusion has been instructed to perform Hipot testing, the test parameters can be defined.

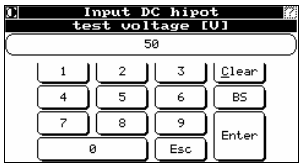


To use an adaptive cycle, press **Adapt** and enter the adaptive duration in seconds (maximum 59999).

In adaptive cycle, the programmed leakage current (or IR) is monitored for the specified period of time. As soon as it decreases below the limit (or the IR increases over the limit), the test begins, even if the adaptive cycle time period has not elapsed. If the leakage current stays above the limit (or the IR stays below the limit) for the whole duration of the adaptive cycle, the test fails.

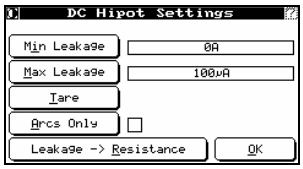
Use this function when the product exhibits a moderate to high soaking characteristic, and the shortest possible Hipot duration is desired. This may actually speed up the Hipot test in some cases since the test immediately terminates when the product passes. Remember that, although the exact duration of the dwell cycle is unknown, it will be between 0 and the programmed duration.

When the proper duration has been entered, press **Enter** to return to *DC Hipot Settings*.



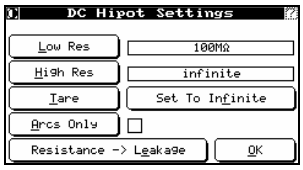
To set the test voltage, press **Hipot Voltage** and enter the desired DC Hipot voltage. You can specify any value you want up to 2500 or 3000 volts, depending on your model. The voltage can be specified in single (1) volt increments.

When the proper voltage has been entered, press **Enter** to return to *DC Hipot Settings*.



To set up leakage handling, press **Leakage Limit** to display a new screen.

Choose whether to calculate the leakage in terms of resistance or the resistance in terms of leakage by pressing **Leakage -> Resistance**. The screen changes depending on which method you have chosen.



If calculating leakage in terms of resistance, leave the button at its default value of **Leakage -> Resistance** and:

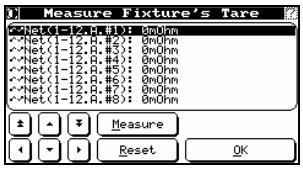
- To enter the desired leakage current, press **Min Leakage** or **Max Leakage**. Pay attention to the insulation specifications for the wire being used. The allowable range is from 0μA to 3mA.

If calculating resistance in terms of leakage, press **Leakage -> Resistance** so it shows **Resistance -> Leakage** and:

- To enter the desired resistance, press **Low Res** (IR) or **High Res** (generally set to 0 or infinite)

In either case:

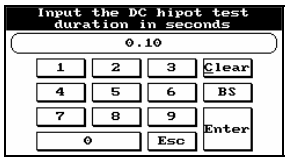
- Choose whether to rapidly test for any insulation or other breakdowns (enable **Arcs Only**). The Fusion will still automatically test for arcs if leakage is specified. If an arc is detected, testing is immediately suspended for that net, the arc is reported, and testing continues on the next net.
- To remove fixture leakage from the leakage calculation, press **Tare** to display the *Measure Fixture's Tare* screen.



Highlight the fixture to be measured and press **Measure**. The fixture's leakage is calculated. To remove the measurement, highlight the fixture and press **Reset**.

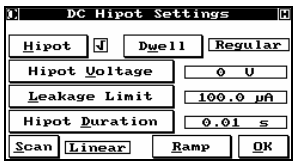
Scan must be set to "Linear" for the Tare leakage option to be available

When the proper voltage has been entered, press **Enter** (twice) to return to *DC Hipot Settings*.



To set the duration for the high voltage application, press **Hipot Duration** to display a new screen. Enter the length of time that you would like the DC high voltage to be applied, from 0.01 to 600 seconds.

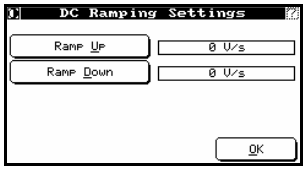
When the proper settings are in place, press **Enter** to return to *DC Hipot Settings*.



Scan switches between the "Mass" scan and "Linear" scan methods. Although the linear method is more traditional, it is highly recommended that you use Mass scan unless your test requirements specifically dictate otherwise. Mass Hipot testing is much faster with no loss in accuracy.

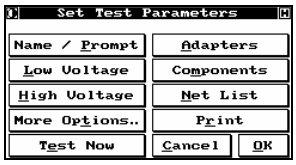
Refer to Appendix C for Mass Hipot examples.

Scan must be set to "Linear" for the Tare leakage option to be available.



To set the slope of the charge and discharge of a PUT, press **Ramp**.

Press either **Ramp Up** or **Ramp Down** to enter the desired value, between .01V to 10kV per second for both ramp up and ramp down.



To save the record for this test, press **OK**. The DC Hipot settings are incorporated into the test.

Test Program as CBL File

\datab\cables\main\testca~1.cbl For syntax information, see chapter 0.

```
*CABLE*,TEST CABLE #$%,2
  *STAR*
 *THRESHOLD*,61
 *DCHIPOT*,572
  *LEAKAGE*,0.0001
  *DWELL*,0.1
  *REGULAR*
  *MASS*
 *ADAPTER*,HA 116,
  *POSITION*,J1
 *ADAPTER*,HA 116,
  *POSITION*,J3
 *NET*,,
  J1.C1.1,,
  J3.C1.1,,
 *NET*,,
  J1.C1.2,,
  J3.C1.2,,
 *NET*,,
  J1.C1.3,,
  J3.C1.3,,
 *NET*,,
  J1.C1.4,,
  J3.C1.4,,
 *NET*,,
  J1.C1.5,,
  J3.C1.5,,
 *NET*,,
  J1.C1.6,,
  J3.C1.6,,
 *NET*,,
  J1.C1.7,,
  J3.C1.7,,
 *NET*,,
  J1.C1.8,,
  J3.C1.8,,
 *NET*,,
  J1.C1.9,,
  J3.C1.9,,
 *NET*,,
  J1.C1.10,,
  J3.C1.10,,
 *NET*,,
  J1.C1.11,,
  J3.C1.11,,
 *NET*,,
  J1.C1.12,,
  J3.C1.12,,
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  J1.C1.13,,
  J3.C1.13,,
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  J1.C1.14,,
  J3.C1.14,,
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  J1.C1.15,,
  J3.C1.15,,
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  J1.C1.16,,
  J3.C1.16,,
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  J1.C1.17,,
  J3.C1.17,,
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  J1.C1.18,,
  J3.C1.18,,
 *NET*,,
  J1.C1.19,,
  J3.C1.19,,
 *NET*,,
  J1.C1.20,,
  J3.C1.20,,
 *NET*,,
  J1.C1.21,,
  J3.C1.21,,
 *NET*,,
  J1.C1.22,,
  J3.C1.22,,
 *NET*,,
  J1.C1.23,,
  J3.C1.23,,
 *NET*,,
  J1.C1.24,,
  J3.C1.24,,
 *NET*,,
  J1.C1.25,,
  J3.C1.25,,
*END*
```
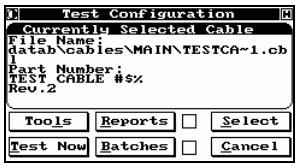
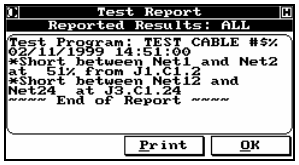

5.5.2.2 Testing Using the DC Hipot

To perform a DC Hipot test on a product, simply follow the same procedures as for low voltage testing.

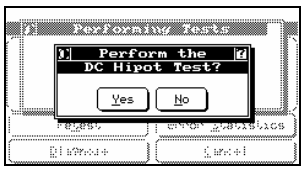


From the *CableTest Main Menu*, press **Test**. Select the test to be performed, if it is not the one displayed, and press **Test Now**. You are instructed to insert the adapters and to connect the product for testing.



The Fusion first performs all of the specified low voltage tests. If any of the tests fail, the "fail" light is lit. When you press **Diagnose**, the low voltage faults will be shown in a display similar to that shown here.

If a product fails any of the low voltage tests, Hipot testing will not be performed.

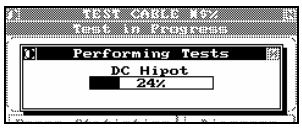


After the product has passed all of its low voltage tests, it can now be tested with high voltage.

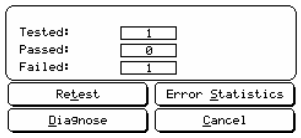
If you specified this test is password-protected, a password will have to be entered before testing will start.

The *Perform the DC Hipot Test?* screen appears:

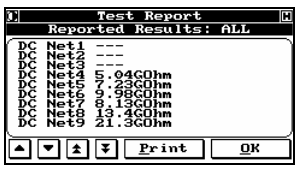
- To continue testing, press **Yes**. The *Performing Tests* screen appears.
- To cancel testing, press **No**. The *Test Statistics* window re-appears and the "fail" light is lit. From this screen, pressing **Diagnose** shows a message indicating that all tests have passed; what has happened, in essence, is a forced failure of the Hipot test.



The display shows the progress of DC Hipot testing.



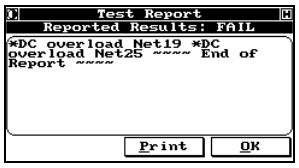
If the product fails or if the Hipot was a linear scan, press **Diagnose** on the *Statistics* window to view the diagnostics.



This display shows that a linear Hipot was performed and passed. The diagnostics report the measurements made during the test. For the PUT the IR is extremely high. The Fusion reports "---" should the measurement be over range.

5.5.2.3 Error Reporting

In addition to the standard error report messages, three additional ones are associated with DC Hipot tests.

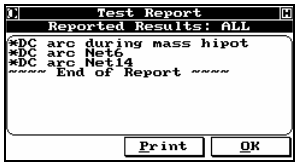


"DC Overload" is reported when an arc or excessive current leakage occurs during the charging cycle of the DC Hipot test. The message is used to differentiate between arcs during the Hipot test duration and during the time the product is being charged to the Hipot voltage level.

The sample *Test Report* indicates that, during the DC Hipot test, a fault occurred at nets 19 and 25.

"DC Leakage" is reported whenever leakage occurs, indicating both the net and the level of leakage.

This sample report indicates that, during the DC Hipot test, there was current leakage at nets 19 and 25.



"DC arc" is reported when an arc occurs.

Arc locations can only be reported during a Mass Hipot if the fault is reoccurring. If the arc occurs only once, the system will report it but will not give a location. If you run a Linear Hipot the location will always be identified.

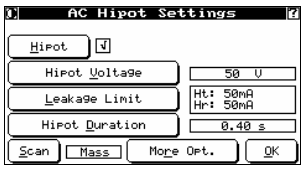
In this example the arc occurred during a LINEAR Hipot test.

All failures are identified with an asterisk (*).

5.5.3 AC Hipot Testing

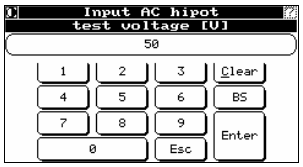
5.5.3.1 AC Hipot Settings

These settings are displayed when you press **AC Hipot Settings** from *High Voltage Settings* (see section 5.5.1.2).



For safety reasons, AC high voltage testing cannot even be set up until the **Hipot** button is pressed, activating the rest of the options.

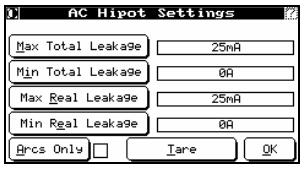
Now that the Fusion has been instructed to perform Hipot testing, the test parameters can be defined.



Press **Hipot Voltage** and enter the desired AC Hipot voltage. You can specify any value you want up to 2500Vrms or 3500 Vrms, depending on your model. The voltage can be specified in single (1) volt increments.

When the proper settings are in place, press **Enter** to return to *AC Hipot Settings*.

Remember that you are specifying an RMS voltage. Take this into consideration if the test specification calls for a peak voltage.



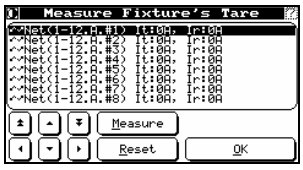
Press **Leakage Limit** to display a new screen.

- To set absolute leakage, press **Max Total Leakage** and **Min Total Leakage** and enter values for each.
- To set neutralized leakage, press **Max Real Leakage** and **Min Real Leakage** and enter values for each. This enables the Fusion to test the true quality of the product's insulation despite the presence of a significant reactive (capacitive) current in the circuit. This current approaches zero in a good product and is an excellent reference for limit setting for a Hipot leakage test.

Pay attention to the insulation specifications for the wire being used. The allowable range is from 0μA to 25mA.

- Choose whether to rapidly test for any insulation or other breakdowns (enable **Arcs Only**). The Fusion will still automatically test for arcs if leakage is specified. If an arc is detected, testing is immediately suspended, the arc is reported, and no further high voltage testing is performed on that product.

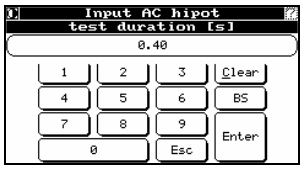
When the proper settings are in place, press **Enter** to return to *AC Hipot Settings*.



To remove fixture leakage from the leakage calculation, press **Tare** to display the *Measure Fixture's Tare* screen.

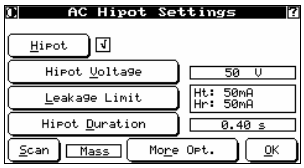
Highlight the fixture to be measured and press **Measure**. The fixture's leakage is calculated. To remove the measurement, highlight the fixture and press **Reset**.

When the proper settings are in place, press **Enter** (twice) to return to *AC Hipot Settings*.



To set the duration for the high voltage application, press **Hipot Duration** to display a new screen. Enter the length of time that you would like the AC high voltage to be applied, from 0.01 to 600 seconds.

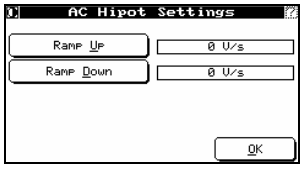
When the proper settings are in place, press **Enter** to return to *AC Hipot Settings*.



Scan switches between the "Mass" scan and "Linear" scan methods. Although the linear method is more traditional, it is highly recommended that you use Mass scan unless your test requirements specifically dictate otherwise. Mass Hipot testing is much faster with no loss in accuracy.

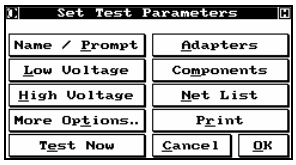
Refer to Appendix C for Mass Hipot examples.

Scan must be set to "Linear" for the Tare leakage option to be available.



To set the slope of the charge and discharge of a PUT, press **More Opt**.

Press either **Ramp Up** or **Ramp Down** to enter the desired value, between .01V to 10kV per second for both ramp up and ramp down.



To save the test record, press **OK**. The AC Hipot settings are incorporated into the test.

Test Program as CBL File

\datab\cables\main\testca~4.cbl

For syntax information, see chapter 0.

```
*CABLE*,TEST CABLE #$%,5
 *STAR*
 *THRESHOLD*,61
 *ACHIPOT*,456
  *LEAKAGE*,0.001
  *DWELL*,0.4
  *LINEAR*
  *60HZ*
 *ADAPTER*,HA 116,
  *POSITION*,J1
 *ADAPTER*,HA 116,
  *POSITION*,J3
 *NET*,,
  J1.C1.1,,
  J3.C1.1,,
 *NET*,,
  J1.C1.2,,
  J3.C1.2,,
 *NET*,,
  J1.C1.3,,
  J3.C1.3,,
 *NET*,,
  J1.C1.4,,
  J3.C1.4,,
 *NET*,,
  J1.C1.5,,
  J3.C1.5,,
 *NET*,,
  J1.C1.6,,
  J3.C1.6,,
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  J3.C1.7,,
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  J1.C1.8,,
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  J1.C1.9,,
  J3.C1.9,,
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  J1.C1.10,,
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  J3.C1.18,,
 *NET*,,
  J1.C1.19,,
  J3.C1.19,,
 *NET*,,
  J1.C1.20,,
  J3.C1.20,,
 *NET*,,
  J1.C1.21,,
  J3.C1.21,,
 *NET*,,
  J1.C1.22,,
  J3.C1.22,,
 *NET*,,
  J1.C1.23,,
  J3.C1.23,,
 *NET*,,
  J1.C1.24,,
  J3.C1.24,,
 *NET*,,
  J1.C1.25,,
  J3.C1.25,,
*END*
```
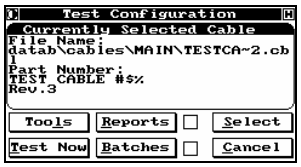
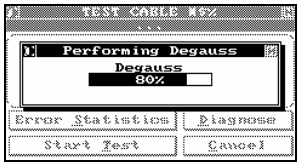

5.5.3.2 Testing Using AC Hipot

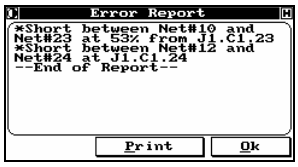
To perform an AC Hipot test on a product, simply follow the same procedures as for low voltage testing.



Press **Test** on the *Main Menu*, select the test to be performed if it is not the one displayed, and press **Test Now**. You will then be instructed to insert the adapters and to connect the product for testing.

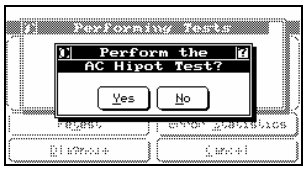


Since the test specification calls for an AC Hipot test, the Fusion automatically performs a degauss cycle before testing starts.



The Fusion will first perform all of the specified low voltage tests. If any of the tests fail, the "fail" light is lit. When you press **Diagnose**, the low voltage faults will be shown in a display similar to that shown here.

If a product fails any of the low voltage tests, Hipot testing will not be performed.



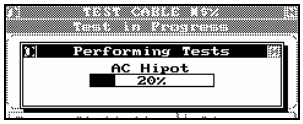
After the product has passed all of its low voltage tests, it can now be tested with high voltage.

If you specified that this test was password-protected, an operator-level password will have to be entered before testing will start.

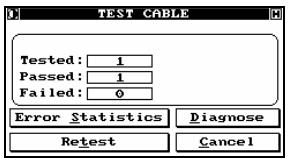
The *Perform AC Hipot Test?* screen appears:

- To continue testing, press **Yes**. The *Performing Tests* screen appears.

To cancel testing, press **No**. The *Test Statistics* window re-appears and the "fail" light is lit. From this screen, pressing **Diagnose** will show a message indicating that all tests have passed; what has happened, in essence, is a forced failure of the Hipot test.



The display shows the progress of AC Hipot testing.

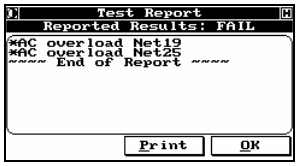


Should the product fail or if the Hipot was a linear scan, press **Diagnose** on the *Statistics* screen to view the diagnostics.

A linear Hipot was performed and passed. The diagnostics report the measurements made during the test.

5.5.3.3 Error Reporting

In addition to the standard error report messages, additional ones are associated with AC Hipot testing.

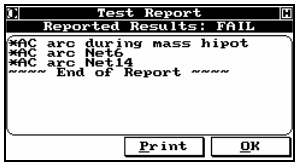


"AC Overload" is reported when an arc or excessive current leakage occurs during the charging cycle of the AC Hipot test. The message is used to differentiate between arcs during the Hipot test duration and during the time the product is being charged to the Hipot voltage level.

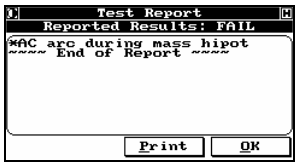
The sample *Test Report* indicates that, during the AC Hipot test, a fault occurred at nets 19 and 25.

"AC Leakage" is reported whenever leakage occurs, indicating both the net and the level of leakage.

This sample report indicates that there was excess leakage at pin 19 and 25 at connector 1 on J1.

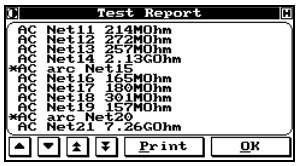


In this example an arc occurred during a MASS Hipot test.



"AC arc" is reported when an arc occurs.

Arc locations can only be reported during a Mass Hipot if the fault is reoccurring. If the arc occurs only once, the system will report it but will not give a location. If you run a Linear Hipot the location will always be identified.



In this example, the arc occurred during a Linear Hipot test.

All failures are identified with an asterisk (*).

5.6 Component Testing

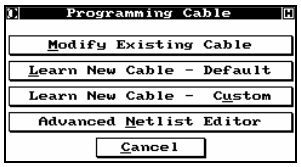
5.6.1 Introduction

The components available for programming and testing are:

- **Resisters** — see section 5.6.3.
- **Capacitors** — see section 5.6.4.
- **Diodes** — see section 5.6.5.
- **Switches** — see section 5.6.6.
- **Keys** — see section 5.6.6.4

For all components, you can choose to program using "auto learn" or manually. Even if you choose to work manually, you must first use auto learn to learn the NetList for that component. If you use auto learn, you can use the manual editing features to modify the learned results.

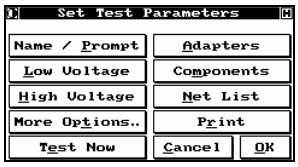
5.6.2 About Manual Programming (Component Editing)



From the *CableTest Main Menu*, press **Program Cable** to display the *Programming Cable* screen.

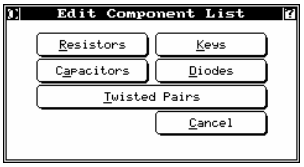
Press **Modify Existing Cable**. You are prompted to choose the program to modify and then the *Set Test Parameters* screen appears.

This screen also appears once a component has been learned.



Press **Components** to display the *Edit Component List* screen.

For information on the other options on this screen, see section 5.1.4



Choose any component.

You are prompted to choose which of the available components of that type you want to work with. In the example shown, we have chosen resistors, but the function is the same for all components.

- Use the arrows to navigate through the list.
- To add a component, press **Add**. A new item is added to the list.

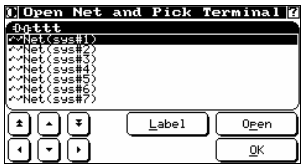
Adding components increments existing ones by 1. For example, each new resistor will be R1 and the current R1 becomes R2, the current R2 becomes R3, etc.

- To remove a component, highlight it and press **Delete**. You are prompted to confirm the deletion.
- To change the label of a component, highlight it and press **Label**. You are prompted to enter a new label for the component.
- To edit a component, highlight it and press **Edit** to display a new screen. Follow the procedure below.

In the example shown, we are editing resistors, but the function is the same for all components.

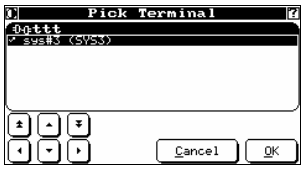
To change the label of the component, press **Label**. You are prompted to enter a new label.

To assign the proper net, press **Terminal 1 (+)** to display the *Open Net* screen.



Highlight the correct net/pin location for Terminal 1.

To open a pin, press **Open** to display the *Pick Terminal* screen.



Highlight a pin and press **OK** to accept the location of Terminal 1.

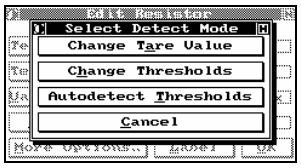
The first terminal is displayed.

Repeat the above operation for Terminal 2

With the terminals properly identified, you now need to program the value of the component.

If your product is attached, press **Test** to retrieve the measured value. The value appears next to **Test**.

To set or modify the tolerance, press **Value** to display the *Select Detect Mode* screen.



- To change the tare value, press **Change Tare Value** and enter a new value.
- To change the thresholds value, press **Change Thresholds** and enter a new minimum and maximum value.
- To have thresholds automatically detected, press **Autodetect Thresholds**.

The **More Options** button displays different values for different components, and is explained in the individual components section of this chapter.

5.6.3 Programming and Running Resistor Tests

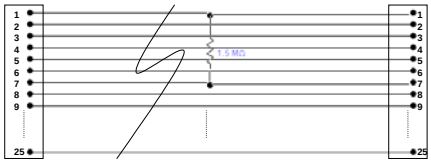
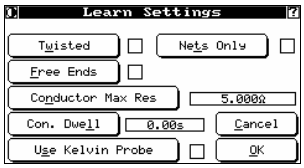
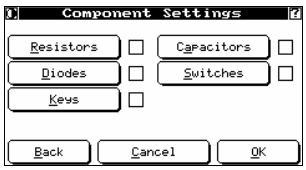


Figure 4-12: PUT with embedded Resistor

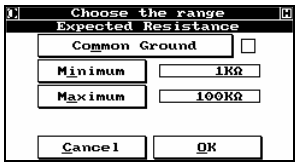
5.6.3.1 Programming Resistor Tests by Learning



On *Learn Settings* (see section 5.2.2.2), set whatever options are necessary, then press **OK** to display the *Component Settings* screen.



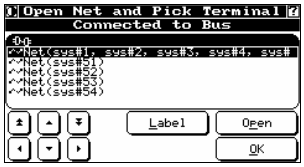
Press **Resistors** to display the *Choose the Range* screen.



Set the following options:

- If components are connected to a common bus, enable **Common Ground**.
- Enter the minimum expected resistance for all of the embedded resistors in your product.
- Enter the maximum expected value for all the resistors in your product.

To return to *Component Settings*, press **OK** and, from that screen, press **OK** to carry out the test as usual.



If you pressed **Common Ground**, you are prompted to choose the common bus from the learned list. Once you have made your choice, the resistors are learned.

Here are some example results. In the example shown, Terminal 1 of the first resistor (R1) is connected to pin 1 of the first connector on the adapter located at J1. Terminal 2 is connected to pin 7 of the same connector.

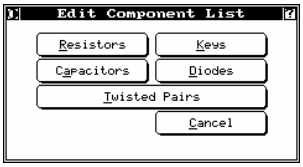
The default tolerance for the component is set to 10%

Test Program as CBL File

```
\datab\cables\main\resistor.cbl   For syntax information, see chapter 0.

*CABLE*,RESISTOR,1
  *CONTINUITY*,0,5
  *STAR*
  *THRESHOLD*,61
  *ADAPTER*,HA 116,
    *POSITION*,J1
  *ADAPTER*,HA 116,
    *POSITION*,J3
  *NET*,,
    J1.C1.1,,
    J3.C1.1,,
  *NET*,,
    J1.C1.2,,
    J3.C1.2,,
  *NET*,,
    J1.C1.3,,
    J3.C1.3,,
  *NET*,,
    J1.C1.4,,
    J3.C1.4,,
  *NET*,,
    J1.C1.5,,
    J3.C1.5,,
  *NET*,,
    J1.C1.6,,
    J3.C1.6,,
  *NET*,,
    J1.C1.7,,
    J3.C1.7,,
  *NET*,,
    J1.C1.8,,
    J3.C1.8,,
  *NET*,,
    J1.C1.9,,
    J3.C1.9,,
  *NET*,,
    J1.C1.10,,
    J3.C1.10,,
  *NET*,,
    J1.C1.11,,
    J3.C1.11,,
  *NET*,,
    J1.C1.12,,
    J3.C1.12,,
  *NET*,,
    J1.C1.13,,
    J3.C1.13,,
  *NET*,,
    J1.C1.14,,
    J3.C1.14,,
  *NET*,,
    J1.C1.15,,
    J3.C1.15,,
  *NET*,,
    J1.C1.16,,
    J3.C1.16,,
  *NET*,,
    J1.C1.17,,
    J3.C1.17,,
  *NET*,,
    J1.C1.18,,
    J3.C1.18,,
  *NET*,,
    J1.C1.19,,
    J3.C1.19,,
  *NET*,,
    J1.C1.20,,
    J3.C1.20,,
  *NET*,,
    J1.C1.21,,
    J3.C1.21,,
  *NET*,,
    J1.C1.22,,
    J3.C1.22,,
  *NET*,,
    J1.C1.23,,
    J3.C1.23,,
  *NET*,,
    J1.C1.24,,
    J3.C1.24,,
  *NET*,,
    J1.C1.25,,
    J3.C1.25,,
  *RESISTOR*,,RESISTOR1
    J3.C1.1,,
    J3.C1.7,,
    *VALUE*,1.46586e+06,1.7916e+06
*END*
```

5.6.3.2 Programming Resistor Tests Manually

Even when you program embedded resistors manually, the NetList must have already been automatically learned (see section 5.6.3.1).



From the *Edit Component List* screen (see section 5.6.2), press **Resistors** to display the *Select Resistor* screen.

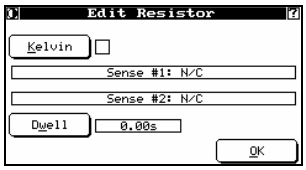
The list is empty if no resistors were detected during the learn process, or if you did not press the **Resistor** option during learning.

Add as many resistors as you have in your product by pressing **Add**.

Highlight a resistor and press **Edit** to display the *Edit Resistor* screen.

For information on all but the **More Options** function, see section 5.6.2.

To set advanced measurement features, press **More Options** to display a new screen.



To make this test a Kelvin test, enable **Kelvin**.

Kelvin requires odd and even consecutive pairs (for example, 7, 8).

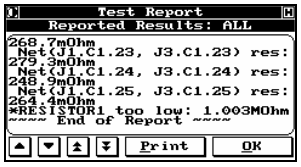
Set a measurement dwell for the selected component (.01s to 1000s)

The sense fields change based on your choices.

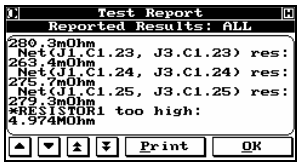
Press **OK** to return to the first *Edit Resistor* screen.

5.6.3.3 Testing A Product With Resistors

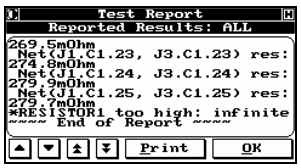
Testing a product with embedded components is the same as testing any other product. Follow the process described in section 5.2.2.2. After the standard low voltage tests (continuity and isolation) are performed, the system scans for resistors. Here are some sample results:



The resistance for resistor 1 is below the expected value, including the tolerance zone. The actual resistance is measured and reported to help a technician correct the problem.



The resistance for resistor 1 is above the expected value, including the tolerance zone. The actual resistance is measured and reported to help a technician correct the problem



The resistor path for resistor 1 is extremely high. The actual problem could be the resistor itself or could be because one of the connecting terminals is open.

5.6.4 Programming and Running Capacitor Tests

5.6.4.1 Programming Capacitor Tests by Learning

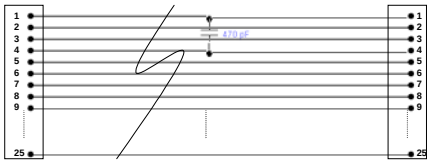
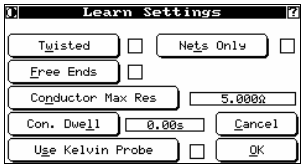
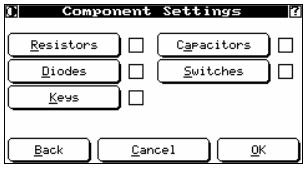


Figure 4-13: PUT with embedded Capacitor

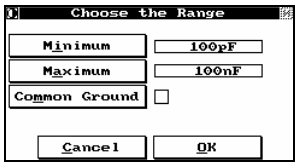


On *Learn Settings* (see section 5.2.2.2), set whatever options are necessary.

Press **OK** to continue and display the *Component Settings* screen.



Press **Capacitors** to display the *Choose the Range* screen.

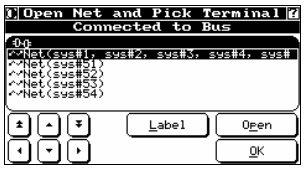


Set the following options:

- Enter the minimum expected resistance for all of the embedded capacitors in your product.
- Enter the maximum expected value for all the capacitors in your product.
- If components are connected to a common bus, enable **Common Ground**.

Do not enter 0 for the minimum!

To return to *Component Settings*, press **OK** and, from that screen, press **OK** to carry out the test as usual.



If you pressed **Common Ground**, you are prompted to choose the common bus from the learned list. Once you have made your choice, the capacitors are learned.

Here is an example result. In the example shown, Terminal 1 of the first resistor (C1) is connected to pin 1 of the first connector on the adapter located at J1. Terminal 2 is connected to pin 4 of the same connector.

For information on editing the capacitor, see section 5.6.2.

The default tolerance for the component is set to 10%

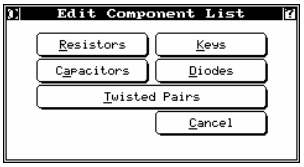
Test Program as CBL File

\datab\cables\main\capacitor.cbl For syntax information, see chapter 0.

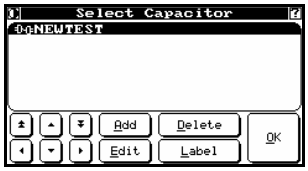
```
*CABLE*,CAPACITOR,1
  *STAR*
  *THRESHOLD*,61
  *ADAPTER*,HA 116,
    *POSITION*,J1
  *ADAPTER*,HA 116,
    *POSITION*,J3
  *NET*,,
    J1.C1.1,,
    J3.C1.1,,
  *NET*,,
    J1.C1.2,,
    J3.C1.2,,
  *NET*,,
    J1.C1.3,,
    J3.C1.3,,
  *NET*,,
    J1.C1.4,,
    J3.C1.4,,
  *NET*,,
    J1.C1.5,,
    J3.C1.5,,
  *NET*,,
    J1.C1.6,,
    J3.C1.6,,
  *NET*,,
    J1.C1.7,,
    J3.C1.7,,
  *NET*,,
    J1.C1.8,,
    J3.C1.8,,
  *NET*,,
    J1.C1.9,,
    J3.C1.9,,
  *NET*,,
    J1.C1.10,,
    J3.C1.10,,
  *NET*,,
    J1.C1.11,,
    J3.C1.11,,
  *NET*,,
    J1.C1.12,,
    J3.C1.12,,
  *NET*,,
    J1.C1.13,,
    J3.C1.13,,
  *NET*,,
    J1.C1.14,,
    J3.C1.14,,
  *NET*,,
    J1.C1.15,,
    J3.C1.15,,
  *NET*,,
    J1.C1.16,,
    J3.C1.16,,
  *NET*,,
    J1.C1.17,,
    J3.C1.17,,
  *NET*,,
    J1.C1.18,,
    J3.C1.18,,
  *NET*,,
    J1.C1.19,,
    J3.C1.19,,
  *NET*,,
    J1.C1.20,,
    J3.C1.20,,
  *NET*,,
    J1.C1.21,,
    J3.C1.21,,
  *NET*,,
    J1.C1.22,,
    J3.C1.22,,
  *NET*,,
    J1.C1.23,,
    J3.C1.23,,
  *NET*,,
    J1.C1.24,,
    J3.C1.24,,
  *NET*,,
    J1.C1.25,,
    J3.C1.25,,
  *CAPACITOR*,,CAPACITOR1
    J3.C1.1,,
    J3.C1.4,,
    *VALUE*,5.38652e-10,6.58352e-10
    *TARE*,1.41919e-09
*END*
```

5.6.4.2 Programming Capacitor Tests Manually

Even when you program embedded capacitors manually, the NetList must have already been automatically learned (see section 5.6.4.1).



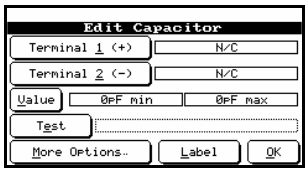
From the *Edit Component List* screen (see section 5.6.2), press **Capacitors** to display the *Select Capacitor* screen.



The list is empty if no capacitors were detected during the learn process, or if you did not press the **Capacitor** option during learning.

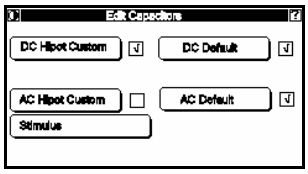
Add as many capacitors as you have in your product by pressing **Add**.

Highlight a capacitor and press **Edit** to display the *Edit Capacitor* screen.



For information on all but the **More Options** function, see section 5.6.2.

To set advanced measurement features, press **More Options** to display a new screen.



Choose one of the following:

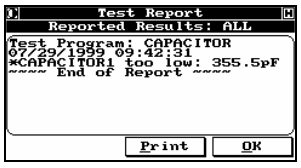
- Use default DC and AC Hipot settings (press **DC Default** or **AC Default**), as set in system settings (see 4.7).
- Press **DC Hipot Custom** or **AC Hipot Custom** to edit values for or eliminate (by disabling **Hipot**) Hipots performed on capacitors.

In order to change local Hipot variables, the global setting for the High Voltage test must be set to Linear. (see 4.7)

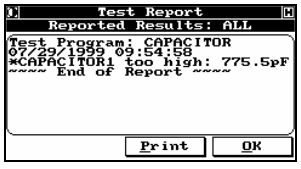
Press **Stimulus** to cycle through the options. The recommended option is “auto”.

5.6.4.3 Testing a Product with Capacitors

Testing a product with embedded components is the same as testing any other product. Follow the process described in section 5.2.2.2. After the standard low voltage tests (continuity and isolation) are performed, the system scans for capacitors. Here are some sample results:



The measured capacitance is too low.



The measured capacitance is too high.

5.6.5 Programming and Running Diode Tests

5.6.5.1 Programming Diode Tests by Learning

The Fusion can be used to test products with the following types of embedded diodes: generic, signal, rectifier, Schottky, Germanium, LED's, and resistor LED's. The diodes are tested for both forward and reverse bias, and the LED's may also be visually tested. Diodes may be automatically learned by the Fusion, or you can choose to program them manually. It is highly recommended that you let the Fusion do the work unless you have a large number of diodes or are not satisfied with the results of the autolearn process.

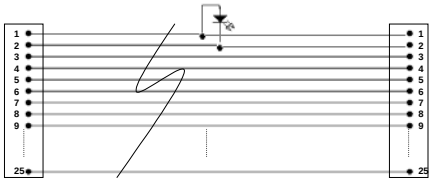
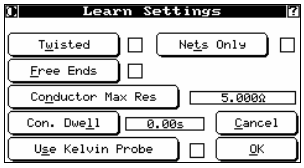
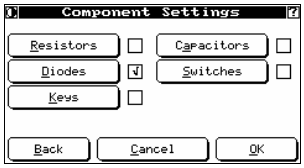


Figure 4-14: PUT with embedded Diode



On *Learn Settings* (see section 5.2.2.2), set whatever options are necessary.

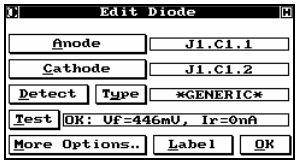
Press **OK** to continue and display the *Component Settings* screen.



Press **Diodes** to indicate to the Fusion that your product has an embedded diode(s). Press **OK** to continue the learning process as normal.

Here is an example result. The Fusion found one diode, and detected that it is a Generic type. For an explanation of how the Fusion determines the diode type, see section 5.6.5.2.

Press **Edit** to view the details of the learned component. For an explanation on the rest of the functions of this screen, see section 5.6.2.



In this example, the diode's anode, at pin 1 and its cathode, at pin 2, are of connector 1 on adapter J1. (This agrees with the test spec. for the example cable.)

5.6.5.2 Diode Types

The following table lists the parameter by which diodes are identified by the Fusion.

Type	V_{fmin}[V] @50µA	V_{Fmax}[V] @50µA	I_{Rmax}[µA] @5V
GENERIC	0.060	2.300	20.0
SIGNAL	0.400	0.600	20.0
RECTIFIER	0.400	0.800	20.0
SCHOTTKY	0.060	0.400	20.0
GERMANIUM	0.060	0.400	20.0
LED	1.475	1.825	20.0
RESISTORLED	1.550	2.300	20.0

Test Program as CBL File

```
\datab\cables\main\diode.cbl   For syntax information, see chapter 0.

*CABLE*,LED,1
  *CONTINUITY*,0,5
  *STAR*
  *THRESHOLD*,61
  *ADAPTER*,HA 116,
    *POSITION*,J1
  *ADAPTER*,HA 116,
    *POSITION*,J3
  *NET*,,
    J1.C1.1,,
    J3.C1.1,,
  *NET*,,
    J1.C1.2,,
    J3.C1.2,,
  *NET*,,
    J1.C1.3,,
    J3.C1.3,,
  *NET*,,
    J1.C1.4,,
    J3.C1.4,,
  *NET*,,
    J1.C1.5,,
    J3.C1.5,,
  *NET*,,
    J1.C1.6,,
    J3.C1.6,,
  *NET*,,
    J1.C1.7,,
    J3.C1.7,,
  *NET*,,
    J1.C1.8,,
    J3.C1.8,,
  *NET*,,
    J1.C1.9,,
    J3.C1.9,,
  *NET*,,
    J1.C1.10,,
    J3.C1.10,,
  *NET*,,
    J1.C1.11,,
    J3.C1.11,,
  *NET*,,
    J1.C1.12,,
    J3.C1.12,,
  *NET*,,
    J1.C1.13,,
    J3.C1.13,,
  *NET*,,
    J1.C1.14,,
    J3.C1.14,,
  *NET*,,
    J1.C1.15,,
    J3.C1.15,,
  *NET*,,
    J1.C1.16,,
    J3.C1.16,,
  *NET*,,
    J1.C1.17,,
    J3.C1.17,,
  *NET*,,
    J1.C1.18,,
    J3.C1.18,,
  *NET*,,
    J1.C1.19,,
    J3.C1.19,,
  *NET*,,
    J1.C1.20,,
    J3.C1.20,,
  *NET*,,
    J1.C1.21,,
    J3.C1.21,,
  *NET*,,
    J1.C1.22,,
    J3.C1.22,,
  *NET*,,
    J1.C1.23,,
    J3.C1.23,,
  *NET*,,
    J1.C1.24,,
    J3.C1.24,,
  *NET*,,
    J1.C1.25,,
    J3.C1.25,,
  *DIODE*,,
    J1.C1.1,,
    J1.C1.2,,
    *GENERIC*
*END*
```

5.6.5.3 Programming Diode Tests by Learning – Phantom Diodes

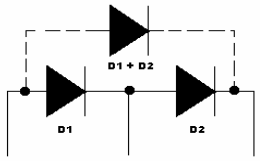


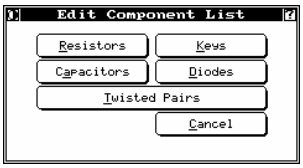
Figure 4-15: Phantom Diodes

Depending on how the diodes are wired, the Fusion could find a "phantom diode" that is a combination of diodes 1 and 2, as illustrated by the dashed line. This could either show up as a third diode or as a single diode. In either case, a careful examination of the components learned will reveal if this has happened and, if so, which occurred.

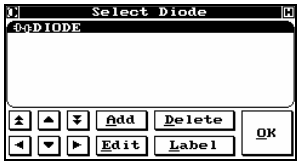
Auto learning this configuration would result in three found components, as shown in this example display. Editing each component will help determine which one is the phantom one, which can then be deleted.

5.6.5.4 Programming Diode Tests Manually

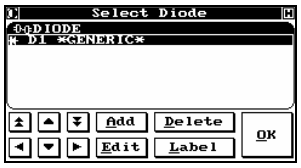
Even when you program embedded diodes manually, the NetList must have already been automatically learned (see section 5.6.5.1).



From the *Edit Component List* screen (see section 5.6.2), press **Diodes** to display the *Select Diode* screen.

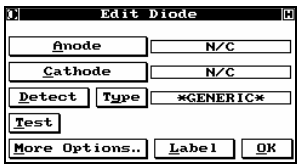


The list is empty if no diodes were detected during the learn process, or if you did not press the **Diode** option during learning.



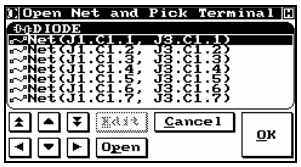
Add as many diodes as you have in your product by pressing **Add**. The new diodes are automatically selected as Generic.

Highlight the first and press **Edit** to display the *Edit Diode* screen (for information on the rest of the functions of this screen, see section 5.6.2).

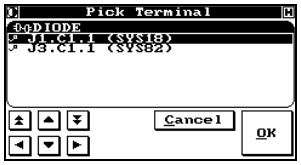


The screen is blank because the diode was manually added.

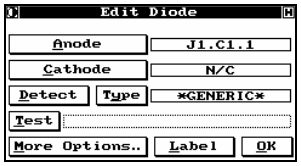
Press **Anode** to display the *Open Net* screen so you can assign it the proper net.



Highlight the correct net/pin location for the anode and press **Open** to select a pin.

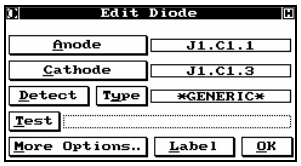


Highlight a pin and press **OK** to accept the location of Terminal 1.



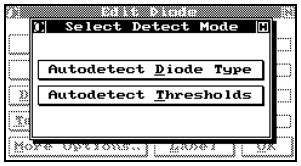
The first anode terminal is displayed.

Repeat the above operation for the cathode.



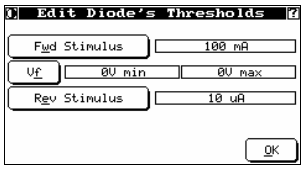
With the anode and cathode properly identified, you now need to program the type of diode embedded. You can do this manually, by pressing **Type** to cycle through the available types, or automatically, as described below.

If your product is attached with the proper diode in place, press **Detect** to display the *Select Detect Mode* screen which can be used to automatically set the type and values.



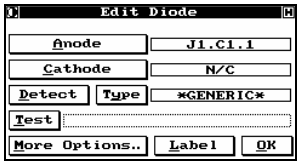
Choose either **Autodetect Diode Type** or **Autodetect Thresholds**.

The diode types preset are listed in the table in section 5.6.5.2. If your component does not conform to one of these types, press **Autodetect Thresholds** to learn the attached component. The *Edit Diode's Thresholds* screen appears.

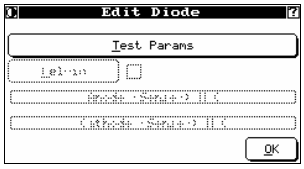


- Press **Fwd Stimulus** and **Rev Stimulus** to scroll through the available settings.
- Press **Vf** and enter a minimum and maximum voltage drop.

To return to *Edit Diode*, press **OK**.



To manually edit the diode's thresholds, press **More Options**.

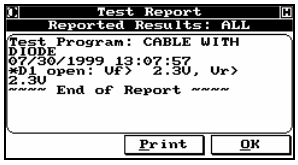


Press **Test Params** to manually edit the diode's thresholds.

Other options on this screen are reserved for future use.

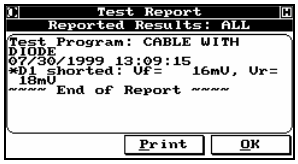
5.6.5.5 Testing Product with Diodes

The testing procedure for a product with embedded components is the same as testing any other product. Follow the process described in section 5.2.2.2. After the NetList is verified for continuity and isolation, the system scans for the diodes. Here are some example results:

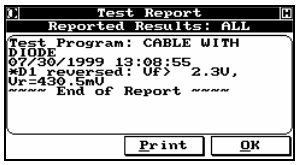


The diode was open. The Fusion measures and reports the forward voltage to be greater than 2300mV (this value is the maximum forward voltage at 50µA for a Generic Diode: see section 5.6.5.2).

"D1" is the designator assigned by the Fusion to the first diode detected. If there is more than one, you will probably want to use the **Label** function so that the diagnostics are more meaningful.



Diode (D1) is shorted. The Fusion measures and reports the reverse voltage across the short.



The diode is present but is installed backwards.

5.6.6 Programming and Running Switch and Key Tests

5.6.6.1 Introduction

The Fusion can test products with embedded switches. The basic philosophy is that each time a switch changes position, the product has changed its configuration. As a result, the learning process steps you through each of the switch positions as the Fusion learns the configuration for each position. Then, during the testing phase, the operator duplicates the process. Switches can be combined with other embedded components, or used in conjunction with any other testing requirement, such as Hipot testing.

Any product that consists of multiple states (NetLists that differ due to mechanical manipulation) is suitable for a switch test.

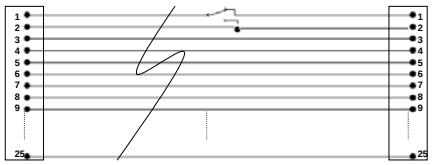
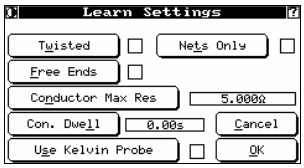
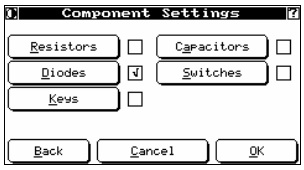


Figure 4-16: PUT with embedded Switch - in OPEN position

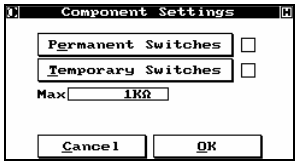


On *Learn Settings* (see section 5.2.2.2), set whatever options are necessary.

Press **OK** to continue and display the *Component Settings* screen.



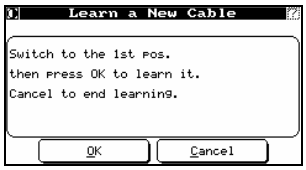
Press **Switches** to indicate to the Fusion that your product has an embedded switch(es). A new screen appears.



- **Permanent Switches:** Used for mechanical switches. Press to enable.
- **Temporary Switches:** Used for momentary switches, such as membrane switches. Press to set maximum expected resistance.

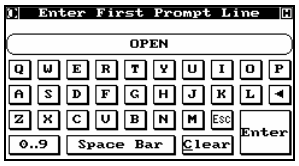
To learn the product as usual, press OK. If you enabled **Permanent Switches**, see section 5.6.6.2. If you enabled **Temporary Switches**, see section 5.6.6.3.

5.6.6.2 *Programming Switch Tests for Permanent Switches*



When you choose to learn a product with a permanent switch, the Fusion instructs you to set your product in the first switch position.

After this is done, press **OK**.



The Fusion learns the first NetList.

You are asked to enter a prompt which will tell the operator what action to take to prepare the product to be tested in its first configuration.

The prompt entered will appear to the operator during the test cycle, prior to testing the switch position.

Press **Enter** to confirm the first line of the prompt. A screen for the next prompt line appears. Continue to add prompt lines until done.

When no more prompt lines are required, press **Esc** to advance to the next switch position and repeat the process.

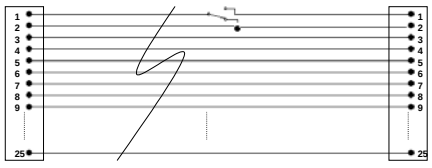
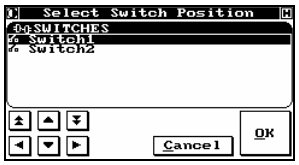


Figure 4-17: PUT with embedded Switch - in CLOSED position



If you view the NetList (by pressing **Net List** from *Set Test Parameters*) you will be prompted to select the switch position you wish to review.

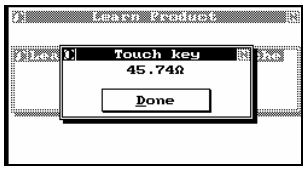
Test Program as CBL File

\datab\cables\main\switch.cbl For syntax information, see chapter 0.

```
*CABLE*,SWITCHES,1
 *STAR*
 *THRESHOLD*,61
 *ADAPTER*,HA 116,
  *POSITION*,J1
 *ADAPTER*,HA 116,
  *POSITION*,J3
 *SWITCH*,,
  *CHAIN*
  *PROMPT*
OPEN
  *NET*,,
   J1.C1.1,,
   J3.C1.1,,
  *NET*,,
   J1.C1.2,,
   J3.C1.2,,
  *NET*,,
   J1.C1.3,,
   J3.C1.3,,
  *NET*,,
   J1.C1.4,,
   J3.C1.4,,
  *NET*,,
   J1.C1.5,,
   J3.C1.5,,
  *NET*,,
   J1.C1.6,,
   J3.C1.6,,
  *NET*,,
   J1.C1.7,,
   J3.C1.7,,
  *NET*,,
   J1.C1.8,,
   J3.C1.8,,
  *NET*,,
   J1.C1.9,,
   J3.C1.9,,
  *NET*,,
   J1.C1.10,,
   J3.C1.10,,
  *NET*,,
   J1.C1.11,,
   J3.C1.11,,
  *NET*,,
   J1.C1.12,,
   J3.C1.12,,
  *NET*,,
   J1.C1.13,,
   J3.C1.13,,
  *NET*,,
   J1.C1.14,,
   J3.C1.14,,
  *NET*,,
   J1.C1.15,,
   J3.C1.15,,
  *NET*,,
   J1.C1.16,,
   J3.C1.16,,
  *NET*,,
   J1.C1.17,,
   J3.C1.17,,
  *NET*,,
   J1.C1.18,,
   J3.C1.18,,
  *NET*,,
   J1.C1.19,,
   J3.C1.19,,
  *NET*,,
   J1.C1.20,,
   J3.C1.20,,
 *SWITCH*,,
  *CHAIN*
  *PROMPT*
CLOSED
  *NET*,,
   J1.C1.1,,
   J1.C1.2,,
   J3.C1.1,,
   J3.C1.2,,
  *NET*,,
   J1.C1.3,,
   J3.C1.3,,
  *NET*,,
   J1.C1.4,,
   J3.C1.4,,
  *NET*,,
   J1.C1.5,,
   J3.C1.5,,
  *NET*,,
   J1.C1.6,,
   J3.C1.6,,
  *NET*,,
   J1.C1.7,,
   J3.C1.7,,
  *NET*,,
   J1.C1.8,,
   J3.C1.8,,
  *NET*,,
   J1.C1.9,,
   J3.C1.9,,
  *NET*,,
   J1.C1.10,,
   J3.C1.10,,
  *NET*,,
   J1.C1.11,,
   J3.C1.11,,
  *NET*,,
   J1.C1.12,,
   J3.C1.12,,
  *NET*,,
   J1.C1.13,,
   J3.C1.13,,
  *NET*,,
   J1.C1.14,,
   J3.C1.14,,
  *NET*,,
   J1.C1.15,,
   J3.C1.15,,
  *NET*,,
   J1.C1.16,,
   J3.C1.16,,
  *NET*,,
   J1.C1.17,,
   J3.C1.17,,
  *NET*,,
   J1.C1.18,,
   J3.C1.18,,
  *NET*,,
   J1.C1.19,,
   J3.C1.19,,
  *NET*,,
   J1.C1.20,,
   J3.C1.20,,
*END*
```

5.6.6.3 Programming Switch Tests for Temporary (Membrane) Switches

Temporary switches are also known as keys. They are seen by the Fusion as a component.



When you choose to learn a product with a permanent switch, the Fusion instructs you to press and hold the momentary switch. Once the measured resistance is displayed, release the switch.

Enter a label name and press **Enter** to accept.

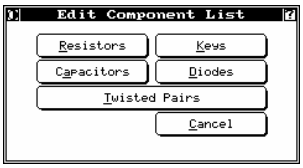
Press and hold to measure the next momentary switch.

When there are no more switches to press, press **Done**.

If the same switch (key) has been pressed twice, you will be warned of this.

To accept the switch, press **Yes**; to continue without accepting the switch, press **No.**

5.6.6.4 *Programming Switches (Keys) Manually*



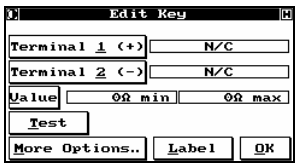
From the *Edit Component List* screen (see section 5.6.2), press **Keys** to display the *Select Key* screen.

The list is empty if no keys were detected during the learn process, or if you did not select the **Switches** option during learning.

Press **Add** to manually enter this component. Add as many keys as you have in your product.

Highlight the first and press **Edit** to display the *Edit Key* screen.

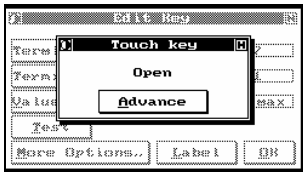
For information on the rest of the functions on this screen, see section 5.6.2.



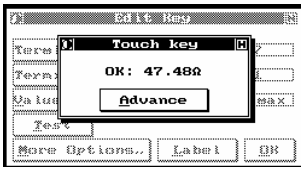
The **Edit Key** screen opens with no information present.

For information on editing the key, see section 5.6.2.

If you use the **Test** function to program the value of the component, you are prompted to touch the key. Follow the instructions below.



Press and hold the key on the product.

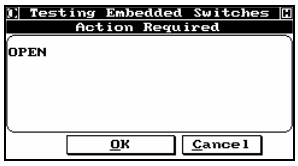


The Fusion will measure the resistance values of the key.

Press **Advance** or release the key on the product to display the value on the *Edit Key* screen.

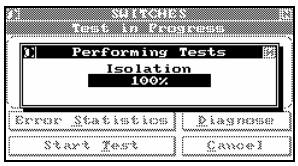
5.6.6.5 *Testing Product with Switches*

The testing procedure for a product with embedded components is the same as testing any other product. Follow the process described in section 5.2.2.2. After the NetList is verified for continuity and isolation, the system scans for the switches.

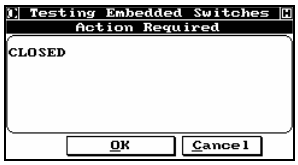


During testing, the first instructional prompt you programmed appears. Flashing at the top is the message "Action Required".

After the instructions are carried out, press **OK** and the Fusion will completely test the first configuration.

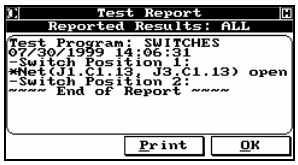


All programmed tests are performed.



As each configuration is tested successfully, the Fusion displays any required prompts for the next configuration until the test is complete.

All common product faults are reported in this mode as they are for general testing. The switch mode differentiates by keeping track of each switch configuration separately.



In this example, the cable passed all tests in configuration 2, but the net containing J1.C1.13 and J3.C1.13 was open in configuration 1.

5.7 Custom Programming Examples

5.7.1 Programming and Running Free Ends or "Flying Leads" Tests

Many products have wires that are terminated into a connector on one end only. These can be fully tested by using the supplied probe. All you need to do is to tell the Fusion where these leads are and how you want them tested.

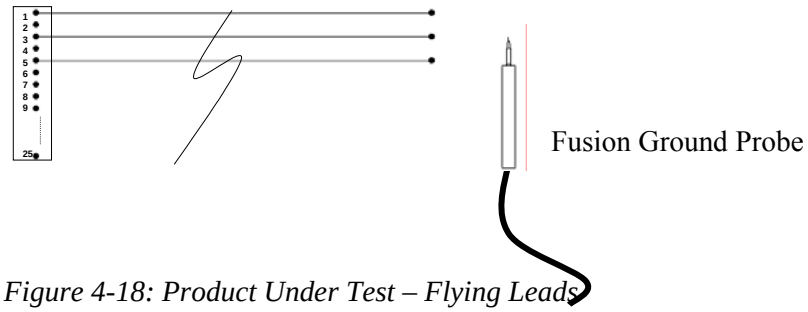
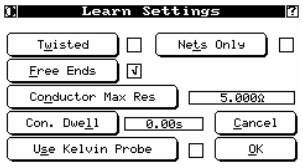


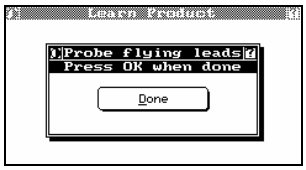
Figure 4-18: Product Under Test – Flying Leads

5.7.1.1 Programming a Free Ends Test



To begin to learn a product with free ends, from *Learn Settings* (see section 5.2.2.2), enable **Free ends**.

Press **OK** to display *Component Settings*, then press OK again to start learning the product as usual.



Once the NetList has been learned, you are prompted to do the first probe.

You are prompted to specify the pin's name. Enter it and press **Enter**.

You are prompted to specify the wire's label. Since this will also be the prompt when the product is tested, make the label as instructive and clear as possible. You can use up to 30 alphanumeric characters.

Enter the label and press **Enter**.

You will continue to be prompted to probe, specify pin name and then wire label. When all pins have been probed, press **Done**.

Here is a sample pin list for net 1.

Test Program as CBL File

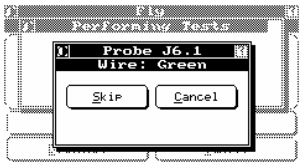
\datab\cables\main\flyingle.cbl For syntax information, see chapter 0.

```
*CABLE*,FLYING LEADS,1
    *STAR*
  *THRESHOLD*,61
  *ADAPTER*,HA 116,
    *POSITION*,J1
  *NET*,,
    FREE_END 1,GREEN,
    J1.C1.1,,
  *NET*,,
    J1.C1.2,,
  *NET*,,
    FREE_END 3,BLACK,
    J1.C1.3,,
  *NET*,,
    J1.C1.4,,
  *NET*,,
    FREE_END 5,WHITE,
    J1.C1.5,,
  *NET*,,
    J1.C1.6,,
  *NET*,,
    J1.C1.7,,
  *NET*,,
    J1.C1.8,,
  *NET*,,
    J1.C1.9,,
  *NET*,,
    J1.C1.10,,
  *NET*,,
    J1.C1.11,,
  *NET*,,
    J1.C1.12,,
  *NET*,,
    J1.C1.13,,
  *NET*,,
    J1.C1.14,,
  *NET*,,
    J1.C1.15,,
  *NET*,,
    J1.C1.16,,
  *NET*,,
    J1.C1.17,,
  *NET*,,
    J1.C1.18,,
  *NET*,,
    J1.C1.19,,
  *NET*,,
    J1.C1.20,,
  *NET*,,
    J1.C1.21,,
  *NET*,,
    J1.C1.22,,
  *NET*,,
    J1.C1.23,,
  *NET*,,
    J1.C1.24,,
  *NET*,,
    J1.C1.25,,
*END*
```

5.7.1.2 Testing A Product With Free Ends

As with all testing on the Fusion, testing a product with free ends is easy and straightforward. Follow the process described in section 5.2.2.2 to start the testing process.

Make sure that the standard probe is attached before starting the testing process.



The Fusion prompts you to touch the first flying lead (free end) to be tested. (Notice that the prompt incorporates the label given during the learning process.)

Using the probe, touch the correct lead; the Fusion sounds a positive tone, and automatically sequences to the next lead. If you touch the wrong lead, or if the lead is open, a negative tone sounds, and the system does not automatically sequence. If you are sure you are touching the correct lead, push **Skip** to sequence to the next lead.

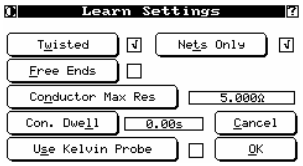
A correct lead will display its address on the prompt screen. To display the address of an incorrect or open lead, hold the probe to the lead

You will continue to be prompted for each of the flying leads defined in the test.

5.7.2 Programming and Running Twisted Pairs Tests

The Fusion can calculate the difference between twisted and non-twisted pairs.

5.7.2.1 Programming Twisted Pairs by Learning



From *Learn Settings* (see section 5.2.2.2), press **Twisted** and enter a threshold capacitance setting value. You should also enable **Nets Only**.

Press **OK** to display *Component Settings*, then press OK again to start learning the product.

Here is an example of the results. To change the threshold capacitance setting value, press **Thres** and enter a new value.

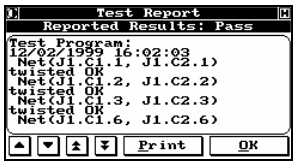
Test Program as CBL File

\datab\cables\main\twisted.cbl For syntax information, see chapter 0.

```
*CABLE*,TWISTED,1
  *THRESHOLD*,61,250
  *STAR*
  *QUICKISOLATION*
  *ADAPTER*,HA 116,
    *POSITION*,J1
  *ADAPTER*,HA 115,
    *POSITION*,J3
  *TWIST*,,
    *THRESHOLD*,2e-11
    *NET*,,
      J1.C1.9,,
      J3.C1.9,,
    *NET*,,
      J1.C1.21,,
      J3.C1.21,,
  *TWIST*,,
    *THRESHOLD*,2e-11
    *NET*,,
      J1.C1.16,,
      J3.C1.16,,
    *NET*,,
      J1.C1.22,,
      J3.C1.22,,
  *TWIST*,,
    *THRESHOLD*,2e-11
    *NET*,,
      J1.C1.24,,
      J3.C1.24,,
    *NET*,,
      J1.C1.25,,
      J3.C1.25,,
  *NOTWIST*
    *NET*,,
      J1.C1.1,,
      J3.C1.1,,
    *NET*,,
      J1.C1.2,,
      J3.C1.2,,
    *NET*,,
      J1.C1.3,,
      J3.C1.3,,
    *NET*,,
      J1.C1.4,,
      J3.C1.4,,
    *NET*,,
      J1.C1.5,,
      J3.C1.5,,
    *NET*,,
      J1.C1.6,,
      J3.C1.6,,
    *NET*,,
      J1.C1.7,,
      J3.C1.7,,
    *NET*,,
      J1.C1.8,,
      J3.C1.8,,
    *NET*,,
      J1.C1.10,,
      J3.C1.10,,
    *NET*,,
      J1.C1.11,,
      J3.C1.11,,
    *NET*,,
      J1.C1.12,,
      J3.C1.12,,
    *NET*,,
      J1.C1.13,,
      J3.C1.13,,
    *NET*,,
      J1.C1.14,,
      J3.C1.14,,
    *NET*,,
      J1.C1.15,,
      J3.C1.15,,
    *NET*,,
      J1.C1.17,,
      J3.C1.17,,
    *NET*,,
      J1.C1.18,,
      J3.C1.18,,
    *NET*,,
      J1.C1.19,,
      J3.C1.19,,
    *NET*,,
      J1.C1.20,,
      J3.C1.20,,
    *NET*,,
      J1.C1.23,,
      J3.C1.23,,
*END*
```

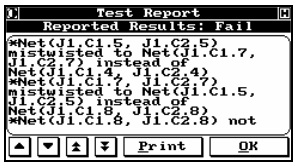
5.7.2.2 Testing a Product with Twisted Pairs

Follow the normal test process described in section 5.2.2.2.



The *Test Report* screen shows all test results.

This example shows all tests that passed.



This example shows a failed twisted pair cable.

6 Programming and Testing in EST Mode

6.1 Introduction

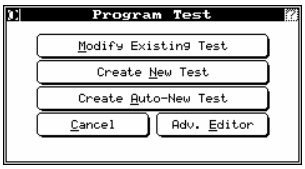
6.1.1 Choosing a Mode

Section 0 explains the difference between the two modes. In essence, if you want highly automated tests, use CableTest mode. If you want to be able to customize your tests, use EST mode.

6.1.2 Choosing a Programming Method

EST lets you develop test programs in two main ways: the auto-new test method and the new test method. The auto-new test method produces results appropriate for most applications, quickly determining whether or not the product has any shorts or opens, or if any wires are connected to the wrong pins, and providing information such as the location of the fault to the operator. Auto-new tests operate on all the wires of a product, similar to how CableTest mode works. The new test method lets you define tests for specific wires, perform a continuity test, and insert a pause to prompt the operator during the test.

Both methods are accessed from the Program Test screen:



From the *EST mode Main Menu*, press **Program test** to display the *Program Test* screen.

Some functions may be password-protected. The factory-installed password is “1234”.

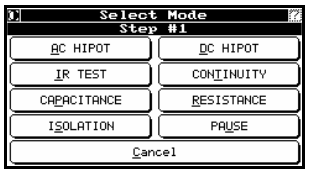
6.1.3 Overview of Steps

The key steps in programming and testing a product are:

1. Add the adapter being used for the product to the adapter library if necessary (see section 5.2).
2. If using the auto-new test method, set the basic test conditions and settings (see section 6.2.2.1).
3. “Learn” a known good product to create the test program (see section 5.2.2).
4. Optionally, change test parameters to further refine the test (see section 6.2.4).
5. Test a product using the test program (see section 5.2.2.2).

6.1.4 About Test Modes

When you use auto-new test, you create a basic test program, based on specific parameters, that applies to all the wires in a product. To apply tests to individual wires, you need to use the *Select Mode* screen, which appears after a product is learned with the new test method or when you modify an existing test.



The functions on this screen are described throughout this chapter:

- AC Hipot (see section 6.5.5.1)
- DC Hipot (see section 6.5.4)
- IR Test (see section 6.5.6)
- Continuity (see section 6.2.4.1)
- Capacitance (see section 6.6.3.2)
- Resistance (see section 6.6.2.2)
- Isolation (see section 6.3.1)
- Pause (see section 6.2.4.2)

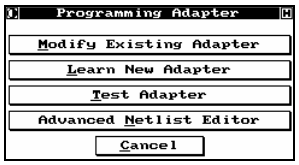
6.1.5 About Test Steps

In EST mode, you can control the order of steps in which different tests (or tests of different wires) are carried out. By default, steps are placed in the order of creation. The screen title will indicate the step number, as shown below:

6.2 General Instructions

6.2.1 Adding an Adapter

The Fusion includes an adapter library containing a single adapter, called "no adapter", which tests all the points. For most purposes, you will want to add the adapter used for your product to the Fusion adapter library. You add an adapter by learning it, much as you will learn a cable.



On the *EST mode Main Menu*, press **Edit Adapter** to display the *Adapter Library* screen.

Press **Learn New Adapter**.

A series of screens prompts you for:

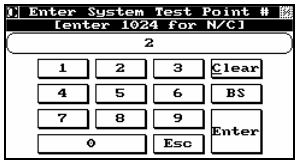
- Name for the adapter.
- Number of connectors mounted on your adapter.
- Name of each connector (it is recommended that you base the name on some easily identifiable feature of the connector, such as its type, color, manufacturer's part number, etc.).
- Number of pins.

The *Edit Connector's Netlist* screen appears.

You now need to map the Fusion's internal pin/switch designators to the connector pin number.

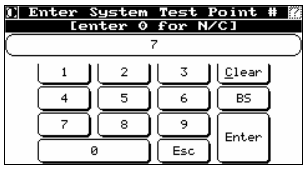
The **Kelvin** toggle is provided for use with Kelvin adapters

Using the provided ground probe, touch the tip to each connector pin in its standard numbering sequence. The Fusion maps the connector pin to its corresponding system pin and displays a pin map similar to the one shown above. The "Sense" column is reserved for the special case, Kelvin adapters (see section 7.4).



The Fusion lets you define the numbering convention needed for your adapter (see section 7.3) or you can edit each individual connector pin name by highlighting the pin and pressing **Edit**. You can also use the edit function to manually enter system pins or define a point as NC (not connected).

To edit a pin, highlight its **Conn. Pin** and press **Edit** to display the *Enter System Test Point #* screen.



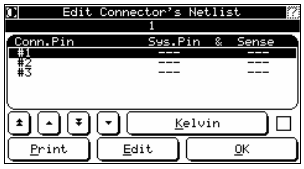
Enter the associated system pin number and press **Enter.** Enter 0 for N/C (not connected) pins.

If the Kelvin toggle is enabled, pressing **Edit** will prompt you to enter values for both the Sys. Pin and Sense pins. If your adapter is not a Kelvin adapter, the default 0 (NC) should be present in the Sense column. With Kelvin disabled you are prompted only for the Sys. Pin value. Kelvin requires odd and even consecutive pairs (for example, 7, 8). For more about Kelvin adapters, see section 7.4.

To continue, press **Enter** to display the *Edit Pin's Name* screen.

Enter a new name for the pin and press **Enter**.

The option to name pins at this level is limited since no lower case letters are available. To properly set a numbering convention you should use the conventions features described in section 7.3.



Repeat the above steps for any and all remaining connectors.

To print the completed pin map, press **Print**.

After you have programmed all the connectors, press **OK** to display the *Edit Adapter* screen.

From *Edit Adapter*, you can edit any of the adapter's properties. See section 0 for details.

- **Label** – enter a label for the adapter.
- **Connectors** – edit connector names and pin mapping of an adapter, as described above.
- **Cap Offset** – For increased capacitance measurement accuracy, the capacitance of the adapter may be learned and utilized as an offset value. Pressing this button takes you through the steps of learning the capacitive offset.
- **Res Offset** – For increased resistance measurement accuracy, the resistance of an adapter can by learned and utilized as an offset value. In order to perform this function, you must short all points together that are contained on each connector. Pressing this button takes you through the steps of learning the resistance offset.

To offset a connector you must have a minimum of three (3) test points.

For more information on working with the adapters in the adapter library, see chapter 7.0.

Adapter as ADP File

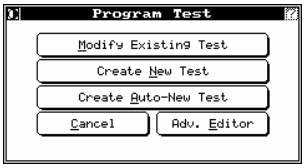
\datab\adapters\special.adp For syntax information, see chapter 0

```
*ADAPTER*,SPECIAL
*CONNECTOR*,DB9 #1,
12,1,,,,
11,2,,,,
10,3,,,,
9,4,,,,
8,5,,,,
13,6,,,,
14,7,,,,
15,8,,,,
0,9,,,,
*CONNECTOR*,DB9 #2,
7,1,,,,
5,2,,,,
1,3,,,,
2,4,,,,
3,5,,,,
6,6,,,,
4,7,,,,
28,8,,,,
24,9,,,,
```

6.2.2 Learning the Product

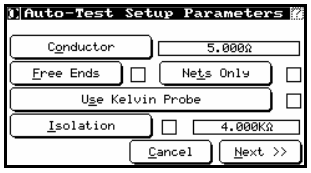
We refer to the process of programming the Fusion to test a product as "learning" the product, since this is almost literally what you do. Starting with a known good, or "golden", product, you are guided through a series of simple steps during which a parametric profile is made of the product. The resulting test program is then stored as a simple ASCII file. After that, any time you want to test an identical product, the parameters are loaded from the file and are used as the basis for the test.

6.2.2.1 Auto-New Test Method



On the *EST mode Main Menu*, press **Program Test** to display the *Program Test* screen.

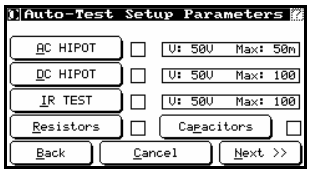
Press **Create Auto-New Test** to display the *Auto-Test Setup Parameters* screen.



- To set the maximum conductor resistance and dwell time, press **Conductor**. Maximum conductor resistance is automatically set to a default value, which you can change if necessary when looking for low ohm resistors or learning a Kelvin fixture.
- To test for free ends, enable **Free Ends** (see section 6.7.1)
- To test only complete nets, enable **Nets Only** (see section 6.5.3).
- To create a probe using two test points for accurate resistance measurements of free end products, enable **Use Kelvin Probe**. The probe is created as an adapter in the adapter library. If you choose this option, you are prompted to select the points where the Kelvin probe is plugged in.

  Kelvin requires odd and even consecutive pairs (for example, 7, 8).
- To set the maximum isolation resistance and dwell time, press **Isolation**. See section 6.3.1.

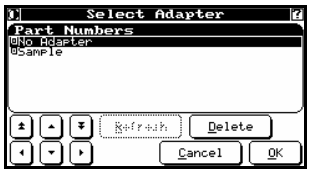
When settings are complete, press **Next** to display a new screen.



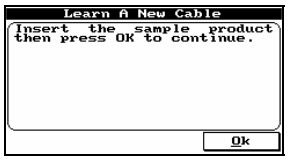
Set up the global parameters for the test. Choose from the following:

- AC Hipot (see section 6.5.5.1)
- DC Hipot (see section 6.5.4.1)
- IR Test (see section 6.5.6)
- Resistors (see section 6.6.2)
- Capacitors (see section 6.6.3)

When test settings are complete, press **Next**.

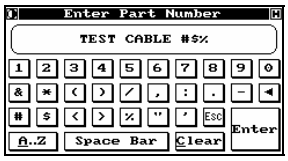


Choose your adapter.



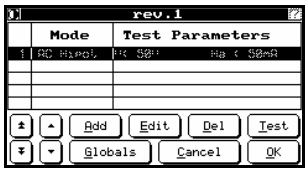
Insert your "golden" product and press **OK** to begin the learning process.

As the Fusion learns your product, a status screen keeps you informed about its progress. The NetList for the product is learned and stored in a file.



After the NetList has been learned, you are asked to enter a test name to be used to label this product's test record. You can use any combination of up to 32 alpha and numeric characters as well as other valid ASCII symbols, such as parentheses, *, &, ^, etc., for your test name.

Press **Enter** to display the test details screen.



To confirm the results of the learning process, highlight the Continuity test step and press **Edit** and then **Netlist** to see the NetList results.

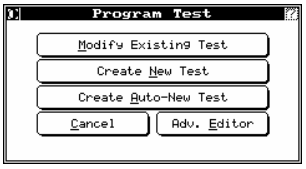
For instructions on the options available from this screen, see section 6.2.4.

Press **OK** to save your test program and display the *Open Directory* screen.

Highlight the directory in which you want to save the test program, then press **OK**. The test program is saved, and you are returned to the *Program Test* screen. (If you want to store your test program in a new directory, press **New**, and you are prompted to enter the new name. Press **Enter** when done.) You can use any combination of up to 32 characters for directory or test program names.

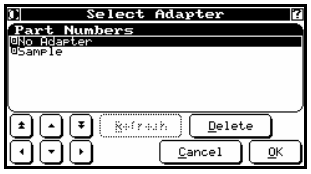
You can continue the learning process and program as many products as you like by simply repeating these steps. When you have finished, press **Cancel** to return to the Main Menu.

6.2.2.2 New Test Method

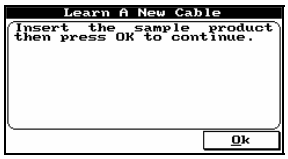


On the *EST mode Main Menu*, press **Program Test** to display the *Program Test* screen.

Press **Create New Test**.

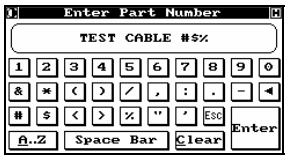


Choose your adapter.



Insert your "golden" product and press **OK** to begin the learning process.

As the Fusion learns your product, a status screen keeps you informed about its progress. The NetList for the product is learned and stored in a file.

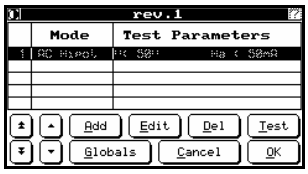


After the NetList has been learned, you are asked to enter a test name to be used to label this product's test record. You can use any combination of up to 32 alpha and numeric characters as well as other valid ASCII symbols, such as parentheses, *, &, ^, etc., for your test name.

Press **Enter** to display the *Select Mode* screen.

Choose the appropriate mode and enter its settings (see section 6.1.4 for a summary of the options)

Once mode settings are complete and you press **OK**, the test details screen appears.



To confirm the results of the learning process, highlight the Continuity test step and press **Edit** and then **Netlist** to see the NetList results.

To add steps to the test, press **Add** to re-display the *Select Mode* screen. Enter the appropriate parameters for the mode, which then is added as a step on this screen. Continue to add steps as needed.

Steps that are grayed out on the display are invalid (will not give results).

For instructions on other functions of this screen, see section 6.2.4.

Press **OK** to save your test program and display the *Open Directory* screen.

Highlight the directory in which you want to save the test program, then press **OK**. The test program is saved, and you are returned to the *Program Test* screen. (If you want to store your test program in a new directory, press **New**, and you are prompted to enter the new name. Press **Enter** when done.) You can use any combination of up to 32 characters for directory or test program names.

You can continue the learning process and program as many products as you like by simply repeating these steps. When you have finished, press **Cancel** to return to the *Main Menu*.

6.2.2.3 Choosing the Wires to Test

Test modes allow you to specify, along with test-specific parameters, the "from" and "to" wires to use for the test.

Choose the ground or common wire(s) by pressing **From** to display the *Net List From* screen.

The example screen shows AC Hipot, but this function applies to all modes in EST.

- Use the arrows to navigate through the list.
- To add a net to the list, press **Add** and select the appropriate net.
- To delete a net from the list, highlight it and press **Delete**. You are prompted to confirm the deletion.
- To change the label of a net, highlight it and press **Label**. You are prompted to enter a new label.
- To open a net, highlight it and press **Open**. The list of pins in the net appears.

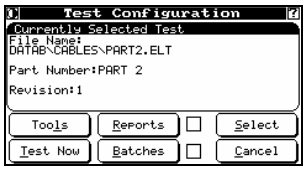
Repeat for the wire(s) to energize by pressing **To** and following the instructions above.

Other common functions available from this screen, regardless of which test is being set up, are:

- **Label**: label or change the label of the test. You are prompted for the new label.
- **Test**: perform the test immediately.

6.2.3 Testing a Product

Note that this function cannot be password-protected since it is a "run-only" function; system and/or test parameters cannot be modified, added or deleted.



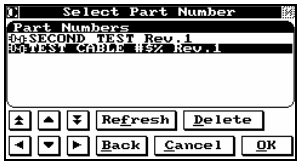
On the *EST mode Main Menu*, press **Test** to display the *Test Configuration* screen.

The screen shows the directory location and test name for the product you just learned or the last test run (whichever happened more recently).

If this screen shows the test you want to run, press **Test Now**; otherwise, you can choose the appropriate test by following the instructions below.

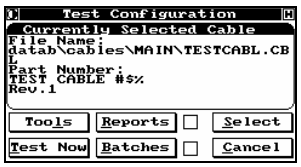
- For information on the Tools function, see section 6.4.
- For information on the Reports function, see section 8.1.
- For information on the Batches function, see section 8.2.

Press **Select** to display the *Open Directory* screen. Highlight the desired directory and press **Open** to see a list of test names contained in that directory. To quickly find a specific directory, use the Fast Load function described in section 3.9.



Highlight the test name to be tested and press **OK** or, alternatively, use the Fast Load feature described in section 3.9.

- **Refresh** re-loads the directory.
- **Delete** removes highlighted test name from directory.
- **Back** returns you to the *Open Directory* screen.
- **Cancel** returns you to the *Test Configuration* screen.

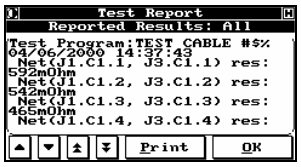


The appropriate test name is now displayed as the *Currently Selected Cable*. Press **Test Now** to start the testing process.

The information for the selected test program is loaded and you are prompted to start the test. Press the Start button on the front of the Fusion.

During the test, the blue "danger" light is lit. If your product passes, the green "pass" light is lit at the end of the test. If it fails, the red "fail" light is lit at the end of the test.

Once the test is complete, if you have set up reports to be printed automatically (see section 8.1.3), they will be sent to the printer.



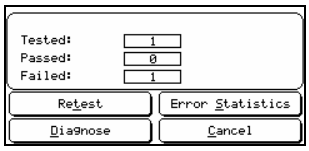
If you enabled the Auto Diagnose option (see section 8.1.3), the Test Report screen appears, showing information on the most recent test. Each time you press the *Test Report* screen you see a different type of display, until you have scrolled through all of them. The choices are:

- None (no results are displayed)
- Fail (shows only failed results)
- Pass (shows only pass results)
- Pass/fail (if the test passed, shows only a statement to that effect; if the test failed, shows details)

Changing the display on-screen also changes it in the test reports setting screen (see section 5.2.3).

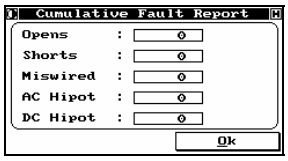
To print an individual test report display, press **Print**.

Press **OK** to display the test summary screen, which appears automatically if you have not enabled Auto Diagnose.



This screen shows the number of products tested, passed and failed.

- To re-test the same product with the same test program, press **Retest**. The number of products tested will not increment.
- To test a new product with the same test program, attach the new product and press the Start button again.
- To stop using this test program, press **Cancel**.
- To display the Test Report screen (see above), press **Error Statistics**.
- To view a report of the faults found in all tests done during this session, press **Error Statistics** to display the Cumulative Fault Report screen.

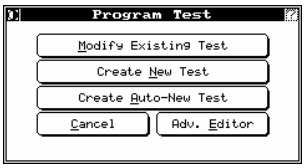


In the example shown, only one test has been performed, and it was good, so the report shows all 0's.

You can also test a program by pressing **Test** from a test-specific screen (see 6.2.2.3).

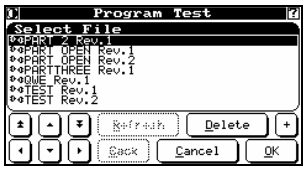
6.2.4 Modifying a Test Program

You can modify an existing test program at any time.



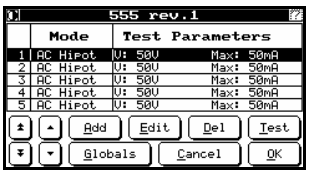
On the *EST mode Main Menu*, press **Program Test** to display the *Program Test* screen.

Press **Modify Existing Test**.



Highlight the directory and test program you wish to modify and press **OK** or, alternatively, use the Fast Load feature described in section 3.9.

The test program is loaded and the test parameters screen for the test appears.



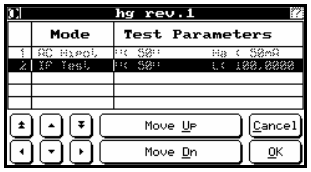
Make changes as necessary.

- To add a step to a test, press **Add** to display the *Select Mode* screen and follow the instructions for the appropriate mode (for a summary, see section 6.1.4).
- To edit a step, highlight it and press **Edit** to display the original parameters for that step. Follow the instructions for the appropriate mode.
- To delete a step, highlight it and press **Del**. You are prompted to confirm the deletion.
- To carry out the test now, highlight it and press **Test**.

ⓘ Steps that are grayed out on the display are invalid (will not give results).

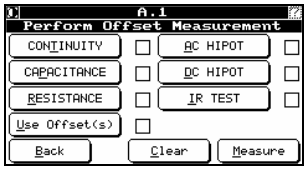
To set global settings that apply to the entire test, press **Global** to display the *Default Settings* screen.

- To require an operator-level password to be entered before this test can proceed, enable **Password Protected** — this is independent of the normal password protection.
- To set the discharge delay that controls the discharge of the PUT, press **Discharge Delay** and enter a value. This affects both AC and DC Hipot testing. By default the Fusion discharges the PUT as fast as possible, but you can set this to any value between .1s and 1200s.
- To name or change the name of the test, press **Name**. You are prompted for a new name.



- To change the order of the steps in the test, press **Re-Order Steps** to display the test parameters screen with new buttons. Highlight any step and press **Move Up** or **Move Down**.

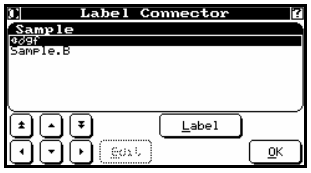
Press **OK** to return to the regular test parameters screen, then **OK** again to return to *Default Settings*.



- To perform offsets for all or some of the test steps, press **Offset** to display the Perform Offset Measurement screen and do one of the following:
  - To perform offsets for a particular type of test step, enable those types (for example, “Capacitance”, “Resistance” and “IR Test”).
  - To measure the offset for selected items, press **Measure**.
  - To use the measurements in tests, enable **Use Offset(s)**. If this option is disabled, measurements are stored but not used.

- To select an adapter and, optionally, change its connector's labels, press **Adapters** to display the *Select Adapter* screen.

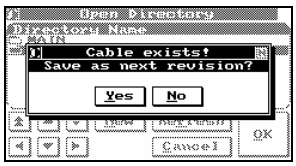
Select the adapter to edit and press **Edit** to display the *Label Connector* screen.



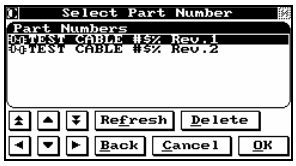
Make the necessary edits and press **OK** twice to return to the test parameters screen.

Highlight a directory to save the file in or press **New** to create a new directory.

Press **OK** to continue.



If you are saving the file into the same directory it was originally stored in, you can save the file as a next revision or overwrite the existing file.



- If you create a next revision, a new record is created with the same test name and an incremented revision number.

- If you do not create a next revision, you are prompted whether you wish to overwrite the existing file.

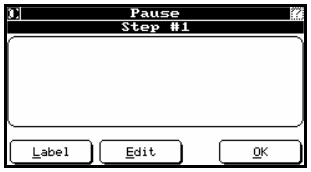
6.2.4.1 Adding Continuity Tests

If you manually create a test using the new test method, you may need to add a continuity test. Press **Continuity** from the *Select Mode* screen (see section 6.1.4) to display the *Continuity* screen.

- To set maximum and minimum resistance, press **Max Res** or **Min Res** and enter a value.
- To set the dwell time, press **Test Time** and enter a value.
- To enter a value for the continuity, press **Label** and enter a label.
- To perform the test, press **Test**. Test results are reported and the test parameters screen appears.

6.2.4.2 Adding Prompts and Pauses

Use this function to insert pauses in the test process, with prompts to the operator. These steps appear when you press **Pause** from the *Select Mode* screen (see section 6.1.4).



- To change the name of the pause, press **Label** and enter a new name.
- To add prompt text, or edit existing prompt text, press **Edit** and enter prompt text.

When settings are complete, press **OK** to return to the test parameters screen.

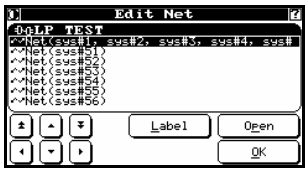
6.2.5 Working with NetLists

With Fusion, you can edit the labels of nets and their pins in the NetList. If you have a VGA monitor and AT keyboard attached to Fusion, you can use the advanced NetList Editor to actually modify the contents of the NetList.

6.2.5.1 Viewing NetLists and Changing Labels

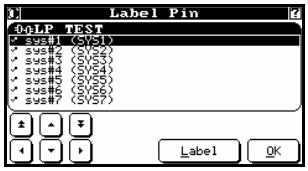
From the *Default Settings* screen (see section 6.2.4), press **Net List** to display the *Edit Net* screen.

The Edit Net screen is also available from the Continuity screen (explained above).



To change the label of a net, highlight it and press **Label**. You are prompted for the new label.

To open a net, highlight it and press **Open** to display the *Label Pin* screen.

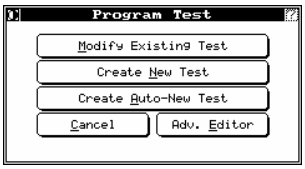


To change the label of a pin, highlight it and press **Label**. You are prompted for the new label.

Press **OK** to return to *Edit Net*, and **OK** again to return to *Default Settings*.

6.2.5.2 Advanced NetList Editor (Optional)

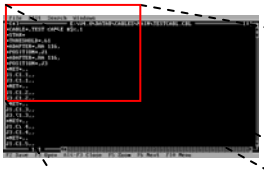
An available option for the Fusion is an onboard script editor. To edit a script from the Fusion you need to have a VGA monitor and an AT keyboard attached to the system.



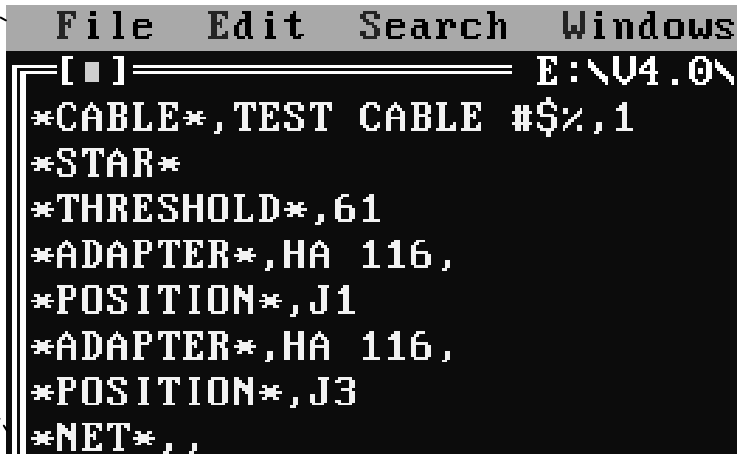
On the *EST mode Main Menu*, press **Program Test** to display the *Programming Test* screen or **Edit Adapter** to display the *Programming Adapter* screen

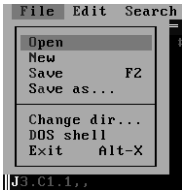
Press **Adv. Editor** to open the text editor.

Open the desired directory and select the product you wish to edit. Press **OK**.



The online text editor opens, displaying the test program's script.





Once you have edited the file as necessary, press **<Alt-F>** to pull down the File menu, then **<S>** or **<F2>** to save and **<Alt-X>** to exit and return to *Program Test*.

6.3 Low Voltage Test

6.3.1 Low Voltage Testing Options

Open *Select Mode* for the test you want to modify (see section 6.1.4) and press **Isolation**.

- Choose the wires to test by pressing **From** and **To**, as explained in section 6.2.2.3.
- To set the minimum resistance, press **Min. Res** and enter a value.
- To set the dwell time, press **Test time** and enter a value.

When settings are complete, press **OK** to return to *Resistor Step #1*.

Press **OK** to return to the test parameters screen.

Measurements higher than the maximum value entered will be considered opens. If your test requires a minimum conductor resistance and the test measures lower than the threshold value, the fault will be reported as "wrong gauge".

6.3.2 Low Voltage Testing Examples

6.3.2.1 Opens

Common errors or faults reported by the Fusion for a cable during a low voltage test are opens, shorts, and miswiring faults. Should the low voltage test fail, before removing the product from the adapters, pressing **Diagnose** will report the cause of the cable failing.

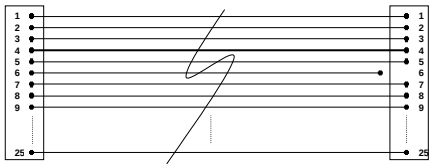
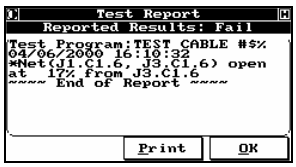


Figure 4-19: PUT with Open J3.C1.6



The first example is an open connection. The Fusion reports that the cause of the fail condition is an open connection located at pin 6 of the first connector on the adapter mounted in the J3 position. Note that the fault is at the adapter level.

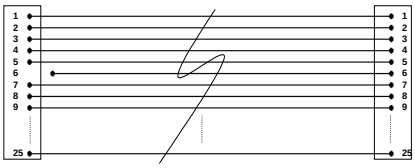
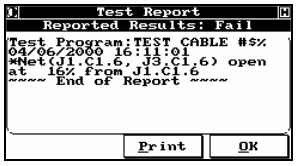


Figure 4-20: PUT with Open J1.C1.6



Reversing the cable with the open connection and re-testing it reveals the Fusion's ability to locate the position of the open net. Note the same fault now appears at J1 instead of J3.

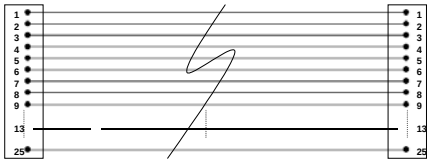
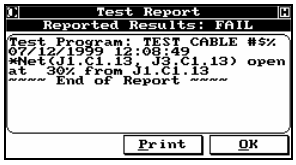


Figure 4-21: Open at 30%.



In this example, the open has occurred at 30% the distance from the first adapter.

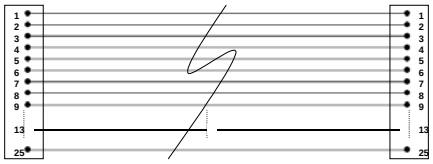
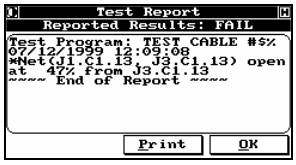


Figure 4-22: Open at 47%.



In this example, the open has occurred at 47% the distance from the first adapter.

6.3.2.2 Miswires

Miswire reports are extremely accurate. A miswire error is reported when the Fusion tests a cable and the nets do not match the configuration of the original "golden" sample.

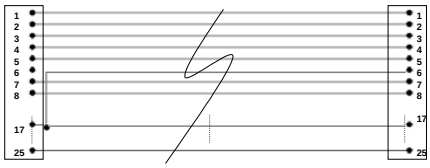
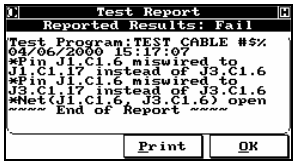


Figure 4-23: PUT Miswired



In the example to the left, the cable is miswired and Fusion notes the current wrong configuration and the correct configuration it expected.

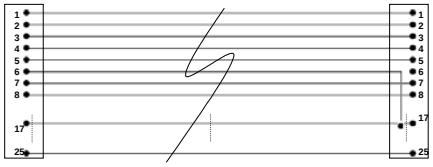
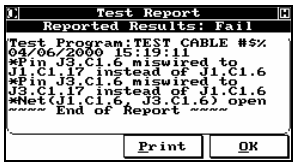


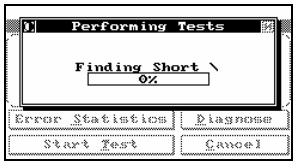
Figure 4-24: PUT Miswired – reversed



Reversing the cable and re-testing, the Fusion reports the same net to be faulty, but points to the correct adapter at which the fault can be located.

6.3.2.3 Shorts

One of the unique features of the Fusion is its ability to pin-point the location of shorts on a test cable. With regards to low voltage tests, shorts can be detected and located by the Fusion.



During the isolation test of a cable, the Fusion can diagnose shorts and the location of the fault relative to its position from the adapters. If a short is detected, the system will display a rotating character next to the "Finding Short" message to tell the operator it is still working and diagnosing faults.

It is important to remember that the Fusion can only detect, and will not pin-point, the location of a short (arc) that is a result of a high voltage test.

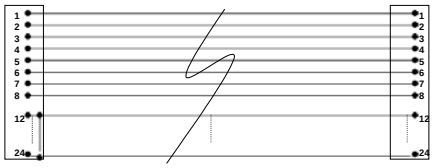
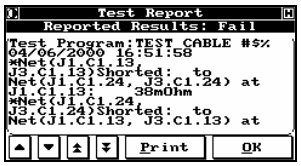


Figure 4-25: Short at J1



In the example above, the cable was tested and failed as a result of a short very close to the adapter at J1. Use the down arrow button to see the remainder of the error message.

Asterisks always precede faults.

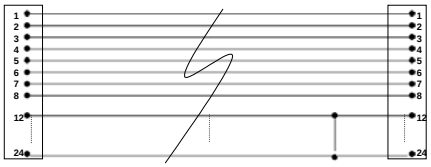
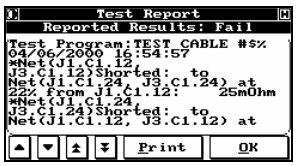
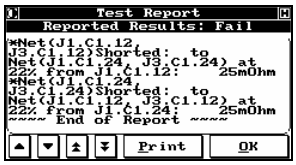


Figure 4-26: Short at 81%



In the next example, the same cable has failed as a result of a short, not at either end of the cable, but 81% of the distance from the first adapter. In this manner, the fault to be dealt with at the re-working station can easily be identified.

Use the down arrow button to see the remainder of the error message.



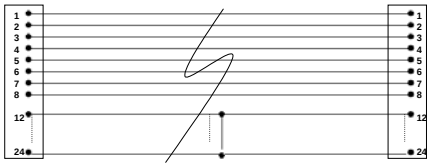
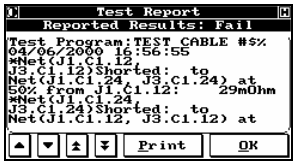
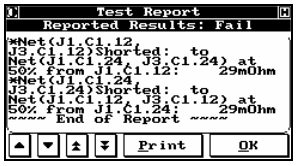


Figure 4-27: Short at 55%



In this example, the short has occurred at 55% the distance from the first adapter.



Use the down arrow button to see the remainder of the error message.

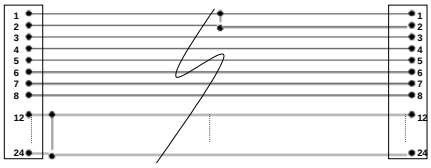
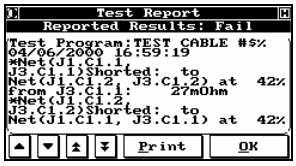
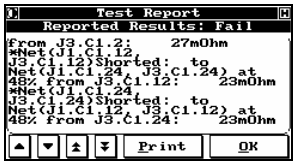


Figure 4-28: Multiple Shorts



It is not unusual to find a product that has more than one fault. The Fusion will report all faults found.



The only exceptions are those cases where one type of fault is masking another type of fault, for example, when an open circuit is sitting behind a short on the same wire. The only other exception is a case in which the product is removed before **Diagnostics** is pressed. In this case, the Fusion simply shows the product as failed and does not retain diagnostics.

Use the down arrow button to see the remainder of the error message.

6.3.2.4 Shorts and Opens with a Test Fixture

If you are using a test fixture, that is, a fixture a particular distance from the adapter level of the Fusion, then the full cable length (100%) will be measured from adapter to adapter unless you perform both a capacitive and resistive tare/offset on the fixture (see section 4.7.1 for details). If you do not wish to do this, the length of cabling from the Fusion to the test fixture is part of the distance calculation.

Consider the following setup:

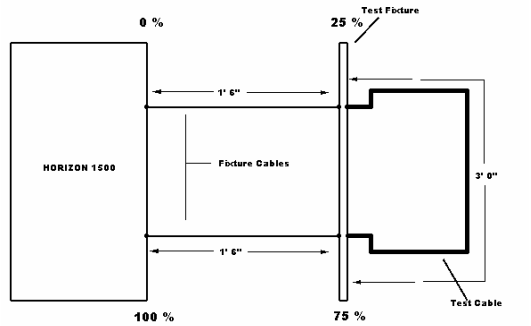


Figure 4-29: Example of a Test Fixture Setup

The above setup demonstrates the notion of faulty end recognition when a test fixture is being used with the Fusion. In the case above, should a short occur on the test cable during a low voltage test, then the short would be reported between 25% and 75%. The front of the cable is located at 25% of the total length and the rear of the cable is located at 75% of the total length.

Adapter level shorts will be reported at 25% or 75%, respectively, from a particular adapter, and a short along the cable would fall in between those two percentages.

6.4 Assembly Aid Tools

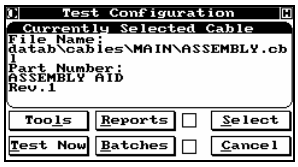
Assembly Aid allows you to randomly populate one end of the product, and then use the tool to test and populate the remaining end(s) of the product.

The following is a step by step example using a cable terminated at one end with a DB50 connector and not terminated at the other.

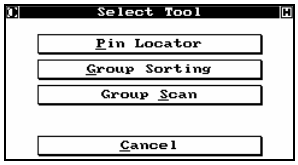
The following example makes use of the standard Fusion ground probe as well as a cup of ordinary unsalted water.

6.4.1 Learn the Open Product

Follow the instructions in section 6.2.2 to learn the open product, then display the *Test Configuration* screen for that product (from the *EST Mode Main Menu*, press **Test**).



Press **Tools** to begin the Assembly Aid process and display the *Select Tool* screen.



- For information on the Pin Locator function, see section 6.4.5
- For information on the Group Sorting function, see section 6.4.3.
- For information on the Group Scan function, see section 6.4.2.

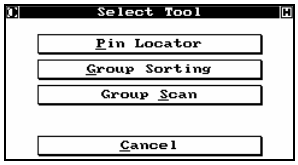
6.4.2 Perform a Group Scan

Before you begin, it is recommended to verify the continuity of all conductors that are terminated within the connector.

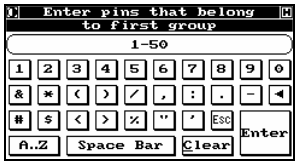
To perform group continuity, place the Fusion probe within the glass of water.

Connect the terminated end of the product to the Fusion.

Place the non-terminated end into the glass of water.

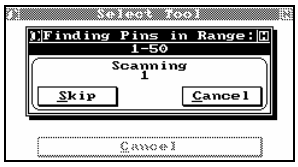


From *Select Tool* (see section 6.4.1), press **Group Scan** to display a new screen.

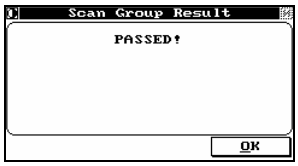


Enter a range that includes all the conductors and press **Enter** to continue.

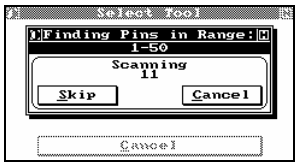
For this example we enter 1-50.



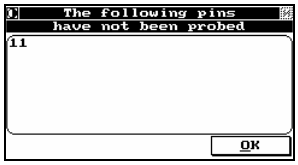
The scan will begin as soon as the conductors are submerged in the grounded water. The results vary depending on the conductor status:



- If all the conductors are continuous, the group scan will pass. Press **OK** to continue.



- If a conductor is open, the scan will pause. Press **Skip** to continue scanning or **Cancel** to exit the scan.



The end of the scan will display the conductor/pin not probed. This conductor is most likely open.

Press **OK** to continue.

To return to *Select Tool*, press **ESC**

6.4.3 Perform Group Sorting

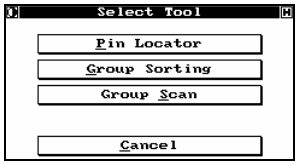
The next step involves separating the loose ends of the product into groups for easy connector assembly.

For the DB50 connector, an ideal method is to separate the conductors into the 3 rows of the DB50 connector.

Group 1: 1 - 17

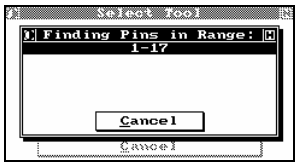
Group 2: 18 - 33

Group 3: 34 - 50

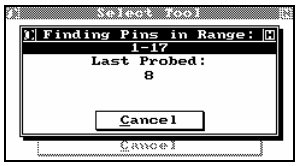


From *Select Tool* (see section 6.4.1), press **Group Sorting** to display a new screen.

Enter the pins that belong to group 1 (1 - 17) and press **Enter** to continue.



Using the ground probe, touch the conductors to isolate group 1.



As you probe the conductors, the pin you last probed is displayed. Conductors that do not belong to the group will not respond to the probe's touch.

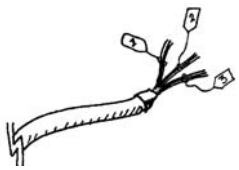
Once you have probed all the conductors, a message is displayed.

At this point you can continue to probe to verify the group.

To continue, press **Done**.

Enter the pins for the second group and begin probing the remaining conductors.

Probe until done. To continue, press **Done**.

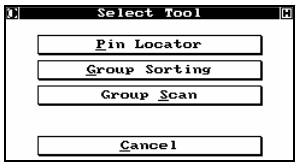


Upon completion of the second group, you will now have three sets of conductors.

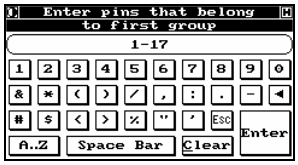
To continue, press **Esc**.

6.4.4 Perform Group Verification (Group Continuity)

It is highly recommended that, once the groups are separated, you perform a group scan on each of the groups.

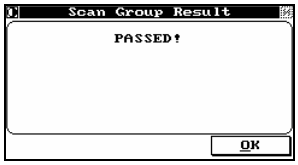


From *Select Tool* (see section 6.4.1), press **Group Scan** to display a new screen.



Enter the pins of group 1.

Place the probe and group 1 into the water and press **Enter** to continue.

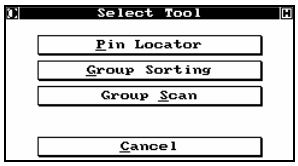


Repeat the scan for group 2 and group 3.

Once all three groups have been verified you can move to connector population.

6.4.5 Assemble the Product

The three verified groups can now be populated within the connector.

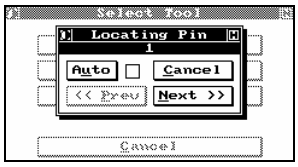


From *Select Tool* (see section 6.4.1), press **Pin Locator** to display a new screen.

Enter the pin range for the first group.

Pin ranges can be ascending or descending depending on your preference or need. If you wish to enter non-sequential pins you can do so by separating them with commas (e.g. 1,3,5,7). You may also enter ranges that are non-sequential by separating them with a comma (e.g. 1-5, 8-20).

To continue, press **Enter**.



Choose from the available methods to sequence through a range of pins.

To have the scan sequence to the next pin once a pin has been successfully probed, enable **Auto**. Be aware this may cause problems should you probe the pin and lose its location: you will then need to press **Prev** to re-scan that pin.

To have to press **Next** to sequence the next pin in the range once a pin has been successfully probed, disable **Auto**.

Once you have probed the final pin in the range, if you press **Next**, or if you are automatically sequencing, you will return to the range entry screen.

Enter the range for the next group of pins you wish to locate and press **Enter** to continue.

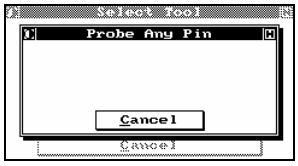
Continue until you have fully assembled the product.

6.4.6 Final Verification

Once all the pins are populated in the connector, it is recommended that you perform a final verification that the product is correctly assembled.

After the last pin is probed, if you press **Next**, or if you are automatically sequencing, you will return to the range entry screen.

If you press **Enter** without entering a range, you will enter the "Probe any Pin" mode.



Probe each pin on the assembled connector, noting the connector position and the pin displayed on the screen.

Probing pins on the newly assembled connector will display the pins as they are populated at the original terminated end.

Verify that the pin and displayed pin match.

6.5 High Voltage Testing

6.5.1 General

The Fusion can be set up to perform a DC or AC Hipot test on any product, provided that it has a high voltage DC or AC source installed. Hipot testing can be done on the entire product, or only on selected nets within the product.

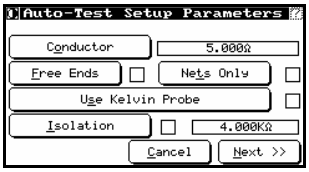
If your product has embedded resistors or diodes and these components are learned when the product is learned, the Fusion will automatically exclude the nets connected to these components. Nets with components connected to them are automatically grouped for isolation and Hipot testing, and the group of nets is treated as a single net while these tests are running. You do not need to worry about manually excluding them.

6.5.2 Safety

Your Fusion lets you set up a number of safety procedures. Which of these you use depends on local regulations, your philosophies, and the training level of your personnel.

6.5.3 Program the Fusion to Hipot the Entire Product or Harness

When using auto-new test, the setup parameters include an option to test only complete nets.



- To test only complete nets, enable **Nets Only**.

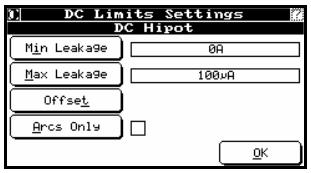
6.5.4 DC Hipot Testing

6.5.4.1 DC Hipot Settings

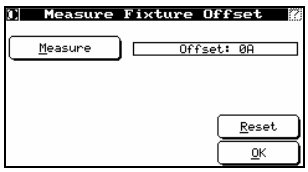
These settings are displayed when you press **DC HIPOT** from the second *Auto-Test Set Parameters* screen (see section 6.2.2.1) or from the *Select Mode* screen (see section 6.1.4).

The **From**, **To**, **Label** and **Test** buttons appear only if the screen was displayed via *Select Mode*.

- Choose the wires to test by pressing **From** and **To**, as explained in section 6.2.2.3.
- To specify a Hipot voltage, press **Voltage** and enter a value.
- To set Hipot voltage limits, press **Limits** to display the *DC Limits Settings* screen.

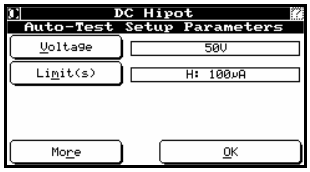


- To enter the desired leakage current, press **Min Leakage** or **Max Leakage**. Pay attention to the insulation specifications for the wire being used. The allowable range is from 1μA to 5mA. Use the arrow keys to change between "μA" and "mA" if needed.
- Choose whether to rapidly test for any insulation or other breakdowns (enable **Arcs Only**). The Fusion will still automatically test for arcs if leakage is specified. If an arc is detected, testing is immediately suspended, the arc is reported, and no further high voltage testing is performed on that cable.
- To remove fixture leakage from the leakage calculation, press **Offset** to display the *Measure Fixture Offset* screen.

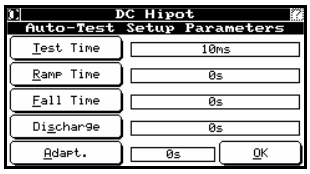


To enter the measurement, press Measure.

Press **OK** to return to *DC Hipot*.



To set up time and discharge limits, press **More** to display a new screen.

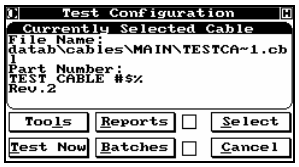


Set the appropriate times and discharge delay.

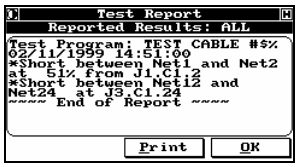
When the appropriate values have been set, press **OK** twice to return to the original screen.

6.5.4.2 Testing Using the DC Hipot

To perform a DC Hipot test on a product, simply follow the same procedures as for low voltage testing.

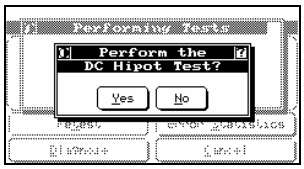


From the *EST Main Menu*, press **Test**. Select the test to be performed, if it is not the one displayed, and press **Test Now**. You are instructed to insert the adapters and to connect the product for testing.



The Fusion first performs all of the specified low voltage tests. If any of the tests fail, the "fail" light is lit. When you press **Diagnose**, the low voltage faults will be shown in a display similar to that shown here.

If a product fails any of the low voltage tests, Hipot testing will not be performed.

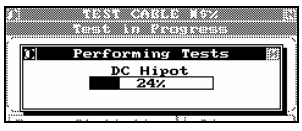


After the product has passed all of its low voltage tests, it can now be tested with high voltage.

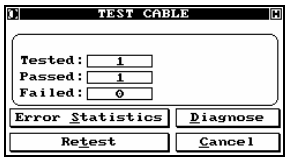
If you specified this test is password-protected, a password will have to be entered before testing will start.

The *Perform the DC Hipot Test?* screen appears:

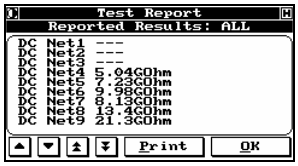
- To continue testing, press **Yes**. The *Performing Tests* screen appears.
- To cancel testing, press **No**. The *Test Statistics* window re-appears and the "fail" light is lit. From this screen, pressing **Diagnose** shows a message indicating that all tests have passed; what has happened, in essence, is a forced failure of the Hipot test.



The display shows the progress of DC Hipot testing.



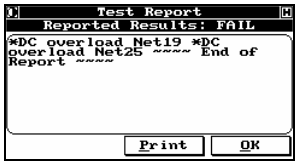
If the product fails or if the Hipot was a linear scan, press **Diagnose** on the *Statistics* window to view the diagnostics.



This display shows that a linear Hipot was performed and passed. The diagnostics report the measurements made during the test. For the PUT the IR is extremely high. The Fusion reports "---" should the measurement be over range.

6.5.4.3 Error Reporting

In addition to the standard error report messages, three additional ones are associated with DC Hipot tests.

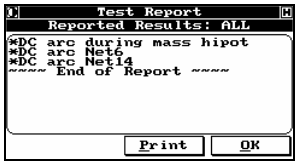


"DC Overload" is reported when an arc or excessive current leakage occurs during the charging cycle of the DC Hipot test. The message is used to differentiate between arcs during the Hipot test duration and during the time the product is being charged to the Hipot voltage level.

The sample *Test Report* indicates that, during the DC Hipot test, a fault occurred at nets 19 and 25.

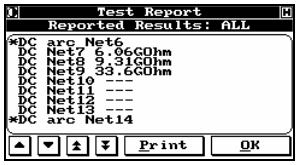
"DC Leakage" is reported whenever leakage occurs, indicating both the net and the level of leakage.

This sample report indicates that, during the DC Hipot test, there was current leakage at nets 19 and 25.



"DC arc" is reported when an arc occurs.

Arc locations can only be reported during a Mass Hipot if the fault is reoccurring. If the arc occurs only once, the system will report it but will not give a location. If you run a Linear Hipot the location will always be identified.



In this example the arc occurred during a LINEAR Hipot test.

All failures are identified with an asterisk (*).

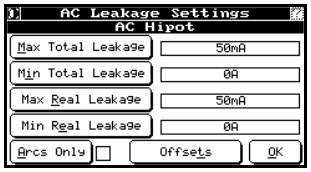
6.5.5 AC Hipot Testing

6.5.5.1 AC Hipot Settings

These settings are displayed when you press **AC HIPOT** from the second *Auto-Test Set Parameters* screen (see section 6.2.2.1) or from the *Select Mode* screen (see section 6.1.4).

The **From**, **To**, **Label** and **Test** buttons appear only if the screen was displayed via *Select Mode*.

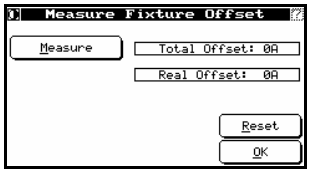
- Choose the wires to test by pressing **From** and **To**, as explained in section 6.2.2.3.
- To specify a Hipot voltage, press **Voltage** and enter a value.
- To set Hipot voltage limits, press **Limits** to display the *AC Leakage Settings* screen.



- To set absolute leakage, press **Max Total Leakage** and **Min Total Leakage** and enter values for each.
- To set neutralized leakage, press **Max Real Leakage** and **Min Real Leakage** and enter values for each. This enables the Fusion to test the true quality of the cable's insulation despite the presence of a significant reactive (capacitive) current in the circuit. This current approaches zero in a good cable and is an excellent reference for limit setting for a Hipot leakage test.

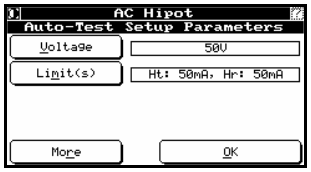
Pay attention to the insulation specifications for the wire being used. The allowable range is from 1μA to 5mA. Use the arrow keys to change between 'μA' and 'mA' if needed.

- Choose whether to rapidly test for any insulation or other breakdowns (enable **Arcs Only**). The Fusion will still automatically test for arcs if leakage is specified. If an arc is detected, testing is immediately suspended, the arc is reported, and no further high voltage testing is performed on that cable.
- To remove fixture leakage from the leakage calculation, press **Offset** to display the *Measure Fixture Offset* screen.

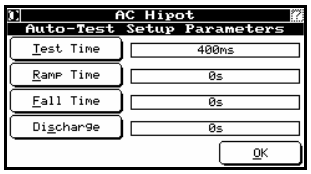


To measure the offset of a part, press **Measure**. You are prompted to remove the part, then press **OK**.

When all the values have been set, press **OK** to return to *AC Leakage Settings.*



To set up time and discharge limits, press **More** to display a new screen.

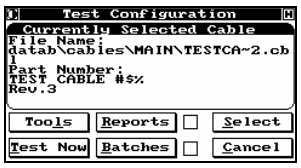


Set the appropriate times and discharge delay.

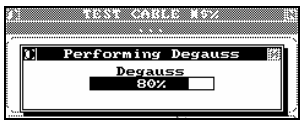
When the appropriate values have been set, press **OK** twice to return to the original screen.

6.5.5.2 Testing Using AC Hipot

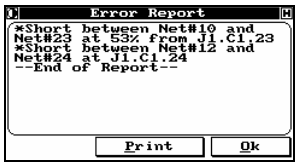
To perform an AC Hipot test on a product, simply follow the same procedures as for low voltage testing.



Press **Test** on the *Main Menu*, select the test to be performed if it is not the one displayed, and press **Test Now**. You will then be instructed to insert the adapters and to connect the product for testing.

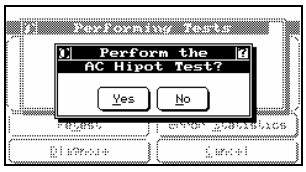


Since the test specification calls for an AC Hipot test, the Fusion automatically performs a degauss cycle before testing starts.



The Fusion will first perform all of the specified low voltage tests. If any of the tests fail, the "fail" light is lit. When you press **Diagnose**, the low voltage faults will be shown in a display similar to that shown here.

If a product fails any of the low voltage tests, Hipot testing will not be performed.

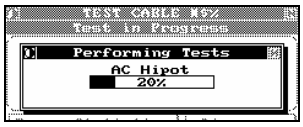


After the product has passed all of its low voltage tests, it can now be tested with high voltage.

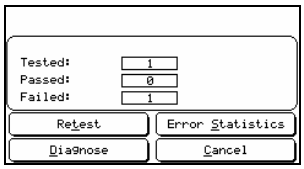
If you specified that this test was password-protected, an operator-level password will have to be entered before testing will start.

The *Perform AC Hipot Test?* screen appears:

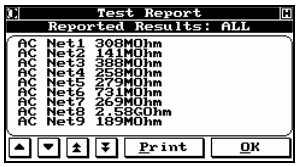
- To continue testing, press **Yes**. The *Performing Tests* screen appears.
- To cancel testing, press **No**. The *Test Statistics* window re-appears and the "fail" light is lit. From this screen, pressing **Diagnose** will show a message indicating that all tests have passed; what has happened, in essence, is a forced failure of the Hipot test.



The display shows the progress of AC Hipot testing.



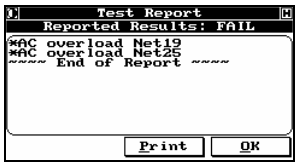
Should the product fail or if the Hipot was a linear scan, press **Diagnose** on the *Statistics* screen to view the diagnostics.



A linear Hipot was performed and passed. The diagnostics report the measurements made during the test.

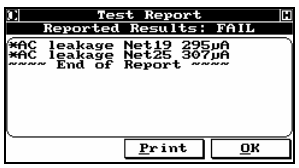
6.5.5.3 Error Reporting

In addition to the standard error report messages, additional ones are associated with AC Hipot testing.



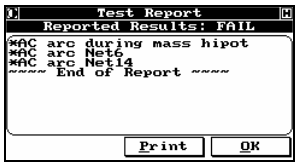
"AC Overload" is reported when an arc or excessive current leakage occurs during the charging cycle of the AC Hipot test. The message is used to differentiate between arcs during the Hipot test duration and during the time the product is being charged to the Hipot voltage level.

The sample *Test Report* indicates that, during the AC Hipot test, a fault occurred at nets 19 and 25.

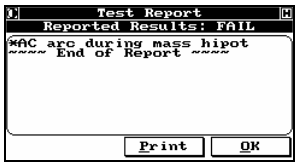


"AC Leakage" is reported whenever leakage occurs, indicating both the net and the level of leakage.

This sample report indicates that there was excess leakage at pin 19 and 25 at connector 1 on J1.

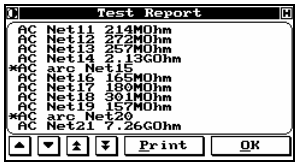


In this example an arc occurred during a MASS Hipot test.



"AC arc" is reported when an arc occurs.

Arc locations can only be reported during a Mass Hipot if the fault is reoccurring. If the arc occurs only once, the system will report it but will not give a location. If you run a Linear Hipot the location will always be identified.



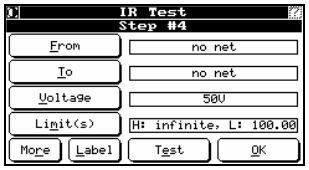
In this example, the arc occurred during a Linear Hipot test.

All failures are identified with an asterisk (*).

6.5.6 IR Hipot Testing

6.5.6.1 IR Hipot Settings

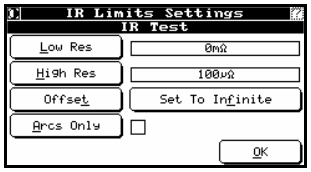
These settings are displayed when you press **IR TEST** from the second *Auto-Test Set Parameters* screen (see section 6.2.2.1) or from the *Select Mode* screen (see section 6.1.4).



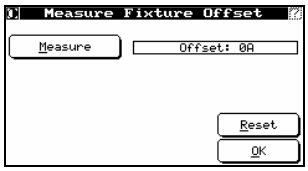
To specify a Hipot voltage, press **Voltage** and enter a value.

To set Hipot voltage limits, press **Limits** to display the *IR Limits Settings* screen.

The **From**, **To**, **Label** and **Test** buttons appear only if the screen was displayed via *Select Mode*.



- To enter the desired resistance, press **Low Res** or **High Res**.
- Choose whether to rapidly test for any insulation or other breakdowns (enable **Arcs Only**). The Fusion will still automatically test for arcs if leakage is specified. If an arc is detected, testing is immediately suspended, the arc is reported, and no further high voltage testing is performed on that cable.
- To remove fixture leakage from the leakage calculation, press **Offset** to display the *Measure Fixture Offset* screen.



To enter a measurement, press **Measure**.

Press **OK** to return to *IR Limits Settings*.

To set up time and discharge limits, press **More** to display a new screen.

Set the appropriate times and discharge delay.

When the appropriate values have been set, press **OK** twice to return to the original screen.

6.6 Component Testing

6.6.1 Introduction

The components available for programming and testing are:

- **Resisters** — see section 6.6.2.
- **Capacitors** — see section 6.6.3.

6.6.2 Programming and Running Resistor Tests

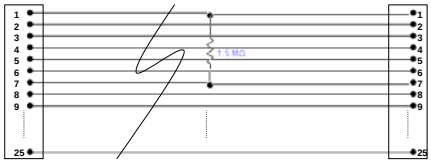
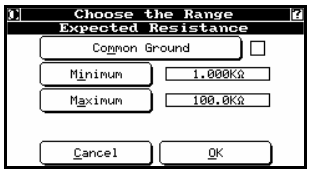


Figure 4-30: PUT with embedded Resistor

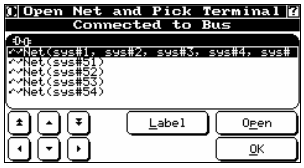
6.6.2.1 Programming Resistor Tests through Auto-New Test



Press **Resistors** from the second *Auto-Test Set Parameters* screen (see section 6.2.2.1) to display the *Expected Resistance* screen.

- If components are connected to a common bus, enable **Common Ground**.
- Enter the minimum expected resistance for all of the embedded resistors in your cable.
- Enter the maximum expected value for all the resistors in your cable.

Press **OK** to return to *Auto-Test Setup Parameters*.



If you pressed **Common Ground**, you are prompted to choose the common bus from the learned list. Once you have made your choice, the resistors are learned.

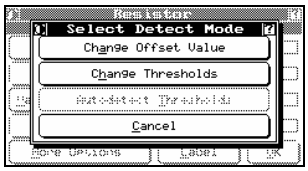
Here are some example results. In the example shown, Terminal 1 of the first resistor (R1) is connected to pin 1 of the first connector on the adapter located at J1. Terminal 2 is connected to pin 7 of the same connector.

The default tolerance for the component is set to 10%

6.6.2.2 Programming Resistor Tests through New Test

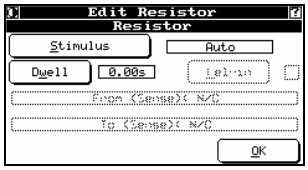
Press **Resistance** from the *Select Mode* screen (see section 6.2.2.2) to display the *Resistor* screen.

- Choose the wires to test by pressing **From** and **To**, as explained in section 6.2.2.3.
- To change the label of the capacitor, press **Label** and enter a new label.
- To run the test, press **Test**.
- To set or modify the tolerance, press **Value** to display the *Select Detect Mode* screen.
- To set the dwell value, press **More Options** and follow the instructions below.



- To change the offset value, press **Change Offset Value** and enter a new value.
- To change the thresholds value, press **Change Thresholds** and enter a new range and minimum and maximum value.
- To have thresholds automatically detected, press **Autodetect Thresholds**.

When settings are complete, press **Cancel** to return to the *Resistor* screen. To set further options, press **More Options** to display a new screen.

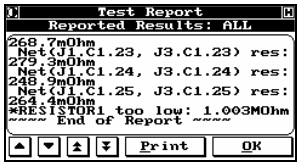


- To set the stimulus press **Stimulus** to cycle through the available settings.
- To set the dwell time, press **Dwell**.

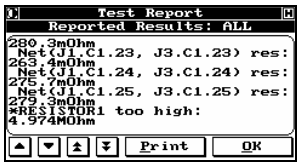
Press **OK** twice to return to the test parameters screen.

6.6.2.3 Testing A Product With Resistors

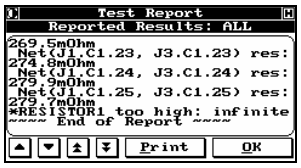
Testing a product with embedded components is the same as testing any other product. Follow the process described in section 6.2.3. After the standard low voltage tests (continuity and isolation) are performed, the system scans for resistors. Here are some sample results:



The resistance for resistor 1 is below the expected value, including the tolerance zone. The actual resistance is measured and reported to help a technician correct the problem.



The resistance for resistor 1 is above the expected value, including the tolerance zone. The actual resistance is measured and reported to help a technician correct the problem



The resistor path for resistor 1 is extremely high. The actual problem could be the resistor itself or could be because one of the connecting terminals is open.

6.6.3 Programming and Running Capacitor Tests

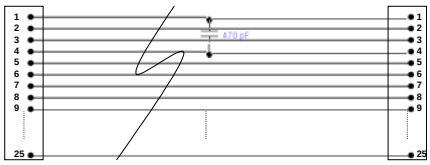
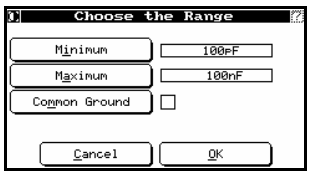


Figure 4-31: PUT with embedded Capacitor

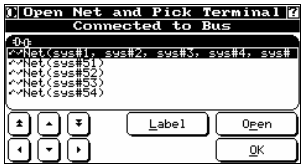
6.6.3.1 Programming Capacitor Tests through Auto-New Test



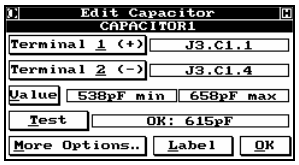
Press **Capacitors** from the second *Auto-Test Set Parameters* screen (see section 6.2.2.1) to display the *Choose the Range* screen.

- Enter the minimum expected resistance for all of the embedded resistors in your cable.
- Enter the maximum expected value for all the resistors in your cable.
- If components are connected to a common bus, enable **Common Ground**.

Press **OK** to return to *Auto-Test Setup Parameters*.



If you pressed **Common Ground**, you are prompted to choose the common bus from the learned list. Once you have made your choice, the capacitors are learned.



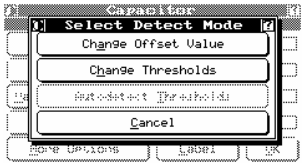
Here is an example result. In the example shown, Terminal 1 of the first resistor (C1) is connected to pin 1 of the first connector on the adapter located at J1. Terminal 2 is connected to pin 4 of the same connector.

The default tolerance for the component is set to 10%

6.6.3.2 Programming Capacitor Tests through New Test

Press **Capacitor** from the *Select Mode* screen (see section 6.1.4) to display the *Capacitor* screen.

- Choose the wires to test by pressing **From** and **To**, as explained in section 6.2.2.3.
- To change the label of the capacitor, press **Label** and enter a new label.
- To set the stimulus, press **More Options** and, on the screen that appears, press **Stimulus** to cycle through the available settings.
- To run the test, press **Test**.
- To set or modify the tolerance, press **Value** to display the *Select Detect Mode* screen.



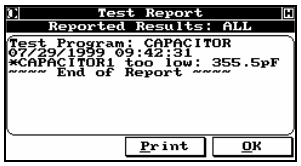
- To change the offset value, press **Change Offset Value** and enter a new value.
- To change the thresholds value, press **Change Thresholds** and enter a new range and minimum and maximum value.
- To have thresholds automatically detected, press **Autodetect Thresholds**.

When settings are complete, press **Cancel** to return to the *Capacitor* screen.

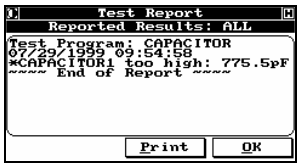
Press **OK** to return to the test parameters screen.

6.6.3.3 *Testing a Product with Capacitors*

Testing a product with embedded components is the same as testing any other product. Follow the process described in section 6.2.3. After the standard low voltage tests (continuity and isolation) are performed, the system scans for capacitors. Here are some sample results:



The measured capacitance is too low.



The measured capacitance is too high.

6.7 Custom Programming Examples

6.7.1 Programming and Running Free Ends or "Flying Leads" Tests

Many products have wires that are terminated into a connector on one end only. These can be fully tested by using the supplied probe. All you need to do is to tell the Fusion where these leads are and how you want them tested.

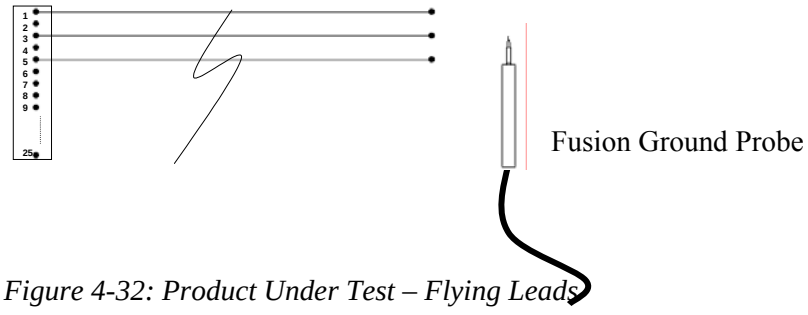
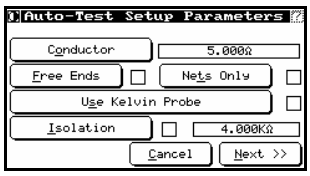


Figure 4-32: Product Under Test – Flying Leads

Flying leads can be programmed through an auto-new test only.

6.7.1.1 Programming a Free Ends Test



To begin to learn a product with free ends, from *Auto-Test Setup Parameters* (see section 6.2.2.1), enable **Free Ends**.

Set any other values necessary on this screen and the next. When you press **Next** from the second screen, the product is learned as usual.

Once the NetList has been learned, you are prompted to do the first probe.

You are prompted to specify the pin's name. Enter it and press **Enter**.

You are prompted to specify the wire's label. Since this will also be the prompt when the product is tested, make the label as instructive and clear as possible. You can use up to 30 alphanumeric characters.

Enter the label and press **Enter**.

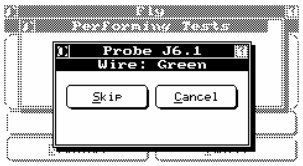
You will continue to be prompted to probe, specify pin name and then wire label. When all pins have been probed, press **Done**.

Here is a sample pin list for net 1.

6.7.1.2 Testing A Product With Free Ends

As with all testing on the Fusion, testing a product with free ends is easy and straightforward. Follow the process described in section 6.2.3 to start the testing process.

Make sure that the standard probe is attached before starting the testing process.



The Fusion prompts you to touch the first flying lead (free end) to be tested. (Notice that the prompt incorporates the label given during the learning process.)

Using the probe, touch the correct lead; the Fusion sounds a positive tone, and automatically sequences to the next lead. If you touch the wrong lead, or if the lead is open, a negative tone sounds, and the system does not automatically sequence. If you are sure you are touching the correct lead, push **Skip** to sequence to the next lead.

A correct lead will display its address on the prompt screen. To display the address of an incorrect or open lead, hold the probe to the lead

You will continue to be prompted for each of the flying leads defined in the test.

7 Adapters

7.1 Introduction

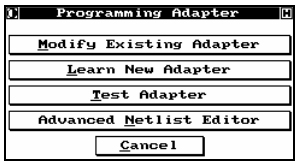
This chapter is an in-depth discussion of the process of "learning" an adapter or fixture and adding it to the Fusion's internal database. This process only needs to be done once for a given adapter or adapter type, unless that adapter is physically modified or its specifications change. For example, once an adapter for a DB25 connector with an ungrounded shield is learned, its data can continue to be used even if the adapter itself is discarded and replaced with an identical one. If, however, you decide to ground the shield, this would represent a new adapter specification and it would have to be relearned.

Fixtures are mechanical platforms that are normally separated from the front face of the Fusion and are connected to the Fusion by some sort of interface cable. They are usually designed to accommodate a number of connectors or connector types, and to optimize the production flow of a given shop. (It is beyond the scope of this manual to engage in a detailed discussion of fixtures. If you would like to build one, and are unsure about how to proceed, contact your authorized QuadTech representative for more details.)

Adapters created in one mode cannot be used in another. For example, an adapter created in Cable Test mode cannot be used in EST mode, or vice versa.

As part of the learning process, the Fusion effectively can recalibrate itself to the surface of the fixture. The net effect is greater testing accuracy of your products, with much less chance of erroneous results.

These functions operate from the *Programming Adapter* screen.



From either *Main Menu*, press **Edit Adapter** to display the *Programming Adapter* screen.

The available functions are:

- **Modify Existing Adapter** — see section 7.5
- **Learn New Adapter** — see section 5.2
- **Test Adapter** — see section 7.2.
- **Advanced Netlist Editor** — see section 5.2.5.2.

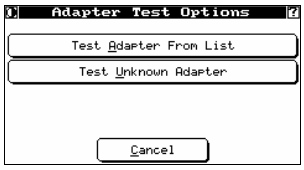
7.2 Testing an Adapter

You should test your adapters before entering them into the database.

This feature is also useful for troubleshooting existing adapters and fixtures.

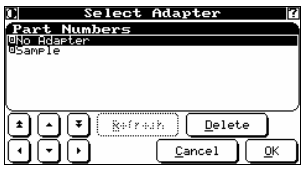
You can either test an adapter already stored in the database, or test a new adapter not yet stored in the database.

7.2.1 Testing Adapter in Database



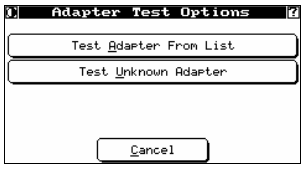
From *Programming Adapter* (see section 6.2.1) press **Test Adapter** to display the *Adapter Test Options* screen.

Press **Test adapter from list** to display the *Select Adapter* screen.



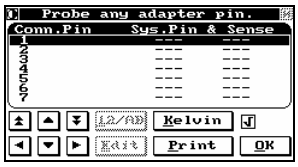
Highlight the appropriate adapter and press **OK**. The test proceeds, prompting you to probe the adapter as required.

7.2.2 Testing Unknown Adapter



From *Programming Adapter* (see section 6.2.1) press **Test Adapter** to display the *Adapter Test Options* screen.

Press **Test Unknown Adapter** to display the *Probe any adapter pin* screen.



Using the standard ground probe for the Fusion, touch all the pins on the adapter to verify they have continuity to system pins and to verify whether any shorts exist or if Kelvin connections are all existent and correct.

Once complete, press **OK** to return to *Adapter Test Options*.

7.3 Connector Pin Conventions

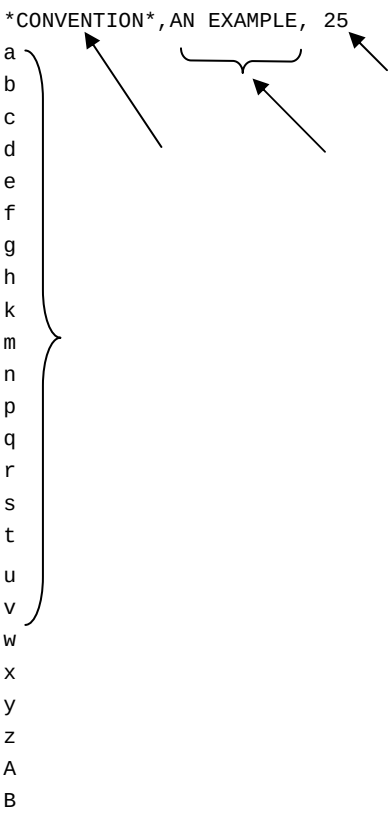
Connector pin conventions can take many forms. The Fusion allows you to create your own conventions and add them to the convention database. To add conventions you need to first create the conventions file and then add it to the Fusion.

7.3.1 Creating the File

Create the conventions file using a text editor (for example, Notepad or Wordpad). There are only three absolute requirements for this file:

- The string `*CONVENTION*` must appear in the first line of the file, along with a name for the convention and the number of pins it supports.
- The file must have the extension .CNV.
- The file must be stored in the CONVENT subdirectory of the Fusion database.

EXAMPLE:



Save the new file as "text only" format, with an 8 character file name and the .CNV extension. For example: "example.CNV".

If you create the file using a word processor (like Word or Word Perfect) you must be sure to save the file as "Text Only")

7.3.2 Adding the File to the Fusion

To add the file to the Fusion database you can use one of two methods: manually copy the file, or use the Fusion software.

To manually copy the file, copy it to the appropriate subdirectory on the Fusion's hard drive: C:\v4.0\datab\convent.

To use the Fusion software, on a blank diskette, create a subdirectory (folder) called "Convent". Copy the new convention files into this directory on the diskette. Use the Fusion's restore feature (see section 9.4) to copy the convention file.

7.4 Special Case: The Kelvin Adapter

To define your adapter as Kelvin, you must enable the Kelvin feature before probing adapter points.

On *Edit Connector's Netlist* (see section 5.2), enable **Kelvin** in order to ensure a Kelvin connection is learned. A check mark will appear next to the option.

By defining an adapter as Kelvin, you are essentially assigning two system pins to each connector/adapter pin.

In this scenario both column one and column two will have system numbers assigned.

Kelvin requires odd and even consecutive pairs (for example, 7, 8).

It is important to remember that the number of system points the Fusion will utilize defines the size of an adapter. In the case of an 18-pin connector defined in Kelvin, 36 system pins are used. That makes the adapter a double as opposed to a single.

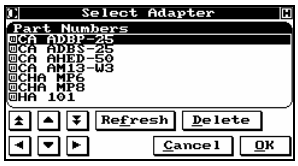
Adapter as ADP File

`\datab\adapters\kelvin.adp For syntax information, see chapter 0.`

```
*ADAPTER*,KELVIN,
*VERSION*,4.0.0
*CONNECTOR*,,
38,1,,46,,,
0,2,,8,,,
39,3,,47,,,
16,4,,24,,,.
```

7.5 Modifying an Existing Adapter

Never edit or alter an adapter file if it has been used to learn a product. If you alter an adapter after creating a test program, you will need to re-learn the product.



From *Programming Adapter* (see section 6.2.1) press **Modify Existing Adapter** to display the *Select Adapter* screen.

Highlight the desired adapter and press **OK** to display the *Edit Adapter* screen.

Edit any of the adapter's properties.

- **Label** – enter a label for the adapter.
- **Connectors** – edit connector names and pin mapping of an adapter, as described in section 5.2.
- **Cap Offset** – For increased capacitance measurement accuracy, the capacitance of the adapter may be learned and utilized as an offset value. Pressing this button takes you through the steps of learning the capacitive offset.
- **Res Offset** – For increased resistance measurement accuracy, the resistance of an adapter can by learned and utilized as an offset value. In order to perform this function, you must short all points together that are contained on each connector. Pressing this button takes you through the steps of learning the resistance offset.

To offset a connector you must have a minimum of three (3) test points.

When editing is done, press **OK**. You are prompted to save or discard your changes, and *Programming Adapter* re-appears.

8 Reports and Batches

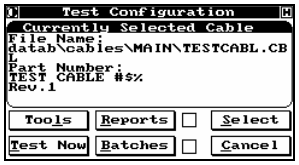
8.1 Reports

8.1.1 About Reports

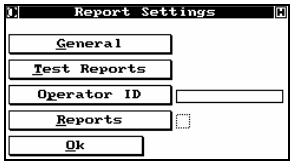
As part of your test procedure, you can generate reports for each product tested. The Fusion allows you to set up reports to be automatically printed or saved to a file, and/or automatically displayed at the completion of a test, as well as set a variety of reporting options.

Report settings can apply to either all test programs or only a specific test program. This section explains how to set up reports for all test programs. If you wish to have different report settings for individual test programs, see section 10.1.4.

These functions operate from the *Report Settings* screen.



From the *Main Menu* of either mode, press **Test** to display the *Test Configuration* screen.



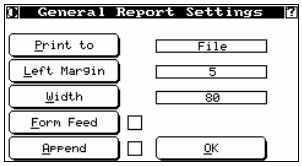
Press **Reports** to access the Report Settings screen.

The available functions are:

- **General**: sets up general report options, such as whether to send reports to a printer or file — see section 8.1.2
- **Test Reports**: sets up test report settings, such as what kind of information to include on the report and/or appear automatically at the conclusion of the test — see section 8.1.3.
- **Operator ID**: adds operator ID to reports — see section 8.1.5.1.
- **Reports**: enables or disables the report function.

8.1.2 General Settings

You can choose to print reports to a printer and/or a file. If reports are printed to file, the system actually saves the test results and any errors to two files. The .ALL file contains all results, including the errors. The .ERR file contains only errors. The file names are created based on the first few characters of the product test name, but the requirement to conform to 8.3 file naming conventions and valid DOS names may mean the file names vary somewhat.



From the Report Settings screen (see section 8.1.1), press **General** to display the *General Report Settings* screen.

- **Print to:** set the target for reports (printer attached to parallel port of the Fusion, log file, or both).
- **Left Margin:** set the width of the left margin (from 0 – 32).
- **Width:** set the width of the page (from 20 – 1000).

The default settings should suit most printers.

- **Form Feed:** enable if each test's report should be on a separate printed sheet. This must be enabled if you plan to have a header or footer on your printed report. To set up the header or footer, see section 0.
- **Append:** if enabled, appends each test to existing log files; if disabled each test overwrites the existing log. The **Print to** option must be set to "file" for this to be enabled.

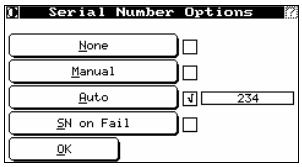
Using **Append** can result in large log files which should be backed up regularly. The risk exists that the log file will become too big to back up to a diskette.

8.1.3 Test Report Settings

From the *Report Settings* screen (see section 8.1.1), press **Test Reports** to display the *Test Report Settings* screen.

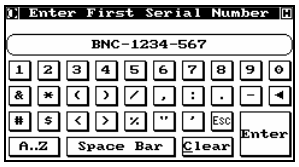
- To serialize a product you are testing, press **Serial Number Options** and follow the instructions in section 8.1.3.1.
- To press the type of information that should appear in reports, press **Test Results** to cycle through these choices:
  - **None:** Does not include any results in the report should the product pass or fail.
  - **Pass:** Results are included only when a product passes.
  - **Fail:** Results are included only when a product fails.
  - **Pass/Fail**: If the test passed, shows only a statement to that effect; if the test failed, shows details.
  - **All:** Results are included for both passed and failed products.
- To select the type of information that should appear automatically at the end of each test, press **Auto Diagnose** to cycle through the same choices as for **Test Results**.
- To set the formatting for reports, including fonts, and to set up headers and footers, press **Body**, **Header**, or **Footer**, and follow the instructions in section 8.1.5.
- To include the test parameters in the reports, enable **Test Parameters**.

8.1.3.1 Using Serial Numbers



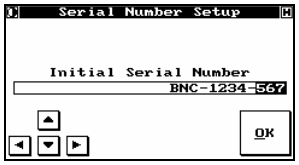
To serialize a product you are testing, from the *Test Report Settings* screen (see section 8.1.3) press **Serial Number Options** to display the *Serial Number Options* screen**.**

- To clear serial number settings, enable **None**.
- To have the operator prompted for a serial number at the end of each test, enable **Manual**.
- To have serial numbers incremented automatically after each tested product, enable **Auto** and follow the instructions below.
- To have serial numbers incremented automatically (if **Auto** is enabled), or to prompt the operator for a serial number on failed products (if **Manual** is enabled), enable **SN on Fail**.



If you enable **Auto**, you are prompted to enter the initial serial number. The serial number can be comprised of up to 30 alpha-numeric characters. The serial number will be advanced either alphabetically or numerically (depending on which is required) after each subsequent test and be logged.

Press **Enter.** The *Serial Number Setup* screen appears.



Using the arrow keys, press which character(s) of the serial number you wish incremented after each tested product.

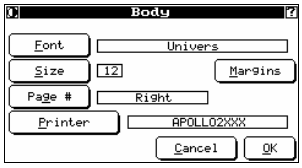
Use the up arrow to increase the width of the cursor to include more characters or numbers of the serial number.

Press **OK** to accept the serial number and return to *Test Report Settings*.

8.1.4 Formatting Reports

Use these functions to format report body text, and to add headers and footers. These settings apply to both printed reports and those sent to electronic files, although not those that appear automatically on the Fusion display.

8.1.4.1 Formatting Body Text



From *Test Report Settings* (see section 8.1.3), press **Body** to display the *Body* screen.

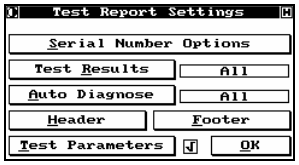
- To cycle through the available font families, press **Font**.
- To cycle through the available type sizes, press **Size**.
- To set margins and page size, press **Margins** and complete the screen that appears.
- To cycle through the available positions for the page number, press **Page #**.
- To cycle through the available printers, press **Printer**.

To return to *Test Report Settings*, press **OK**.

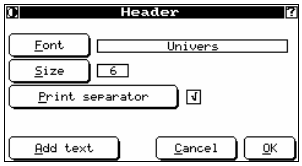
8.1.5 Formatting Headers and Footers

Header and footer information can be added to both printed and logged reports. Headers and footers can be based on:

- the settings for this test session (in effect until you shut down the Fusion) , used for all tested products regardless of their individual test programs — explained below
- individual test program (see section 10.1.6.6).

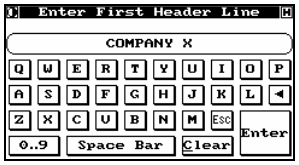


From the *Test Report Settings* screen (see section 8.1.3), press **Header**. The *Header* screen appears.



- To cycle through the available font families, pres **Font**.
- To cycle through the available type sizes, press **Size**.
- To include a line below the header, enable **Print separator**.

Press **Add text**. A new screen appears.

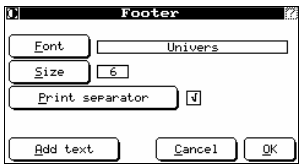


Enter the first line of the header and press **Enter** to move to the next line.

You can have an unlimited number of lines in the header. The width of each line is limited by the maximum character width of the sheet to be printed on.

Continue to enter lines, pressing **Enter** after each.

After the last line, press **ESC** to exit.



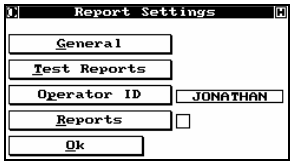
Repeat for the footer.

For headers and footers to operate correctly you must set the reports to have a form feed after each tested product. See section 8.1.2.

8.1.5.1 Operator ID Settings

To include the name of the operator for this test session, from *Report Settings* (see section 8.1.1), press **Operator ID**.

Enter an ID of up to 30 characters.



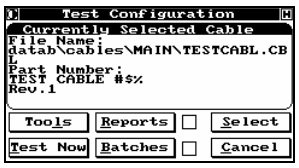
After you enter the operator ID, it appears on *Report Settings*.

8.1.6 Viewing Reports Saved to File

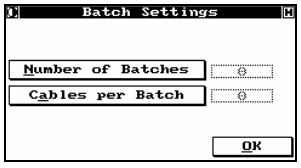
To view the reports generated by a test session that have been saved to file(s), you need to copy the files to diskette using the save log files function (see section 9.3). You can read the log files using any text editor on your personal computer.

8.2 Batches

In many shops, products must be sorted or packaged in lots. It goes without saying that each product in the lot must be a good product. While this sounds trivial, in the press of running a production floor, keeping this straight can prove to be difficult. The Fusion has a special feature designed to help you if this is your situation.



From either *Main Menu*, press **Test** to display the *Test Configuration* screen.

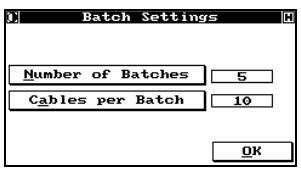


To set up the batch parameters needed for a given product, press **Batches** to display the *Batch Settings* screen.

Note that this must be set up for each testing session where batches are needed. Once this is one, batches will not require any special attention by supervisory personnel.

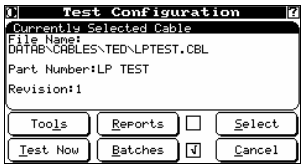
- To input the desired number of batches, press **Number Of Batches.**
- To enter the number of products needed per batch, press **Cables Per Batch.**

For example, you might need five batches of ten products each.



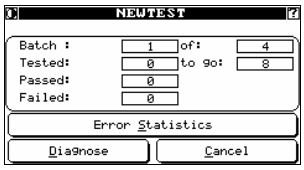
The *Batch Settings* screen shows your settings. To return to *Test Configuration*, press **OK**.

Once values have been entered, the batches feature has been enabled.



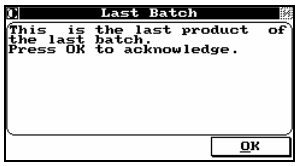
Note that the box by **Batches** now has a check mark indicating that the Fusion will keep track of each lot as the products are tested.

To disable the batch function, clear either the number of batches or number of products per batch.



Now, when you run a test, the *Test Product* display shows batch information. In the example shown, 8 good products will need to be tested in order to fulfill the requirement. The failed products have not been counted towards meeting the requirement.

The Fusion will indicate when each batch is filled with good products. You are prompted to acknowledge the completion of a batch.



As soon as you disconnect the last successfully tested product, the Fusion prompts you to acknowledge the last batch completed.

Press **OK** to return to *Test Configuration*.

9 Backups and Restores

9.1 Introduction

These functions operate from the *Backup – Restore Shell* screen.

From the *Main Menu* of either mode, press **Backup** to display the *Backup – Restore Shell* screen.

The Fusion supports multiple removable media drives hooked to its serial port (see chapter 1). Should you, for example, have an external drive attached to the unit, the system detects it and requests you to choose the drive you wish to backup to or restore from.

The available functions are:

- **Backup**: backs up specific files — see section 9.2
- **Restore**: restores backed-up files — see section 9.4
- **Save Log Files**: saves log files (reports) — see section 9.3
- **More Options**: lets you set up automatic backup and log file saving — see section 9.5.

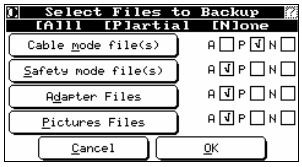
9.2 Performing Backups

The Fusion allows you to safeguard your test programs and adapter library by backing them up to diskette or removable media. A backup transfers the files from the internal hard disk to diskette or removable media, while a restore transfers the files from a diskette or removable media to the hard disk.

You are strongly advised to perform backups regularly. This is especially important after learning a new product, after changing a test program, or after defining a new adapter. Note that if you are appending information to log files, those files may become too large to fit on a diskette, so regular backups are important. Make sure you store the backup diskette in a safe place.

Another good use of the backup/restore function is to transfer test programs or adapter library files between systems. When multiple systems are used to test the same product, you can learn the product on one system, then use the diskette to transfer the test program to other systems.

These instructions explain how to perform a backup immediately. You can also set up the Fusion so that operators are prompted to perform backups when they shut down (see section 3.2).



From *Backup – Restore Shell* (see section 9.1), press **Backup** to display the *Select Files to Backup* screen. Choose which items you want to backup, and whether you want to back up all or some of the related files. Press each button to scroll through the choices of **A** (all), **P** (partial)**, or N** (none).

In the example shown, only partial cable mode files will be backed-up and all of the other files will be backed up. (Pictures files are screen captures created by pressing F10, used for support purposes.)

Press **OK** to continue.

If you chose partial backup of any item, you are prompted to select the files to be backed up.

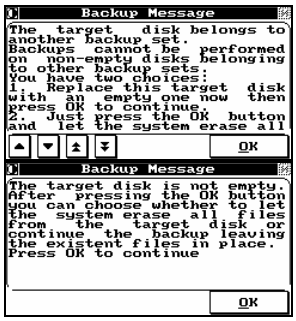
Press "**+**"to expand the directories, press "**-**" to collapse them.

Using the arrow keys, highlight the file to be backed up and press **Select**. A check mark appears in the left column, indicating that the file will be backed up.

When you have selected all the files to be backed up, press **OK** to continue.

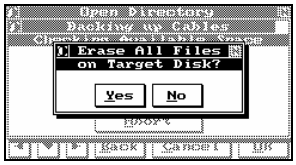
Depending on what you are backing up, you may need to repeat the file selection process for each item you want to partially back up.

If you are prompted with this screen, ensure the diskette is properly inserted and it is not write-protected.



If the diskette is not empty or the Fusion detects an older backup on the diskette, a message appears, giving you the choice of replacing the diskette or erasing the files.

Press **OK** to continue.



To erase the contents of the diskette, press **Yes**. To append the information to what is already on the disk, press **No**.

As files are being backed-up, the progress bar indicates the remaining space on the disk and the progress of the total backup.

Once backup is complete, you are prompted to remove the disk (this prompt also includes a suggested label for the diskette).

Once the diskette is removed, the *Backup Report* screen shows all files that have backed up. Use the arrow keys to scroll through the list.

To return to *Backup - Restore Shell*, press **OK**.

9.3 Saving Log Files

You can save the log files containing report information to diskette. Log files can then be read using any text editor. For more on log files, see section 9.5.

These instructions explain how to save log files immediately. You can also set up the Fusion so that operators are prompted to save log files when they shut down (see section 3.2).

From *Backup – Restore Shell* (see section 9.1), press **Save Log Files** to backup the log files on the Fusion.

You are prompted to choose whether or not to delete log files after transferring them to a diskette.

The log files are stored on the diskette in a "logs" subfolder of a folder given the serial number of the Fusion that the log files came from.

9.4 Performing Restores

From *Backup – Restore Shell* (see section 9.1), press **Restore** to display the *Select Files to Restore* screen. As with back up, choose the items you want to restore.

During restore, the screen displays which directory and files are being restored. The top progress bar displays the available space in the diskette, and the bottom progress bar displays the percentage completed

Once the restore is complete, this screen appears.

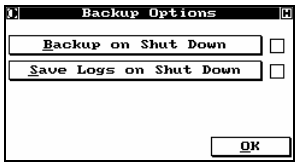
Remove the diskette from the floppy drive.

Once the diskette is removed, the *Restore Report* screen shows all files restored. Use the arrow keys to scroll through the list.

To return to *Backup - Restore Shell*, press **OK**.

9.5 Prompting for Backups and Log File Saving

You can set up the Fusion to prompt the operator, at shut down, to perform a backup and/or save log files.



To set up the auto-backup feature, from *Backup – Restore Shell* (see section 9.1), press **More Options** to display the *Backup Options* screen.

- To prompt the operator at shut down to choose whether or not to perform a backup, press **Backup on Shut Down**. When Fusion is shut down, the operator will be prompted to choose the files to be backed up.
- To prompt the operator at shut down to choose whether or not to save log files prior to shutting down, press **Save Logs on Shut Down**.

To return to *Backup - Restore Shell*, press **OK**.

10 Creating and Editing Nets (CableTest Mode)

10.1 Test File Format

10.1.1 Introduction

A Fusion test program is a Comma-Delimited ASCII (CDA) file. This makes it easy to generate test programs off-line using a spreadsheet or a text editor. It also makes it possible to write plug-in modules for popular desktop applications that can port legacy test programs into Fusion ones. CableTest has successfully implemented such conversion plug-ins for Microsoft Excel and Word. Conversions from CAD programs are also possible. This opens a new avenue for the "Test by Design" concept.

The Fusion software automatically indents the saved test programs for better readability, though indentation is not mandatory. The space character or the TAB character can be used for indentation. It is recommended to use spaces whenever possible since this guarantees that the test program file is viewed in the same way no matter what text editor is used. While the Fusion software can read the TAB character properly, it is treated differently in different text editors, thus rendering the source difficult to read in some cases.

A basic test program is generally sectioned into:

- Identification Header (ID Header)
- Adapter Interface
- Test Parameters and Prompts
- List of Nets (NetList)
- Lists of Components

Only the Identification Header and Adapter Interface sections are mandatory: all other sections are optional (though a test program without a NetList will not test anything). Some elements of a Fusion test program are not only optional, but they cannot be used unless optional software packages are purchased. Some other elements of the test program can only be used if the Fusion hardware supports them (e.g. DC Hipot commands can only be executed if the machine is equipped with a DC Hipot Unit)

Below is a sample test program with its individual sections identified:

```
*CABLE*,AWP-1001GT,1
```
ID Header

```
  *ADAPTER*,AATEST,
    *POSITION*,J5
  *STAR*
  *THRESHOLD*,61
  *DCHIPOT*,50
    *IR*,5e+07
    *DWELL*,2
    *REGULAR*
    *LINEAR*
```
Adapter Interface

Test Parameters and Prompts

```
  *NET*,,
    J5.C1.1,,
    J5.C2.3,,
  *NET*,,
    J5.C1.2,,
    J5.C2.6,,
  *NET*,,
    J5.C1.3,,
    J5.C2.10,,
  *NET*,,
    J5.C1.4,,
    J5.C2.5,,
  *NET*,,
    J5.C1.5,,
    J5.C2.9,,
  *NET*,,
    J5.C1.6,,
    J5.C2.8,,
  *NET*,,
    J5.C1.7,,
    J5.C2.1,,
  *NET*,,
    J5.C1.8,,
    J5.C2.7,,
  *NET*,,
    J5.C1.9,,
    J5.C2.2,,
  *NET*,,
    J5.C1.10,,
    J5.C2.4,,
*END*
```
NetList

10.1.2 Test Program ID Header

The test program **ID Header** section is mandatory. It consists of the tested product's name and test program's revision.

The **ID Header** consists of a single line that must have the following structure:

`*CABLE*,<s_cableName>,<s_programRevision>`

where:

`*CABLE*`	is a keyword or tag
`<s_cableName>`	indicates a string field representing the cable's name
`<s_programRevision>`	indicates a string field representing the test program's revision.

The example below indicates revision 1 of a test program for the cable AWP-1001GT.

```
*CABLE*,AWP-1001GT,1
```

As can be seen in the example above, commas separate the fields.

String fields can be of any length (unless otherwise noted) and can contain any printable character (including spaces). Due to the nature of the CDA rules, if a field contains one comma character or more, the entire string must be enclosed in double quotation marks. While the Fusion system and all CDA aware applications take care of this aspect automatically, when manually generating test programs using a text editor, you will need to keep this in mind. An example of a field-embedded comma is given below:

```
*CABLE*,"RW113, RW114, RW115",1
```

The program revision does not have to be a number. The Fusion software can automatically increment to the next revision even if it is a letter:

```
*CABLE*,RJ45 PATCH CORD,A
```

When the above test program is modified, Fusion can save it as the next revision:

```
*CABLE*,RJ45 PATCH CORD,B
```

By default, Fusion will use revision 1 for any newly learned test program.

It is important to remember that all test programs that reside in the same directory must have unique combinations of cable name and program revision. The file name (what is seen when the DIR command is issued at the DOS prompt) is not important for this purpose. Although it is a good practice to name the file in a way that reflects what the test program contains, this is not always possible because of the DOS file naming limitations. The Fusion generates the file name (maximum 8 characters in length) by truncating the internal cable name and making sure that the file name is unique (this last requirement is for the sake of DOS only). The Fusion will not save a test program if the cable's name and program's revision collide with an existent one. When manually creating a test program, you must ensure that such a collision doesn't occur.

10.1.3 Adapter Interface Section

Any tested product is connected to a test system one way or another. This connection is usually called an adapter interface, adapter cable, test fixture, or test panel. The Fusion calls it simply an adapter. In this light, an adapter defines the connections between the Fusion's test points and the product under test (typically a cable).

Each test program must specify its adapters. This is done in the Adapter Interface section as described below:

```
*CABLE*,AWP-1001GT,1
  *ADAPTER*,AATEST,
    *POSITION*,J5
```

The first line tells the system that the adapter called AATEST is to be used. The second line specifies where on the test bed the adapter is placed. Adapters can be physically placed in more than one position on Fusion's test bed (some limitations apply). Therefore it makes sense that the position of the adapter is specified.

Please note that the `*ADAPTER*` line is not followed by a `*POSITION*` line.

If more than one adapter is specified, then they are described in sequence. The sequence of the listed adapters has no rules.

```
*CABLE*,AWP-1001GT,1
  *ADAPTER*,AATEST,
    *POSITION*,J5
  *ADAPTER*,HA 116,
    *POSITION*,J3
```

There is one more thing worth mentioning in this section. By default, the connectors on an adapter are named C1 through C*n* where *n* is the number of connectors per adapter (i.e. an adapter with 3 connector would have them named C1, C2 and C3 by default). Although this annotation is straightforward and intuitive, you may want to use other names for the connectors. More often than not this comes about because pre-existent test fixtures are already labelled. For such cases, the Fusion lets you create labels for the adapters' connectors. This allows for more meaningful NetList annotation. You can choose to label the connectors when a new adapter is defined. However, it is sometimes wiser to "attach" the label to the connector within the test program as opposed to the adapter file. The latter case is covered here.

Let's assume that in the test program listed above, the adapter has two connectors you want to label "P" and "K". The new test program looks like the one following. The `*CONNECTOR*` keyword followed by the connector number and the connector label has an impact on the way the NetList is generated.

The bolded areas show where the changes occurred. Besides creating operator meaningful point names, the connector labels can be used to reduce the size of the test program file or to simplify the default Fusion pin naming scheme (in some cases it can reduce the typing load).

```
*CABLE*,AWP-1001GT,1                    ID Header

  *ADAPTER*,AATEST,                     Adapter Interface
    *POSITION*,J5
    *CONNECTOR*,1,P
    *CONNECTOR*,2,K
  *STAR*                                Test Parameters and Prompts
  *THRESHOLD*,61
  *DCHIPOT*,50
    *IR*,5e+07
    *DWELL*,2
    *REGULAR*
    *LINEAR*
  *NET*,,                               NetList
    .P.1,,
    .K.3,,
  *NET*,,
    .P.2,,
    .K.6,,
  *NET*,,
    .P.3,,
    .K.10,,
  *NET*,,
    .P.4,,
    .K.5,,
  *NET*,,
    .P.5,,
    .K.9,,
  *NET*,,
    .P.6,,
    .K.8,,
  *NET*,,
    .P.7,,
    .K.1,,
  *NET*,,
    .P.8,,
    .K.7,,
  *NET*,,
    .P.9,,
    .K.2,,
  *NET*,,
    .P.10,,
    .K.4,,
*END*
```

It is worth noting that labelling an adapter's connector in a test program doesn't affect other test programs (i.e. other test programs can label the same adapter's connectors in a different way or not label them altogether).

10.1.4 Test Parameters

The test parameter fields are optional. If they are not encountered in the text file, the default test parameters are automatically used. There are two main groups of testing parameters: the low voltage test parameters group and the high voltage test parameters group. The syntax and the default values are given for each testing parameter below.

10.1.4.1 Low Voltage Test Parameters

Low voltage test parameters are used during the low voltage tests and affect the continuity, isolation and flex tests. Some of the parameters can be set globally, to affect all the nets within the cable, or individually, on a per net basis. Others can only be set globally.

Continuity Test Parameters

The continuity test can be performed by resistance measurement using the built-in continuity test algorithm.

Resistance thresholds can be specified globally, at the cable or section of cable (switch position) level and/or individually, at the net level. The `*CONTINUITY*` line may require additional test parameters in some cases. Whenever additional continuity related test parameters are specified, they must appear immediately after the `*CONTINUITY*` line.

The syntax and options related to the continuity test are described below:

```
[[*CONTINUITY*,{<d_min>,<d_max>|<s_contScriptCmdAndArgs>}]
  [*KELVIN*]
  [{*HCRES*|*HCDROP*},<d_stimulus>]]
```

Kelvin requires odd and even consecutive pairs (for example, 7, 8).

The minimum and maximum limits **must** be specified. When the measured continuity resistance is within the range defined by the two limits, the test passes. When the measured continuity resistance is outside the range, the test fails.

Most of the time the minimum limit would be set to 0. It only makes sense to specify a higher minimum limit when a 4-wire measurement is used (best to be used in conjunction with the High Current Source option). When a continuity resistance lower than the minimum limit is measured, it is probably because of a wrong wire gauge or length. Most of the time, test engineers are only interested in having the measured resistance values below the maximum limit.

In the example below, a continuity test with the 0Ω and 5Ω limits is specified.

```
*CONTINUITY*,0.0,5.0
```

The continuity minimum and maximum thresholds must always be given in [Ω]. For example a 1KΩ resistance would be entered as 1e3 or 1000.

In the example below, the bolded line specifies that a Kelvin (4-wire) measurement is to be performed. Please note that, as the name suggest, a 4-wire measurement requires a special interconnection to the tested product where each point in the tested product is wired to two test points on the Fusion test bed. This is usually done via the adapter interface.

```
*CONTINUITY*,0,0.1
  *KELVIN*
```

The example below specifies a Kelvin (4-wire) using the high current source. The bolded line instructs the tester to run a High Current source RESistance measurement using a stimulus of 0.5A.

```
*CONTINUITY*,0,0.3
  *KELVIN*
  *HCRES*,0.5
```

The high current source can also be used in a voltage drop mode as can be seen in the example below. The minimum and maximum limits specified on the *CONTINUITY* line are 0V and 0.08V respectively. As the voltage drop test requires the two limits are given in [V] this time. The bolded line specifies a High Current voltage DROP test using a stimulus current of 1A.

```
*CONTINUITY*,0,0.08
  *KELVIN*
  *HCDROP*,1
```

A special case is when an empty field is specified after the *CONTINUITY* keyword. In such a case, no continuity test will be performed at all. This may make sense in conjunction with the flex test which is described below or in some cases where something else other than a cable is tested (i.e. printed circuit board loaded with active components) and the final goal is achieved by running other tests. The example below specifies that the continuity test is not to be performed:

```
*CONTINUITY*,
```

Continuity Scan Method

Fusion describes the nets by means of a test point list (pin list or node list). Most common nets have just two test points each, the continuity test being performed on the conductor that connects the two points. With nets having more than two pins in their pin list, there would be more than one conductor to be checked. In such cases Fusion can perform the test in two different ways: *Star* and *Chain*.

Let's assume that we have a net with three nodes called A, B and C. Fusion can check the continuity among the three points in the *Star* mode by verifying from A to B and then from A to C or it can check the continuity in *Chain* mode by verifying from A to B and then from B to C.

To set the system for *Star* continuity specify the keyword *STAR* as in the example below:

```
*STAR*
```

To set the system for *Chain* continuity specify the keyword *CHAIN* as in the example below:

```
*CHAIN*
```

Isolation Test Parameters

The isolation test can be performed by resistance measurement using the built-in isolation test algorithm.

The resistance measurements work globally. They can be specified globally (at the cable or section of cable (switch position) level) only.

The syntax and options related to the isolation test are described below:

```
[*ISOLATION*,<d_min>]
```

In the example below, the isolation threshold was set for all the nets to 1MΩ. Any isolation resistance measurement that is below the minimum limit fails. Any measurement that is above the minimum limit passes. The isolation minimum limit must be always given in [Ω].

```
*ISOLATION*,1e6
```

A special case is when an empty field is specified after the *ISOLATION* keyword. In such a case, no isolation test will be performed at all. This may make sense in conjunction with the flex test which is described below or in some cases where something else other than a cable is tested (i.e. printed circuit board loaded with active components) and the final goal is achieved by running other tests. The example below specifies that the isolation test is not to be performed:

```
*ISOLATION*,
```

Auto-Insertion Threshold

By default, when the product to be tested is plugged in the test fixture (adapter), the test starts automatically. The test is started upon one of the following conditions, whichever occurs first:

- 100% of the product tests OK for continuity
- the **Start Test** button is pressed
- less than 100% but more than the specified threshold of the product tests OK for continuity and a specified insertion delay lapses.

The third option allows for defective products to automatically start the test too. The default value for the insertion threshold is 61%. Depending on the product to be tested other values may be specified. You should experiment with various values if the default 61% doesn't satisfy your needs.

The syntax for this option is given in the example below. When a 100% threshold is specified, the test doesn't start automatically unless all connections test good.

```
*THRESHOLD*,100
```

10.1.4.2 High Voltage Testing Parameters

The high voltage testing parameters are used during the high voltage tests and affect the DC and AC Hipot tests. Some of the parameters can be set globally, to affect all the nets within the cable, or individually, on a per net basis. Others can only be set globally.

Password Protection

Password protection is a safety feature used in conjunction with a product to be tested at high voltage. It prevents unauthorized personnel to perform such a test. The option is off by default. If password protection is turned on, a valid password must be entered before the first test can start. The syntax is given below.

```
*PROTECTED*
```

In this example, the test program is password protected.

Hipot Not Connected Points

By default, Fusion doesn’t apply high voltage to the not connected points (single point nets) within the tested product. This is intended as a safety feature that stems from the idea that the not connected pins may be part of the unused connectors on the adapter (test fixture) and therefore might be exposed to operator touch during the Hipot tests. To HIPOT the Not Connected points use the keyword given below.

```
*HIPOTNC*
```

DC Hipot Test Parameters

The DC Hipot test can be specified for units that are equipped with a DC Hipot module. By default the DC Hipot is disabled. The DC Hipot parameters are usually specified for the entire product or section of product (switch position), but it is possible (only in the linear mode) to specify the DC Hipot parameters on a per net basis. When the DC Hipot is to be run in the mass mode, the only parameter that can be changed on a per net basis is disabling the Hipot test on that net by setting the Hipot voltage to 0. When the Hipot is to be run in the linear mode, any Hipot parameter (except for the Hipot type) can be modified for any net. The leakage can be measured either as a current, an insulation resistance or ignored altogether. The `*DCHIPOT*` line must appear the first. All other lines can appear in any order afterwards.

```
[*DCHIPOT*,<d_voltage>
[{*LEAKAGE*|*IR*},<d_limit>]
[*DWELL*,<d_dwell>]
[{*REGULAR*|*BYPASS*|*ADAPTIVE*|*SOAK*,<d_soak>}]
[{*MASS*|*LINEAR*}]]
```

In the example below, a 1000V dc Hipot will be performed using a 0.2s dwell time and the mass algorithm. The leakage current won't be measured – only the arcs will be monitored.

```
*DCHIPOT*,1000
  *DWELL*,.2
  *MASS*
```

In the example below, a 500V dc Hipot will be performed. The dwell time is 1s, the insulation resistance (IR) threshold is set to 100MΩ and the linear algorithm is used. The IR is measured using the regular mode.

```
*DCHIPOT*,500
  *IR*,100e6
  *DWELL*,1
  *REGULAR*
  *LINEAR*
```

In the example below, a 500V dc Hipot will be performed. The dwell time is 1s, the leakage current threshold is set to 100μA and the linear algorithm is used. The leakage current is measured using a soak time of up to 5s.

```
*DCHIPOT*,500
  *LEAKAGE*,100e-6
  *DWELL*,1
  *SOAK*,5
  *LINEAR*
```

AC Hipot Test Parameters

The AC Hipot test can be specified for units that are equipped with an AC Hipot module. By default the AC Hipot is disabled. The AC Hipot parameters are usually specified for the entire product or section of product (switch position), but it is possible (only in the linear mode) to specify the AC Hipot parameters on a per net basis. When the AC Hipot is to be run in the mass mode, the only parameter that can be changed on a per net basis is disabling the Hipot test on that net by setting the Hipot voltage to 0. When the Hipot is to be run in the linear mode, any Hipot parameter (except for the Hipot type) can be modified for any net. The leakage can be measured either as a current, an insulation resistance or ignored altogether. The `*ACHIPOT*` line must appear the first. All other lines can appear in any order afterwards.

```
[*ACHIPOT*,<d_voltage>
[{*LEAKAGE*|*IR*},<d_limit>]
[*DWELL*,<d_dwell>]
[{*60HZ*|*50HZ}]
[{*MASS*|*LINEAR*}]]
```

In the example below, a 60Hz 1000V ac Hipot will be performed using a 2s dwell time and the mass algorithm. The leakage current won't be measured – only the arcs will be monitored.

```
*ACHIPOT*,1000
  *60HZ*
  *DWELL*,2
  *MASS*
```

In this example, a 50Hz 500V ac Hipot will be performed. The dwell time is 1s, the insulation resistance (IR) threshold is set to 100MΩ and the linear algorithm is used.

```
*ACHIPOT*,500
  *IR*,100e6
  *DWELL*,1
  *LINEAR*
  *50HZ*
```

10.1.5 Build Aid

10.1.5.1 Activating the Build Aid Feature

To activate the build aid feature add the following syntax to the test list.

```
*BUILDAID*
```

10.1.5.2 Default Settings

With no further parameters, build aid will behave as follows…

- Build nets sequentially
- All beeps will be disabled
- No out of sequence test will be performed
- Probe is disabled

10.1.5.3 Audible Feedback

Enable audible feedback for a passed test:

```
*BUILDAID*
   *PASS*
     *BEEP*
```

Enable audible feedback for a failed test:

```
*BUILDAID*
   *FAIL*
     *BEEP*
```

10.1.5.4 Building a Cable Sequentially

By default, the Fusion expects the cable to be built sequentially (in the order defined in the test program). However, this may be explicitly set for clarity:

```
*BUILDAID*
   *SEQUENTIAL*
     [  *PIN*  ]
     [  *OUTOFSEQUENCE* [ ,<timeout> ] ]
```

The optional `*PIN*` subcommand specifies that the build aid is to be done on a pin per pin basis. Otherwise the build aid is conducted on a net per net basis.

To build a cable on a net-per-net basis:

```
*BUILDAID*
   *SEQUENTIAL*
```

To build a cable on a pin-per-pin basis:

```
*BUILDAID*
   *SEQUENTIAL*
     *PIN*
```

The optional *OUTOFSEQUENCE* subcommand specifies the system to consider an error when a net or pin was build out of sequence. If the optional timeout parameter is missing or is 0, then an out of sequence error is signaled as soon as it is detected. If a positive timeout value is specified, then the system waits that period and then if the out of sequence condition still exists it will signal an error. This latter feature is used when coaxial wires are built and both contacts close almost simultaneously but there is no guarantee which one closes first. It is then acceptable for the second conductor to make contact before the first, provided the first makes contact within the specified timeout period.

To build a cable with the out of sequence option with no timeout:

```
*BUILDAID*
   *OUTOFSEQUENCE*
```

To build a cable with the out of sequence option with a programmed timeout (in seconds):

```
*BUILDAID*
   *OUTOFSEQUENCE*, 0.5
```

10.1.5.5 Building a Cable Randomly

By default, the Fusion expects the cable to be build sequentially. When a random building order is acceptable and desired (at the operators discretion), then the random mode must be explicitly selected.

To build a cable randomly:

```
*BUILDAID*
   *RANDOM*
     [ *PIN* ]
```

The optional *PIN* subcommand specifies that the build aid is to be done on a pin per pin basis. Otherwise the build aid is conducted on a net per net basis.

To build a cable on a net-per-net basis:

```
*BUILDAID*
   *RANDOM*
```

To build a cable on a pin-per-pin basis:

```
*BUILDAID*
   *RANDOM*
      *PIN*
```

10.1.5.6 Probing During Build Aid

By default, the system doesn't use the Fusion ground probe during the build aid process. To activate the use of the probe:

```
*BUILDAID*
   *PROBE*
      [ *ALL* ]
```

The optional *ALL* subcommand specifies that all wires may be probed and not only the one that is currently being built. When this option is used the Fusion's response when probing is deteriorated since it must scan all available points.

To activate the probe just for the wire that is being built:

```
*BUILDAID*
   *PROBE*
```

To activate the probe just for all wires:

```
*BUILDAID*
   *PROBE*
      *ALL*
```

10.1.6 Print Options

Each tested product can have its own print options set within the test program. To set global print options see section 8.1.2.

Global report options will take precedence over embedded report options.

10.1.6.1 Logging Test Results to File

To enable report logging:

```
*REPORTS*
        *FILE*
                [*APPEND*]
                [*FORMFEED*]
                {*PASS* | *FAIL* | *PASSFAIL* | *ALL*}
```

The optional *APPEND* specifies that the results are to be appended at the end of the existent log file if any. If *APPEND* is missing or the log file doesn't exist then a new log file is generated.

The optional *FORMFEED* specifies that a form feed character is to be output to the file after each tested product. This is especially useful if the file is to be printed later.

The *PASS* specifies that test results are to be logged for passed cables only.

The *FAIL* specifies that test results are to be logged for failed cables only.

The *PASSFAIL* specifies that detailed test results are to be logged for failed cables only. The passed cables will only log a brief *Pass* message.

The *ALL* specifies that detailed test results are to be logged for both passed and failed cables.

If none of the *PASS*, *FAIL*, *PASSFAIL* and *ALL* options is listed, then no test results would be logged.

The *FILE* and *PRINTER* keywords are mutually exclusive. Either one can be used but not both in the same test program. If both are missing, then the report printing defaults to the printer.

10.1.6.2 Printing Test Results to a Printer

To enable the report printing use the syntax described below:

```
*REPORTS*
        *PRINTER*
                [*FORMFEED*]
                [*LEFTMARGIN*,<number of characters>]
                [*WIDTH*,<number of characters>]
                {*PASS* | *FAIL* | *PASSFAIL* | *ALL*}
```

The optional *APPEND* specifies that the results are to be appended at the end of the existent log file if any. If *APPEND* is missing or the log file doesn't exist then a new log file is generated.

The optional *FORMFEED* specifies that a form feed character is to be output to the file after each tested product.

The optional *LEFTMARGIN* specifies the number of characters to be skipped at the left margin of the printout. If not specified it defaults to 5.

The optional *WIDTH* specifies the width of the page in number of characters. If not specified it defaults to 80.

The *PASS* specifies that test results are to be printed for passed cables only.

The *FAIL* specifies that test results are to be printed for failed cables only.

The *PASSFAIL* specifies that detailed test results are to be printed for failed cables only. The passed cables will only print a brief "Pass" message.

The *ALL* specifies that detailed test results are to be printed for both passed and failed cables.

If none of the *PASS*, *FAIL*, *PASSFAIL* and *ALL* options is listed then no test results would be printed.

The *FILE* and *PRINTER* keywords are mutually exclusive. Either one can be used but not both in the same test program. If both are missing, then the report printing defaults to the printer.

10.1.6.3 Auto-diagnose Option

To enable the auto diagnose options:

```
*REPORTS*
        *AUTODIAGNOSE*
                {*PASS* | *FAIL* | *PASSFAIL* | *ALL*}
```

The *PASS* specifies that test results are to be displayed automatically for passed cables only.

The *FAIL* specifies that test results are to be displayed automatically for failed cables only.

The *PASSFAIL* specifies that detailed test results are to be displayed automatically for failed cables only. The passed cables will only display a brief *Pass* message.

The *ALL* specifies that detailed test results are to be displayed automatically for both passed and failed cables.

If none of the *PASS*, *FAIL*, *PASSFAIL* and *ALL* options is listed then no test results would be displayed automatically.

The *AUTODIAGNOSE* can coexist with either one of the *PRINTER* and *FILE* options.

10.1.6.4 Test Parameters

To enable reporting the test parameters (test limits):

```
*REPORTS*
        *TESTPARAMS*
```

When included in the test program, the *TESTPARAMS* keyword enables the printing of test parameters. When omitted, the test parameters will not be printed.

10.1.6.5 Serial Numbers

To enable serial numbers:

```
*REPORTS*
        *SERIALNUMBER*
                [*FAIL*]
                [*AUTO*]
```

When included in the test program, the *SERIALNUMBER* keyword enables serial number printing.

The optional *FAIL* specifies that a serial number is to be generated for failed products too. If omitted from the test program, the serial numbers would only be generated for the passed products.

The optional *AUTO* specifies that the serial number is to be automatically generated started from an initial value entered by the operator. The operator will also specify the part of the serial number that gets incremented. When *AUTO* is not specified the operator will have to enter the serial number for each product.

10.1.6.6 Header

To insert a header into a test program:

```
[*HEADER*
<s_first header line>
. . .
<s_last header line>]
*<keyword>*
```

All text following the *HEADER* tag up to the next tag (*<keyword>*) will be printed as a header. The option exists to have header information added during the test cycle. To prompt the operator for header information use the *PROMPT* tag following the header line that requires entry.

EXAMPLE:

```
*HEADER*
CABLETEST SYSTEMS INC.
400 ALDEN RD
MARKHAM, ON L3R 4C1
CUSTOMER: *PROMPT*
CONTRACT/PO NO: *PROMPT*
PART NUMBER: *PROMPT*
```

10.1.6.7 Footer

To insert a footer into a test program:

```
[  *FOOTER*
<s_first footer line>
. . .
<s_last footer line>]
*<keyword>*
```

All text following the *FOOTER* tag up to the next tag (*<keyword>*) will be printed as a footer. The option exists to have footer information added during the test cycle. To prompt the operator for footer information, use the *PROMPT* tag following the footer line that requires entry.

EXAMPLE:

```
*FOOTER*
Authorization Signature/Stamp: _________________
```

10.1.7 Prompts

To display instructions for the operator prior to starting the test on the product or prior to any of the switch tests, use one of the prompt features. Fusion supports prompts on the fly (defined inline in the test program), prompt files and graphical bitmaps.

10.1.7.1 Prompts On the Fly

To insert a prompt on-the-fly:

```
[*PROMPT*
<s_first_prompt_line>
...
<s_last_prompt_line>]
*<keyword>*
```

The first line that contains a keyword (starts with a '*' character) will end the prompt sequence. The text enclosed between the *PROMPT* line and the next keyword will be displayed on the screen prior to the test.

In the example below, the bolded text represents the prompt that will be displayed on the screen:

```
*PROMPT*
Use following hook-up cables:
AKS 104-0005
AKJ 100-0021
AKH 101-0001
*CONTINUITY*,0,1
```

10.1.7.2 Prompts Using Text Prompt Files

Sometimes it may be desirable that multiple test programs share the same prompts. To use text defined in a prompt file:

```
[*PROMPTFILE*,<s_file_name>]
```

When the field <s_file_name> contains just the name of the file without the path, then the file is searched in the DATAB\PROMPTS directory. When the complete file path is given then the file is searched on that path.

The example below searches the file on an absolute path.

```
*PROMPTFILE*,c:\v4.0\datab\cables\main\prmpt1.txt
```

The text contained in PRMPT1.TXT is loaded and displayed on the screen.

10.1.7.3 Using Graphical Bitmap Prompts

Fusion supports graphical files in PCX format. The PCX must be 1 bit black and white and must be exactly 240 pixels wide and 128 pixels high or they won't display properly. To use such a graphical prompt:

```
*BITMAP*,< s_file_name >
```

When the field <s_file_name> contains just the name of the file without the path, then the file is searched in the DATAB\PROMPTS directory. When the complete file path is given then the file is searched on that path.

The example below searches the file on an absolute path.

```
*BITMAP*,c:\v4.0\datab\cables\main\switch1.pcx
```

The text contained in SWITCH1.PCX is loaded and displayed on the screen.

10.1.7.4 Abort/Retry/Ignore/Prompt Operator on Failure

By default, the system uses a system setting to decide whether to abort, retry, ignore or prompt the operator on a switch test failure. The system setting can be overridden in the test program by using an appropriate keyword.

```
[*ONFAIL*,{ABORT|RETRY|IGNORE|PROMPT}]
```

In the example below, the system will abort testing any further the product. The product is failed as a result of the current switching position test failure.

```
*ONFAIL*,ABORT
```

In the example below, the current switching position will be re-tested following a failure this allows for some repairing the product on the fly and re-testing it without removing it from the test station. If this option is used, the operator must make sure that the product can be repaired to pass or the system will loop infinitely on a failed test. Sometimes prompting the operator to choose whether to retry the test would be a better option. See below the PROMPT option.

```
*ONFAIL*,RETRY
```

In the example below, the system will continue testing with the next switching position in case the current position has failed. This allows for a complete diagnostic of a defective product.

```
*ONFAIL*,IGNORE
```

In the example below, the system will prompt the operator to choose whether to abort a failed test, ignore it (go to the next test) or retry it.

```
*ONFAIL*,PROMPT
```

10.1.8 NetList

Most test programs must contain the NetList section. The NetList describes the tested product's connectivity. Each net consists of a list of at least one test point and may have a name and a label. Each net may also have customized test parameters. Even though the customized test parameters include DC and AC Hipot ones, the type of Hipot scan (mass or linear) cannot be specified at the net level.

```
*NET*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
       ...
  <s_pinAddress_n>[,<s_pinLabel_n>]

  [*CONTINUITY*,<d_min>,<d_max>
    [*KELVIN*]
    [{*HCRES*|*HCDROP*},<d_stimulus>]]
  [*DCHIPOT*,<d_voltage>
    [{*LEAKAGE*|*IR*},<d_limit>]
    [*DWELL*,<d_dwell>]
    [{*REGULAR*|*BYPASS*|*ADAPTIVE*|*SOAK*,<d_soak>}]]
  [*ACHIPOT*,<d_voltage>
    [{*LEAKAGE*|*IR*},<d_limit>]
    [*DWELL*,<d_dwell>]
    [{*50HZ* | *60HZ*}]]
```

In the example below, the first net is labelled Ground and the second one Term. Pwr. Both nets consist of two test points. Neither one of the nets has customized test parameters.

```
*NET*,,Ground
  B1.J1.C1.1,
  B2.J1.C1.1,
*NET*,,Term. Pwr.
  B1.J1.C1.2,
  B2.J1.C1.2,
```

In the example below, an anonymous net containing 6 test points will be tested for continuity using the customized test parameters of min 0.0Ω and max 0.1Ω measured Kelvin. The DC Hipot is disabled on this net.

```
*NET*,,
  B1.J5.C1.5,
  B1.J5.C1.6,
  B3.J6.C3.7,
  B3.J6.C3.8,
  B5.J5.C1.5,
  B5.J5.C1.6,
  *CONTINUITY*,0,.1
    *KELVIN*
  *DCHIPOT*,0
```

10.1.8.1 NetList – Special Type – Shields

A net that is functionally a shield within your product may not need the same stringent testing that other nets need. A tag exists for these nets:

```
*NET*,,
  B1.J5.C1.5,
  B1.J5.C1.6,
  *SHIELD*
```

The Shield tag ties all nets designated shield together for both Isolation tests and Hipot tests. The result is to prevent failures do to shield nets being shorted together and or exhibiting high leakage levels during a high voltage test.

10.1.8.2 NetList – Advanced Option - Embedded Switches

A cable can be tested in a multi-phase fashion. This kind of testing is usually associated with embedded switches. Basically each switch position can have its own customized test parameters and NetList. With minor exceptions a switch position may have the same features as a simple product test program (i.e. a switch position cannot have adapters or other switch positions). For the purpose of testing, the switch position holds the same capabilities as the whole product (without switches) does.

```
*SWITCH*[,<s_switch_name>[,<s_switch_label>]]]
```

In the example below, the anonymous switch position has a NetList of three single-point nets and will perform a Hipot on them. The low voltage and Hipot parameters are the global ones specified at the cable level but a local override will force the Hipot on the single-point nets.

```
*SWITCH*,,
  *HIPOTNC*
  *NET*,,
    B1.J1.C1.1,,
  *NET*,,
    B1.J1.C1.2,,
  *NET*,,
    B1.J1.C1.3,,
```

In the example below, a test program with switches is depicted.

```
*CABLE*,TEST1,1
  *STAR*
  *ONFAIL*,IGNORE
  *THRESHOLD*,61
  *ADAPTER*,HA 138,
    *POSITION*,B1.J5
  *ADAPTER*,HA 138,
    *POSITION*,B1.J6
  *SWITCH*
    *PROMPT*
Connect probe to
first position
    *NET*,,
      B1.J5.C1.9,
      B1.J6.C1.3,
   *NET*,,
     B1.J5.C1.10,
     B1.J6.C1.1,
  *SWITCH*
    *PROMPT*
Connect probe to
second position
    *NET*,,
      B1.J5.C1.7,
      B1.J6.C1.3,
```

```
    *NET*,,
      B1.J5.C1.8,
      B1.J6.C1.1,
  *SWITCH*
    *DCHIPOT*,1000
      *DWELL*,.5
      *MASS*
      *IR*,10e6
      *HIPOTNC*
    *PROMPT*
Disconnect probe
from product!
Hipot Will be Performed!
    *NET*,,
      B1.J5.C1.1,
    *NET*,,
      B1.J5.C1.2,
    *NET*,,
      B1.J5.C1.3,
*END*
```

10.1.9 Components

10.1.9.1 Programming Resistors

The text file format for resistors is as follows:

```
*RESISTOR*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *VALUE*,<minimum in ohms>,<maximum in ohms>
```

Programming Resistors – Kelvin

The text file format for resistors wired in Kelvin is as follows:

```
*RESISTOR*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>],<s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>],<s_pinAddress_2>[,<s_pinLabel_2>]
  *VALUE*,<minimum in ohms>,<maximum in ohms>
  *KELVIN*
```

Resistor address includes sense and source at each terminal.

Programming Resistors – High Current Source

The text file format for resistors measured using the High Current Source is as follows:

HC Resistance:

```
*RESISTOR*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *VALUE*,<minimum in ohms>,<maximum in ohms>
  *HCRES*,<value>
```

where <value> is in amperes

HC VoltageDrop:

```
*RESISTOR*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *VALUE*,<minimum in ohms>,<maximum in ohms>
  *HCDROP*,<value>
```

where <value> is in amperes

HC Load:

```
*RESISTOR*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *VALUE*,<minimum in ohms>,<maximum in ohms>
  *HCLOAD*,<value>
```

where <value> is in volts

Programming Resistors – Lamps

The text file format for resistive loads such as Lamps is as follows:

```
*RESISTOR*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *VALUE*,<minimum in ohms>,<maximum in ohms>
  *VISUAL*
  *HCVOLT*,<value>
```

Where <value> is in volts

10.1.9.2 Programming Capacitors

The text file format for capacitors is as follows:

```
*CAPACITOR*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *VALUE*,<minimum in Farads>,<maximum in Farads>
  *TARE*,<value>
```

Where <value> is the learned/Modified tare in Farads.

Programming Capacitors – Hipot

The text file format for Hipot testing capacitors is as follows:

```
*CAPACITOR*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *VALUE*,<minimum in Farads>,<maximum in Farads>
  *TARE*,<value>
  *DCHIPOT*,<voltage in volts>
    *DWELL*,<time in seconds>
    *LEAKAGE*,<current in amps>
  *ACHIPOT*,<voltage in volts>
    *DWELL*,<time in seconds>
    *LEAKAGE*,<current in amps>
```

Where <value> is the learned/Modified tare in Farads.

Programming Capacitors – Electrolytic

The text file format for electrolytic capacitors is as follows:

```
*CAPACITOR*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *VALUE*,<minimum in Farads>,<maximum in Farads>
  *TARE*,<value>
  *ELECTROLYTIC*
```

10.1.9.3 Programming Diodes

The text file format for diodes is as follows:

```
*DIODE*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *<type>*
```

Where <type> is defined as shown in section 5.6.5.2.

The text file format for diodes with custom or Auto detected thresholds is as follows:

```
*DIODE*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *<type>*
  *FORWARD*,<minimum in volts>,<maximum in volts>
  *REVERSED*,(minimum in amps>,<maximum in amps>
```

Programming Diodes – Visual test with LEDs

The text file format for a visual test using LEDs is as follows:

```
*DIODE*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *LED*
  *VISUAL*
```

Programming Diodes – Parallel

The text file format for diodes in parallel is as follows:

```
*DIODE*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *<type>*
  *FORWARD*,<minimum in volts>,<maximum in volts>
  *REVERSE*<minimum in volts>,<maximum in volts>
  *PARALLEL*
```

Where <type> is defined as explained in section 5.6.5.2.

Programming Diodes – LEDS/BI-LEDs

The text file format for a visual test of BI-LEDs is as follows:

```
*DIODE*[,<s_netName_1>[,<s_netLabel_1>]]
  <s_pinAddress_1>[,<s_pinLabel_1>]
  <s_pinAddress_2>[,<s_pinLabel_2>]
  *LED*
  *FORWARD*,<minimum in volts>,<maximum in volts>
  *REVERSE*<minimum in volts>,<maximum in volts>
  *VISUAL*
  *PARALLEL*
```

Where <type> is defined as explained in section 5.6.5.2.

10.2 Adapter File Format

The tested products are usually connected to the Fusion system through conventional adapters or adapter cables. The adapters or adapter cables are described in the adapter files. These files contain the connectivity tables that make correspondence between the connector's pin name and the system's test point number. In this way the Fusion system is able to test the product (by means of using test point numbers) while providing the operator with meaningful diagnostics (by means of using connector pin names).

10.2.1 Format

The syntax of an adapter file is as follows:

```
*ADAPTER*, <adapter's name>,
*CONNECTOR*, <name of connector #1>
Sys. Pin, Pin Name, Pin Label , Sense, CTare, LVRL Tare, LVRH Tare, HCRL Tare, HCRH Tare,
```

10.2.1.1 ADAPTER: Required

The name of the adapter is required and limited by 30 characters. No two adapters within the library can have the same name. The adapter's name is capitalized automatically.

10.2.1.2 CONNECTOR: Required

The name of the connector is optional. An adapter can have more than one connector. In such cases the subsequent connectors are listed in sequence – one after another.

`Sys. Pin`	The actual system pin on the Fusion Switching Cards
`Pin Name`	The pin designation as selected by operator — default numerical
`Pin Label`	An optional designation value for each pin — has a higher priority than the Pin Name.
`Sense`	Sense Test Point for Kelvin connections
`CTare`	Capacitance Tare Value
`LVRL Tare`	Low Voltage Resistance Low Test Point Tare Value
`LVRH Tare`	Low Voltage Resistance High Test Point Tare Value
`HCRL Tare`	High Current Resistance Low Test Point Tare Value
`HCRH Tare`	High Current Resistance High Test Point Tare Value

The pin list is terminated either when another `*CONNECTOR*` keyword is encountered or when the file ends.

The last line in the adapter file must be a blank line (terminate the last pin list line with a carriage return such as the end of file character doesn't follow immediately after the last connector pin name).

10.2.2 Example 1

```
*ADAPTER*,HA 116,
*VERSION*,V4.2.50
*CONNECTOR*,DB 25 FEMALE,
18,1,,,6.49643e-12,0.0549,0.0347,0.0371066,0.0372955,,
19,2,,,4.225e-12,0.0424,0.0224,,0.0383864,,
20,3,,,3.5e-12,0.0521,0.0434,0.0163888,0.0415342,,
21,4,,,4.85e-12,0.0472,0.0433,0.0297879,0.0443802,,
22,5,,,5.975e-12,0.0548,0.0572,0.0458907,0.0489997,,
23,6,,,4.1e-12,0.0664,0.0477,0.0287416,0.0520463,,
28,7,,,5.175e-12,0.0745,0.0683,0.0449316,0.0758962,,
6,8,,,5.09286e-12,0.074,0.0639,0.0616145,0.0653432,,
7,9,,,4.875e-12,0.0503,0.0543,0.0352298,0.0545201,,
15,10,,,4.25e-12,0.0443,0.0388,,0.0449438,,
14,11,,,3.025e-12,0.0323,0.0345,0.0299088,0.0388788,,
13,12,,,4.7e-12,0.0214,0.0321,0.0337148,0.0360858,,
12,13,,,3.205e-12,0.0346,0.04,0.0307894,0.0340614,,
17,14,,,3.15e-12,0.05,0.0437,0.0299103,0.0417339,,
16,15,,,4.75e-12,0.0545,0.0425,0.015863,0.0442314,,
24,16,,,5.15e-12,0.0483,0.0627,0.0536157,0.0579428,,
25,17,,,6.525e-12,0.0651,0.0657,0.0505918,0.0734726,,
26,18,,,5.325e-12,0.102,0.0734,0.0838286,0.0856556,,
2,19,,,6.925e-12,0.0847,0.087,0.0837441,0.0877148,,
1,20,,,6.825e-12,0.0815,0.0826,0.051058,0.0748405,,
0,21,,,7.3e-12,0.0621,0.0745,0.056447,0.0598312,,
8,22,,,6.175e-12,0.0438,0.0424,0.0382992,0.0500458,,
9,23,,,4.35e-12,0.0389,0.0542,0.0314001,0.0445852,,
10,24,,,5.3e-12,0.0467,0.0379,0.0763667,0.0399493,,
11,25,,,4.575e-12,0.0404,0.044,0.056884,0.0380404,,
```

In the example above, the adapter called HA 116 uses a DB 25 female connector. The adapter's size is Single and it uses two resistor ID's. The first ID component has 1KΩ and the second has 1.5KΩ. This adapter has been fully tared for capacitance, LV Resistance, and HC Resistance.

10.2.3 Example 2

```
*ADAPTER*,HSA 214
  *CONNECTOR*,MIL ROUND M. 11
    0,A
    1,B
    2,C
    3,D
    8,E
    4,F
    5,G
    9,H
    28,J
    27,K
    24,L
    26,M
  *CONNECTOR*,MIL ROUND F. 11
    47,A
    39,B
    38,C
    37,D
    36,E
    35,F
    41,G
    54,H
    53,J
    52,K
    50,L
    51,M
```

In the example above, it can be seen that the connector pin names are no longer numbers. The operator has total freedom to name the connector pins according to their documentation.

10.2.4 Creating Custom Adapter Files Off-line

To create a custom adapter cable file, one would normally start from the adapter file that the adapter cable will be interfacing to. The examples below make the assumption that the HSA 272 adapter is used to interface two different types of adapter cables: ADPTCBL 1 and ADPTCBL 2. Using a text editor open the file called HSA272.ADP and save it as ADPTCBL1.ADP and then as ADPTCBL2.ADP. This way you have created the templates for the two new adapter files. The a portion of the original HSA272.ADP is listed below:

```
*ADAPTER*,HSA 272
*VERSION*,4.0.0
*CONNECTOR*,ZIF 104 SOCKETS
8,1
9,2
10,3
11,4
12,5
13,6
14,7
15,8
40,9
41,10
42,11
43,12
44,13
0,14
2,15
3,16
4,17
5,18
6,19
7,20
.
.
.
```

Now, let's assume that the first adapter cable that you want to create a file for is described in the table below:

ADPTCBL 1:

Product Connector Name	Pins	ZIF connector pins (mating to HSA 272)
C	A	1
C	B	3
C	C	5
C	D	7
C	E	9
C	F	11
C	G	13
C	H	15
C	J	17
C	K	19

Use the text editor to open the file ADPTCBL1.ADP (created above) and change the adapter and connector names. Also, based on the observation that only the odd numbered ZF pins from 1 to 19 are used, eliminate all other pin lines from the file. The adapter file would now look like:

```
*ADAPTER*,ADPTCBL 1
*VERSION*,4.0.0
*CONNECTOR*,MIL ROUND CONN 10 PINS,C
8,1
10,3
12,5
14,7
40,9
42,11
44,13
2,15
4,17
6,19
```

Now substitute the numbers in the right column (which represent the ZIF pin numbers) with the product connector's pin numbers. The file ADPTCBL1.ADP would now look like:

```
*ADAPTER*,ADPTCBL 1
*VERSION*,4.0.0
*CONNECTOR*,MIL ROUND CONN 10 PINS,C
8,A
10,B
12,C
14,D
40,E
42,F
44,G
2,H
4,J
6,K
```

Save the file.

Appendix A: Mass Hipot Examples

Introduction

The following binary tables show the nets connected to high potential (+) and to ground potential (–) for a 16-net product during the Mass Hipot routine. Similar patterns are generated for other product sizes. The 16-net product is used for illustrative purposes only.

The routine presented in Table 1 (below) guarantees that each net is raised to high voltage at least once. This is important to ensure that leakage (IR) is measured on all points and to ensure that Dielectric Withstand Voltage (DWV) testing is performed on all nets against all external ground points.

Scenario 1: Good Product

When PUT is "good" (i.e. passes IR and DWV tests), and the current limit of the MPT's high voltage supply is not exceeded, the iterations will be carried out as shown in Table 1.

Table 1: Mass Hipot Routine - Product Under Test is 'Good', no faults exist.

Test Phase	Net Number															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
2	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-
3	+	+	+	+	-	-	-	-	+	+	+	+	-	-	-	-
4	+	+	-	-	+	+	-	-	+	+	-	-	+	+	-	-
5	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-

The MPT will automatically divide the nets into smaller groups so that the current requirements are reduced when either of the following situations occurs:

a. More current is required to charge the PUT than the source can deliver; or

b. The leakage limit is exceeded due to the size of the group during IR tests.

These situations are illustrated in the following scenarios.

Scenario 2: Good Product – PUT's High Capacitance Overloads HV Source

Overload of the high voltage (HV) source can be caused by high capacitance when the PUT's grouped nets are connected in parallel. This scenario is most likely to occur in AC Mass Hipot testing when the AC drive current is too high for a large number of nets. To avoid overloading the HV source during Mass Hipot testing, group splitting will occur recursively until the combined capacitance of the nets connected to the high potential is small enough so that the system's overload condition is not triggered when high voltage is applied. An overload condition will not result in a FAIL condition unless it is caused by one net only (i.e. a true fault is detected). An example of group splitting caused by an overload condition is shown in Table 2.

Table 2: Splitting caused by current overload due to mass grouping

Test Cycle	Net Number																
	Condition	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Pass!	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
2	Overload?	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-
2a	Pass!	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
2b	Pass!	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	-
3	Pass!	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
4	Pass!	-	-	-	-	-	-	-	-	+	+	+	+	-	-	-	-
5	Pass!	+	+	-	-	+	+	-	-	-	-	-	-	-	-	-	-
6	Pass!	-	-	-	-	-	-	-	-	+	+	-	-	+	+	-	-
7	Pass!	+	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-
8	Pass!	-	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-

Scenario 3: Good Product – Mass IR Tests Fail – Net Groups Are Too Large

The MPT's IR leakage limit is typically chosen as though one net in the PUT was being tested against all other nets. For this reason, it is possible to reach a "good" product's current leakage limit during Mass IR testing due to the net grouping that occurs.

Table 3: Splitting caused by excessive current leakage due to mass grouping

Test Cycle	Net Number																
	Condition	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Pass!	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
2	Leakage?	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-
2a	Pass!	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
2b	Pass!	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	-
3	Leakage?	+	+	+	+	-	-	-	-	+	+	+	+	-	-	-	-
3a	Pass!	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
3b	Pass!	-	-	-	-	-	-	-	-	+	+	+	+	-	-	-	-
4	Leakage?	+	+	-	-	+	+	-	-	+	+	-	-	+	+	-	-
4a	Pass!	+	+	-	-	+	+	-	-	-	-	-	-	-	-	-	-
4b	Pass!	-	-	-	-	-	-	-	-	+	+	-	-	+	+	-	-
5	Leakage?	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
5a	Pass!	+	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-
5b	Pass!	-	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-

During the Mass IR test's binary scan, multiple nets are measured simultaneously. As the combined leakage of all these nets adds up, the PUT's IR leakage limit may be exceeded. If this occurs, a FAIL condition is detected by the MPT. The MPT will then determine whether this condition was caused by cumulative net grouping or by the excessive leakage of a faulty net.

This is done by performing recursive group splitting in a “divide and re-test” fashion until all faulty nets are identified or the condition disappears (e.g. Test Cycles 2a, 2b, 3a, 3b, etc.).

If the FAIL condition disappears on group splitting, a FAIL will not be recorded.

Scenario 4: Bad Product – Arc Detected During Mass Hipot Test

When an arc is detected during a mass Hipot test, the system can either split the group recursively (binary iterations) or it can default directly to linear (sequential or “single phase”) fault detection. The use of binary or linear iterations upon fault detection is a programmable option. Linear fault detection may be required when it is not desirable to expose the PUT to repeated arc faults that can occur during the faster binary fault detection routine. The binary and linear fault detection methods are illustrated in Tables 4a and 4b respectively.

Table 4a: ‘Bad’ PUT – Arc between 2 nets during Mass Hipot (Binary search for fault)

Test Cycle	Net Number															
	Condition	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Pass!	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
2	ARC!	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-
2a	ARC!	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
2b	Pass!	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2c	Pass!	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2d	ARC!	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
2e	Pass!	-	-	F	+	-	-	-	-	-	-	-	-	-	-	-	-
3	Pass!	-	-	F	-	+	+	+	+	-	-	-	-	-	-	-	-
4	Pass!	+	+	F	+	-	-	-	-	+	+	+	+	-	-	-	-
5	ARC!	+	+	F	-	+	+	-	-	+	+	-	-	+	+	-	-
5a	Pass!	+	+	F	-	+	+	-	-	-	-	-	-	-	-	-	-
5b	ARC!	-	-	F	-	-	-	-	-	+	+	-	-	+	+	-	-
5c	Pass!	-	-	F	-	-	-	-	-	+	-	-	-	-	-	-	-
5d	Pass!	-	-	F	-	-	-	-	-	-	+	-	-	-	-	-	-
5e	Pass!	-	-	F	-	-	-	-	-	-	-	-	-	+	-	-	-
5f	ARC!	-	-	F	-	-	-	-	-	-	-	-	-	-	+	-	-
6	Pass!	+	-	F	-	+	-	+	-	+	-	+	-	+	F	+	-

Table 4b: 'Bad' PUT – Arc between 2 nets during Mass Hipot (Linear search for fault)

Test Cycle	Net Number															
	Condition	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Pass!	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
2	ARC?	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-
2a	Pass!	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2b	Pass!	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2c	ARC!	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
2d	Pass!	-	-	F	+	-	-	-	-	-	-	-	-	-	-	-	-
2e	Pass!	-	-	F	-	+	-	-	-	-	-	-	-	-	-	-	-
2f	Pass!	-	-	F	-	-	+	-	-	-	-	-	-	-	-	-	-
2g	Pass!	-	-	F	-	-	-	+	-	-	-	-	-	-	-	-	-
2h	Pass!	-	-	F	-	-	-	-	+	-	-	-	-	-	-	-	-
3	Pass!	+	+	F	+	-	-	-	-	+	+	+	+	-	-	-	-
4	ARC?	+	+	F	-	+	+	-	-	+	+	-	-	+	+	-	-
4a	Pass!	+	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-
4b	Pass!	-	+	F	-	-	-	-	-	-	-	-	-	-	-	-	-
4c	Pass!	-	-	F	-	+	-	-	-	-	-	-	-	-	-	-	-
4d	Pass!	-	-	F	-	-	+	-	-	-	-	-	-	-	-	-	-
4e	Pass!	-	-	F	-	-	-	-	-	+	-	-	-	-	-	-	-
4f	Pass!	-	-	F	-	-	-	-	-	-	+	-	-	-	-	-	-
4g	Pass!	-	-	F	-	-	-	-	-	-	-	-	-	+	-	-	-
4h	ARC!	-	-	F	-	-	-	-	-	-	-	-	-	-	+	-	-
5	Pass!	+	-	F	-	+	-	+	-	+	-	+	-	+	F	+	-

Scenario 5: Bad Product – Leakage Failure During IR Test

The following table shows an example of splitting as a result of a leakage condition. Test cycles 3a through 3f correspond to the recursive group splitting that is used to detect the fault.

Table 5: 'Bad' PUT – Splitting due to excessive current leakage during Mass IR Test

Test Cycle	Net Number															
	Condition	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Pass!	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
2	Pass!	+	+	-	-	+	+	-	-	+	+	-	-	+	+	-	-
3	Leakage?	+	+	+	+	-	-	-	-	+	+	+	+	-	-	-	-
3a	Pass!	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
3b	Leakage?	-	-	-	-	-	-	-	-	+	+	+	+	-	-	-	-
3c	Pass!	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
3d	Leakage?	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-
3e	Pass!	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
3f	Leakage!	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
4	Pass!	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-
5	Pass!	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+

Linear (Sequential or "Single Phase") Testing

The linear fault detection method relies on holding one net at a time at the high potential and all other nets at ground potential. That net under test is qualified in a single pass or test cycle and is tested against all other nets. For groups of 4 nets or less, linear (sequential or 'single phase') testing will be performed until all faults are found.

Table 6: Sequential or "Linear" Testing

Test Cycle	Net or Net Group Number															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+

Summary

If an error condition occurs during one of the mass high voltage test phases where multiple nets are at high potential, the mass algorithm will use a recursive fault detection routine.

The binary mode uses a "divide and re-test" strategy. The group of nets connected to the high potential is divided in two new groups and testing is repeated. If the new subgroups experience a new FAIL condition that requires splitting again, the subgroups will be split recursively in a similar fashion until the fault is found or the FAIL condition is eliminated.

In this example, the PUT has 16 nets and the smallest sub-group that will be tested with the "divide and re-test" strategy has 5 nets. For groups of 4 nets or less, linear (sequential or 'single phase') testing will be performed until all faults are found.

Glossary

Build Aid	A special test parameter that allows the Fusion to aid in the building of a product. Assists in avoiding miswiring during product assembly.
CapTare	Measurement of capacitance up to a specific location for increased measurement accuracy.
Conventions	The numbering / lettering of connector pins using a specific sequence.
EPO	Emergency Power Off
FER™	Faulty End Recognition – a unique feature of the Fusion that enables the operator to quickly and easily locate low voltage shorts anywhere along the length of a product.
Flying Leads	Any product that is terminated at one end with accessible contacts at another location.
HIPOT	High potential Test
Hipot testing	The application of high voltage (either DC or AC) to a product.
HV	High Voltage
LV	Low Voltage
MSR	Measurement Board
Netlist	Groups of test points, sorted by their connections.
PUT	Product Under Test
ResTare	Measurement of resistance up to a specific location for increased measurement accuracy.
Standard Probe	Included tool with the Fusion to use with the Build Aid feature of the Fusion.

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