HOT LINKS!
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Section 2: THE CABLEEYE TEST FIXTURE

2 The CableEye® Test Fixture

2.1 General Description

The CableEye M2 test fixture reads wiring information from an attached cable. The test fixture itself houses removable connector boards for the cable under test, applies test signals to the various conductors within the cable, and accepts electrical responses from the cable. The CableEye Windows application generates all control signals that operate the fixture. Responses from the cable under test immediately return to the Windows program for analysis. No processing or analysis of any kind is performed within the test fixture; it serves simply as a data acquisition unit and depends on the PC for control. This method of operation, in fact, distinguishes PC-based equipment from stand-alone equipment.

CAMI Research provides several variations of the CableEye test fixture.

- Model M2-Basic, catalog Item 810, measures continuity only, provides 128 test points, and cannot be expanded; see Figure 2-1. This unit provides basic continuity testing for cables of 64 or fewer conductors and is our lowest-cost tester.
- Model M2, catalog Item 811, measures continuity only, offers 152 test points, and may be expanded in increments of 128 test points up to 1048 test points maximum; see Figure 2-2. The expandable M2 tester can test up to a 68-conductor SCSI cable without an expansion module, and may be expanded using additional plug-in modules for larger cables and wiring harnesses. M2 has a fixed resistance threshold of about 46 kΩ, making it very sensitive to short circuits and excellent for general-purpose testing of electronic cables that do not carry current above 500ma per conductor.
- Model M3 (serial port), catalog Item 821, and Model M3U (USB port), catalog Item 821U, provide the same benefits as M2, but also offer two settable resistance thresholds, allowing you to check connection quality down to 0.5 ohms and conductor isolation up to 10 megohms; see Figure 2-3. Use M3 to ensure that cables carrying currents above 500ma do not experience resistive losses in the cable, and that cables carrying voltages above 25v do not exhibit leakage between conductors. The M3U tester scans about three times faster than the M3 and is sensitive down to 0.3 ohms.

Expand the test point capacity of both Models M2 and M3 by adding expansion modules. For each, you may add a Side-by-Side Expansion Module (Item 812 for M2 or 822 for M3), see Figure 2-5, or an Attached Expansion Module (Item 813 for M2 or 823 for M3), see Figure 2-6. Each module adds 128 test points. Use the side-by-side module (a separate case connected by cable to the base unit) when checking cables or wiring harnesses whose connectors are spread out or if you wish to use four or more CAMI CB boards. Because of its compact nature, the attached expansion module (AEX) is best for general-purpose expansion or when you will build your own cable/harness interface.

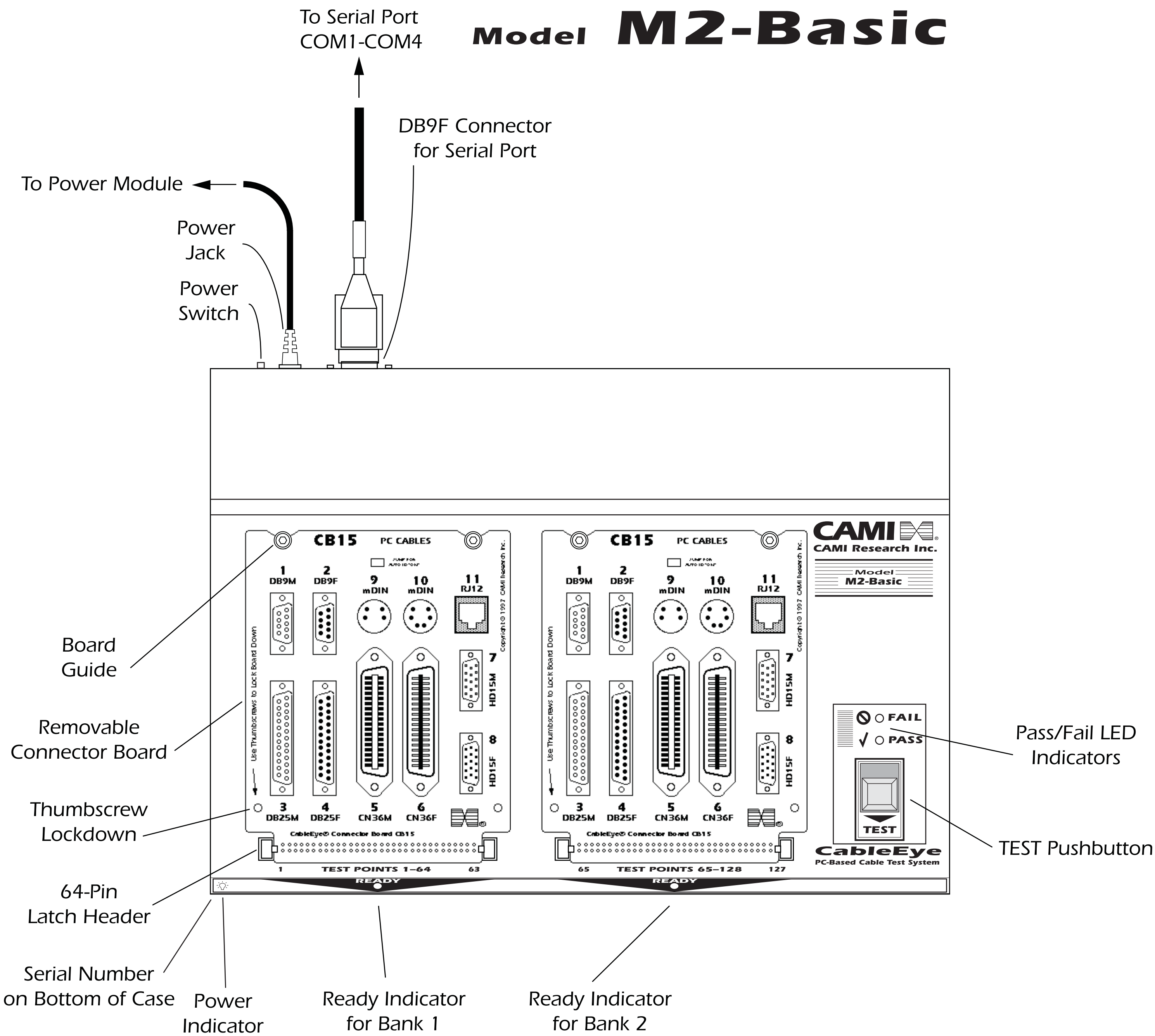


Figure 2-1: The M2-Basic test fixture offers 128 test points and can accommodate all CB boards having connectors of 64 or fewer pins.

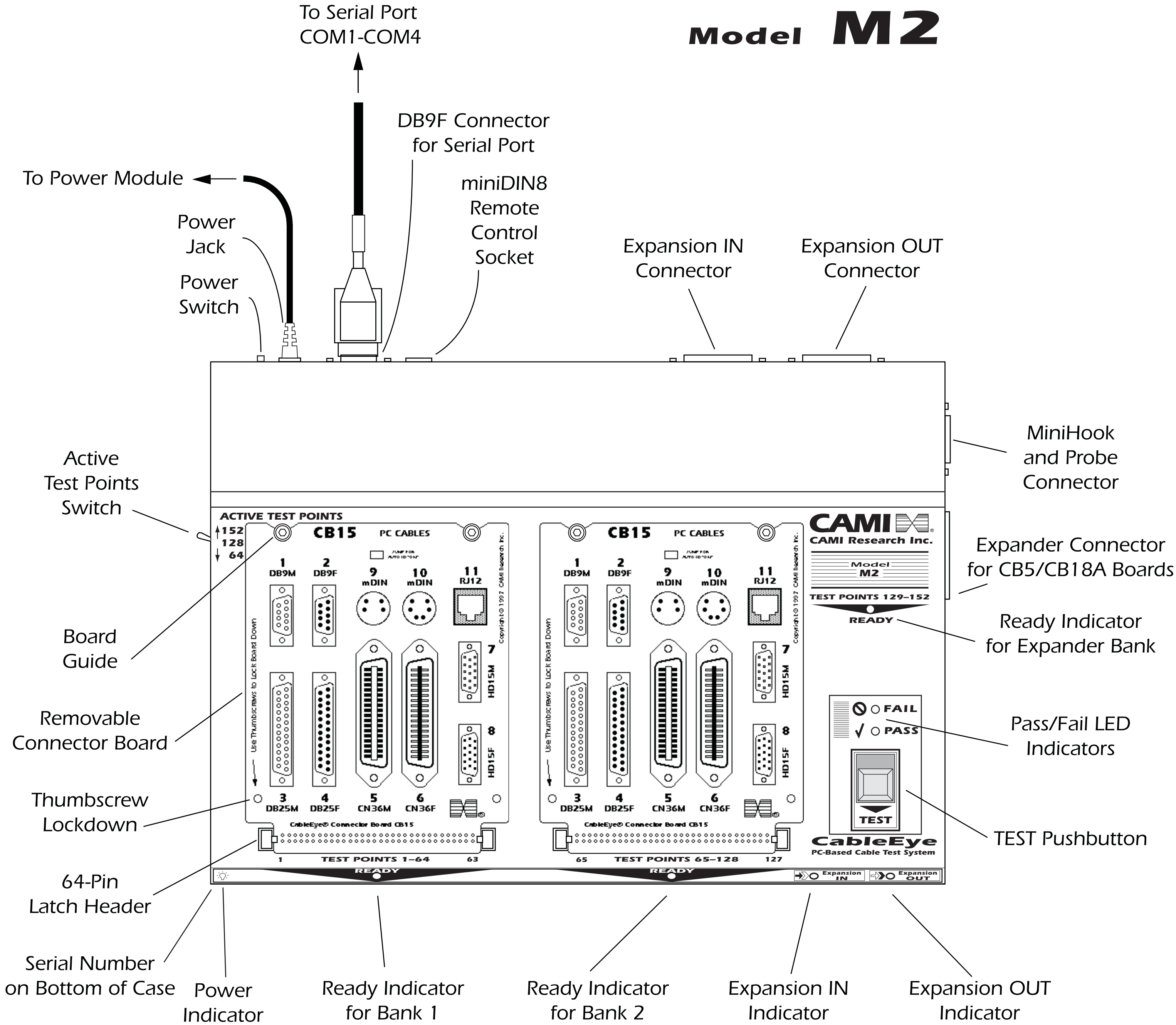


Figure 2-2: Because the M2 test fixture provides 152 test points, it can support all CB boards having connectors of 76 or fewer pins. You may add expansion modules to accommodate larger cables or wire harnesses. The M2 may be used itself as an expansion module to another M2 if two separate testers are available.

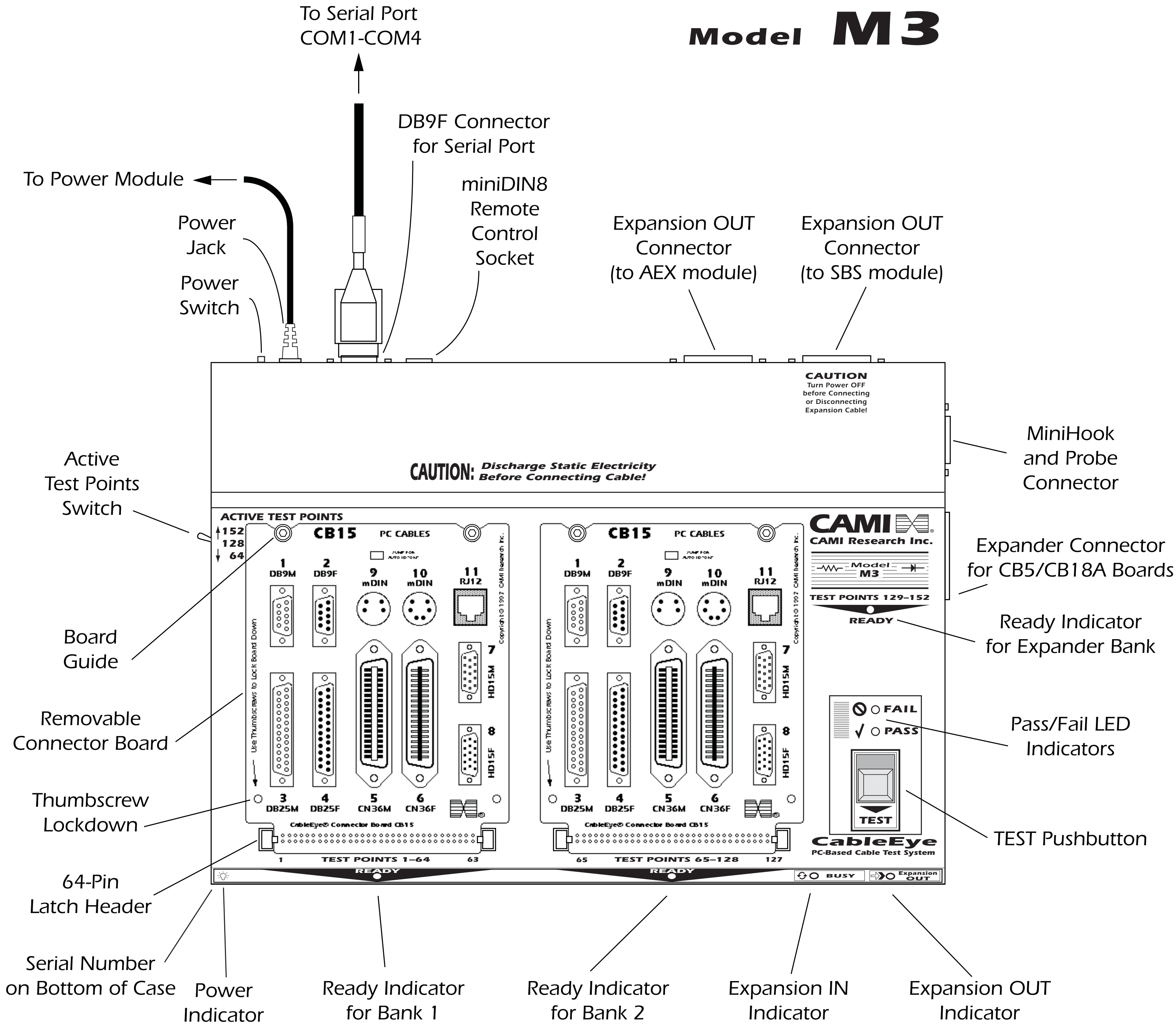


Figure 2-3: The M3 CableEye looks almost identical to M2, but a different electronic design of the internal circuit permits it to check cables against resistance thresholds and measure embedded resistors.

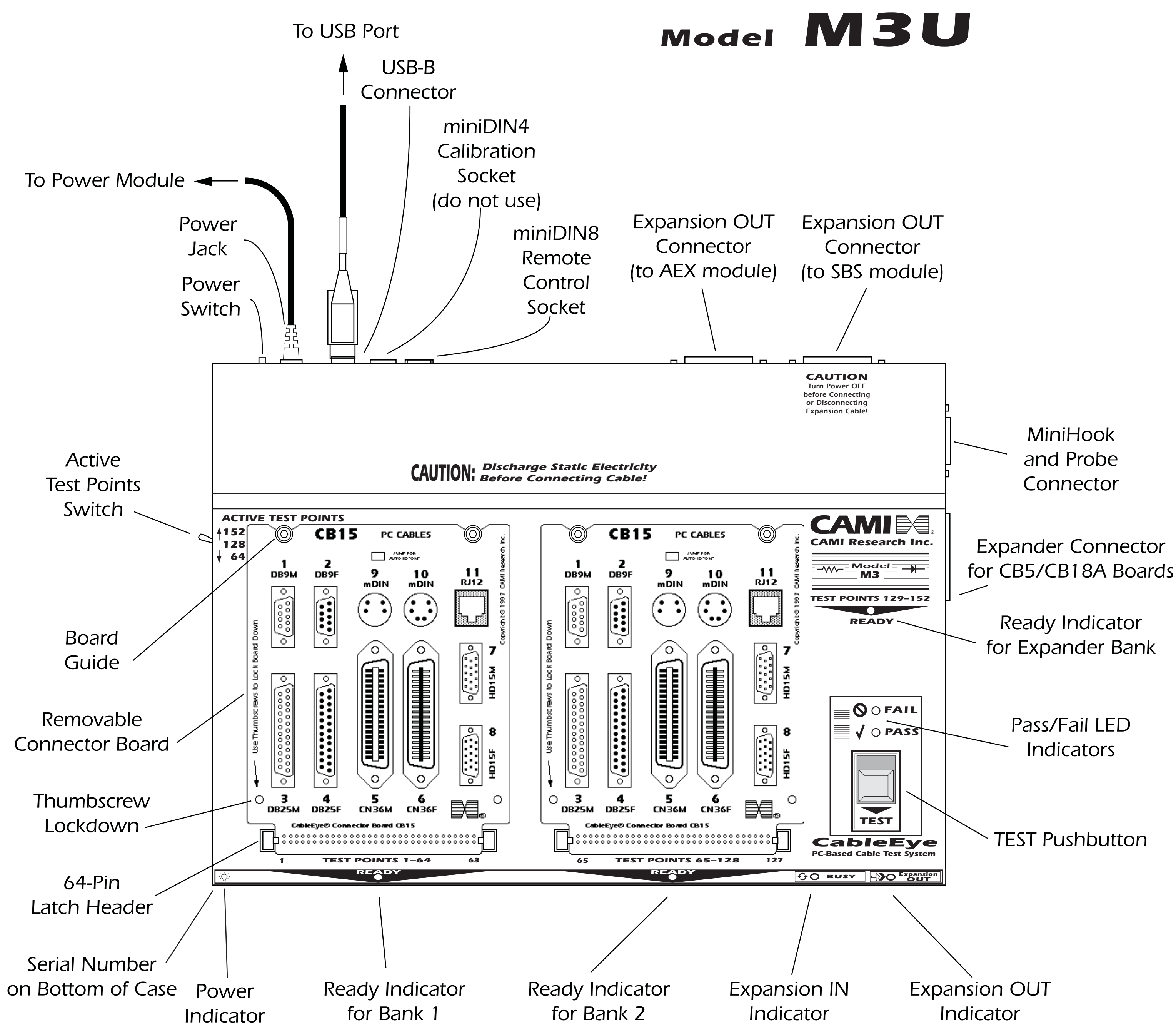


Figure 2-4: The M3U CableEye employs a USB port rather than a serial port for faster communications. This version of the M3 also has a miniDIN4 calibration connector near the remote control socket. The calibration connector is not for general use.

Side-by-Side
Expansion Module

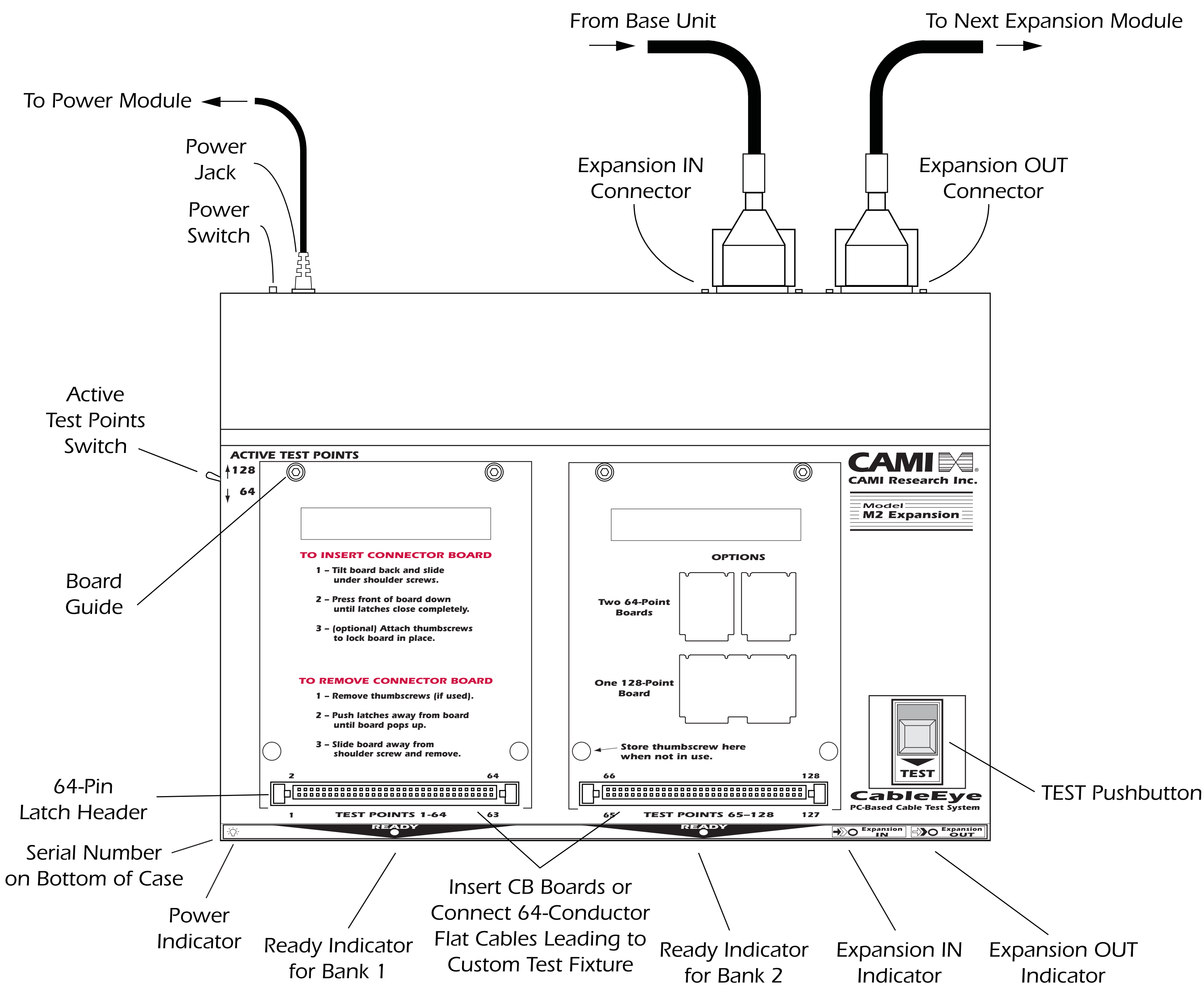


Figure 2-5: The side-by-side (SBS) expansion module adds 128 test points to an M2 or M3 tester. You may add up to seven expansion modules to provide a total of 1048 test points. Each module offers two more CB board fixture positions.

Attached
Expansion Module

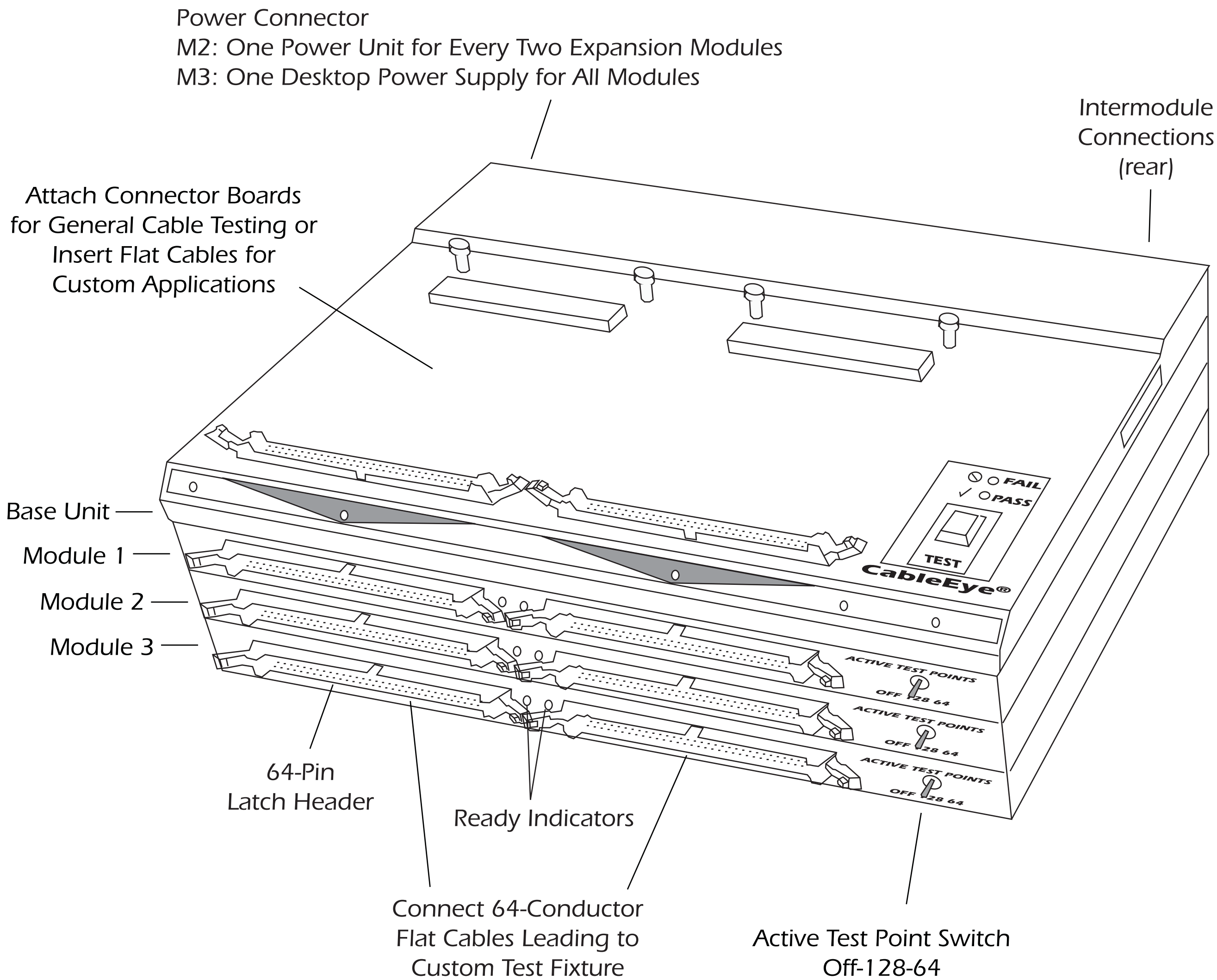


Figure 2-6: The attached expansion module (AEX) permanently joins to the bottom of an M2 or M3 base unit. Stack up to seven modules under the base to provide a total of 1048 test points. The AEX and SBS modules are electrically equivalent. While the AEX uses the same bench footprint as the base unit itself, only two CB boards may be mounted directly to the tester.

Note that the case, connectors, and controls of Models M2, M3, and M3U appear almost identical, however, their electronic circuit boards and internal operation are entirely different. M2 applies a test signal of +5v at about 0.3ma, whereas M3 and M3U apply a test signal of +10v at about 1ma.

The unusual choice of 152 test points for M2 and M3 occurred because of our desire to accommodate the CB5 board, having SCSI connectors of up to 68 pins, with a single test fixture. The ability to test cables of 68 or fewer conductors meets all of the requirements for many customers, and this averts the need and extra expense of an expansion module.

> ***IMPORTANT:*** All CB connector boards we manufacture will attach to any M2 or M3 tester. However, some boards require more than 64 test points each (such as CB5). Boards requiring more than 64 test points cannot be used with M2-Basic. Some boards, such as the CB20 for 100-pin SCSI cables, require an expansion module. See the CB Compatibility Chart for details (page 3-xx).

2.2 Controls and Connectors

Power Switch – Push ON/Push OFF. A yellow power indicator lamp on the left front panel glows when the digital circuitry receives the needed 5v DC power. If you do not see this lamp "on", the fixture is not receiving power and will not operate.

Left Rear

Left Front

Power Jack, Power Module –

> ***M2:*** The supplied power module provides 11–14v of unregulated DC, unloaded, at approximately 300ma maximum. You may use a substitute power source if desired as long as these voltage and current requirements are met. The circular power plug has a 2.5mm opening with center-positive, and has a 12mm barrel. Use one power module for every other expansion module (e.g.: the M2 base unit and one expansion module may operate from a single power unit).

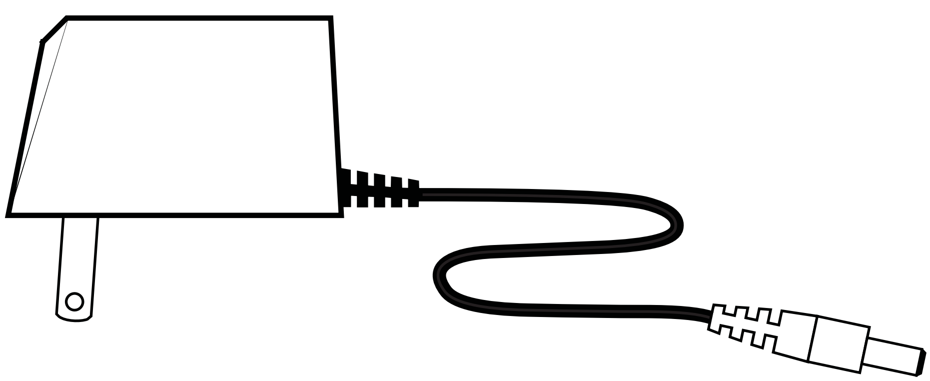


Figure 2-7: The M2 power module, marked as 9v DC output at 300ma. Unloaded output voltage may be 11-14v which is acceptable.

M3: An M3 base unit with no expansion modules operates from a single power module providing 15–18v of unregulated DC at approximately 500ma. The appearance is similar to that in Figure 2-7, although the M3 module is a bit larger. You may substitute another power source if desired as long as these voltage and current requirements are met. An M3 tester with side-by-side expansion modules requires a separate power unit of this type for each expansion module. When an M3 system includes attached expansion modules, we provide a single desktop power unit supplying 18v of regulated DC at 1.6 amps or more, depending on the number of modules employed.

Remote Control Socket (Models M2 and M3) –

M2

M3U

This miniDIN8 socket accepts a footswitch (catalog Item 714) or remote control (customer designed). The footswitch, and the pushbutton that would normally be included on a remote control, operate in parallel with the TEST pushbutton on the main housing so both switch types can be used alternately during testing, if desired. We provide a cord length of 10 feet on the footswitch; however, you may extend the cord up to 20 feet if necessary.

CAUTION: when connecting and disconnecting a footswitch or remote control, be careful not to discharge static electricity into the remote control socket!

You may build a custom remote control or footswitch for special applications. Refer to the wiring diagram in Figure 2-8. If you choose to build a remote control, we suggest inserting a 100ma fuse on the power input to the IC driver chip.

Note that Pin 3 of the remote control socket (“External Relay Assert”) provides a function available only on Model M3. This pin, normally pulled up to +5v, will be driven to logic ‘0’ in response to the Macro command “Relay Assert On” (see Section 6 on Automatic Testing). You may sink up to 100ma into this pin, sufficient to operate a relay coil. Use this function when you wish to signal external test equipment during the execution of an automatic test sequence (Macro).

Calibration Socket (Model M3U Only) –

This miniDIN4 socket provides test signals for use during calibration and is not for customer use. Do not connect anything here!

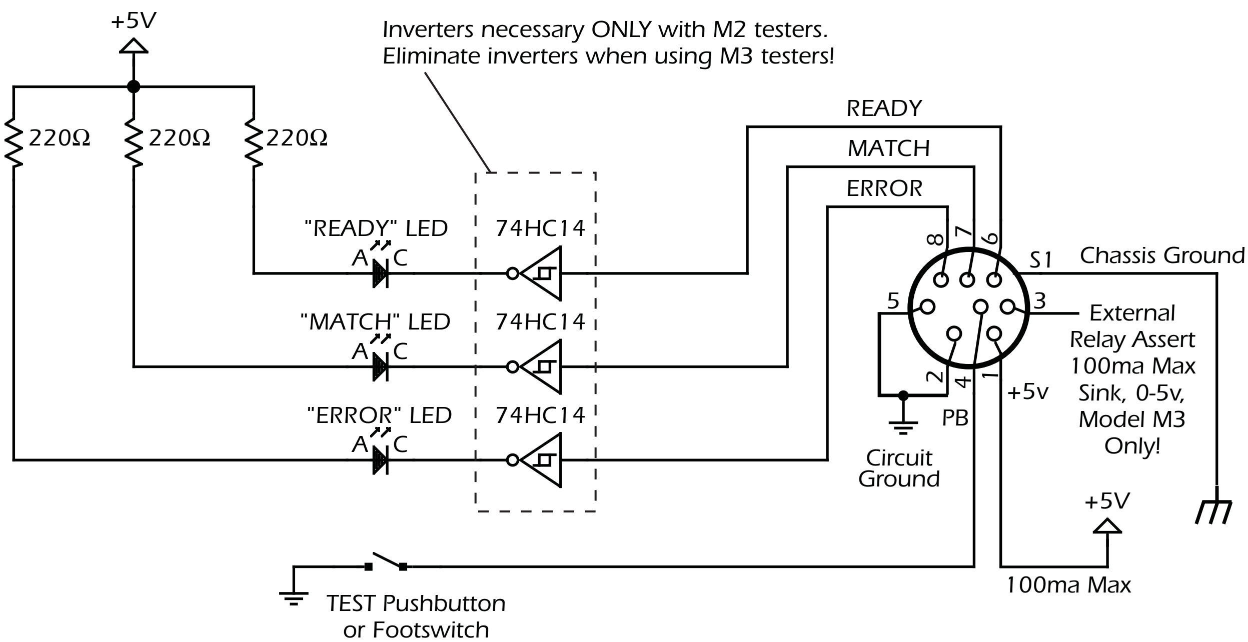


Figure 2-8: Use this wiring if you build a custom remote control or footswitch, being sure to fuse the power input to the IC driver chips.

Expansion-IN and Expansion-OUT Connectors –

M2: Use a DB15-female-to-DB15-male cable to link the M2 fixture to an M2 side-by-side expansion module or to join two such modules. The genders of these connectors prevent misconnection of the cable. We include a standard 6-foot cable with each expansion module ordered, however, you may extend the cable's length to at least 20 feet, depending on cable quality and the electrical noise environment.

M2

M3: Use a DB26HD-female-to-DB26HD-male cable to link the M3 fixture to an M3 side-by-side expansion module or to join two such modules. The genders of these connectors prevent misconnection of the cable. We include a standard 6-foot cable with each expansion module ordered. To maintain accurate resistance readings, do not use any cable longer than 6 feet with an M3 expansion module.

M3U

Probe or Minihook Connector (Models M2 and M3) – Attach a Probe Cable (Item 718) or a MiniHook cable (Item 710) to this DB9 male connector when you need to identify wires in a connectorless cable or a cable in which one end has a connector and the other does not. The shell of this connector represents a tenth test point for the DB9 connector and *is not grounded to the case.* The optional PinMap software (Item 708) requires the probe also.

M2
M3
M3U

Expander Cable connector (Models M2 and M3) – Twenty-four test points exit the tester on this 24-pin header connector located on the tester's right side. When added to the 128 test points available on the two 64-pin latch headers along the front, we obtain the 152 test point total offered by the M2 or M3 testers. When using the CB5 connector board set (for SCSI cables) or the CB18A connector board set (shielded octal RJ45 connectors), we supply an expander cable which joins to this connector, providing additional test points. Although no other CB boards use these extra test points, you may build a custom fixture employing them, in which case you would use the PinMap software (Item 708) to map these points to a particular connector graphic.

READY Indicator for the Expander Bank (Models M2 and M3) – The 24 test points available on the Expander Connector are active when you see this LED "on". The Active Test Points switch (described later) enables this upper bank of 24 test points when set to the "152" position.

PASS and FAIL LED Indicators – These software-controlled lamps indicate test results when checking cables. They operate automatically when manually testing, and in response to the COMPARE TEST TO MATCH or CONTINUOUS TEST Macro instructions.

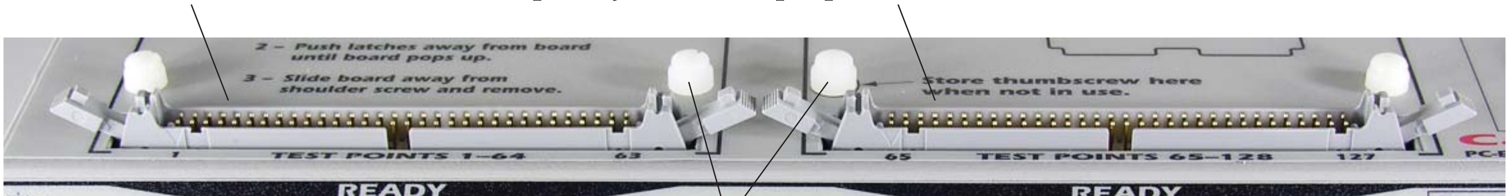
TEST Pushbutton – Press this button to trigger a Macro (automatic test sequence) or, if no Macro is loaded, to execute TEST CABLE. Achieve the same result in most cases by pressing ENTER on the keyboard, or by using the Footswitch (catalog Item 714) or the pushbutton on a custom remote control. Software scans the TEST button; it has no direct hardware action. The READY indicators (for Bank 1, Bank 2, or the Expander Bank) show that the TEST button is active. When the READY indicators are off, the software is unavailable to scan the TEST button and no action will ensue if pressed.

Expansion-IN and Expansion-OUT Indicators (Model M2) – You will see the Expansion-IN lamp "on" to show that an expansion unit is properly linked "upstream" via the Expansion-IN connector. Similarly, the Expansion-OUT lamp glows when an expansion unit is properly linked "downstream" via the Expansion-OUT connector.

BUSY and Expansion-OUT Indicators (Model M3) The BUSY lamp glows to show that the tester is actively acquiring data from a cable. When on, the software cannot respond to the TEST button or to keyboard commands. When you measure a cable or wire harness with many test points, a large number of resistors, or many complex interconnections, measurement time may exceed 30 seconds. Once all data has been received from the tester, the BUSY lamp turns off. In addition, the BUSY lamp will flash when the probe is being scanned. The Expansion-OUT lamp glows when an expansion unit is properly linked "downstream" via the Expansion-OUT connector.

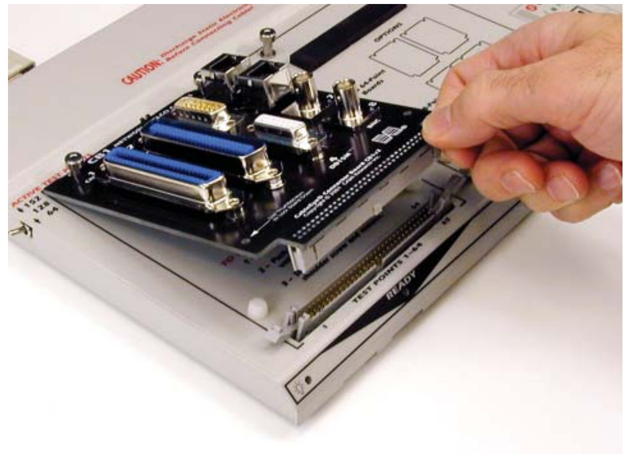
READY Indicators for Bank 1 and Bank 2 – Bank 1 (test points 1-64) and Bank 2 (test points 65-128) are active when you see the corresponding READY lamp "on". A READY lamp will be off when either the software is not ready to measure a cable, or the corresponding bank is not selected by the Active Test Points switch (described later). On M2 testers, these lamps will appear to dimly flicker during a measurement cycle; this is normal behavior.

64-Pin Latch Header – CB connector boards attach to the tester with these connectors. You may instead connect a 64-conductor flat cable here to extend the test points to a custom fixture of your own design. In either case, when you insert a CB board or other connector, be sure the latches close completely to ensure proper electrical contact.

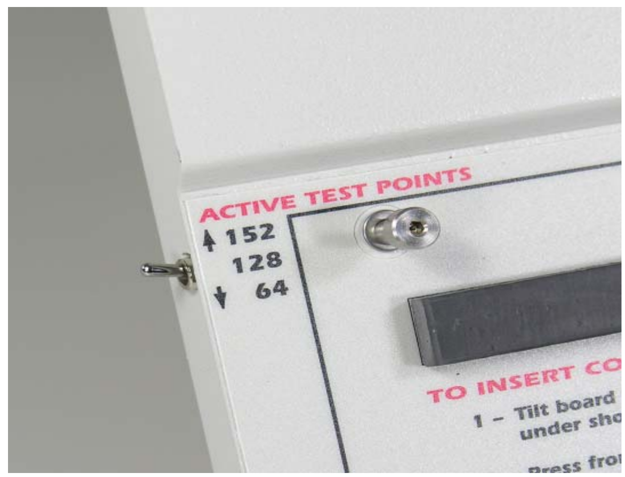


Thumbscrew Lockdown – Use the supplied thumbscrews to lock a CB board into position if necessary. Store the thumbscrews by attaching them to the chassis with no board present (we ship them this way).

> ***IMPORTANT:*** You normally will not need to lock the boards down, but if you do, be certain to remove the thumbscrews before you attempt to remove the board; if you fail to do this, you may break one of the connector latches.



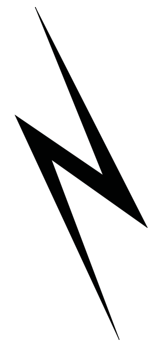
Removable Connector Board – CAMI Research manufactures a series of connector interface boards that fit into the test fixture. Slots along the top of each board accept board guide posts on the fixture to align the board before mating it to the latch headers. A section titled Inserting Connector Boards follows with a further description (see page 2-19).



Active Test Points Switch (models M2 and M3) – This switch determines the number of test points in the scan loop. For the base unit, you may set this to 64, 128, or 152 test points. For an expansion module, your choices are Off, 64, or 128 test points (in the "Off" position, that expansion module and any units downstream from it are deactivated). Scan time increases dramatically as the number of active test points increases, so if you enable only the test points you need, you will minimize the measurement time.

Serial Number – Each CableEye tester and Expansion Module has a unique serial number located on the bottom of the unit. We track each tester through the serial number throughout its lifetime, so it is important to protect this label. The serial number also appears on the warranty certificate and other paperwork we send you on which the serial number is given, so be sure to keep these in a safe place. All USB testers have the serial number encoded in an internal microcontroller and can be tracked even if the label becomes detached or unreadable. If you have an expanded CableEye system with a stack of Attached Expansion Modules, you will be able to see only the serial number of the last module; this is sufficient for us to find your machine in our database. Your warranty and calibration certificates will have all serial numbers shown. When you call for tech support or to arrange service, *please be sure to have your serial number available before calling!*

2.3 Static Discharge Precautions



CableEye employs CMOS circuitry in the test fixture, so virtually no heat will be produced by it. Because CMOS inputs have very high impedance, however, the test fixture may show sensitivity to static discharge. To minimize static disruption, you should avoid setting up CableEye in a room with carpets, and humidify the room if possible for the benefit of all electronic equipment.

> ***NOTE:*** In the event that static discharge into the case or a connector should occur, one or more LED lamps may turn on. If this happens, just toggle the power switch off and on to reset the circuitry. Alternatively, exit the software program on the PC and restart it (this action generates a hardware reset from within the program).

Clamping diodes inside the ICs make the circuit highly resistant to static damage. Although direct discharges into the connectors or case may disrupt the circuit, simply resetting the system as described above should correct any problems.

CAUTION: If you test cables longer than about 10 feet (3 meters), static buildup in the copper conductors of the cable will not be discharged before testing, even when you use the normal precautions of a grounded work surface, sufficient humidity, and wrist straps. Long cables may contain a large volume of static charge which may discharge into CableEye's electronics when you connect the cable to the tester. Such a discharge may permanently damage the electronics. Figure 2-9 illustrates the cause.

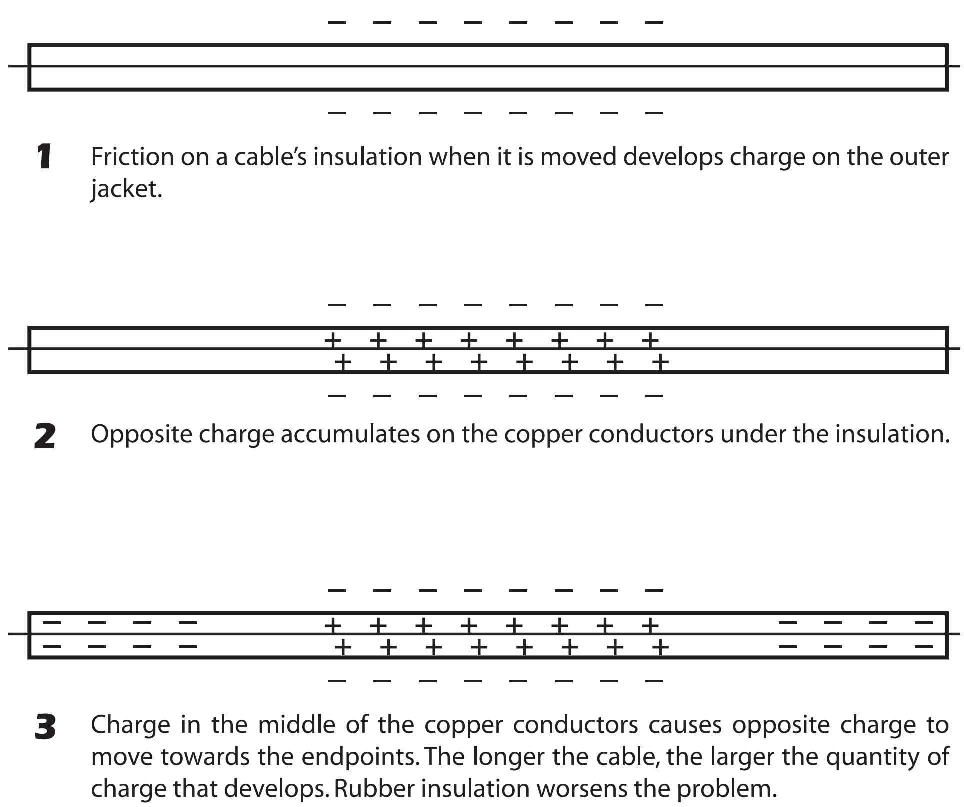


Figure 2-9: Static buildup on the surface of a long cable will transmit static to the copper conductors by the mechanism shown here.

To ensure the copper conductors of a long cable are properly discharged, build a discharge connector in which all pins are bussed to a common point which is then tied to ground, as shown in Figure 2-10, or purchase the CB25 Transient Suppressor Board, Figure 2-11.

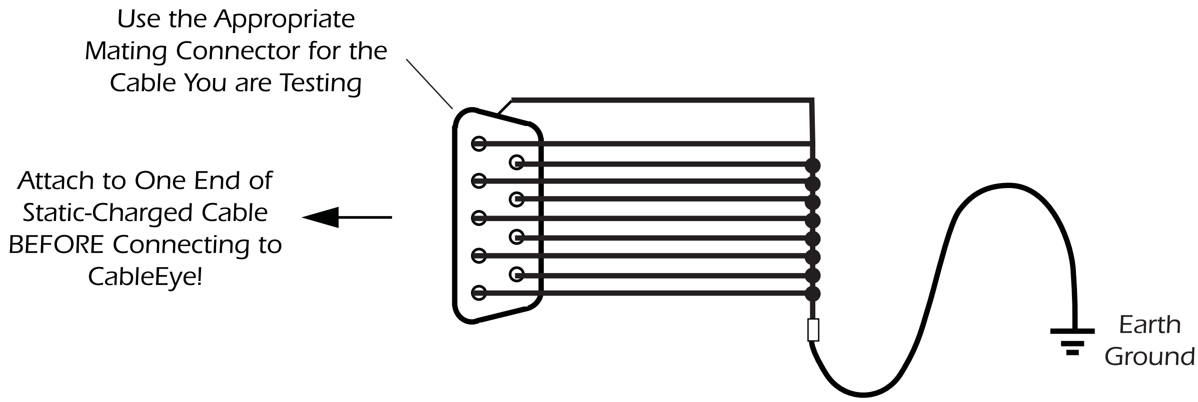


Figure 2-10: Build a grounding cable like this to discharge long, static-charged cables before connecting to CableEye.

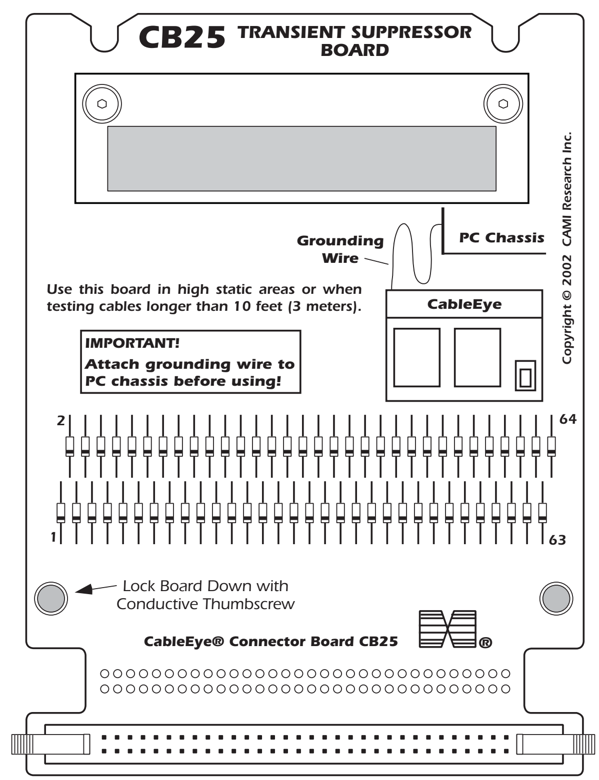


Figure 2-11: Use CB25 when regularly testing cables longer than 10 feet, when testing cables with a large surface area shield or conductor, or when working in a high static environment to guard your CableEye tester against damage from electrostatic discharge. On each board, 64 transient suppressor diodes especially designed for fast switching divert any overvoltages to ground before damage to Cable-Eye's electronics can occur. The CB25 mounts to the CableEye tester like any CB board and is physically secured with supplied stainless steel thumbscrews. Attach the CB boards you use directly to CB25.

2.4 Use of the External Ground Wire

If you operate CableEye in a high-static area or experience static disruption, you should connect the test fixture to a nearby grounded object, such as the PC chassis. We include a grounding wire for this purpose; see Figure 2-12. To attach the wire, loosen the screw on the underside rear corner of the case where bare metal is visible. Insert the lug at one end of the wire and tighten the screw. Attach the other end of the wire to a grounded surface. If the chassis of your PC is grounded (most are), use one of the screws on the back of your PC for the other end of the wire. The lug is suitable for a #6 or smaller screw.

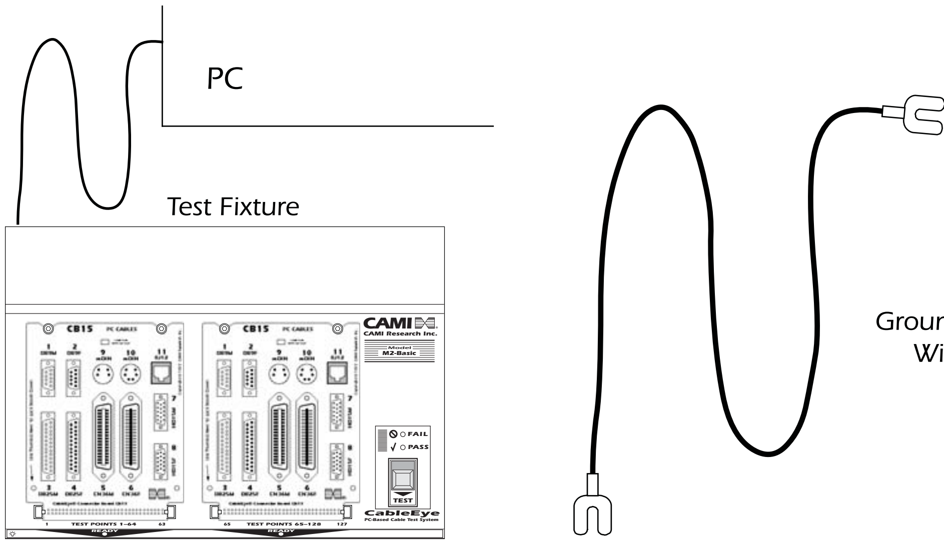


Figure 2-12: Use the supplied ground wire if you operate CableEye in a high-static environment (rugs, no humidification).

2.5 USB Interface

Most new CableEye testers sold include a USB 1.1 interface and USB A to B cable. USB systems, in addition to being much faster than traditional serial ports, provide plug-and-play capability and problem-free setup. Please do keep in mind the following points:

1 – When you install CableEye for the first time on a new computer, *install the software first, before connecting or turning on the CableEye hardware!* When you install CableEye's software, our custom USB driver is installed also, and your computer becomes aware of CableEye's unique USB device assignment provided by the USB registration authority. When you then attach and turn on the tester, the ID code coming from the microcontroller inside the test fixture is recognized, and you get the familiar message "Your new hardware is now ready for use." Should you inadvertently turn on the hardware first, several restarts may be necessary after you install the software for the fixture to be recognized.

2 – Connect CableEye directly to a USB port on the computer for best results. If you find it necessary to connect to a hub, use a *powered* hub to ensure error-free transmission. Note that some hubs use USB ICs that do not exactly follow the USB specifications, resulting in transmission errors when used with CableEye. This is an unusual situation that is possible, but unlikely. However, you should keep this in mind should the system report spurious cable connections or appears unable to recognize cables or CB boards.

2.6 Serial Interface

Some CableEye models are equipped with serial ports. For these, we include a six-foot-long DB9 female-to-DB9 male cable with each system. This cable links the COM port on your PC to the test fixture. Differences in the gender of these connectors ensure proper connection of the cable at both ends. Use an adapter if your computer's serial port has a DB25 connector. The CableEye test fixture looks like a *DCE device* to the PC, utilizing pins 2, 3, 5, 7, and 8, as shown in Figure 2-13. The Baud rate is internally set at 115K Baud. All M2 and M3 testers operate at 115K Baud. Optional settings of 9600 Baud and 38.4K Baud apply only to earlier CableEye models.

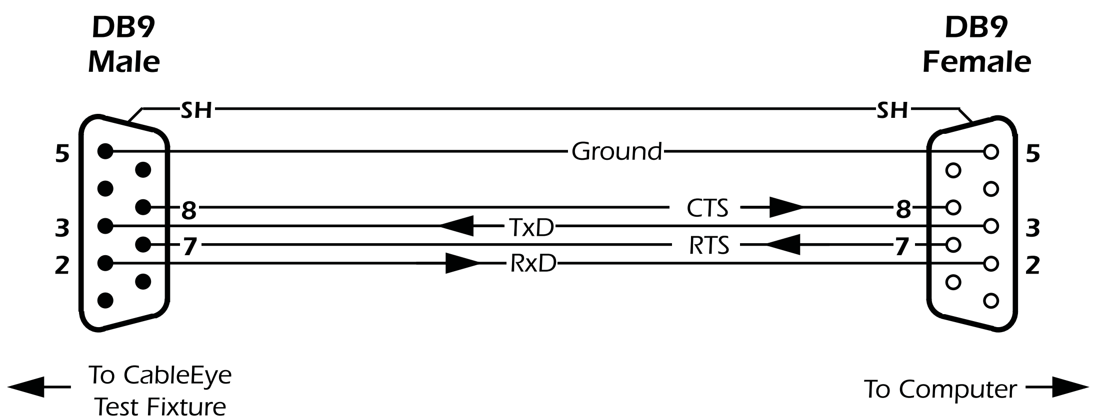


Figure 2-13: These active lines in the serial cable link the CableEye test fixture to your PC.

Connect the serial cable to an available COM port on your computer (COM1 to COM4). On your first startup, the software assumes COM1 when looking for the test fixture. If it is not found, an error message will appear, in which case you should click the "Preferences" button in the pop-up box and change the port assignment. Your Preferences settings, stored in the "CableEye.ini" file in the CableEye/Software folder, take effect each time the program is started.

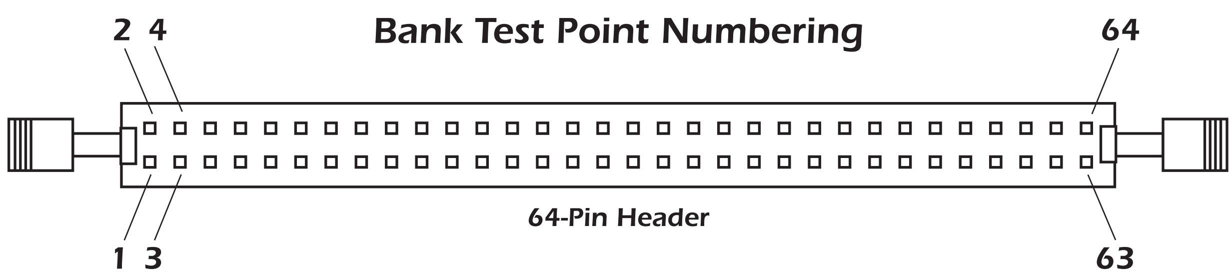
> ***IMPORTANT:*** If you have a serial port CableEye and need to use this on a computer that has only USB ports, *a serial-to-USB converter will not work!* The volume of data exchanged between the computer and CableEye overwhelms the microcontroller protocol converter in these devices. You may either purchase a PCI serial-port plug-in card for your desktop computer, or a PCMCIA serial card for your laptop. You may also upgrade your CableEye tester to a newer model that operates with a built-in USB port; contact CAMI Research for price and availability.

2.7 Test Point Connectors

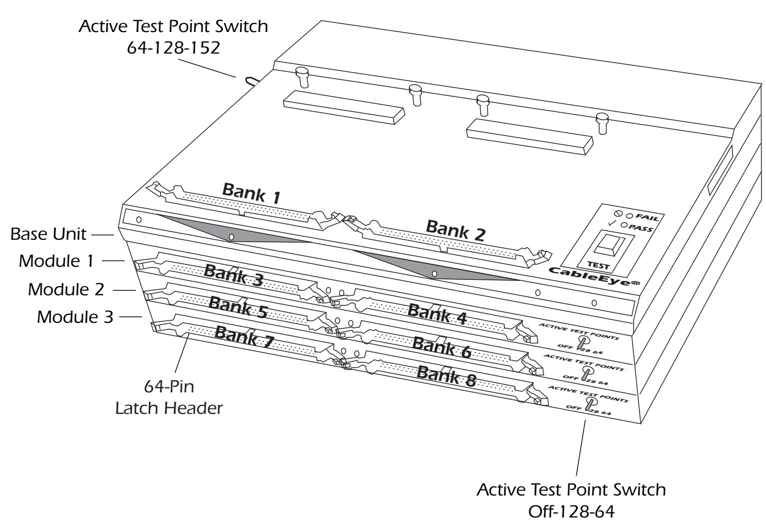
Two 64-pin dual-row headers found along the front of the tester provide the test point interface to CableEye, as seen below. To these connectors, you may attach one of the many removable connector boards (CB1 through CB35), or a test fixture of your own design using 64-conductor flat cables. The 64-pin header is an industry standard connector common to many commercial cable testers. Thus, customers who have existing test fixtures designed to work with Cirris™, Cablescan™, or other stand-alone systems may connect these fixtures directly to CableEye.

If you choose a fixture of your own design or from another source, you need to use our PinMap™ program (Item 708) to link the wiring of your fixture to the pin labels and connector graphics generated by CableEye's software. Refer to Section 9 in this manual for more information about custom interfaces and PinMap.

We refer to each 64-pin header as a "bank" containing 64 "test points". All CableEye base units provide two banks. Model M2 and M3 also includes 24 additional test points on a separate header along the right side of the tester for certain CB boards that require slightly more than the 64-points provided on each bank.



When expansion modules are added to the system, additional banks become available as shown here. Each expansion module includes a toggle switch allowing you to determine the number of active test points on that module. Setting a module to 64 or "off" deactivates all modules downstream from it.

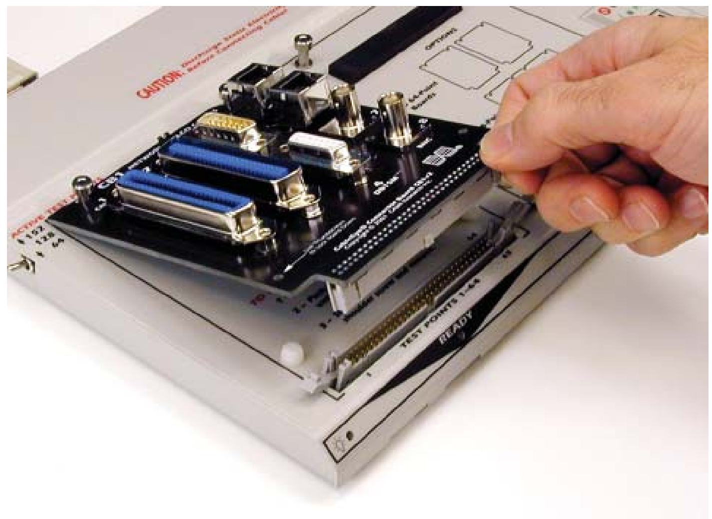


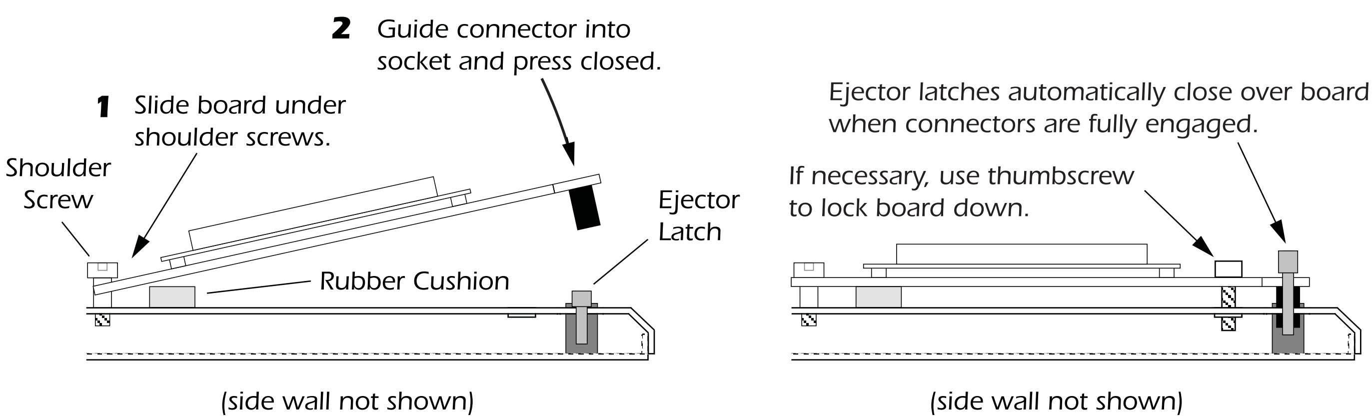
2.8 Inserting Connector Boards

Each tester accommodates two removable connector boards. You may attach whichever boards have appropriate mating connectors for the cables you will be testing; refer to the CableEye Catalog for a complete list of the board types currently available. All boards insert in the manner shown in Figure 2-10. Some boards having connectors with more than 64 pins require an expander cable to access additional test points. In this case, you must also connect this expander cable from the board in use to an additional test point bank, or in the case of CB5 or CB18A, to the 24-pin expander connector on the right side of the tester.

Figure 2-14: Install a connector board by sliding it under the shoulder screws and pressing the front down until the latches close. Remove the board by pushing the latches apart and pulling up.

You may use nylon thumbscrews (shown here attached to the base) should you wish to lock the board in place, however, this is generally not necessary.





2.9 M2 Test Point Driver Circuit

Each test point in the CableEye fixture has a driver circuit consisting of an analog switch and pull-up resistor. The circuit typical of M2 testers appears in Figure 2-15.

When the analog switch closes in the M2 circuit shown here, the test point becomes active and a current of about 0.1 ma flows through it to ground. Because of the relatively high resistance of the drive resistor compared to the internal resistance of the analog switch, the test point will appear well below the 1v logic '0' threshold of the Response Register when the test point is active. Thus, an active test point will read back as logic '0'.

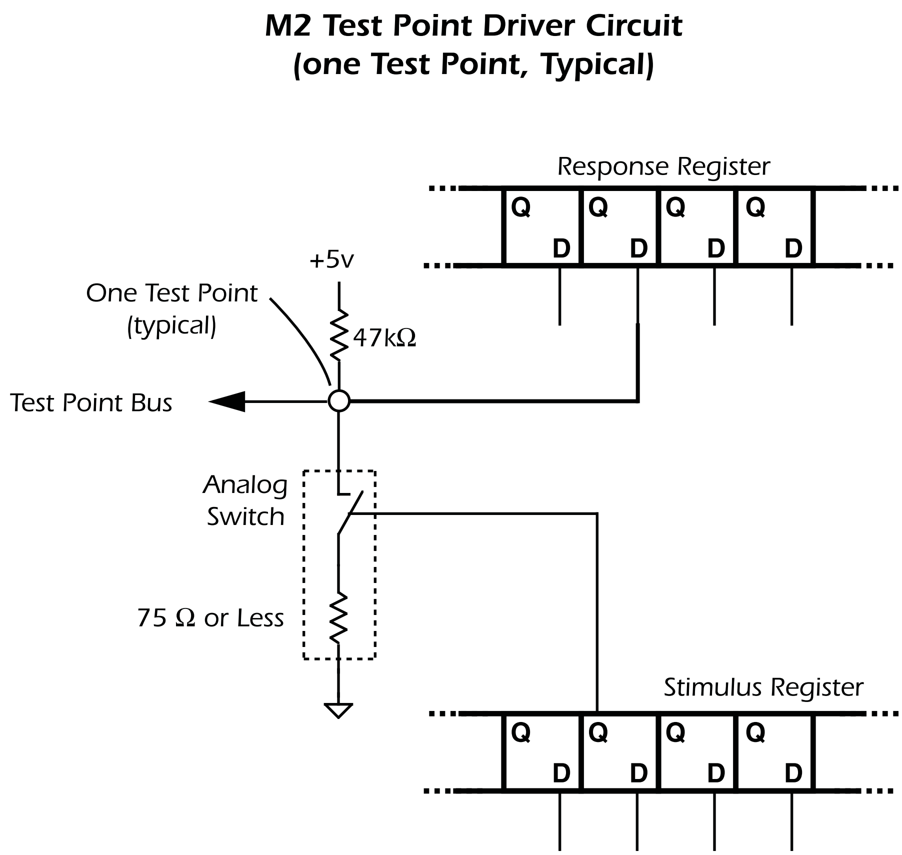


Figure 2-15: Each test point in an M2 tester uses this driver circuit. The dwell time determines how long the analog switch remains closed.

When wiring is introduced (i.e., a cable is attached to the connectors), two or more test points are electrically joined to a single point by each wire connection in the cable. As a result, the response register will indicate two or more logic '0' responses when only a single test point is driven. In this manner, wire connections are determined. By successively activating each test point in sequence and recording the response of all test points, a *continuity matrix* is acquired, and the complete interconnection state of all test points is thus established.

2.10 M2 Resistance Threshold

Assuming a 47kΩ drive resistor, a 75Ω on resistance for the analog switch in an M2 tester, and +5v reference voltage, a cable conductor joining two test points may have a resistance of up to 46kΩ to produce a test point voltage of about 2.5v, approximately the logic '1' threshold for the response register. Resistances below this 46kΩ threshold exhibit closed-circuit continuity, and this represents the detection of a connection between the two test points. The 50 µA leakage current flowing at the threshold resistance makes the M2 circuit very sensitive to short circuits in a cable as shown in Figure 2-16. Slightly higher or lower leakage resistances may also be read as shorts, depending on the actual logic ‘0’ maximum threshold voltage of the ICs used in the response registers. A minimum of 40kΩ is guaranteed for leakage detection in M2 testers.

Note that the resistance threshold in M2 CableEyes cannot be adjusted by the operator; it is determined by the design of the driver circuit. However, the voltage and current levels of the drive signal are similar to the digital and analog signals carried by many cables. Thus, if a cable measures correctly with CableEye Model M2, the cable is extremely likely to function properly in actual use. If you test cables carrying current over 500ma, you should use CableEye Model M3 which can test against adjustable resistance thresholds.

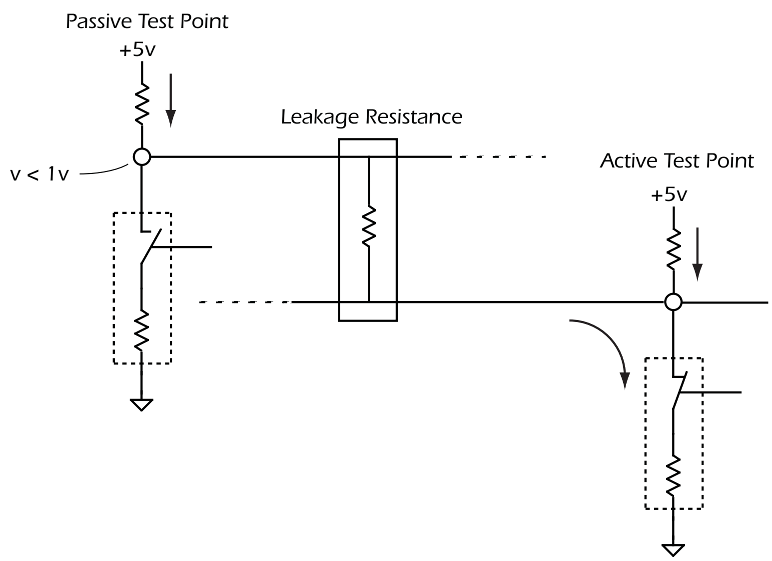


Figure 2-16: Leakage currents as low as 50 μA follow this path between two test points in an M2 circuit.

2.11 M3 Test Point Driver Circuit

The topology of the M3 test point driver appears in Figure 2-17 and differs in four respects from the M2 circuit. First, we insert a comparator between the test point and the response register; second, we use a different type of analog switch with much lower “on” resistance; third, we increase the reference voltage to +10v; and finally, we employ a 10kΩ drive resistor to provide greater test current. By measuring the test point voltage using the comparator in a successive approximation sequence, we can compute the wire resistance.

Computing resistance between two test points involves the precise measurement of voltage between those points, and knowledge of the current flowing through it. This, in turn, demands a precision 10kΩ drive resistor of ±1% or better (this establishes the current), a 10v reference voltage accurate to 1 mv or better, and exact control of the test voltage “Vref” as set by an instrumentation-quality digital-to-analog converter. We’ve developed an equation that takes account of the analog switch’s “on” resistance to compute the wire resistance based on measurement of the voltage between test points.

2.12 M3 Resistance Thresholds

M3 Test Point Driver Circuit (one Test Point, Typical)

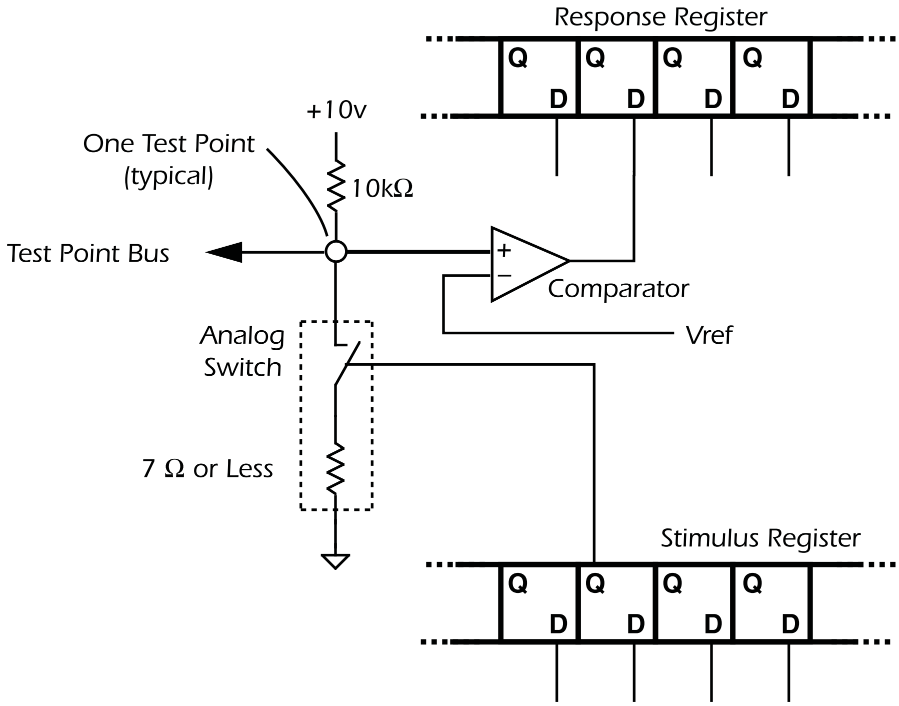


Figure 2-17: Each test point in an M6 tester uses this driver circuit. which differs from the M2 circuit by the addition of a comparator, use of a low-resistance analog switch, and use of a 10kΩ precision drive resistor. As with the M2 circuit, the "dwell time" setting determines how long the analog switch remains closed.

Prior to starting a measurement cycle in the M3, we set a test voltage "Vref" which drives the "–" input of *all* comparators using a precision D/A converter. This test voltage corresponds with a resistance threshold set by the operator, and thus provides the variable threshold that M3 offers. When testing a cable, we make *two* complete measurements, the first with the test voltage set for the *conduction* threshold (typically 2 to 10 ohms), and the second with the test voltage set for the *isolation* threshold (typically 1 to 3 Megohms). Violations of the conduction threshold represent connections whose resistance *exceeds* the maximum allowable wire resistance and thus flag an error condition. Violations of the isolation threshold represent leakage between conductors that *should not be connected* and also flag an error condition. Figure 2-18 shows how the conduction and isolation thresholds divide the full resistance range into three sections. Set these thresholds using the Resistance Control Panel described in Section 13.

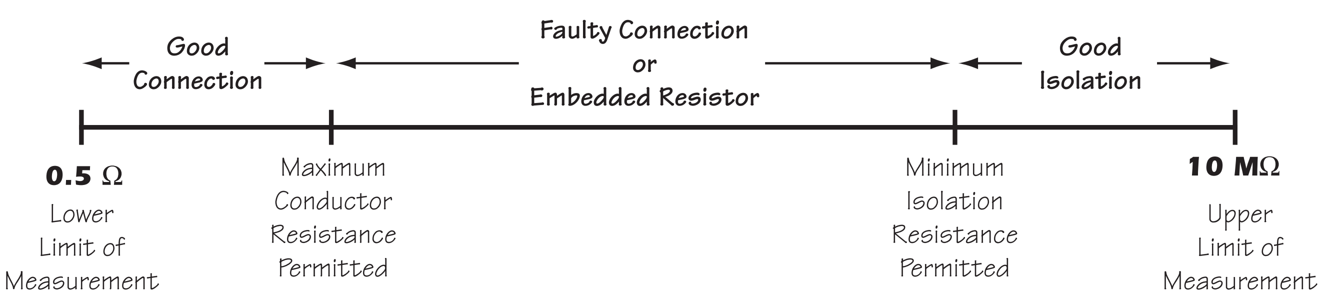


Figure 2-18: The "maximum conductor resistance permitted" sets the highest resistance that a good connection may have, while the "minimum isolation resistance permitted" sets the lowest leakage resistance that unconnected wires may have.

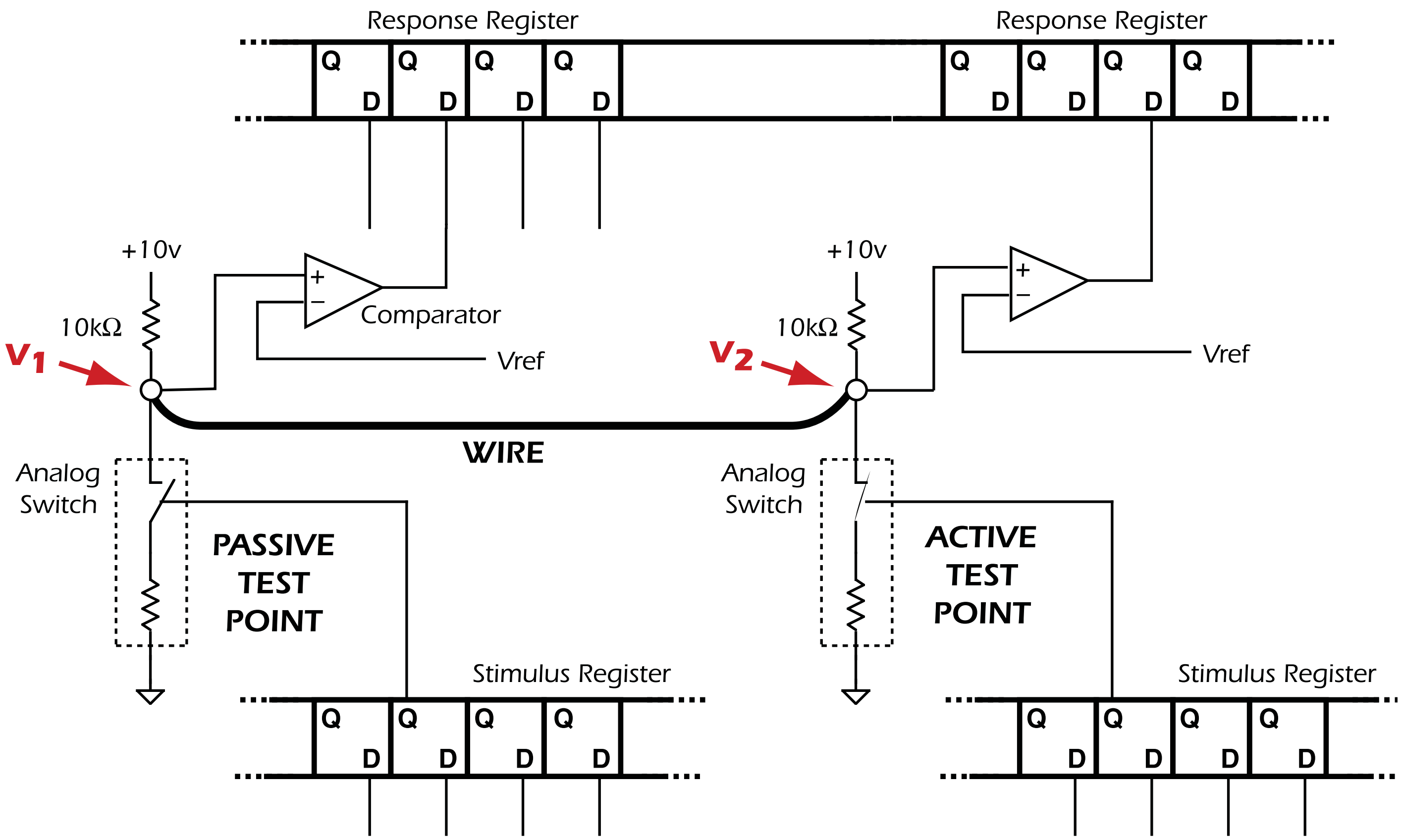


Figure 2-19: The method of computing wire or component resistance is illustrated here.

To calculate wire or component resistance, we use the comparators in a successive approximation method to compute the voltages V1 and V2, as shown in Figure 2-19, and knowing the current contributed by each 10kΩ ohm precision resistor, can easily apply Ohm's law.

2.13 Calibration

Certain components within CableEye Model M3 have characteristics which change slightly over time. This aging is a natural phenomenon common to all electronic components and may cause resistance measurements to gradually deviate from their correct values. The process of *calibration* ensures that the output of an instrument falls within an allowable range of error with respect to a reference standard. To ensure that resistance measurements remain accurate, we suggest yearly calibration.

The CableEye tester is *digitally calibrated* using special software developed by CAMI Research. Recalibration does not involve changing components or adjusting potentiometers. Instead, the calibration software develops a table of *calibration constants*, one set of values for each test point. These constants in combination with precision voltage measurements made during the calibration process are employed by equations in the CableEye software when resistance values are computed to arrive at resistance values.

In a properly calibrated tester, resistance values in the range of 100 ohms to 500K ohms should be accurate to within 1%, values within 10 to 100 ohms accurate to within 5%, and values in the range of 100K ohms to 10 Megohms and 0.5 to 10 ohms accurate to within 20%.

One month before your equipment reaches its recalibration anniversary, CAMI Research will automatically send a letter to the person whose name is on record as the contact individual at your company advising this fact and the cost and procedure for recalibration. You will need to send the test fixture and power module to CAMI Research or to an authorized international distributor for recalibration. The equipment will be returned with a CD ROM or floppy disk containing the calibration data file. You would then replace your existing calibration file with the new one. Recalibration can usually be within 24 hours of the day we receive your equipment, so you would be deprived of its use only one day more than the round-trip transportation time which will of course depend on the shipping method you choose.

Note the following important points:

1 – M2 testers do not require calibration. M3 testers that are not used for resistance measurements may be operated *uncalibrated* in *Single Threshold* mode as set in the application's *Preferences\M3\Resistance* control panel.

2 – The calibration file contains an internal date code allowing the CableEye software to remind you when the instrument needs recalibration. An option available when the message appears allows you to suppress further reminders if you wish.

3 – Should you decide to add one or more expansion modules to an M3 tester, the instrument must be returned to CAMI Research to have the expansion module recalibrated with the base unit. There is no charge for recalibration when you purchase expansion modules.

4 – You may purchase the calibration software and written calibration procedure it for in-house calibration. Order Item 717S. You will additionally need a 6-digit Digital Multimeter, and a precision resistance substitution box to check the calibration when finished. Purchasing the calibration software and procedure might be worthwhile if you own more than one CableEye tester or find it impractical to return the equipment to us for recalibration.

2.14 Measuring Long Cables

Cables longer than 25 feet noticeably distort pulses that CableEye applies during measurement. When viewed on an oscilloscope, the applied pulse appears to "ring" at the rising and falling edge transition, with the ringing subsiding after a period of time. Inductance and capacitance in the copper wire causes this effect and cannot be avoided. Twisting and shielding tend to increase the capacitance per foot, causing the ringing effect to worsen. If the ringing has not subsided at the time we latch a response from the cable, erroneous readings may result. Specifically, you may see spurious diodes or wire connections in the test result. This effect may also occur if the cable has capacitors, inductors, coils, or semiconductor components connected to it. You may compensate for capacitive or inductive effects in the cable in the following ways:

1 – Increase the *Dwell Time*. Normally, the system ships with a default dwell time set to 200 microseconds. To increase this, go to the *Preferences* menu and choose *Communications*. In this control panel, a section on *Transfer Properties* includes an edit box for dwell time. Try doubling the dwell time to see if the spurious connections disappear. If they do not, continue doubling the dwell time (400 µS, 800 µS, 1600 µS, etc.) until you see an effect. The dwell time can be increased to over 100,000 µS, if necessary. Note that above 1000 µS, you will begin to experience a noticeable increase in measurement time.

2 – Reduce the *Isolation Threshold* (M3 testers only). Normally, we set the Isolation Threshold (minimum allowed resistance between unconnected wires) to one Megohm. You may change this in the Resistance control panel (double-click on the Default Thresholds shown along the bottom of the screen, or go to the *Preferences* menu and choose *M3/Resistance*. Initially, try setting the Isolation Threshold to 100K ohms. It may be reduced further if the problem persists.

Some combination of increasing the dwell time and reducing the isolation threshold usually corrects problems resulting from capacitance and inductance in long cables. Note that CableEye has been successfully used to measure resistance and connectivity in cables of 7000 meters (23,000 feet, 4.4 miles) in length.