MODEL 93

W1 CABLE ASSEMBLY TEST UNIT

User Guide

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This User Guide is applicable for serial numbers:

M93-00151 and later

with software version 1.04 and higher

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Introduction

The Model 93 is designed to test the integrity of W1-type cable assemblies. Widely used by the audio industry, “W1s” provide twelve balanced signal pairs, each with an individual shield. For live production and broadcast applications it’s critical that all signal paths are fully functional. But without specialized test equipment it’s impossible to confirm W1 performance. The Model 93 accomplishes this task in a simple-to-use but technically sophisticated manner—it’s far from just a continuity checker. Under software control, the internal microcontroller-based circuitry independently tests each signal pin for connectivity, opens, and shorts. The Model 93 can ensure that the value of a production company’s significant investment in W1 cable assemblies is maximized. When two Model 93 units are used together they can prove invaluable for facilities that include permanently installed W1 cabling.

For operator convenience, testing can be selected from among two formats: channel mode or pin mode. Channel mode is provided specifically for field applications where testing is most effective when oriented toward how a W1 is actually used. Pin mode is oriented toward supporting technical personnel who are responsible for fabricating or repairing cable assemblies. In both modes solid-state displays indicate which channel or pin is being tested, along with the test result. For ease of use the Model 93 supports both automatic and manual testing. The unit is housed in a rugged aluminum enclosure and is constructed for reliable “field” performance where abuse is often a way of life. An internal rechargeable battery provides the operating power.

When the Model 93’s channel mode is selected, testing is organized as twelve signal channels. Two of the display digits indicate which channel is currently being tested. The display digits, depending on which mode is selected, can also display the test results. The results can include ALL OK and FAIL, as well as a number of error codes. The codes allow conditions such as open shields or pins, crossed signal pairs, or short circuits to be displayed. In the pin test mode, all 39 pins associated with the

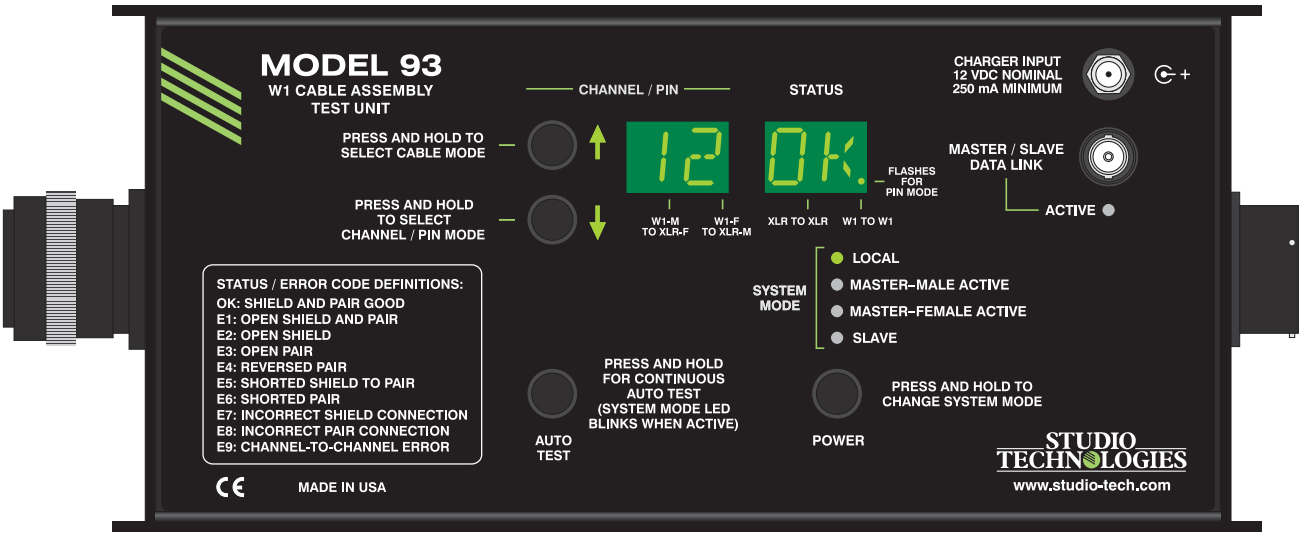

Figure 1. Model 93 Top View

W1 connectors can be tested. Two of the display digits indicate which specific pin, or pin group, is being tested. The other two digits can display which pin (or pins) are connected to the pin under test.

The Model 93 is capable of testing individual cable assemblies where both the male and female W1 connector associated with a specific cable assembly are accessible. Referred to as the Model 93's local system mode, both connectors of the designated cable assembly are terminated on the Model 93. This mode is appropriate for testing flexible cable assemblies that are newly assembled or are being prepared for temporary deployment. With rapid and complete testing, W1s will either be confirmed as ready for use or "flagged" for repair or replacement.

The Model 93 also allows testing of W1 "fanouts." These cable assemblies typically have a female or male W1 connector on one end and twelve male or female 3-pin XLR-type connectors on the other. Connecting this type of fanout to the Model 93 is simple. In addition to one male and one female W1 connector, the Model 93 also provides two 3-pin XLR-type connectors, one male and one female. Under software control, a technician can "walk through" the twelve channels, connecting one fanout channel at a time. In addition to testing fanouts, this feature can find use in testing W1 cabling that terminates on patch bays or breakout panels. As a "bonus" the Model 93 also supports testing of standard 3-conductor audio cables that terminate on XLR-type connectors.

A unique testing challenge is encountered when W1 cable assemblies have already been "run" in preparation for a broadcast event or have been permanently installed as part of a facility's infrastructure. Using the master/slave system modes, two Model 93 units can work together to perform end-to-end testing of in-place cabling. This unique capability can be valuable for new installations as well as during routine maintenance and repair. Using a separate cable path, a bidirectional data link is established to allow the two Model 93 units to coordinate their resources. One unit is designated as the master while the other is designated as the slave. Two master modes ensure that W1 cable assemblies with either male or female connectors on the master end can be tested. While the buttons on the master unit control the testing functions to be performed, both units simultaneously display the test status. BNC connectors are used to establish the data link between the two Model 93 units. This connector type was selected because of its common use in video applications. However, cable other than 75 ohm coax can also be used for the data link, including microphone, "CAT5" data, and multi-pair "telco."

Four pushbutton switches, five LED indicators, and a 4-digit LED display provide the Model 93's operator interface. The power button is used to power up and power down the unit. The power button is also used to select which of the four system modes is selected. Four LED indicators, one associated with each system mode, display which mode is active. The up and down buttons allow manual selection of the channel or pins designated for testing. The up button is also used to select which cable mode is active. The down button is also used to select between channel and pin mode. The auto test button is used to enable the two automatic test sequences. The LED display indicates which of the twelve W1 channels or 39 connector pins is currently being tested. And, depending on which test is selected, will also display the test results in a variety of ways. These green-colored LED displays were selected for their visibility

and long-term reliability. An LED indicator is also provided to confirm when data associated with the master/slave mode data link is present.

The Model 93 provides two automatic test sequences: auto test and continuous auto test. The auto test sequence is the unit's fastest test method, specifically included to support busy field broadcast applications. It takes less than six seconds from the time the auto test pushbutton is pressed until the test results are displayed. In the channel mode, auto testing begins with channel 1 and continues on through to channel 12. When selected for pin mode auto testing will begin with pin q and continue on through pin g. (While available for manual testing as a group, pins r, m, and k are not part of the auto test sequences.) During the auto test sequence the LED display will indicate which channel or pin is being tested.

At the end of the entire test sequence one of three result messages will then display: ALL OK, FAIL, or OPEN. As expected, when the result is ALL OK the W1 is ready for use. A FAIL message will display if one or more errors are detected. And OPEN will display should no pins be detected as being connected. This typically indicates that the cable designated for testing has not been correctly connected to the Model 93.

The continuous auto test sequence is enabled whenever the auto test button is pressed and held. Using this test sequence, the Model 93 will test all channels or pins followed by a summary results message. However, the difference with this test sequence is that the results for each individual channel or pin will be displayed as testing progresses. Whenever a defective channel or pin is detected the sequence will pause momentarily while the right two digits display the applicable error information. The

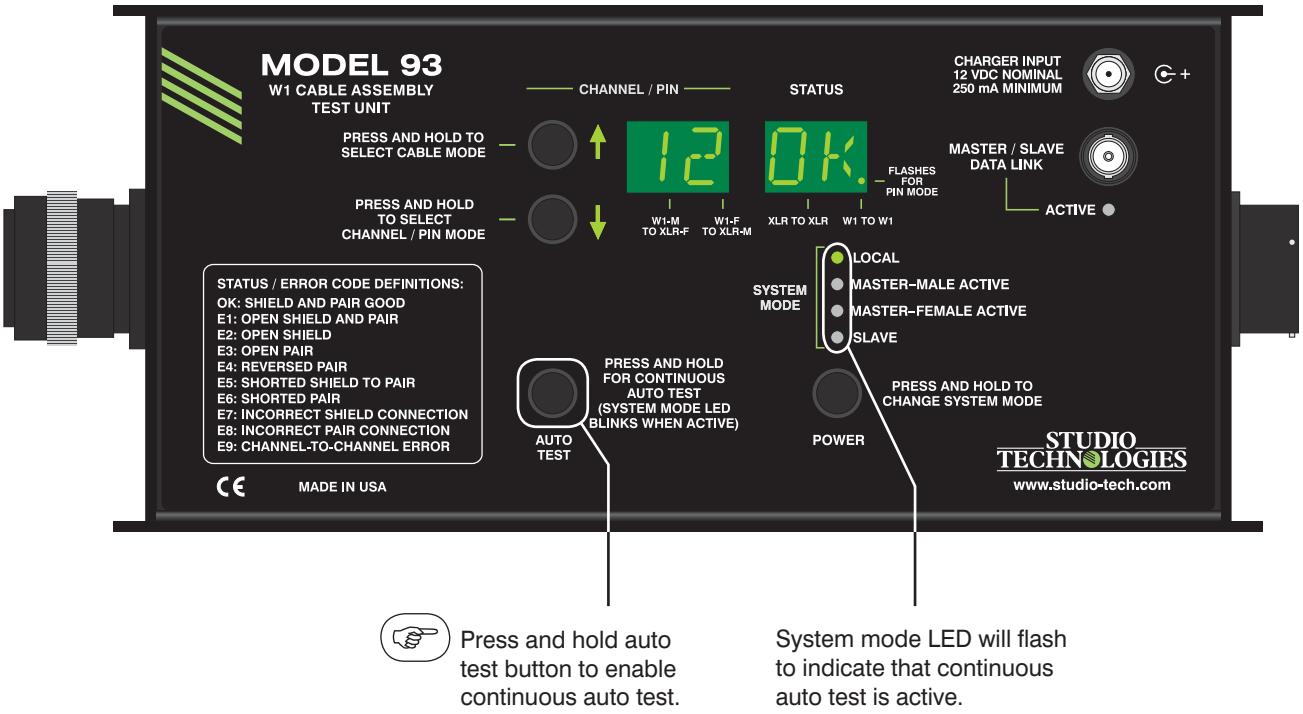

Figure 2. Model 93 Configuration—Continuous Auto Test

test sequence will then continue on to the next channel or pin. After a slight pause for the summary results to be displayed, testing will continue, again starting with channel 1 or pin q. The continuous auto test mode was specifically included for situations where a more detailed view of the test results is desired.

To ensure a thorough analysis of the connection status of a W1 cable assembly the Model 93 is capable of testing all 39 pins of the male and female mating connectors, organized as 36 individual pins and one group of three pins. This allows confirmation of correct channel wiring, as well as detecting opens, shorts, and reverses (pair crosses). All Model 93 input and output circuits are extensively protected from damage due to static discharge (ESD) and DC voltages commonly found in field-production and broadcast environments. These voltage sources can include tally, intercom, IFB, and microphone phantom power among others that might be present on a W1 cable assembly that has been designated for testing.

Contained within the Model 93's enclosure is a rechargeable 12 volt sealed lead-acid battery. This will provide continuous operation in excess of eight hours before recharging is required. An external 12 volt DC power adapter, provided with each Model 93, allows simultaneous charging of the battery and powering of the unit. Circuitry contained within the Model 93 implements the actual battery charging function, minimizing recharge time while maximizing battery life. While the power button can be used to manually turn off the Model 93, to conserve the battery's energy automatic shutdown will occur after ten minutes of inactivity. Under software control, automatic shutdown will also occur whenever the battery voltage reaches its minimal acceptable value. This prevents the battery from reaching a deep-discharge condition. For reliability under the less-than-gentle field environments the battery is securely clamped within the Model 93's enclosure. It's expected that the battery will provide correct operation for a period of three to five years before replacement will become necessary. A competent technician should be able to perform the task in well under 30 minutes.

Overview

Power On and Off

There are two ways that the Model 93 can be brought to its operational state, i.e., be "powered up." One is manual and the other is automatic. To manually apply power to the Model 93 tap the power on/off button. A short "power up" sequence will commence, first testing the LED displays and indicators, and then briefly displaying the unit's software version number. The unit will then display four dashes, indicating that testing can now begin.

The Model 93 can also be powered up by the presence of data on the master/slave data link. This allows unattended operation where the Model 93 unit that is designated as the "master" can "wake up" its companion unit. The master unit will send out data, "waking up" the slave unit. In this case the normal power up sequence will take place, with the exception that at the end of the sequence the unit will be forced into the slave mode.

No matter whether the Model 93 is manually or automatically powered up, the voltage of the internal rechargeable battery is automatically measured. A value of less than 10 volts will result in a low battery message being displayed. This is followed by the

Model 93 automatically powering down. With a low battery condition, normal operation can't take place unless an external source of nominal 12 volts DC is applied. This power source will allow Model 93 operation as well as charging the internal battery. Maintaining the external 12 volt source for up to 24 hours may be required to fully recharge the battery.

There are four ways that the Model 93 can be "powered down." One is manual and three are automatic. The power on/off button can be used to manually halt the unit's operation; simply tap the power button. Pressing and holding the on/off button while the unit is operating will cause a change in the unit's operating mode rather than turning off the unit.

The three automatic power down methods are inactivity, master/slave command, and low battery voltage. To maximize the Model 93's battery operating time, automatic shutdown will occur after ten minutes of inactivity. Technically, inactivity is defined as a continuous 10-minute period in which none of the buttons are pressed. The only exception to the inactivity timer is if the unit is operating in the slave mode and data is present on the master/slave data link. In this case, for the Model 93 to automatically power down requires that a power down command be received by way of the master/slave data link. The final way that the Model 93 will power down is if a low battery voltage condition is detected. Under software control, the battery voltage is continually monitored. A measurement of lower than 10 volts will result in an automatic power down.

For operator convenience, upon power down three operating conditions are saved in non-volatile memory: operating mode, connector mode, and channel/pin mode.

Powering the Model 93

Internal Battery

The Model 93's enclosure includes an internal 12 volt, 1.3 amp-hour, sealed lead-acid rechargeable battery. This type of battery was selected for two reasons: its ability to supply peak current and long cumulative operating time. The LED-based displays used in the Model 93 offer several nice operating characteristics as well as one limitation. The first positive is that they are very rugged and should be able to meet the often-harsh conditions of field production settings. A second is that they provide a clear indication in low-light conditions. However, as with most things one must take the good with bad. The downside of LED displays is that they require high peak currents for effective operation. Standard one-use (disposable) batteries, such as the ubiquitous 1.5 volt AA style, would simply not be suitable. The Model 93's internal lead-acid battery doesn't have a problem supplying the required peak current.

The energy capacity of the Model 93's internal battery is such that cumulative operating time in excess of eight hours can be expected before recharging is required. In actual applications it can be expected that it will be weeks, or even months, between required charges.

External Power Source

An external source of nominal 12 volts DC is required for Model 93 operation and battery charging. The exact voltage value isn't critical; anything in the range of 10 to 15 volts is acceptable. Proper battery charging will always take place because circuitry contained within the Model 93 converts the incoming voltage to the required nominal 13.8 volt DC charge voltage. A minimum of 150 milliamperes is required for operation and

anything additional, up to 100 milliamperes more, will be used by the charging circuitry. As such, a power supply with a minimum of 250 milliamperes is recommended.

A 120 volt AC input, 12 volt DC, 300 milliampere, plug-in-the-wall power supply is included with each Model 93. While good quality, it's a generic unit that can be easily replaced or substituted (Studio Technologies part number 10320; Digi-Key part number MT7146). The connector required for the power supply source is 2.1 x 5.5 mm with positive on the inner lead. The DC input connector on the Model 93 is a locking type, allowing a locking mating connector to be attached if desired.

Stand alone, the Model 93 can function correctly as long as the battery voltage is 10 volts or greater. It will also function correctly whenever an external power source is connected. This flexibility is due to the presence of a secondary power supply, located on the Model 93's printed circuit board, that generates the 5 volts DC required for the logic circuitry.

The Model 93's internal battery will charge whenever an external power source is connected. The unit doesn't have to be "powered up" for battery charging to take place. The time required to fully recharge the battery will depend on its discharge state at the time charging begins. Allowing 24 hours will ensure that full recharging will always take place, although a shorter duration will probably be sufficient. The Model 93 implements a constant voltage charging method. This minimizes the chance that battery overcharging will take place. Keeping an external power source connected to the Model 93 for long durations, or even permanently, won't cause damage to the battery.

Note that a text message will be displayed whenever the Model 93 is operating under battery power and an external power source is then connected. To indicate that the external source has been detected, the LED displays will briefly show the message CHRG. Removing an external power source will not result in any message being displayed.

System Modes

The Model 93 can be set to one of four overall ways of operating. These are called the system modes and the choices are local, master-male active, master-female active, and slave. Refer to Figure 3 for details The local system mode is intended for testing W1 cable assemblies where both ends will be connected to the same Model 93. This is the default system mode and the one that will most commonly be used. The other three system modes are provided so that two Model 93 units can work together in a master-slave arrangement. This unique capability allows testing of cable assemblies that are permanently installed or already deployed in a facility or venue. Specifically this is the situation where the connectors on both ends of a single W1 cable assembly are not accessible for connection to the same Model 93.

To select the desired system mode, press and hold the power button. The four modes will "cycle" through. Release the power button when the appropriate indicator light is active. The selected system mode will generally remain in effect until it is manually changed. Power cycling the Model 93 will not cause it to change or revert to a "default" setting. The exception is in the master-slave situation where a Model 93 configured for master-male active or master-female active can "force" its companion unit into the slave mode.

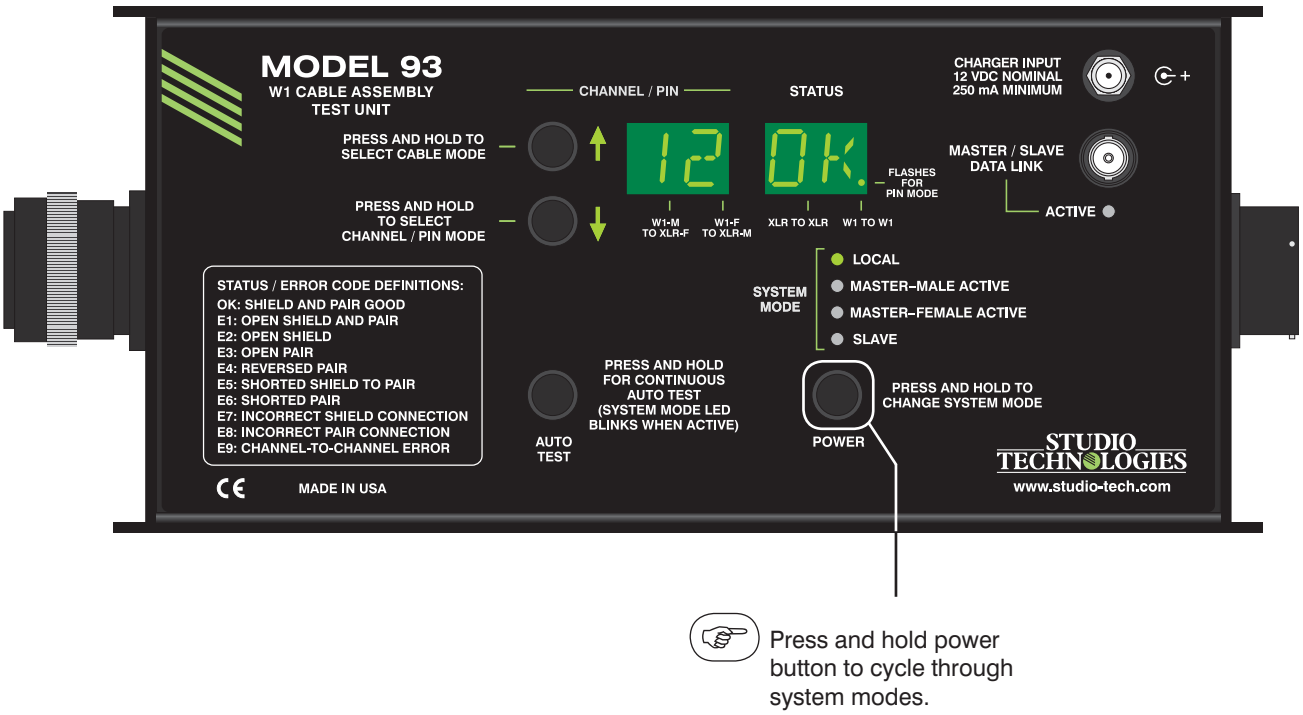

Figure 3. Model 93 Configuration—System Modes

Cable Modes

The Model 93 offers four cable modes. Refer to Figure 4 for more details. The W1 to W1 cable mode allows testing of W1 assemblies that have a male W1 connector on one end and a female W1 connector on the other end. These are typically referred to as "standard" W1 cables. Refer to Appendix B for W1 wiring details. In the W1-M to XLR-F cable mode the Model 93 is ready to test W1 cable assemblies that have a male W1 on one end and twelve 3-pin female connectors on the other. This type of cable assembly is typically referred to as a W1 "fanout." In the W1-F to XLR-M cable mode the Model 93 is configured to test W1 fanout assemblies that have a female W1 on one end and twelve 3-pin male connectors on the other. The XLR to XLR cable mode allows testing of standard audio cables that have a 3-pin male XLR connector on one end and a 3-pin female XLR connector on the other end.

To select the desired cable mode is simple. Press and hold the button to the left of the up arrow; the Model 93 will slowly "cycle" among the four choices. To select the desired cable mode, release the up button when the appropriate indicator light is active. The decimal point portion of the displays is used to indicate the active cable mode. The selected cable mode will remain in effect until it is manually changed. Powering cycling the Model 93 will not cause it to change or revert to a "default" setting.

Channel/Pin Mode

The Model 93 offers two basic ways of testing cable assemblies: channel mode or pin mode. Refer to Figure 5 for details. The channel mode is available for use in all four of the cable modes: W1 to W1, W1-M to XLR-F, W1-F to XLR-M, and XLR to XLR. Channel mode is generally appropriate for rapid field testing of existing inventory of

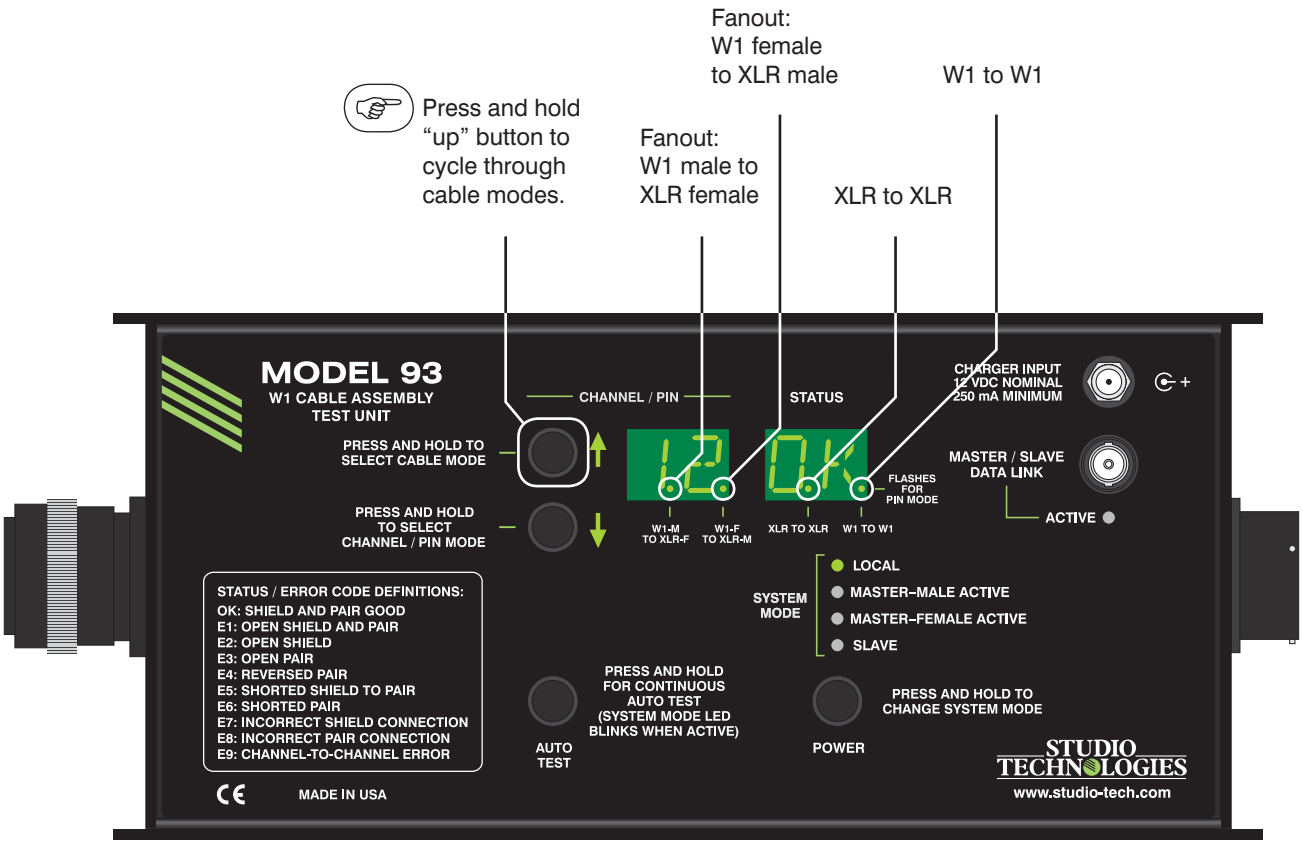

Figure 4. Model 93 Configuration—Cable Modes

W1 and XLR cables. Pin mode is only available in the W1 to W1 and XLR to XLR cable modes. It is not offered with the other two cable modes as it’s not appropriate for use with W1 “fanouts.”

In the channel mode W1 testing is organized as twelve 3-conductor groups. The 3-conductors consist of a shield and a signal pair. In standard W1 cable assemblies these twelve channels are wired using 36 pins of 39 provided on W1 connectors; pins r, m, and k are generally not used.

The pin mode is provided so that a detailed view of the signal paths associated with a cable assembly can be obtained. In the pin mode testing can be performed on all 39 pins of a W1 connector associated with a W1 assembly, although pins r, m, and k are tested as a group. Pin mode is useful when fabricating new W1 assemblies or repairing cable assemblies which the channel mode has identified as being defective.

The button located to the left of the down arrow is used to select between channel mode and pin mode. Pressing and holding this button for two seconds will cause the mode to change between channel mode and pin mode, or vice-versa. As previously discussed, only when the cable mode is selected for W1 to W1 or XLR to XLR is it possible to select pin mode. The indicator light associated with the active cable mode is used to display whether channel mode or pin mode is selected. When channel mode is selected the light is lit steadily. The light will flash to indicate that pin mode is selected. The selected mode, channel or pin, will

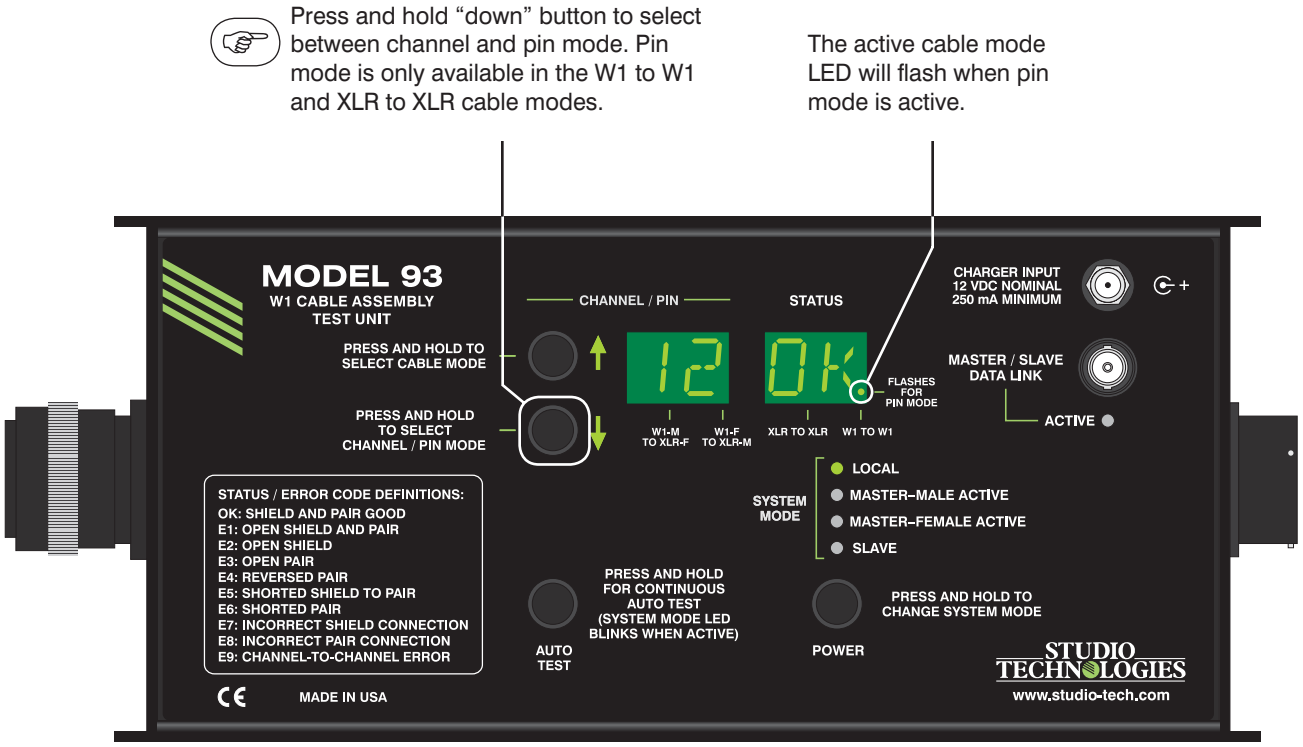

Figure 5. Model 93 Configuration—Channel/Pin Mode

remain in effect until it is manually changed. Powering down the Model 93 will not cause this mode to change or revert to a “default” setting.

Operation

It’s now time to actually test cable assemblies using the Model 93.

Local Mode Operation

The following four sections provide details on using the Model 93 when the system mode is selected for local.

System Mode: Local Cable Mode: W1 to W1

When the cable mode is selected to W1 to W1 the Model 93 is ready to test W1 cable assemblies where both ends are terminated to W1 connectors. In this case the cable-mounted W1 connectors should be mated with those on the Model 93. Ensure that the connectors are “locked” together using the outer rings to ensure that a reliable interconnection has been made. Automatic or manual testing can now begin.

Tapping the auto test button will initiate a rapid scan of all the channels or pins, depending on whether channel or pin mode is selected. At the end of the test sequence one of three messages will display: ALL OK, FAIL, or OPEN. ALL OK indicates that the cable assembly is ready to be placed into service. FAIL indicates that one or more failures were detected during the test sequence. If FAIL displays then manual testing of the channels or pins should be used to identify where the specific problem or problems are located. OPEN indicates that no connections were detected, most likely the result of one or both of the W1 connectors not being correctly terminated on the Model 93.

Pressing and holding the auto test button for two seconds will initiate a continuous auto test mode. The local mode LED will flash when continuous auto test mode is active. In this mode each channel or pin will be sequentially tested and the result displayed in real time. The left two digits of the display will indicate the channel or pin being tested while the right two digits will indicate the result. In the channel mode the result will be either OK or one or more of the nine possible error codes. The label on the front of the Model 93 contains a brief summary of the error codes. A detailed description of the error codes can be found in Appendix A. In the pin mode the displayed result will be the numeric code for the pin or pins that are connected. A one-to-one relationship between the pin being tested and the connected pin is the desired result. If no pin is detected as being connected to the pin selected for testing two dashes (- -) will display. At the end of each full test sequence a summary result will display: ALL OK, FAIL, or OPEN. The meaning of the three possible results is the same as with the auto test function, discussed in the previous paragraph. After a slight pause to display the summary result, the continuous auto test mode will begin another complete test of all the channels or pins. To cancel continuous auto test simply press and release the auto test, the channel up, or the channel down select buttons.

At any time manual testing of individual channels or pins is possible. The buttons adjacent to the up and down arrows are used to select the channel or pin to be tested. The left two digits of the display will indicate which channel or pin is currently being tested. The right two digits will display the results of the test. In the channel mode the results will be either OK or one or more of the nine possible error codes.

In the pin mode the light indicating that W1 to W1 mode is active will flash. The test results displayed will be the pin or pins that are connected to the pin selected for testing. If no pin is detected as being connected two dashes (- -) will display. Repeat testing of the selected channel or pin will take place every two seconds. The displayed results will refresh with each test cycle.

System Mode:
Local Cable Mode: W1-M to XLR-F

When the cable mode is selected for W1-M to XLR-F the Model 93 is configured to test W1 “fanouts” that have an W1 male on one end and twelve 3-pin female XLR connectors on the other.

Begin testing by connecting the fanout’s W1 male connector to the female W1 connector located on the right side of the Model 93. Ensure that a solid connection is made by “locking” the connectors together using the outer ring. Each fanout channel can now be individually tested. Start by plugging the fanout’s female XLR connector associated with channel 1 into the male XLR connector located on the left side of the Model 93. Use the buttons adjacent to the up and down arrows to select channel 1 for testing. The left two display digits will indicate the selected channel. The right two display digits will indicate the test result. The result will either display an OK or one or more of the nine error codes. OK indicates that the connections associated with channel 1 are correct. If the E1 error code is displayed, be certain to use the channel select buttons to manually “step through” all channels looking for an OK result. This will identify whether the fanout’s XLR connector has been labeled with the incorrect channel number. After channel 1 has been tested remove its associated female XLR connector from

the Model 93 and in its place connect the connector associated with channel 2. Use the manual channel select buttons to select channel 2 for testing. Repeat this process for all twelve of the fanout's channels.

Note that in the W1-M to XLR-F cable mode only channel mode is available. In addition, the auto test and continuous auto test sequences are not available. Also, the Model 93 doesn't directly support fanouts that contain a mixture of female and male XLR connectors. In this case the use of gender changers or "turn arounds" is recommended.

System Mode:
Local Cable Mode: W1-F to XLR-M

When the cable mode is selected for W1-F to XLR-M the Model 93 is configured to test W1 "fanouts" that have an W1 female on one end and twelve 3-pin male XLR connectors on the other.

Begin testing by connecting the fanout's W1 female connector to the male W1 connector located on the left side of the Model 93. Ensure that the connection is made solidly by "locking" the connectors together using the outer ring. Each fanout channel can now be individually tested. Start by plugging the fanout's male XLR connector associated with channel 1 into the female XLR connector located on the right side of the Model 93. Use the buttons adjacent to the up and down arrows to select channel 1 for testing. The left two display digits will indicate the selected channel. The right two display digits will indicate the test result. The result will either display an OK or one or more of the nine error codes. OK indicates that the connections associated with channel 1 are correct. If the E1 error code is displayed, be certain to use the channel select buttons to manually "step through" all channels looking for an OK result. This will identify that the fanout's XLR connector has been labeled with the incorrect channel number. After channel 1 has been tested remove its associated male XLR connector from the Model 93 and in its place connect the connector associated with channel 2. Use the manual channel select buttons to select channel 2 for testing. Repeat this process for all twelve of the fanout's channels.

Note that in the W1-F to XLR-M cable mode only channel mode is available. In addition, the auto test and continuous auto test sequences are not available. Also, the Model 93 doesn't directly support fanouts that contain a mixture of male and female XLR connectors. In this case the use of gender changers or "turn arounds" is recommended.

System Mode:
Local Cable Mode: XLR to XLR

In the XLR to XLR cable mode the Model 93 allows testing of standard audio cables that use a 3-pin male XLR connector on one end and a 3-pin female XLR connector on the other. Begin by plugging the cable's female connector into the Model 93's male connector, located on the left side of the unit. The cable's male connector should mate with the female connector located on the right side of the Model 93. Testing can take place in either the channel mode or the pin mode. In the channel mode the left two display digits will always show XL, indicating that the XLR to XLR cable mode is active. The right two digits will either show OK or one or more of the nine error codes.

In the pin mode the light indicating that XLR to XLR mode is active will also flash. In this mode the left two digits will display the pin selected for testing. The exact text will be X1, X2, or X3, indicating XLR connector pins 1, 2, or 3. The up and down buttons are used to select the desired pin. The right two digits

will show the pin or pins that are connected to the pin selected for testing. Repeat testing of the cable, when in channel mode, or the specific pin, when in the pin mode, will take place. The displayed results will refresh with each test cycle.

Master/Slave Mode Operation

A challenge is encountered when testing cable assemblies where both ends can't be physically connected to one Model 93. This occurs in cases such as where W1s are permanently installed in stadiums and arenas, or when portable cabling has been "run" and can't be accessed easily. Using two Model 93 units, virtually any W1 cable assembly, fan out, or even 3-pin XLR cables can be tested.

The master/slave mode is created in the Model 93's hardware and software so that the unit's functions are "split" into a send-test-signals portion and a receive-test-signals portion. A communications link is established between two Model 93 units, allowing the two functions, send and receive, to work together. The data passing in each direction on the data link effectively "couples" the two Model 93 units into one. One unit is designated as "master" and coordinates the activities of a test. The "slave" unit follows the commands of the master, performing the actions requested and returning test results as required.

Master/slave testing operation is quite easy to initiate and use. But the flexibility provided by the Model 93's multiple operating modes can be a bit tricky to get one's head around. While this user guide will document the basic "hows and whys" of master/slave operation, only experience can serve as the best teacher. It's recommended that some "bench" experimentation be done prior to going full bore out in the field.

Master/Slave Data Link

For two Model 93 units to be used in a master/slave arrangement they must be interconnected with a 2-conductor signal path. This connection is referred to as the master/slave data link. It supports the transmission of bi-directional serial data as well as linking the power supply common connections of both units. A BNC connector is used for the master/slave data link. This type of connector was selected not because of a specific technical requirement, but because of its wide popularity in the broadcast and video industry. In many applications where W1 cable assemblies are to be tested there will also be BNC-terminated video cables present. This will most likely allow the easier method of interconnecting two Model 93 units. However, there's no reason that other types of cable can't be used. Options can include shielded microphone cable and twisted pair telephone cable. While using coax will allow the greatest distance between Model 93 units, even twisted pair has been tested at over 4000 feet! This should be well in excess of the length of any W1 cable assembly that needs to be tested.

It's important to note that two metallic connections must be made between the master and slave Model 93 units. When using a coaxial cable the two metallic connections would consist of the inner conductor and the shield. Alternately pins 2 and 3 of a standard audio cable that uses XLR connectors would serve the purpose. However, any transformers, "baluns," or capacitors in the connection path that provide DC isolation will prevent master/slave operation.

After interconnecting two Model 93 units, it's quite easy to confirm that the master/slave data link has been established. Temporarily designate one of the units as slave. Be sure that it is powered down. Turn on the other

(master) unit by tapping its power button. Then press and hold its power button until the system mode has changed to master-male active or master-female active. At this point if the connection is valid data coming from the master Model 93 will "wake up" the slave unit. The active LED, located below the BNC connector, on each unit will flash as data packets move between the units. Once data link operation has been confirmed power down the unit designed as master. The slave unit should also power down in response to a command from the master unit.

Note that maintaining a short circuit on the Model 93's data link BNC connector is something to avoid. Due to an idiosyncrasy in the operation of the data communications transceiver integrated circuit an error in the data link wiring can force the Model 93 to stay in the powered up state. The 10-minute inactivity timer will not be able to power down the unit; nor will a low-battery-voltage condition be able to invoke a power down either. Damage to the battery will occur if a deep discharge state is reached. This situation is not something that the Model 93's designers are especially proud of, but they weren't aware of the condition until it was too late to make a change. And contacting the world-class maker of the integrated circuit didn't get much of a response except "hmmm…" So in conclusion, as long as the BNC connector isn't presented with a short circuit or a low impedance load condition things will work fine.

Master/Slave Cable Testing

Once the data link has been established between the two Model 93 units testing operation can begin. Start from the condition of having both units in their powered down state. Then review the desired testing scenario, knowing exactly which cable assembly is going to be tested first. Designate one of the Model 93s as the master unit. There's no requirement as to which unit is the master and which unit is the slave. Typically the Model 93 that's most conveniently accessible should be the master unit. For example, when testing W1s in a stadium, it probably makes sense to have the master situated in the truck dock or main wiring location. Then the slave unit can move among the destination locations such as the broadcast booth, side of the field, etc.

Now activate power to the unit that has been designated as master. Ignore the status of the data link active LED and whether or not the slave unit powers up. Before these issues come into play a couple of other things must first be accounted for. On the master unit, set the cable mode to match the type of cable to be tested. If, for example, the cable to be tested has W1 connectors on each end select the cable mode as W1 to W1. Another example would be if the cable to be tested has an W1 female on one end that "breaks out" into twelve XLR males on the other end. This would necessitate setting the master unit's cable mode to W1-F to XLR-M.

The final step is to set the master unit's system mode. This is a little tricky to understand but we'll work through it! Begin by confirming the exact type of connector that is to be connected to the master unit. For example, while the cable mode might be set for W1 to W1, there's no requirement as to which connector end, male or female, is physically located near the Model 93 that's been designated as master. For our example let's specify that an W1 male connector is on the end of the cable that's to be attached to the master Model 93 unit. To meet the needs of this situation, set the master

unit's system mode for Master-Female Active. This is accomplished by pressing and holding the power on/off button until the desired system mode is enabled.

At this point the master unit is configured to perform the required cable test. To review, the cable mode has been set to match the type of cable to be tested and the system mode has been selected to activate the connector type required for the test environment.

Once configured to the desired system mode, the master Model 93 should have caused the slave Model 93 to power up. The master/slave data active LEDs on both units should indicate that data is passing back and forth. The slave Model 93 should have its system mode LED indicating that slave mode is active. The auto test and manual channel select (up and down) buttons on the master unit perform the same functions as if the local system mode was selected. On the slave unit the auto test and manual channel select buttons are disabled. The power on/off button on the slave unit remains active but isn't generally utilized during master/slave operation.

Connect the cable to be tested to the master and slave Model 93 units. In the example covered a few paragraphs previously, an W1 male would be connected to the master Model 93. An W1 female would be connected to the slave Model 93. Testing functions can only be controlled by the master Model 93. However, the test results will display on both the master and slave Model 93 units. This ensures that someone assisting at the slave position is kept "in the loop" about the testing process. To the user, the master unit should "look and feel" just as if it was set for local system mode. The auto test, continuous auto test, and manual channel or pin tests can be used as desired.

After testing has been completed powering down the master Model 93 will also cause the slave Model 93 to power down. An inactivity timer shutdown of the master Model 93 will also cause the slave unit to power down. Manually powering down the slave Model 93 will cause the unit to shut down and end any tests in progress. But the unit will immediately power on again in response to the master unit data commands. Only by disconnecting the data link connection can the slave unit be independently turned off. (But this isn't something that one would typically want to do anyway!)

"Jumper" Cables

In many cases it will probably be necessary to use W1 or 3-pin XLR "jumper" cable assemblies to connect the master and slave Model 93 units to the cables to be tested. For example, a flexible W1 cable assembly might be required to connect a panel-mounted (bulkhead) W1 connector to a Model 93. In this case be certain that the cables that are going to be part of the test setup are themselves tested first using the Model 93's local system mode. Don't add variables to an already fairly complicated situation!

Ten Steps to Success

With some practice master/slave mode operation should become second nature. The key is to follow a logical setup and configuration sequence before attempting to test a cable assembly. This will make testing a simple matter, rather than leading to a confusing situation! The steps might be organized as follows:

1. Deploy two Model 93 units at the ends of the cable or cables to be tested.
2. Establish the data link connection and confirm that it's functioning correctly.

3. Turn off both units.
4. Designate one unit as master and power up that unit.
5. On the master unit, select the cable mode as required for the cable under test.
6. Identify the type (sex) of the connector to be connected to the master unit.
7. On the master unit, select the system mode (master-male active or master-female active) so as to activate the connector that will mate with the cable to be tested.
8. Confirm that the slave unit has automatically powered up and its system mode is set for slave.
9. Connect the ends of the cable to be tested to both the master and slave units.
10. Use the buttons on the master Model 93 to perform the desired tests. The displays on both the master and the slave units will display the test results.

Technical Notes

Theory of Operation

At its core the Model 93 uses a fairly simple method to test the signal paths of the connected cables. Under software control a test signal can be assigned to any one of the first 36 pins of the male W1 connector, pins r, m, and k as a group, and the three pins of the male XLR connector. This test signal is a DC level of approximately 4 volts which is created by way of a pulse-width-modulator output on the microcontroller. Again under software control, the DC level of signals present on the first 36 pins of the female W1 connector, pins r, m, and k as a group, and the three pins of the female XLR connector can be measured. An analog-to-digital converter input on the microcontroller measures the actual voltages. All signals are generated and measured in reference to the power supply, battery, and data link common connection.

Resistors, in series with each of the male and female connector pins, along with other protection circuitry limit the current that can come into or go out of the Model 93. This will prevent most external DC or static-discharge signals from damaging the Model 93.

The Model 93's channel and pin test routines specify which male (output) pin is active and then scans the female (input) pins, measuring the voltage present on each pin. The data is analyzed and interpreted so as to provide meaningful results to the user.

Specifications

Application: electrical testing of standard W1 cable assemblies

Connectors:

W1 Cable Assemblies: one male and one female 39-pin circular W1-type

Fanout and XLR: one male and one female 3-pin XLR-type

Data Link: BNC

12 Volt DC Power In: coaxial power jack, 2.1 x 5.5 mm, locking bushing, compatible with Switchcraft S760K plug

Power Source:

Internal: 12 volt 1.3 amp-hour sealed lead-acid battery. Operating time 8 hours minimum with fully charged battery. Recharge time 8 hours maximum.

External: 12 volts DC nominal, acceptable range 10-15 volts DC; 250 mA minimum recommended for operation and battery charging. Units shipped to North America and Japan include a 120 V input/ 12 Vdc output power supply.

Master/Slave Operation:

Data Link: modified LIN bus, 1200 bit/s

Maximum Distance between Units: tested to 2400 feet using Belden 1694A coaxial cable and 4000 feet using standard CAT5E UTP

Dimensions:

Height: 5.0 inches (12.7 cm)
Width: 5.0 inches (12.7 cm)
Length: 11.0 inches (27.9 cm)
Overall Length: 12.5 inches (31.8 cm)

Weight: 5.5 pounds (2.5 kg)

Specifications and information contained in this User Guide subject to change without notice.

Appendix A

Error Code Definitions

In this section a detailed description will be given of the Model 93's nine error codes. The error codes are only displayed when the Model 93 is selected for the channel mode and an issue is detected. In the channel mode the three conductors associated with a W1 channel are tested for shorts, opens, and proper connectivity. All the tests are made in relation to the pins associated with the specific channel on the W1 connectors.

E1: Open Shield and Pair

No connections have been detected on the shield, signal low, and signal high paths of the channel selected for testing. The channel is completely "open."

E2: Open Shield

No connection has been detected on the shield path of the channel selected for testing.

E3: Open Pair

No connection has been detected on the signal low path, the signal high path, or both the signal low and signal high paths.

E4: Reversed Pair

The signal path has been reversed or "flipped." The signal low connection on the female connector end of the cable under test is connected to the signal high connection on the male connector end of the cable under test. And, as expected, the signal high connection on the female connector end of the cable under test is connected to the signal low connection on the other end.

E5: Shorted Shield to Pair

A connection has been detected between the shield path and the signal low path, between the shield path and the signal high path, or between the shield path and both the signal low and signal high paths.

E6: Shorted Pair

A connection has been detected between the signal low path and the signal high path.

E7: Incorrect Shield Connection

The shield pin on the female connector end of the cable under test is connected to the pin designated for signal low or signal high on the male connector end of the cable under test.

E8: Incorrect Pair Connection

The signal low pin or the signal high pin on the female connector end of the cable under test is connected to the pin designated for shield on the male connector end of the cable under test.

E9: Channel-to-Channel Error

This is a somewhat general-purpose error code. It indicates that one or more problems exist between the pins associated with the selected channel on the female connector end of the cable under test and pins associated with other channels on the male end of the cable.

Appendix B

W1 Pinout Chart

Model 93 Pin Test Order	W1 Pin Number	W1 Channel	W1 Function
1	q		SHIELD
5	p	1	+
6	n		–
2	X		SHIELD
3	W	2	+
7	A		–
4	P		SHIELD
8	N	3	+
9	f		–
10	M		SHIELD
16	L	4	+
17	e		–
11	K		SHIELD
12	J	5	+
18	d		–
13	H		SHIELD
19	G	6	+
20	c		–
14	F		SHIELD
15	E	7	+
21	b		–
23	Z		SHIELD
24	D	8	+
29	a		–
25	Y		SHIELD
30	C	9	+
31	B		–
26	V		SHIELD
27	U	10	+
32	j		–
22	T		SHIELD
28	i	11	+
33	h		–
34	S		SHIELD
35	R	12	+
36	g		–
37*	r, m, k	---	---

* Connected to allow testing of spare W1 pins.