

Model 2001 7.5 Digit Multimeter with Scanning

Repair Manual

2001-902-01 Rev. D September 2023



2001-902-01D

Model 2001 Multimeter Repair Manual

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Cleveland, Ohio, U.S.A.

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The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with nonhazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the user documentation for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product warranty may be impaired.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the user documentation. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are measurement, control, and data I/O connections, with low transient overvoltages, and must not be directly connected to mains voltage or to voltage sources with high transient overvoltages. Measurement Category II (as referenced in IEC 60664) connections require protection for high transient overvoltages often associated with local AC mains connections. Certain Keithley measuring instruments may be connected to mains. These instruments will be marked as category II or higher.

Unless explicitly allowed in the specifications, operating manual, and instrument labels, do not connect any instrument to mains.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30 V RMS, 42.4 V peak, or 60 VDC are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 V, no conductive part of the circuit may be exposed.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance-limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, ensure that the line cord is connected to a properly-grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.


For safety, instruments and accessories must be used in accordance with the operating instructions. If the instruments or accessories are used in a manner not specified in the operating instructions, the protection provided by the equipment may be impaired.


Do not exceed the maximum signal levels of the instruments and accessories. Maximum signal levels are defined in the specifications and operating information and shown on the instrument panels, test fixture panels, and switching cards.


When fuses are used in a product, replace with the same type and rating for continued protection against fire hazard.


Chassis connections must only be used as shield connections for measuring circuits, NOT as protective earth (safety ground) connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.


If a  screw is present, connect it to protective earth (safety ground) using the wire recommended in the user documentation.

The  symbol on an instrument means caution, risk of hazard. The user must refer to the operating instructions located in the user documentation in all cases where the symbol is marked on the instrument.

The  symbol on an instrument means warning, risk of electric shock. Use standard safety precautions to avoid personal contact with these voltages.


The  symbol on an instrument shows that the surface may be hot. Avoid personal contact to prevent burns.

The  symbol indicates a connection terminal to the equipment frame.

If this  symbol is on a product, it indicates that mercury is present in the display lamp. Please note that the lamp must be properly disposed of according to federal, state, and local laws.

The **WARNING** heading in the user documentation explains hazards that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in the user documentation explains hazards that could damage the instrument. Such damage may invalidate the warranty.

The **CAUTION** heading with the  symbol in the user documentation explains hazards that could result in moderate or minor injury or damage the instrument. Always read the associated information very carefully before performing the indicated procedure. Damage to the instrument may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits — including the power transformer, test leads, and input jacks — must be purchased from Keithley. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. The detachable mains power cord provided with the instrument may only be replaced with a similarly rated power cord. Other components that are not safety-related may be purchased from other suppliers as long as they are equivalent to the original component (note that selected parts should be purchased only through Keithley to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Keithley office for information.

Unless otherwise noted in product-specific literature, Keithley instruments are designed to operate indoors only, in the following environment: Altitude at or below 2,000 m (6,562 ft); temperature 0 °C to 50 °C (32 °F to 122 °F); and pollution degree 1 or 2.

To clean an instrument, use a cloth dampened with deionized water or mild, water-based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., a data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

Safety precaution revision as of June 2018.

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1

Routine Maintenance

1.1 Introduction

In general, the information in this section deals with routine type maintenance that can be performed by the operator. This information is arranged as follows:

- 1.2 **Line fuse replacement** — Explains how to replace a blown line power fuse.
- 1.3 **Current fuse replacement** — Explains how to replace a blown current fuse.
- 1.4 **Fan filter cleaning** — Explains how to remove and clean the filter element for the cooling fan.
- 1.5 **Firmware updates** — Recommends a course of action for firmware updates provided by Keithley.

1.2 Line fuse replacement

WARNING

Disconnect the line cord at the rear panel. Remove all test leads connected to the instrument (front and rear).

The power line fuse is accessible from the rear panel, just below the ac power receptacle (see Figure 1-1). Perform the following steps to replace the line fuse:

1. Insert a bladed screwdriver into the slot of the fuse carrier.
2. While pushing in, turn the screwdriver counter-clockwise until the spring loaded fuse carrier releases from the fuse holder.
3. Pull out the fuse carrier and replace the fuse with the type specified in Table 1-1.

CAUTION

To prevent instrument damage, use only the fuse type specified in Table 1-1.

4. Re-install the fuse carrier.

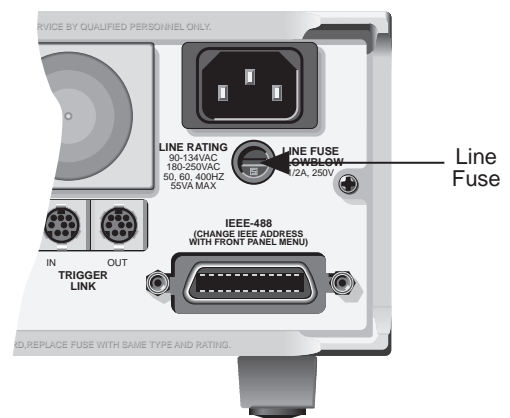


Figure 1-1
Line fuse location

NOTE

If the power line fuse continues to blow, a circuit malfunction exists and must be corrected. Refer to the troubleshooting section of this manual for assistance.

Table 1-1
Power line fuse

| Size | Rating | Keithley Part No. |
|----------|-------------------|-------------------|
| 5 × 20mm | 250V, ½A, Slo-Blo | FU-71 |

1.3 Current fuse replacement

Each AMPS input (front and rear) has its own current fuse. When replacing a current fuse, use the type specified in Table 1-2.

Table 1-2
Current fuse

| Size | Rating | Keithley Part No. |
|----------|----------------------|-------------------|
| 5 × 20mm | 250V, 2A, Normal-Blo | FU-48 |

WARNING

Disconnect the instrument from the power line and remove all test leads (front and rear).

1.3.1 Front AMPS input fuse

The front panel AMPS jack functions as the AMPS input terminal and as the carrier for the AMPS fuse (see Figure 1-2). Perform the following steps to replace the fuse:

1. Push in the AMPS input jack and turn counter-clockwise until the spring loaded fuse carrier releases from the fuse holder.
2. Pull out the fuse carrier and replace the fuse with the type specified in Table 1-2.

CAUTION

To prevent instrument damage, use only the type specified in Table 1-2.

3. Re-install the fuse carrier.

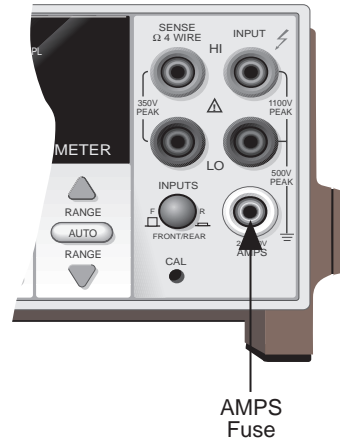


Figure 1-2
Front AMPS input fuse location

1.3.2 Rear AMPS input fuse

The rear AMPS input fuse is located just below the AMPS input jack (see Figure 1-3). Perform the following steps to replace the fuse:

1. Insert a bladed screwdriver into the slot of the fuse carrier.
2. While pushing in, turn the screwdriver counter-clockwise until the spring loaded fuse carrier releases from the fuse holder.
3. Pull out the fuse carrier and replace the fuse with the type specified in Table 1-2.

CAUTION

To prevent instrument damage, use only the fuse type specified in Table 1-2.

4. Re-install the fuse carrier.

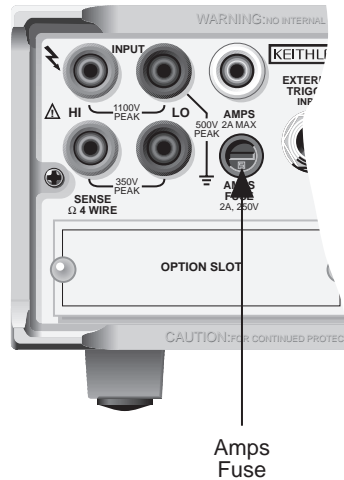


Figure 1-3
Rear AMPS input fuse location

1.4 Fan filter cleaning

The filter for the cooling fan requires periodic cleaning to maintain proper ventilation. The fan filter is accessible from the rear panel. Perform the following steps to remove the filter for cleaning:

1. While facing the rear panel, locate the lower right-hand corner of the filter cover plate.
2. At this corner, place a thin-bladed screwdriver between the cover plate and the rear panel and gently pry the filter assembly away from the chassis.

The filter element is permanently fixed to the cover plate. Do not attempt to remove the filter element from

the cover plate.

WARNING

Exercise care when handling the filter assembly. The filter element is a metal screen with sharp edges that could cause injury if not handled carefully.

The filter element is made of a rugged metal screen allowing the use of any type cleaning solution to clean it. A small metal brush can be used to remove dirt and debris. After cleaning the filter, rinse thoroughly with water. Make sure the filter assembly is completely dry before re-installing it.

1.5 Firmware updates

It is possible that you may receive a firmware update from Keithley to enhance operation and/or fix “bugs”. The firmware program for the main microprocessor is contained in U611 (EPROM). A socket is used on the pc board for this device to make replacement relatively easy.

The replacement procedure requires that the case cover be removed. Also, this surface mount, static-sensitive device requires special handling. As a result, the firmware update should only be performed by qualified service personnel. The procedure to replace the firm-ware (U611) is in paragraph 3.8.

Service upon receipt of material

Unpacking

Special material in this shipping carton provides maximum protection for the multimeter. Avoid damaging carton and packing material during equipment unpacking. Use the following steps for unpacking the multimeter.

- Cut and remove the paper sealing tape on the carton top, and then open the carton.
- Grasp multimeter while restraining shipping carton and lift equipment vertically.
- Place multimeter on a suitable flat, clean, and dry surface.

Checking unpacked equipment

- Inspect equipment for damage incurred during shipment.
- Check the equipment to see if shipment is complete.

Preparation for storage or shipment

Packaging

Package the multimeter in the original shipping container. When using packing materials other than the original, use the following guidelines:

- Wrap the multimeter in plastic material.
- Use a double-wall cardboard shipping container.
- Protect all sides with shock-absorbing material to prevent the multimeter from movement within the container.
- Seal the shipping container with approved sealing tape.
- Mark **FRAGILE** on all sides, top, and bottom of the shipping container.

Environment

The multimeter should be stored in a clean, dry environment. In high humidity environments, protect the multimeter from temperature variations that could cause internal condensation. Model 2001 specifications are available for download from the Keithley Product Support and Downloads web page (tek.com/support/product-support).

2

Troubleshooting

WARNING

The information in this section is intended for qualified service personnel. Some of these procedures may expose you to hazardous voltages. Do not perform these hazardous procedures unless you are qualified to do so.

2.1 Introduction

This section of the manual will assist you in troubleshooting the Model 2001. Included are self-tests, test procedures, troubleshooting tables and circuit descriptions. It is left to the discretion of the repair technician to select the appropriate tests and documentation needed to troubleshoot the instrument.

This section is arranged as follows:

- 2.2 **Repair considerations** — Covers some considerations that should be noted before making any repairs to the Model 2001.
- 2.3 **Power-on test** — Describes the tests that are performed on its memory elements every time the instrument is turned on.
- 2.4 **Front panel tests** — Provides the procedures to test the functionality of the front panel keys and the display.

- 2.5 **Built-In tests** — Provides the procedures to test and exercise the various circuits on the digital board, analog board and A/D converter boards.
- 2.6 **Diagnostics** — Explains how to use the Diagnostics test mode of the Model 2001. In general, Diagnostics locks-up the instrument in various states of operation. With the instrument in a static state, you can then check the state of the various logic levels on the control registers and signal trace through the unit.
- 2.7 **R1_STB and R2_STB registers** — Provides shift register bit patterns for the basic measurement functions and ranges.
- 2.8 **Display board checks** — Provides display board checks that can be made if Front Panel Tests fail.
- 2.9 **Power supply checks** — Provides power supply checks that can be made if the integrity of the power supply is questioned.
- 2.10 **Documentation** — Provides support documentation for the various troubleshooting tests and procedures. Included is some basic circuit theory for the display board and power supply, and support documentation for Built-in Test.

2.2 Repair considerations

Before making any repairs to the Model 2001, be sure to read the following considerations.

CAUTION

The PC-boards are built using surface mount techniques and require specialized equipment and skills for repair. If you are not equipped and/or qualified, it is strongly recommended that you send the unit back to the factory for repairs or limit repairs to the pc-board replacement level (see following NOTE).

Without proper equipment and training, you could damage a PC-board beyond repair.

NOTE

For units that are out of warranty, completely assembled PC-boards can be ordered from Keithley to facilitate repairs.

1. Repairs will require various degrees of disassembly. However, it is recommended that the Front Panel Tests (paragraph 2.4) and Built-In-Test (paragraph 2-5) be performed prior to any disassembly. The disassembly instructions for the Model 2001 are contained in Section 3 of this manual.
2. Do not make repairs to surface mount pc-boards unless equipped and qualified to do so (see previous CAUTION).
3. When working inside the unit and replacing parts, be sure to adhere to the handling precautions and cleaning procedures explained in paragraph 3.2.
4. Many CMOS devices are installed in the Model 2001. These static-sensitive devices require special handling as explained in paragraph 3.3.
5. Anytime a circuit board is removed or a component is replaced, the Model 2001 will have to be recalibrated.

2.3 Power-on test

During the power-on sequence, the Model 2001 will perform a checksum test on its EPROM (U611 and U618) and test its RAM (U608, U609, and U610). If one of these tests fail the instrument will lock up.

2.4 Front panel tests

There are two Front Panel Tests; one to test the functionality of the front panel keys and one to test the display. In the event of a test failure, refer to paragraph 2.8 to troubleshoot the display board.

2.4.1 KEYS Test

The KEYS test allows you to check the functionality of each front panel key. Perform the following steps to run the KEYS test.

1. Display the MAIN MENU by pressing the MENU key.
2. Use the ◀ or ▶ key to place the cursor on TEST and press ENTER to display the SELF-TEST MENU.
3. Place the cursor on FRONT-PANEL-TESTS and press ENTER to display the following menu:

```
FRONT PANEL TESTS
KEYS  DISPLAY-PATTERNS
```

4. Place the cursor on KEYS and press ENTER to start the test. When a key is pressed, the label name for that key will be displayed to indicate that it is functioning properly. When the key is released, the message "No keys pressed" is displayed.
5. Pressing EXIT tests the EXIT key. However, the second consecutive press of EXIT aborts the test and returns the instrument to the SELF-TEST MENU. Keep pressing EXIT to back out of the menu structure.

2.4.2 DISPLAY PATTERNS Test

The display test allows you to verify that each pixel and annunciator in the vacuum fluorescent display is working properly. Perform the following steps to run the display test:

1. Display the MAIN MENU by pressing the MENU key.
2. Use the ◀ or ▶ key to place the cursor on TEST and press ENTER to display the SELF-TEST MENU.
3. Place the cursor on FRONT-PANEL-TESTS and press ENTER to display the following menu:

FRONT PANEL TESTS
KEYS DISPLAY-PATTERNS

4. Place the cursor on DISPLAY-PATTERNS and press ENTER to start the display test. There are five parts to the display test. Each time a front panel key (except EXIT) is pressed, the next part of the test sequence is selected. The five parts of the test sequence are as follows:
 - A. Checkerboard pattern (alternate pixels on) and all annunciators.
 - B. Checkerboard pattern and the annunciators that are on during normal operation.
 - C. Horizontal lines (pixels) of the first digit are sequenced.
 - D. Vertical lines (pixels) of the first digit are sequenced.
 - E. Each digit (and adjacent annunciator) is sequenced. All the pixels of the selected digit are on.
5. When finished, abort the display test by pressing EXIT. The instrument returns to the SELF-TEST MENU. Keep pressing EXIT to back out of the menu structure.

2.5 Built-in test

BUILT-IN TEST is used to test and exercise various circuits and components on the digital board, analog board and A/D converter board. The Built-In Tests are listed in Table 2-1. Many of the tests are actual pass/fail type tests, while others are circuit exercises that are used for subsequent tests. Each Built-In Test can be run manually. After a test is manually run, operation is "frozen" to allow the technician to troubleshoot the circuit. Troubleshooting documentation for each Built-In Test is provided in paragraph 2.10.3.

Table 2-1
Built-in-test summary

| Test | Circuit tested/exercised |
|---|--|
| 100 Series 100.1 | Memory: EPROM |
| 101 Series 101.1 | Memory: RAM |
| 102 Series 102.1 | Memory: E ² PROM |
| 103 Series 103.1 - 103.4 103.5 | Digital I/O: Digital Output Digital Input |
| 104 Series 104.1 104.2 | IEEE-488 Bus: Handshake Data |
| 105 Series 105.1 - 105.6 105.7 105.8 105.11 - 105.18 | Triggers: System Trigger Bus External Trigger / Voltmeter Complete Group Execute Trigger (GET) Trigger Shorts |
| 200 Series 200.1 200.2 200.3 200.4 200.5 200.6 200.7 | A/D Converter: A/D Zero A/D Noise FAST Circuit x10 Line Cycle Integration x0.1 Line Cycle Integration x0.02 Line Cycle Integration x0.01 Line Cycle Integration |
| 201 Series 201.1 201.2 201.3 | Calibration: Test Cal Zero 7V Reference 1.75V Reference |
| 300 Series 300.1 300.2 300.3 | A/D Multiplexer (MUX), A/D Buffer: 7V Reference, x1.5 Gain 1.75V Reference, x5 Gain 0V Reference, x50 Gain |
| 301 Series 301.1 301.2 | Input Buffer: Front End (FE) Zero Divide by 100 |

Table 2-1 (cont.)
Built-in-test summary

| Test | Circuit tested/exercised |
|------------|--|
| 302 Series | Ohms: |
| 302.1 | Zero Reference Measurement (for next test) |
| 302.2 | Open Circuit Ohms and Ohms Protection |
| 303 Series | Input Path: |
| 303.1 | Zero Reference Measurement (for next test) |
| 303.2 | Open Circuit Ohms and Ohms Protection |
| 303.3 | Front End (FE) Zero Protection |
| 304 Series | Ohms Sources: |
| 304.1 | Zero Reference Measurement (for tests 304.2 - 304.7) |
| 304.2 | 0.98mA and 9.2mA Ohms Sources |
| 304.3 | 89µA and 0.98mA Ohms Sources |
| 304.4 | 7µA and 89µA Ohms Sources |
| 304.5 | 770nA and 7µA Ohms Sources |
| 304.6 | 70nA and 770nA Ohms Sources |
| 304.7 | 4.4nA and 770nA Ohms Sources |
| 305 Series | Input Divider: |
| 305.1 | Zero Reference Measurement (for next test) |
| 305.2 | Divide by 100 |
| 306 Series | Switching: |
| 306.1 | Ohms Cal Switch |
| 307 Series | Cal Divider: |
| 307.1 | Zero Reference Measurement (for next test) |
| 307.2 | A/D MUX /10 |
| 307.3 | A/D MUX /Buffer (x-0.5) |

Table 2-1 (cont.)
Built-in-test summary

| Test | Circuit tested/exercised |
|------------|---|
| 308 Series | 4-Digit Mode: |
| 308.1 | A/D MUX 4-Digit Signal Path |
| 308.2 | A/D MUX 4-Digit Zero Path |
| 309 Series | Amps: |
| 309.1 | 200µA Range |
| 309.2 | 2mA Range |
| 309.3 | 20mA Range |
| 309.4 | Reference Measurement (for tests 309.5 and 309.6) |
| 309.5 | 200mA Range |
| 309.6 | 2A Range |
| 310 Series | Protection: |
| 310.1 | Amps Protection |
| 400 Series | Digital-to-Analog Converter (DAC): |
| 400.1 | -4.21V Output |
| 400.2 | -2.08V Output |
| 400.3 | -0.001V Output |
| 400.4 | +2.25V Output |
| 400.5 | +4.33V Output |
| 401 Series | Signal Switching: |
| 401.1 | Zero Cal Switch |
| 402 Series | Signal Switching: |
| 402.1 | Frequency Switch |
| 403 Series | Signal Switching: |
| 403.1 | Ground Switch |
| 404 Series | Absolute Value (x1 Gain): |
| 404.1 | -Full Scale DAC Output |
| 404.2 | -Half Scale DAC Output |
| 404.3 | Zero DAC Output |
| 404.4 | +Half Scale DAC Output |
| 404.5 | +Full Scale DAC Output |

Table 2-1 (cont.)
Built-in-test summary

| Test | Circuit tested/exercised |
|------------|---|
| 405 Series | Absolute Value (x10 Gain): |
| 405.1 | Gain Comparison (Large +DAC Output) |
| 405.2 | Gain Comparison (Large +DAC Output) |
| 405.3 | Gain Comparison (Small +DAC Output) |
| 405.4 | Gain Comparison (Small +DAC Output) |
| 405.5 | Gain Comparison (Small -DAC Output) |
| 405.6 | Gain Comparison (Small -DAC Output) |
| 405.7 | Gain Comparison (Large -DAC Output) |
| 405.8 | Gain Comparison (Large -DAC Output) |
| 406 Series | Test Buffer: |
| 406.1 | Measure DAC Output (for test 406.6) |
| 406.2 | Test Buffer Output (-1.13V) |
| 406.3 | Read Test Buffer (for test 406.6) |
| 406.4 | Read DAC Output (for test 406.6) |
| 406.5 | Test Buffer Output (-0.01V) |
| 406.6 | Voltage Comparisons |
| 407 Series | Front End: |
| 407.1 | 2V Range |
| 407.2 | 200V Range |
| 407.3 | 750V Range |
| 408 Series | /200 Correction Factor: |
| 408.1 | Circuit Setup (for next test) |
| 408.2 | Signal Stored (for next test) |
| 408.3 | Setup (for test 408.5) and Measurement (for test 408.6) |
| 408.4 | Same as Test 408.3 but no measurement. |
| 408.5 | Signal Stored (for next test) |
| 408.6 | Signal Comparisons |

Table 2-1 (cont.)
Built-in-test summary

| Test | Circuit tested/exercised |
|------------|---|
| 409 Series | /750 Correction Factor: |
| 409.1 | Circuit Setup (for next test) |
| 409.2 | Signal Stored (for next test) |
| 409.3 | Setup (for test 409.5) and Measurement (for test 409.6) |
| 409.4 | Same as Test 409.3 but no measurement. |
| 409.5 | Signal Stored (for next test) |
| 409.6 | Signal Comparisons |
| 410 Series | Converter: |
| 410.1 | TRMS Converter |
| 411 Series | Filters: |
| 411.1 | TRMS Filter |
| 411.2 | Variable Gain Amplifier Filter |
| 412 Series | Switching: |
| 412.1 | AC Amps Switch |

Typical Way To Use BUILT-IN-TEST

1. Run the AUTOMATIC Built-In-Test as explained in paragraph 2.5.1 and note the first (lowest numbered) test that has failed. You should always address the lowest numbered test failure first because that failure could cause subsequent tests to fail.
2. Familiarize yourself with the failed circuit. Documentation for the Built-In Tests are provided in paragraph 2.10.3. Be sure to read the documentation for the complete series. For example, if test 200.4 fails, read the documentation for all 200 series tests (200.1 through 200.7). Note that the documentation directs you to the appropriate schematic(s) for the circuit.
3. Manually run the test that failed as explained in paragraph 2.5.2. Keep in mind that many of the pass/ fail type tests require that one or more circuit exercise tests be run first. Using the manual step looping mode will “freeze” instrument operation after a test is run.
4. After manually running the test, use the test documentation and your troubleshooting expertise to locate the problem.

- After repairing the instrument, start again at step 1 to check the integrity of the repair and to see if there are any other failures.

2.5.1 AUTOMATIC Testing

- Display the MAIN MENU by pressing the MENU key.
- Use the ◀ or ▶ key to place the cursor on TEST and press ENTER to display the SELF-TEST MENU.
- Place the cursor on BUILT-IN-TEST and press ENTER to display the following menu:

```
BUILT-IN TEST
AUTOMATIC  MANUAL
```

- Place the cursor on AUTOMATIC and press ENTER. The following prompt is displayed:

```
CONTINUOUS REPEAT?
NO  YES
```

In the non-repeat mode (NO), the testing process stops after all tests have been performed one time. In the continuous repeat mode (YES), the testing process loops around and repeats indefinitely until the EXIT key is pressed to stop the tests.

- Place the cursor on the desired repeat mode selection (NO or YES) and press ENTER to start the testing process. The instrument displays the number of the test being run. An "A" on the display indicates that the tests are being run automatically in the non-repeat mode. An "AC" indicates that the tests are being run automatically in the continuous repeat mode. If a failure occurs, a star (*) appears at the right hand end of the display and remains on for the remainder of the tests.
- If the non-repeat mode is selected, the testing process automatically stops when all the tests have been performed. If the continuous repeat mode is selected, you will have to manually stop the testing process by pressing EXIT. When EXIT is pressed, all the tests in a series already started will be allowed to finish.

When the testing process stops, the following message is displayed:

```
All tests complete *
Press ENTER to review or EXIT
```

The star (*) is only displayed if a failure occurs.

- If all the tests passed (no star displayed), use the EXIT key to back out of the menu structure. Otherwise, press ENTER to display the test number of the first failure. You can display any additional failures by using the ◀ and ▶ keys. With a failed test displayed, pressing the INFO key provides an abbreviated description of the failure. Paragraph 2.10 provides detailed documentation for troubleshooting the defective circuit. When finished, use EXIT to back out of the menu structure.

2.5.2 MANUAL Testing

- Display the MAIN MENU by pressing the MENU key.
- Use the ◀ or ▶ key to place the cursor on TEST and press ENTER to display the SELF-TEST MENU.
- Place the cursor on BUILT-IN-TEST and press ENTER to display the following menu:

```
BUILT-IN TEST
AUTOMATIC  MANUAL
```

- Place the cursor on MANUAL and press ENTER to display the currently selected test series number.

Test number: 100

This test number indicates that the 100 series tests can be performed. In this case there is only one test; test 100.1.

- Use the ◀ or ▶ to display the desired test series number. For example, if you wish to run test 200.5, display the series 200 test number.

Test number: 200

- With the desired test series number displayed, press ENTER. The following menu displayed:

```
SELECT LOOPING
SINGLE  CONTINUOUS  STEP
```

- Place the cursor on the desired looping selection and press ENTER.
 - SINGLE Looping performs all the tests in the specified series. The instrument displays the number of the test being run, and an "M" is dis-

played to indicate that the tests are being run in the manual single looping mode. If a failure occurs, a star (*) appears at the right hand end of the display and remains on for the remainder of the tests in the series. This testing process automatically stops after the last test in the series is completed. This test process can also be stopped by pressing EXIT. When EXIT is pressed, any test in process will be allowed to finish before aborting the testing process.

- B. CONTINUOUS looping continuously repeats all the tests in the specified series until the testing process is manually stopped. During testing, the "MC" message is displayed to indicate that tests are being run in the manual continuous looping mode. If a failure occurs, a star (*) appears at the right hand end of the display and remains on for the remainder of the tests in the series. This test process can be stopped by pressing EXIT. When EXIT is pressed, any test in process will be allowed to finish before aborting the testing process.
 - C. STEP looping is used to perform one test at a time. Each press of the ENTER key performs the displayed test. The "MS" message is displayed to indicate that tests are being run in the manual step looping mode. If a failure occurs, a star (*) appears at the right hand end of the display and remains on for the remainder of the tests in the series. The instrument automatically aborts the testing process after the last test in the series is run. If you do not wish to run all the tests in the series, simply press EXIT after the desired test is run.
8. After the testing process is stopped, the following message is displayed:

All tests complete *
Press ENTER to review or EXIT

The star (*) is only displayed if a failure occurs.

- 9. In the event of no test failures, press any key to return to the BUILT-IN TEST menu. If you wish to run more tests, repeat steps 4 through 8.

In the event of a failure, press ENTER to display the first test that failed. Other test failures can be displayed by using the ◀ and ▶ keys. The INFO key can be used to provide a brief summary of each displayed test failure. Paragraph 2.10.3 provides detailed documentation for troubleshooting the defective circuit. When finished, press EXIT to re-

turn to the BUILT-IN TEST menu. If you wish to run more tests, repeat steps 4 through 8.

- 10. When finished with BUILT-IN TEST, use the EXIT key to back out of the menu structure.

2.6 Diagnostics

The Model 2001 has diagnostic test modes which allow you to "freeze" instrument operation to allow you to check logic levels on the DC_STB control registers (U303, U300, U800 and U801). The known bit pattern at these registers can then be used for signal tracing through the unit. Table 2-10 provides a brief description of each register bit.

Perform the following steps to use DIAGNOSTICS:

1. Select the desired function and range to be checked. Note that there are no range selections for FREQ and TEMP.
2. Display the MAIN MENU by pressing the MENU key.
3. Using the ◀ or ▶ key to place the cursor on TEST and press ENTER to display the SELF-TEST MENU.
4. Place the cursor on DIAGNOSTICS and press ENTER. The first diagnostic test mode (Signal Phase or Ohms Sense High) is selected (displayed).
5. Perform the following steps to determine the bit pattern at the control registers:
 - A. Refer to one of the following DIAGNOSTIC Test Modes tables to determine the bit pattern designator (A through X) for the selected function/range:
 - Table 2-2 — All functions except Ω4
 - Table 2-3 — Ω4 function; 20Ω and 200Ω ranges
 - Table 2-4 — Ω4 function, 2kΩ, 20kΩ and 200kΩ ranges
 - B. Once the bit pattern designator is determined, use Table 2-5 to determine the logic state of each register bit.

Example: Assume the 20VDC range is selected and the instrument is in the "Signal Phase" of DIAGNOSTICS. From Table 2-2, the bit pattern designator is C. Table 2-5 provides the logic states for bit pattern C.
6. Use the cursor keys to select the other diagnostic test modes. The ▶ key scrolls forward through the

test modes and the ◀ key scrolls backward. Again, use the appropriate tables to determine the bit pattern at the control registers.

7. When finished, press EXIT three times to back out

of the menu structure and return to the normal measurement mode of operation.

8. If you wish to check another function/range, repeat steps 1 through 7.

Table 2-2
DIAGNOSTICS test modes (all functions except Ω4)

| Test mode | Selected function | Selected range | Bit pattern designator* |
|-------------------|----------------------------------|-----------------------------------|-------------------------|
| Signal Phase | DCV | 200mV 2V, 200V 20V 1000V | A B C D |
| | ACV, ACI and FREQ | All | E |
| | DCI | All | F |
| | Ω2 | 20Ω, 200Ω 2kΩ-200MΩ 1GΩ | G H I |
| | TEMP RTD (open input) TEMP TC | — — | H B |
| 7V div by 1 * 1 | All (except Ω4) | All | J |
| 7V div by 1 * 1.5 | All (except Ω4) | All | K |
| 2V div by 1 * 5 | All (except Ω4) | All | L |
| 0V div by 1 * 1 | All (except Ω4) | All | M |
| 0V div by 1 * 5 | All (except Ω4) | All | N |
| 0V div by 1 * 50 | All (except Ω4) | All | O |
| 0V div by 1 * 1.5 | All (except Ω4) | All | P |
| FE zero for 200mV | All (except Ω4) | All | Q |
| FE zero for 2V | All (except Ω4) | All | R |

*Bit patterns are provided in Table 2-5.

Table 2-3
 DIAGNOSTICS test modes ($\Omega 4$ function; 20Ω
 and 200Ω ranges)

| Test mode | Bit pattern designator* |
|-------------------|-------------------------|
| Ohms sense high | G |
| 7V div by 1 * 1 | P |
| 7V div by 1 * 1.5 | Q |
| 2V div by 1 * 5 | R |
| 0V div by 1 * 1 | S |
| 0V div by 1 * 5 | T |
| 0V div by 1 * 50 | U |
| 0V div by 1 * 1.5 | V |
| Ohms sense minus | W |
| FE zero for 2V | X |

*See Table 2-5 for bit patterns.

Table 2-4
 DIAGNOSTICS test modes ($\Omega 4$ function; $2k\Omega$
 thru $200k\Omega$ ranges)

| Test mode | Bit pattern designator* |
|-------------------|-------------------------|
| Ohms sense high | H |
| 7V div by 1 * 1 | P |
| 7V div by 1 * 1.5 | Q |
| 2V div by 1 * 5 | R |
| 0V div by 1 * 1 | S |
| 0V div by 1 * 5 | T |
| 0V div by 1 * 50 | U |
| 0V div by 1 * 1.5 | V |
| FE zero for 200mV | W |
| Ohms sense minus | X |

*See Table 2-5 for bit patterns.

Table 2-5
 DIAGNOSTICS bit patterns (DC_STB registers)

| Bit pattern | Registers | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-------------|-----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | U303 | | | | | | | | U300 | | | | | | | | U800 | | | | | | | | U801 | | | | | | | |
| | Q8 | Q7 | Q6 | Q5 | Q4 | Q3 | Q2 | Q1 | Q8 | Q7 | Q6 | Q5 | Q4 | Q3 | Q2 | Q1 | Q8 | Q7 | Q6 | Q5 | Q4 | Q3 | Q2 | Q1 | Q8 | Q7 | Q6 | Q5 | Q4 | Q3 | Q2 | Q1 |
| A | X | X | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | |
| B | X | X | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | |
| C | X | X | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| D | X | X | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| E | X | X | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| F | X | X | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| G | X | X | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| H | X | X | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| I | X | X | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| J | X | X | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| K | X | X | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| L | X | X | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| M | X | X | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| N | X | X | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| O | X | X | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| P | X | X | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| Q | X | X | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| R | X | X | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| S | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | |
| T | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | |
| U | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | |
| V | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | |
| W | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | |
| X | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | |

2.7 R1_STB and R2_STB shift registers

Table 2-6 and Table 2-7 are provided to allow you to check logic levels on the R1_STB and R2_STB shift registers (U302, U305, U307, U501, U530, U500 and U505) for each basic measurement function (DCV, ACV, DCI, ACI, $\Omega 2$ and $\Omega 4$) and range. The known bit pattern at these registers can then be used for signal tracing through the unit. Tables 2-11 and Table 2-12 provide a brief description of each register bit.

To use these tables, simply place the instrument in the designated function and range and check the output of the shift registers for the indicated bit pattern. The bit patterns in these tables assume the following conditions:

NPLC > 0.01

AC Type = RMS or Average

Offset Compensated Ohms = Off

Current Measurement Mode = Normal (No In-Circuit I)

Table 2-6
Bit patterns for R1_STB registers

| Function | Range | Registers | | | | | | | | | | | | | | | | | | | | | | | |
|----------|-------------|-----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | | U302 | | | | | | | | U305 | | | | | | | | U307 | | | | | | | |
| | | Q8 | Q7 | Q6 | Q5 | Q4 | Q3 | Q2 | Q1 | Q8 | Q7 | Q6 | Q5 | Q4 | Q3 | Q2 | Q1 | Q8 | Q7 | Q6 | Q5 | Q4 | Q3 | Q2 | Q1 |
| DCV | 200mV-20V | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| | 200V, 1000V | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| ACV | All | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| | 200µA | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| DCI | 2mA | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| | 20mA | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| ACI | 200mA | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| | 2A | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| Ω2 | 200µA | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| | 2mA | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| Ω4 | 20mA | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| | 200mA | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| Ω2 | 2A | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| | 20Ω | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| Ω2 | 200Ω, 2kΩ | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| | 20kΩ | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| Ω2 | 200kΩ | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| | 2MΩ | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| Ω4 | 20MΩ | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| | 200MΩ, 1GΩ | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| Ω4 | 20Ω | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| | 200Ω, 2kΩ | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| Ω4 | 20kΩ | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| | 200kΩ | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |

Table 2-7
Bit patterns for R2_STB registers

| Function | Range | Registers | | | | | | | | | | | | | | | |
|----------------------|-------|-----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | | U501 | | | | | | | | U530 | | | | | | | |
| | | Q8 | Q7 | Q6 | Q5 | Q4 | Q3 | Q2 | Q1 | Q8 | Q7 | Q6 | Q5 | Q4 | Q3 | Q2 | Q1 |
| DCV | All | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ACV | 200mV | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2V | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 20V | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 200V | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 750V | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DCI | All | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ACI | All | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $\Omega 2, \Omega 4$ | All | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Range | Range | Registers | | | | | | | | | | | | | | | |
|----------------------|-------|-----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | | U500 | | | | | | | | U505 | | | | | | | |
| | | Q8 | Q7 | Q6 | Q5 | Q4 | Q3 | Q2 | Q1 | Q8 | Q7 | Q6 | Q5 | Q4 | Q3 | Q2 | Q1 |
| DCV | All | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| ACV | 200mV | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| | 2V | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 20V | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| | 200V | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| | 750V | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| DCI | All | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| ACI | All | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| $\Omega 2, \Omega 4$ | All | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |

2.8 Display board checks

If the FRONT PANEL TESTS (paragraph 2.4) indicate that there is a problem on the display board, use Table 2-8.

Circuit theory for the display is provided in paragraph 2.9.1.

2.9 Power supply checks

Power supply problems can be checked out using Table 2-9.

Table 2-8
Display board checks

| Step | Item/component | Required condition | Remarks |
|------|-----------------------------|---|---------------------------------------|
| 1 | FRONT PANEL TESTS | Verify that all pixels operate | Use SELF-TEST MENU selection |
| 2 | P1033, pins 4, 6, 14 and 16 | 5VAC, ± 0.3 VAC | VFD filament |
| 3 | P1033, pin 5 | +5V, $\pm 5\%$ | Digital +5V supply |
| 4 | P1033, pin 9 | +60V, $\pm 10\%$ | VFD +60V supply |
| 5 | P1033, pin 12 | Goes low briefly on power-up, then goes high | Microcontroller RESET line |
| 6 | P1033, pin 2 | 4MHz square wave | Controller 4MHz clock |
| 7 | P1033, pin 8 | Pulse train every 1msec | Control from main processor |
| 8 | P1033, pin 10 | Brief pulse train when front panel key is pressed | Key down data sent to main processor. |

Table 2-9
Power supply checks

| Step | Item/component | Required condition | Remarks |
|------|----------------|--|-------------------------------------|
| 1 | F100 line fuse | Check continuity | Remove to check |
| 2 | Line power | Plugged into live receptacle, power on | Check for correct power up sequence |
| 3 | U108, pin 3 | +5V, $\pm 5\%$ | Reference to Common 3 |
| 4 | U107, pin 3 | +15V, $\pm 0.75V$ | Reference to COM |
| 5 | U102, pin 3 | -15V, $\pm 0.75V$ | Reference to COM |
| 6 | CR109, +BS | +34V to +38V | Reference to Common 3 |
| 7 | CR110, -BS | -34V to -38V | Reference to Common 3 |
| 8 | U103, pin 3 | $\sim +18V$ | Reference to Isolated Common |
| 9 | U103, pin 2 | +8V | Reference to Isolated Common |
| 10 | U619, +5VC | +5V, $\pm 5\%$ | Reference to Digital Common |
| 11 | U629, pin 3` | +5V, $\pm 5\%$ | Reference to Digital Common |

2.10 Documentation

The following information is provided to support the troubleshooting tests and procedures previously covered in this section of the manual. Figure 2-1 provides an overall block diagram of the Model 2001 showing the major circuit groups. Most circuits in the Model 2001 are tested and/or exercised by Built-in Test. A short description for each of these tests explains how

that particular circuit operates. The display board and the power supply are not tested by Built-in Test. Thus, some basic theory is provided for these circuits in paragraphs 2.10.1 and 2.10.2.

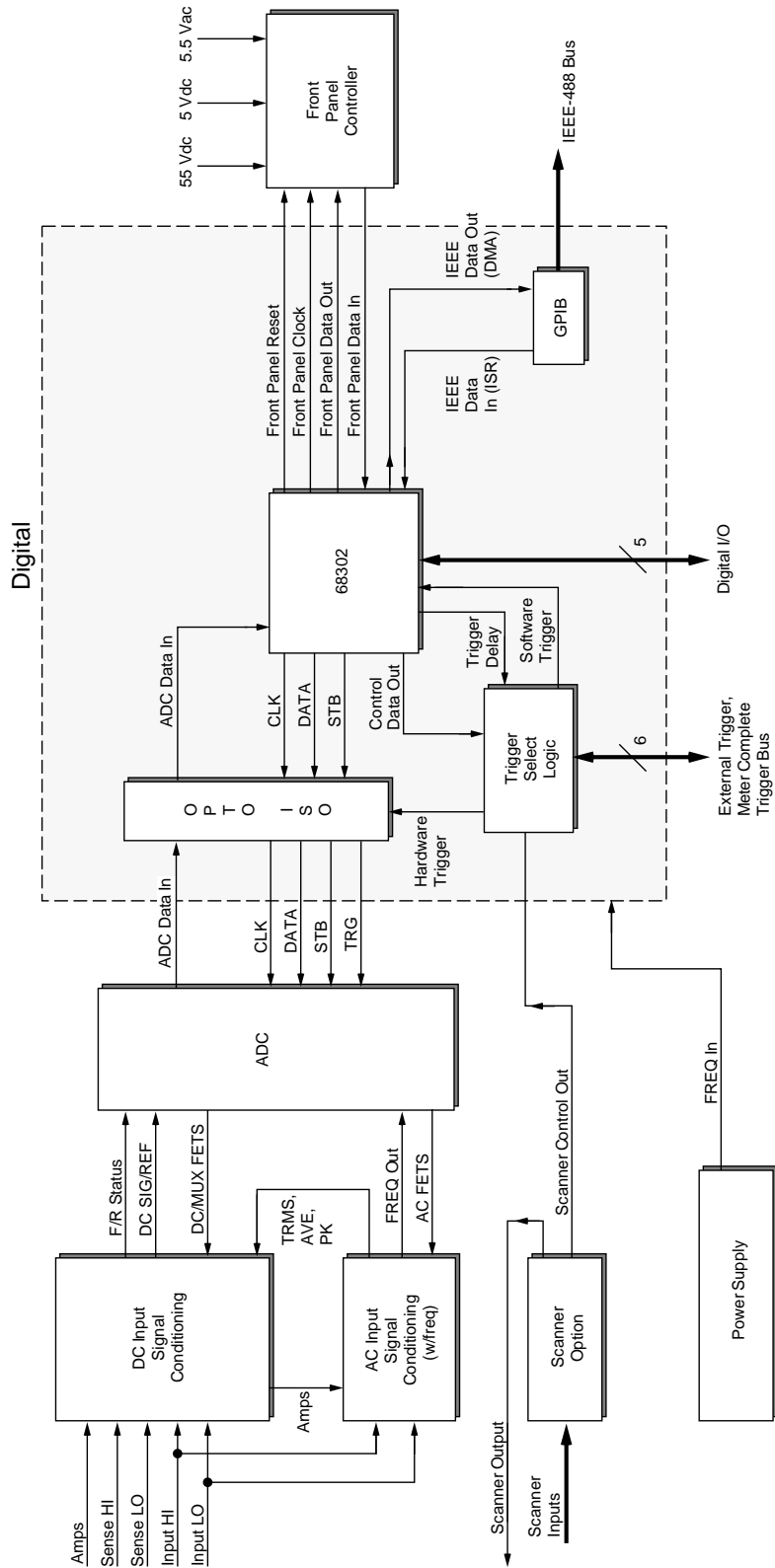


Figure 2-1
Model 2001 overall block diagram

2.10.1 Display board circuit theory

The following information provides some basic circuit theory that can be used as an aide to troubleshoot the display and keyboard.

Display microcontroller

U902 is the display microcontroller that controls the VFD (vacuum fluorescent display) and interprets key data. The microcontroller has four peripheral I/O ports that are used for the various control and read functions.

Display data is serially transmitted to the microcontroller from the digital board via the TXB line to the microcontroller PD0 terminal. In a similar manner, key data is serially sent back to the digital board through the RXB line via PD1. The 4MHz clock for the microcontroller is generated on the digital board.

Vacuum fluorescent display

DS901 is the VFD (vacuum fluorescent display) module, which can display up to 49 characters. Each character is organized as a 5×7 matrix of dots or pixels and includes a long under-bar segment to act as a cursor.

The display uses a common multiplexing scheme with each character refreshed in sequence. U903 and U904 are the grid drivers, while U901 and U905 are the dot drivers. Note that dot driver and grid driver data is serially transmitted from the microcontroller (PD3 and PC1).

The VFD requires both +60VDC and 5VAC for the filaments. These VFD voltages are supplied by U625, which is located on the digital board.

Key matrix

The front panel keys (S901-S931) are organized into a row-column matrix to minimize the number of microcontroller peripheral lines required to read the keyboard. A key is read by strobing the columns and reading all rows for each strobed column. Key down data is interpreted by the display microcontroller and sent back to the main microprocessor using proprietary encoding schemes.

2.10.2 Power supply circuit theory

The following information provides some basic circuit theory that can be used as an aide to troubleshoot the power supply.

Pre-regulator circuit

The pre-regulator circuit regulates power to the transformer. When power is applied to the instrument, a power transformer secondary voltage (pins 12 and 13) is rectified (CR622), doubled (C624, C630, CR624 and CR625) and applied to U619 which is a +5V regulator. This +5V (+5VC) is used for the pre-regulator circuit.

The pre-regulator circuit monitors the voltage level on C611 using an integrator (U627). The voltage on C611 (typically around 7.5V) is divided by three through R712 and R713 and applied to the inverting input (pin 2) of the integrator. The +5V (+5VC) is divided by two through R706 and R708. This 2.5V reference is applied to the non-inverting input (pin 3) of the integrator.

When the voltage on the inverting input of the integrator is less than the 2.5V reference on the non-inverting input, the integrator output ramps in the positive direction. This positive ramp turns on Q608 which pulls the CONT line low to digital common. With CONT connected to common, current flows through the photodiode of U100 and generates a positive voltage at the gate of FET Q528. As Q528 turns on, the 470 Ω resistor (R100) becomes shunted and results in less effective resistance to the transformer. The resultant increase in current (power) will increase the voltage on C611.

Conversely, when the voltage on the inverting input of the integrator is more than the 2.5V reference, the integrator output ramps in the negative direction and begins to turn Q608 off. This will decrease current through U100, decrease the positive voltage on Q528 and thus, increase the effective resistance to the transformer. The resultant decrease in current (power) will decrease the voltage of C611.

This constant regulation of effective resistance in series with the transformer regulates the power delivered to the instrument.

Line voltage (110V/220V) selection circuit

This circuit automatically selects the proper power line voltage setting for the instrument. The line selection circuit derives its power from the AC1 and AC2 lines on the primary side of the transformer. Rectifier CR101 applies approximately +18V to regulator U103. The output of U103 provides the +8V for the line voltage selection circuit and the HI/LO voltage control circuit.

U106 is a comparator that has a +4V reference (via voltage divider R125 and R126) applied to its non-inverting input. The inverting input monitors the voltage on C111. When the voltage at the inverting input is greater than 4V, the output of U106 goes low and turns on FET Q103. With Q103 on, +8V will be applied to the +RELAY1 line which energizes relay K101 to select the 110V setting. Conversely, when the voltage at the inverting input is less than 4V, the output of U106 goes high and turns off Q103. With Q103 off, the +8V is removed from K101 and thus, the line voltage setting defaults to 220V.

The AC power line is tied to C111 through CR104, R227 and R114 via control line ACL. When the AC power line voltage is less than approximately 135VAC, sufficient charge remains on C111 to keep the inverting input of U106 above 4V to ultimately energize K101 (110V setting). When the AC power line voltage is greater than approximately 18VAC, charge will be pulled from C111 dropping the voltage at the inverting input of the comparator to less than 4V. This will de-energize K101 (220V setting).

HI/LO voltage control circuit

This circuit automatically selects the appropriate HI/LO setting for the available power line voltage. During power-up, the line voltage is rectified (CR100), divided (R103 and R105, or R102 and R105) and applied to the base of Q101.

If the voltage level at the base of Q101 is high (above zener VR101), the transistor will turn on and apply power to the ISO1+ and ISO1- lines. With power applied to ISO1+ and ISO1-, U105 will turn on and allow Q105 to be forward biased. With U105 and Q105 on, TRIG of U110 will be pulled low and allow its output (OUT) to latch at +8V which will turn on FET Q102. With Q102 on, the -RELAY2 line will be connected to common, and thus energize K100 (HI setting).

If the power line voltage decreases to a low level, U105 will turn off, but the output of U110 will remain latched at +8V. However, the LOW line will be driven low turning on U109. With U109 and Q106 on, +8V will be applied to THR of U110 forcing its output (OUT) to reset to low. With the gate of Q102 low, the FET will turn off and open the relay coil circuit for K100 (LO setting).

The LOW line is controlled by comparator U628. The inverting input of the comparator is connected to the 2.5V reference. The non-inverting input monitors (via divider R709 and R711) C611. As previously explained, the typical power line voltage level will apply around 7.5V to C611. However, if the line voltage decreases such that the voltage on C611 becomes less than 6V, the voltage level on the non-inverting input of the comparator will drop below 2.5V causing its output (LOW line) to go low.

2.10.3 Built-in test documentation

The information in this paragraph provides documentation for each Built-In Test. Paragraph 2.5 explains how to use the Built-In Test.

The following documentation is provided for each Built-In Test:

1. Test Type — Some tests are pass/fail type tests while others are circuit exercises that are used for subsequent tests.
2. Failure Analysis — For pass/fail type tests, a summary is provided to explain the cause of the failure.
3. Description — Provides a description of the circuit being tested.
4. Schematic Reference — Directs you to the appropriate schematic(s) for the circuit being tested.
5. High Suspect Components — When appropriate, possible defective components and/or circuits are listed. It is left to the expertise of the repair technician to pin-point the problem.
6. Shift Registers — For tests starting with 200.1, the logic states for the control shift registers are provided. After one of these tests is manually run, you can check the registers for the correct logic levels. Tables 2-10 through 2-12 provide functional descriptions for the register bits.
7. Multiplexer — For manually run tests that exercise the multiplexer (U511), you can use Table 2-13 to check the logic levels on its control lines.

Table 2-10
DC_STB control registers

| Register | Bit | Pin | Control | Description |
|----------|-----|-----|-------------------|--|
| U801 | Q1 | 4 | FAST | 1 = FAST integration on A/D converter (ADC). |
| | Q2 | 5 | LST_PH | 1 = Normal ADC operation. |
| | Q3 | 6 | FREQ_EN | 1 = Normal ADC operation. |
| | Q4 | 7 | I3, FREQ_LOAD | 1 = Normal ADC operation. |
| | Q5 | 14 | I4 | Set ADC conversion rate (LSB). |
| | Q6 | 13 | I5 | Set ADC conversion rate. |
| | Q7 | 12 | I6 | Set ADC conversion rate. |
| | Q8 | 11 | I7 | Set ADC conversion rate. |
| U800 | Q1 | 4 | I8 | Set ADC conversion rate. |
| | Q2 | 5 | I9 | Set ADC conversion rate. |
| | Q3 | 6 | I10 | Set ADC conversion rate. |
| | Q4 | 7 | I11 | Set ADC conversion rate. |
| | Q5 | 14 | I12 | Set ADC conversion rate. |
| | Q6 | 13 | I13 | Set ADC conversion rate (MSB). |
| | Q7 | 12 | OHMCA | Select Ohms Cal on U325 (LSB). |
| | Q8 | 11 | OHMCB | Select Ohms Cal on U325 (MSB). |
| U300 | Q1 | 4 | BUF, /BUF | 1 = Q306 on and Q304 off. |
| | Q2 | 5 | VLO2, BSCOM | 0 = -8VF to VLO2, 1 = -8VF to BSCOM. |
| | Q3 | 6 | /REF | 0 = 7V ref to A/D Buffer (via U317). |
| | Q4 | 7 | //1 | 0 = Input Buffer to A/D Buffer (Q308 and Q313 on). |
| | Q5 | 14 | /CAL | 0 = Cal Divider to A/D Buffer (via U319). |
| | Q6 | 13 | //2 | 0 = -0.5 or 1.5 gain (via U319). |
| | Q7 | 12 | /ZERO | 0 = Zero to A/D Buffer (via U319). |
| | Q8 | 11 | FE ZERO, ONE SHOT | 1 = Q527 and Q539 on, 0 = ONE SHOT (via U334) for PRECHARGE (Q538 on). |
| U303 | Q1 | 4 | /X1 | 0 = x1 A/D Buffer; U318 (/X1) closed. |
| | Q2 | 5 | /X5 | 0 = x5 A/D Buffer; U318 (/X5) closed. |
| | Q3 | 6 | /X50 | 0 = x50 A/D Buffer; U318 (/X50) closed. |
| | Q4 | 7 | /2VREF | 0 = 1.75V ref to A/D Buffer (via U318). |
| | Q5 | 14 | /AC | 0 = ACV/A to A/D Buffer (via U320). |
| | Q6 | 13 | /DCA | 0 = DCA to A/D Buffer (via U320). |
| | Q7 | 12 | nc | x |
| | Q8 | 11 | nc | x |

Table 2-11
R1_STB control registers

| Register | Bit | Pin | Control | Description |
|----------|-----|-----|----------------------------|---|
| U307 | Q1 | 4 | OHM FA | U332 ohms range select (LSB). |
| | Q2 | 5 | OHM FB | U332 ohms range select (MSB). |
| | Q3 | 6 | 4W OHM | 0 = U323 closed, 1 = U323 open. |
| | Q4 | 7 | /OHM CAL | 0 = OHM CAL to A/D Buffer (via U320). |
| | Q5 | 14 | /4 DIGIT | 0 = BSCOM or common (via U317) to A/D Buffer (U319 closed). |
| | Q6 | 13 | OHM FD | 1 = U332 Inhibit (INH); all channels off. |
| | Q7 | 12 | /LOV/OHM, BSCOM | 1 = Q333 off, 0 = Q333 on to connect signal to BSCOM. |
| | Q8 | 11 | /2M | 0 = Q329 on (10MΩ range). |
| U305 | Q1 | 4 | 4 DIGIT | 0 = Common to A/D Buffer (via U317). |
| | Q2 | 5 | OHM | 1 = K300 closed (OHMS relay). |
| | Q3 | 6 | VLO, /VLO | 1 = U336 and U337 turns on Q337-Q340. |
| | Q4 | 7 | HI OHM, /HI OHM | 1 = Q320 and Q312 off, Q324 on. |
| | Q5 | 14 | /HIV | 1 = Q328 off; opens divider common. |
| | Q6 | 13 | /DIVIDER, BSCOM | 1 = Q525 off, 0 = Q525 on to connect divider signal to BSCOM. |
| | Q7 | 12 | OHM SELECT, /4W OHM, BSCOM | 0 = U323 closed and Q331 on to connect signal to BSCOM. |
| | Q8 | 11 | /200M | 0 = U323 closed (/16 gain for 4.4nA ohms source). |
| U302 | Q1 | 4 | /ACA | 0 = U320 (ACA) and U522 (ACBS) closed. |
| | Q2 | 5 | /ACAL | 0 = U323 closed. |
| | Q3 | 6 | /200μA | 0 = U317 closed (1kΩ shunt). |
| | Q4 | 7 | /2mA | 0 = U317 closed (100Ω shunt). |
| | Q5 | 14 | /20mA | 0 = Q311 on (10Ω shunt). |
| | Q6 | 13 | /200mA | 0 = Q309 and Q307 on (1Ω shunt). |
| | Q7 | 12 | /2A | 0 = Q310 and Q305 on (0.1Ω shunt). |
| | Q8 | 11 | nc | x |

Table 2-12
R2_STB control registers

| Register | Bit | Pin | Control | Description |
|----------|-----|-----|------------|---|
| U505 | Q1 | 4 | DCF | 0 = U526 (divider) closed and U526 (ACA) open. |
| | Q2 | 5 | SELFTEST | 1 = Q518 off, U513 arms U503, and U522 (control pin 9) open. |
| | Q3 | 6 | SELFTESTEN | 1 = Arms U513 (pin 5) for SELFTEST. |
| | Q4 | 7 | SHORT | 0 = U526 closed (common to AC Buffer). |
| | Q5 | 14 | REL1 | 1 = Q504 on; closes relay K502 (ACV). |
| | Q6 | 13 | REL2 | 1 = Q519 on; closes relay K503 (SELFTEST). |
| | Q7 | 12 | REL3 | 1 = Opens U510 and turns on Q500 which closes relay K501 (pins 4 and 5). |
| | Q8 | 11 | REL4 | 1 = Q502 on; closes K500 (Q503 on). |
| U500 | Q1 | 4 | 750V | 0 = U526 on (/500 AC divider). |
| | Q2 | 5 | ACLOW | 0 = Q513 on and Q516 off, 1 = Q513 off and Q516 on. |
| | Q3 | 6 | RANGE | 1 = U515 closed and Q508 on (x10 rectifier). |
| | Q4 | 7 | /PEAK | 0 = Q533 off; disables peak circuit. |
| | Q5 | 14 | /RSTPK | 0 = U510 (pin 9) closed and U510 (pin 16) open. |
| | Q6 | 13 | TRIG9 | 0 = Q520 off; increases DAC resolution (1/512). |
| | Q7 | 12 | TRIGLEV | 0 = U515 closed and Q542 on. |
| | Q8 | 11 | SEL | 0 = Hold DAC B, 1 = hold DAC A. |
| U530 | Q1 | 4 | TRIG8 | Bit DB0 of DAC U531 (LSB). |
| | Q2 | 5 | TRIG7 | Bit DB1 of DAC U531. |
| | Q3 | 6 | TRIG6 | Bit DB2 of DAC U531. |
| | Q4 | 7 | TRIG5 | Bit DB3 of DAC U531. |
| | Q5 | 14 | TRIG4 | Bit DB4 of DAC U531. |
| | Q6 | 13 | TRIG3 | Bit DB5 of DAC U531. |
| | Q7 | 12 | TRIG2 | Bit DB6 of DAC U531. |
| | Q8 | 11 | TRIG1 | Bit DB7 of DAC U531 (MSB). |
| U501 | Q1 | 4 | SEL1 | SEL1, SEL2 and SEL3 control lines determine which MUX switch (U511) is closed (see Table 2-13). |
| | Q2 | 5 | SEL2 | |
| | Q3 | 6 | SEL3 | |
| | Q4 | 7 | FREQ | 1 = Arms U508 and closes U522. |
| | Q5 | 14 | RMS | 0 = U532 (pin 9) closed and U510 open. |
| | Q6 | 13 | DAC | 0 = U532 (pin 1) closed; DAC V to AC Buffer. |
| | Q7 | 12 | nc | x |
| | Q8 | 11 | nc | x |

Table 2-13
Multiplexer (U511)

| MUX Control Lines | | | Selected Input |
|-------------------|------|------|-----------------------|
| SEL3 | SEL2 | SEL1 | |
| 0 | 0 | 0 | IN1; Peak output |
| 0 | 0 | 1 | IN2; Filter output |
| 0 | 1 | 0 | IN3; TRMS output |
| 0 | 1 | 1 | IN4; ACF output |
| 1 | 0 | 0 | IN5; Rectifier output |
| 1 | 0 | 1 | IN6; SELFTEST OUT |
| 1 | 1 | 0 | IN7; AMP IN output |
| 1 | 1 | 1 | IN8; Common |

Memory element tests

Tests 100.1, 101.1 and 102.1 check the memory elements (ROM, RAM and E²PROM) of the Model 2001.

Test 100.1 – EPROM

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Cannot properly read ROM. |
| Description | All ROM bytes (except checksum bytes) are read, a checksum is calculated and compared to the stored checksum. Failing this test indicates that one or more ROM locations cannot be read properly. |
| High suspect components | U611 and associated logic. |

Test 101.1 – RAM

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Cannot properly write to and/or read RAM. |
| Description | This is an abbreviated version of power-on RAM testing. Memory locations are written to, and then read back. It is highly unlikely that this built-in-test will fail. A unit with faulty memory will probably fail the power-on memory test or will lock up intermittently. |
| High suspect components | U609, U610 and associated logic. |

Test 102.1 – RAM

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Cannot properly read the E ² PROM. |
| Description | An attempt is made to read a byte of information from the 24C16 configuration E ² PROM (U617) and an acknowledgement signal is verified. Failing this test indicates a problem with the E ² PROM or associated circuitry. This is a hardware test only and does not verify the validity of configuration information stored in the E ² PROM. |
| High suspect components | U617 and associated circuitry. |

Digital I/O tests

The Digital I/O on the Model 2001 consists of four open collector outputs, and one TTL-level input. Outputs originate from Port A of the 68302 microprocessor (U626), lines PA4 through PA7. PA4 drives Output #1, PA5 drives Output #2, PA6 drives Output #3 and PA7 drives Output #4. These signals are buffered by a 2596A open collector driver (U612).

The following table summarizes how the lines of Port A of the microprocessor and the IN/OUT designations of the 2596A driver correspond to the digital output lines:

| Digital Output | 68302 (U626) Port A | 2596A (U612) IN, OUT |
|----------------|---------------------|----------------------|
| Output #1 | PA4 | IN4, OUT4 |
| Output #2 | PA5 | IN3, OUT3 |
| Output #3 | PA6 | IN1, OUT1 |
| Output #4 | PA7 | IN2, OUT2 |

The single Digital Input is buffered by protection circuitry (CR619, CR626, R610, R733) and read by the 68302 at PB8.

NOTE

Digital I/O tests may fail or not be run depending on the hardware and firmware revisions of the instrument.

Test 103.1 through 103.4 – Digital output

| | |
|-------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Defective digital output port |
| Description | <p>These tests make use of the fact that the Port A registers of the 68302 microprocessor (U626) are bidirectional even though in normal use they are programmed as outputs only.</p> <p>Diodes and resistors are configured around the 2596 driver (U612) so that Output #1 feeds back to PA5, Output #2 feeds back to PA6, Output #3 feeds back to PA7 and Output #4 feeds back to PA4.</p> <p>During test 103.1, PA4 is programmed as an output and PA5 is programmed as an input. As PA4 (Output #1) is toggled from high to low, the signal is read (verified) at PA5. For test 103.2, PA5 is programmed as an output and PA6 is programmed as an input. As PA5 (Output #2) is toggled from high to low, the signal is read (verified) at PA6. Tests 103.3 and 103.4 check Outputs #3 and #4 in a similar manner.</p> <p>Success of these tests assures the basic functionality of Port A, the 2596 and associated components.</p> |

Test 103.5 – Digital input

| | |
|-------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Defective digital input port. |
| Description | This test only verifies that the digital input signal is pulled high at PB8 of the microprocessor (U626). Success of this test does not guarantee complete functionality of the input port. |

IEEE-488 bus tests

The IEEE-488 interface in the model 2001 consists of the 9914 GPIB chip (U622) and the 75160 (U621) and 75161 (U623) bus drivers. The 75160 buffers the data lines (DIO1-DIO8), and the 75161 buffers the bus handshake lines and other control signals. The circuitry to test these components is contained in the 5064 ASIC (U618).

Test 104.1 – Handshake

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Cannot properly perform an IEEE-488 handshake. |
| Description | <p>Circuitry in the 5064 (U618) is set up to simulate an IEEE-488 handshake. Bytes are written to the 9914 (U622) Data Out register and the interrupt status register is checked to verify that a Byte-Out handshake is completed.</p> <p>These tests verify the basic functionality of the 9914, 75161 and the handshake portion of the ASIC (Signals BNRFD, BNDAC, and BDAV).</p> |
| High suspect components | U618, U622 and U623. |

Test 104.2 – Data

| | |
|--------------------------------|--|
| Type | Pass/Fail |
| Failure analysis | Cannot properly write data to the 9914. |
| Description | For this test, bytes are written to the 9914 Data Out register (U622) to drive and release bus line DIO1. The state of this signal is verified at the 68302 (U626) through PB0 (BITB1). This test verifies the basic functionality of the 9914 and 75160 (U621). |
| High suspect components | U612 and U622. |

Triggers tests

Triggers are controlled by the 5064 ASIC (U618). This component has seven trigger outputs (STO1-STO7) and eight trigger inputs (STI1-STI8). Lines STI1-STI6 and STO1-STO6 are used to control the system trigger bus, line STO7 is used for Meter Complete, and line STI7 is used for External Trigger. STI8 is connected to the Group Execute Trigger signal (GET) of the 9914 IEEE-488 bus controller (U622).

Test 105.1 through 105.6 – System trigger bus

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Defective system trigger bus. |
| Description | <p>System trigger inputs are normally pulled up to 5V through the protection diodes and 5.1kΩ resistors (CR611-CR616, R648-R650 and R655-R657). The Model 2001 can generate a trigger on any of the six trigger bus inputs by turning on the appropriate FET (Q602-Q607). These FETs are controlled by system trigger outputs (STO1-STO6) of the 5064 ASIC (U618).</p> <p>In test 105.1, STI1 is set up as the trigger input. The trigger 1 FET (Q606) is then turned on and off through STO1, and it is verified that this trips the trigger circuitry in the ASIC. This test is then repeated for trigger 2 through 6 for tests 105.2 through 105.6. Success indicates proper operation of the trigger bus.</p> |
| High suspect components | ASIC, FETs, diodes and 5.1kΩ resistors. |

Test 105.7 – External Trigger/Meter Complete

| | |
|-------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Short between External Trigger and Meter Complete |
| Description | <p>This test is similar to System Trigger tests 105.1 through 105.6 except that there is no internal connection between External Trigger and Meter Complete. Consequently, the meaning of a failure is reversed from that of the previous trigger tests. A failure is registered if a trigger does occur. A failure indicates that a short exists between External Trigger and Meter Complete.</p> <p>An alternate way to test these triggers is to externally connect a BNC cable from External Trigger to Meter Complete. When test 105.7 is run, the short should cause the test to fail. If it does not, a problem in the signal path exists.</p> |

Test 105.8 – Group Execute Trigger (GET)

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | GET signal not detected. |
| Description | Trigger 8 (STI8) is set up as an input and the 9914 (U622) is then programmed to generate a GET signal. |
| High suspect components | U618 and U622. |

Test 105.11 through 105.18 – Trigger shorts

| | |
|-------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Short detected between system triggers. |
| Description | In test 105.11, STI1 is programmed as the trigger input. Each of the other triggers (STI2 through STI7 and GET) are programmed to toggle in sequence. If a trigger is detected at STI1, a short is indicated and the test fails. The test is repeated for STI2 through STI8 in tests 105.12 through 105.18. |

Ordinarily, Built-In-Tests should be run with no external connections. However, the Trigger Shorts tests may be used to verify proper operation at the external trigger bus connector (J1029, J1030). For example, by shorting pins 1 and 2, tests 105.11 and 105.12 should fail indicating that the short was detected between system trigger 1 and system trigger 2.

A/D converter and analog circuitry tests

There are three data words used to configure and control the instrument. The DC STB data word is used to control A/D multiplexing and the input gain configuration. The R1 STB data word is used to control the DCV and ohms configuration. The R2 STB data word is used to control the ACV configuration. Each 32-bit data word is generated in the digital section and is passed by U808 to the three sets of control shift registers. U808 uses the two least significant bits of a data word to determine which strobe (DC_STB, R1_STB or R2_STB) will be active to latch the data word into the appropriate shift registers.

Tables 2-5 through 2-7 lists the control registers for the three strobes and provides a functional description of each bit. The documentation for each of the following Built-In Tests includes the logic states for the registers after each test is manually run. Also included as a troubleshooting aid is Table 2-8 which provides the state of the control lines for each selected input of multiplexer U511.

Test 200.1 – A/D zero

Type Pass/Fail

Failure analysis No A/D communication and/or noisy A/D.

Description This test turns on Q328 by setting /HIV low and turns on Q525 by setting /DIVIDER low. Switches U319 (/ZERO pulled low) and U318 (/X1 pulled low) are closed and U808 is set for line cycle integration.

Common (ZERO) zeroes the A/D buffer (x1 gain). The zero is then applied to the A/D converter. The A/D is triggered until the Charge Balance (CB) counts are the same. The value is then stored and compared to a zero-by-design CB value. Final Slope (FS) counts are also stored. If the A/D cannot make this measurement, the test will fail.

High suspect components U808 (not communicating with the digital section) and most any component in A/D circuitry.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 200.2 – A/D noise

Type Pass/Fail
Failure analysis Noisy signal conditioning.

Description This test uses the same circuit setup as test 200.1. The A/D is triggered for 10 readings and a minimum/maximum comparison is done for 30 counts or less. Failing this test indicates A/D buffer noise or A/D converter circuit noise.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 200.3 – FAST circuit

Type Pass/Fail

Failure analysis Defective FAST circuit

Description This test uses the same circuit setup as Test 200.1. Line cycle integration and FAST is selected on U808. The FAST circuit includes U806 (FS1), Q813, R842, and the FS1 control line from U808.

High suspect components U606, Q813, R842 and U808

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 200.4 – x10 line cycle integration

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Cannot select x10 line cycle integration. |
| Description | Same circuit setup as test 200.1 but x10 line cycle integration selected. Configures I3 through I13 for x10 line integration. |
| High suspect components | U801, U800, and U808. |
| Bit pattern | |

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 200.5 – x0.1 line cycle integration

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Cannot select x0.1 line cycle integration. |
| Description | Same circuit setup as test 200.1 but x0.1 line cycle integration selected. Configures I3 through I13 for x0.1 line integration. |
| High suspect components | U801, U800, and U808. |
| Bit pattern | |

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 200.6 – x0.02 line cycle integration

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Cannot select x0.02 line cycle integration. |
| Description | Same circuit setup as test 200.1 but x0.02 line cycle integration selected. Configures I3 through I13 for x0.02 line integration. |
| High suspect components | U801, U800, and U808. |
| Bit pattern | |

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 200.7 – x0.01 line cycle integration

Type Pass/Fail

Failure analysis Cannot select x0.01 line cycle integration.

Description Same circuit setup as test 200.1 but x0.01 line cycle integration selected. Configures I3 through I13 for x0.01 line integration.

High suspect components U801, U800, U808, and FAST circuitry (see test 200.3).

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 201.1 – Test cal zero

Type Circuit exercise

Description Same circuit setup as test 200.1. A zero reading is acquired for tests 201.2 and 201.3.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|---------------------|--|---------------------|--|---------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 201.2 – 7V reference

Type Pass/Fail

Failure analysis Cannot measure 7V at A/D IN.

Description This test turns on Q328 by setting /HIV low and turns on Q525 by setting /DIVIDER low. Switches U317 (/REF pulled low) and U318 (/X1 pulled low) are closed and U808 is set for line cycle integration.

REF OUT (7V) is connected to the A/D buffer at x1 gain and is then applied to the A/D converter. The A/D is triggered and the REF OUT counts are stored and compared to a design REF OUT value.

High suspect components U330, U329, U328 and associated resistors and capacitors.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 201.3 – 1.75V reference

| | |
|--------------------------------|--|
| Type | Pass/Fail |
| Failure analysis | Cannot measure 1.75V at A/D IN. |
| Description | <p>This test turns on Q328 by setting /HIV low and turns on Q525 by setting /DIVIDER low. Two switches of U318 (/2VREF pulled low) and (/X1 pulled low) are closed and U808 is set to line cycle integration.</p> <p>The 1.75V reference is connected to the A/D buffer at x1 gain and 1.75V REF is applied to the A/D converter. The A/D is triggered and the 1.75V REF counts are stored. A calculation is performed using the values stored in tests 200.1, 200.2, and 200.3.</p> |
| High suspect components | U327, U330, U329, U328 and associated resistors and capacitors. |
| Bit pattern | |

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 300.1 – A/D mux, A/D buffer, 7V reference, x1.5 gain

Type Pass/Fail

Failure analysis Cannot measure 10.5V ±1.5V at A/D IN.

Description This test switches the 7V reference (REF OUT from U329, pin 1) through analog switch U317 (/REF pulled low) to the non-inverting input of Op Amp U322. Analog switch U319 (/ /2 pulled low) is closed and Q306 is turned on (BUF = 0V) connecting R327 to common. This configuration results in a gain of x1.5. Measure 10.5V (7V x 1.5) at A/D IN.

High suspect components U317, U319, Q306, Q342, R334, R327 and R422.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 300.2 – A/D mux, A/D buffer, 1.75V reference, x5 gain

Type Pass/Fail

Failure analysis Cannot measure $8.75V \pm 0.875$ at A/D IN.

Description This test switches the 1.75V reference (U327 output) through analog switch U318 (/2VREF pulled low) to the non-inverting input of Op Amp U322. Analog switch U318 (/X5 pulled low) is closed to use resistors R326 and R335 to obtain a gain of x5. Measure $8.75V (1.75V \times 5)$ at A/D IN.

High suspect components U318, R326 and R335.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 300.3 – A/D mux, A/D buffer, 0V reference, x5 gain

Type Pass/Fail

Failure analysis Cannot measure 0V ±0.01V at A/D IN.

Description This test switches common through R340 and analog switch U319 (/ZERO pulled low) to the non-inverting input of Op Amp U322. Analog switch U318 (/X50 pulled low) is closed to use thick film resistor R215 to obtain a gain of x50. The actual gain is not tested here, but the presence of R215 is detected. A later test will check the actual value. Measure 0V at A/D IN.

High suspect components U319, U318 and R215.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 301.1 – Input buffer, front end (FE) zero

| | |
|--------------------------------|--|
| Type | Pass/Fail |
| Failure analysis | Cannot measure 0V ±0.02V at A/D IN. |
| Description | The front end (FE) zero (common) is switched through U323 (4W OHM pulled low) and Q527 (FE ZERO = 0V) to Q330. Pin 6 of Q330 and pin 6 of input buffer U335 should be at 0V. Zero is then routed through Q313 and Q308 (/ / 1 = 0V) to the non-inverting input of Op Amp U322. Analog switch U318 (/X1 pulled low) is closed to obtain a gain of x1. Measure 0v at A/D IN. |
| High suspect components | U323, Q527, R200, R213, Q330, Q335, Q336, U335, Q313, Q308, R424, R423, R353, U318 and R278. |

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 301.2 – Input buffer, divided by 100

Type Pass/Fail

Failure analysis Cannot measure 0V ±0.01V at A/D IN.

Description This test routes 0V (common) to input buffer U335. The 0V signal path to the input buffer is through FET Q328 (/HIV pulled low), the 100kΩ leg of R394, FET Q525 (/DIVIDER = 0V) and finally through signal FETs Q522 and Q523 (VLO2 is floating and pin 4 of U339 is at 0V) to pin 2 of Q330. The 0V output of the input buffer is then routed to Op Amp U322, which is configured for x1 gain. Measure 0V at A/D IN.

High suspect components Q328, R394, Q525, Q522, Q523, U339, R201, R242 and R428.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 302.1 – Ohms; zero reference measurement for test 302.2

| | |
|--------------------------------|--|
| Type | Circuit Exercise |
| Description | This measurement is the same as the one in test 301.1. Although the reading is very close to 0V, it is not exactly zero due to offsets in the input buffer and A/D buffer circuits. This reading is used as the zero reference for test 302.2. |
| High suspect components | Q328, R394, Q525, Q522, Q523, U339, R201, R242 and R428. |
| Bit pattern | |

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 302.2 – Ohms; open circuit and protection

Type Pass/Fail

Failure analysis Cannot measure 5.9V ±0.59V at A/D IN.

Description This test closes the ohms circuit feedback loop by selecting the 9.2mA ohms source resistor path (parallel combination of R355, R356 and R357). The parallel resistor combination is configured by closing the switches at pins 1 and 12 of U332. FETs Q312 and Q320 are on (/HI OHM pulled low). Measure 7V across the resistors.

There is no load connected to the ohms source circuit. Current flows through CR335, zener VR304 and resistor R375 to common. The 5.9V drop across this combination (0.6V across CR335, 5.1V across VR304, and 0.2V across R375) is routed through Q321, Q323 and K300 (OHM control line pulled low) to OHMS. From OHMS, the 5.9V is applied to the input buffer through the 9.9MΩ leg of R394 and Q525 (/DIVIDER = 5.9V). Op Amp U322 is set up for x1 gain. Measure 5.9V at A/D IN.

NOTE: This is the first test that checks any part of the ohms circuit. The components listed above are not necessarily all of the components that are tested. The ohms circuit is used for most of the 300 series tests that follow. If test 302.2 fails, then the other 300 level tests will most likely fail.

High suspect components K300, Q323, Q321, R377, Q320, Q312, CR335, VR304, R375, U331, U332, U333, U324, Q317, U330, R355, R356 and R357.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 303.1 – Input path; zero reference measurement for test 303.2

Type Circuit Exercise

Description This measurement is exactly the same as test 301.1. Although the reading is very close to 0V, it is not exactly zero due to offsets in the input buffer and A/D buffer circuits. This reading is used as the zero reference for test 303.2.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 303.2 – Input path; open circuit ohms and ohms protection

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Cannot measure 5.9V ±0.59V. |
| Description | This test uses the same open circuit ohms voltage as test 302.2, except the voltage is routed through the input path of Q340, Q339, Q338, Q337, and Q333 (/LOV/OHM = 5.9V)) to the input buffer. Op Amp U322 is set up for x1 gain. Measure 5.9V at A/D IN. |
| High suspect components | Q340, Q339, Q338, Q337, Q333, U336, U337, U338, R399, R400, R401, R398, R411, R410, R409 and R408. |

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 303.3 – Input path; front end (FE) zero protection

| | |
|--------------------------------|--|
| Type | Pass/Fail |
| Failure analysis | Cannot measure 2.5V ±2.5V at A/D IN. |
| Description | This test is identical to test 303.2, except that Q539 (FE ZERO = 0V) is turned on. Some current will flow through Q340, Q339, Q338, and Q337. With Q539 turned on, current will flow through CR329, VR511, VR510, Q539, and R369 to common. Op Amp U322 is set up for x1 gain. Measure 0 to 5V (typically around 3.5V) at A/D IN. |
| High suspect components | CR329, VR511, VR510, Q539 and R369. |

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 304.1 – Ohms sources; zero reference measurement for tests 304.2 – 304.7

Type Circuit Exercise

Description This measurement is exactly the same as test 301.1. Although the reading is very close to 0V, it is not exactly zero due to offsets in the input buffer and A/D buffer circuits. This reading is used as the zero reference for tests 304.2 through 304.7.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|---------------------|--|---------------------|--|---------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 304.2 – Ohms sources; 0.98mA and 9.2mA

Type Pass/Fail
Failure analysis Cannot measure 0.78V ±0.08V at A/D IN.

Description Switches in R358 for the 0.98mA ohms source by closing the analog switches at pins 5 and 14 of U332. The parallel combination of R355, R356 and R357 (used for the 9.2mA source during normal operation) acts as the load and is connected to common through the analog switch at pin 1 of U325. FETs Q312 and Q320 are also on. 7V will appear across R358. Op Amp U322 is set up for x1 gain. Measure 0.78v at A/D IN.

High suspect components R355, R356, R357, R358, U322 and U325.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 | U305 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 304.3 – Ohms sources; 89µA and 0.98mA

Type Pass/Fail

Failure analysis Cannot measure 0.65V ±0.065V at A/D IN.

Description Switches in R365 for the 89uA ohms source by closing the analog switches at pins 2 and 15 of U332. R358 (used for the 0.98mA ohms source during normal operation) acts as the load and is connected to common through the analog switch at pin 5 of U325. FETs Q312 and Q320 are also on. 7V will appear across R365. Op Amp U322 is set up for x1 gain. Measure 0.65v at A/D IN.

High suspect components R365, U322 and U325.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 0 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 0 | U305 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 304.4 – Ohms sources; 7μA and 89μA

| | |
|--------------------------------|--|
| Type | Pass/Fail |
| Failure analysis | Cannot measure 0.56V ±0.056V at A/D IN. |
| Description | Switches in R366 for the 7uA ohms source by closing the analog switches at pins 4 and 11 of U332. R365 (used for the 89uA ohms source during normal operation) acts as the load and is connected to common through the analog switch at pin 2 of U325. FETs Q312 and Q320 are also on. 7V will appear across R366. Op Amp U322 is set up for x1 gain. Measure 0.56v at A/D IN. |
| High suspect components | R366, U322 and U325. |

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 | U305 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 304.5 – Ohms sources; 770nA and 7μA

Type Pass/Fail

Failure analysis Cannot measure 0.7V ±0.07V at A/D IN.

Description Switches in R366 for the 7μA ohms source as in test 304.4. R394 (used for the 770nA ohms source during normal operation) acts as the load and is connected to common by turning on Q328 (/HIV pulled low). FETs Q312 and Q320 are also on. 7V will appear across R366. Op Amp U322 is set up for x1 gain. Measure 0.70V at A/D IN.

High suspect components R394 and U322.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 304.6 – Ohms sources; 70nA and 770nA

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Cannot measure 0.7V ±0.07V at A/D IN. |
| Description | Switches in R354 for the 70nA ohms source by closing the analog switches at pins 1 and 12 of U332. Q324 (HI OHM pulled low) is on while Q312 and Q320 are off. This selects R354 as the only source resistor. No other resistor is in parallel with it. The load is again R394 and is connected to common through Q328. 7V will appear across R354. Op Amp U322 is set up for x1 gain. Measure 0.70V at A/D IN. |
| High suspect components | R354 and Q324. |
| Bit pattern | |

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 304.7 – Ohms sources; 4.4nA and 770nA

Type Pass/Fail

Failure analysis Cannot measure 2.2V ±0.6V at A/D IN.

Description This test uses the same ohms source resistor (R354) as the previous test except that analog switch U323 (/200M pulled low) is closed to configure Op Amp U324 into a divide by 16 amplifier. This reduces the voltage drop across R354 from 7V to 0.44V (7/16 = 0.44). 4.4nA is sourced through R394 to common through Q328. Op Amp U322 is set up for x50 gain. Measure 2.2V at A/D IN.

High suspect components U323, R350, R349 and R215.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 305.1 – Input divider; zero reference measurement for test 305.2

Type Circuit Exercise

Description This measurement is exactly the same as test 301.1. Although the reading is very close to 0V, it is not exactly zero due to offsets in the input buffer and A/D buffer circuits. This reading is used as the zero reference for test 305.2.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 305.2 – Input divider; divide by 100

Type Pass/Fail

Failure analysis Cannot measure 2.95V ±0.295V at A/D IN.

Description Basically, this test utilizes the same open circuit ohms scheme as test 302.2. The 9.2mA ohms source is connected through R394 (10MΩ) to common via Q328. The open circuit ohms circuit clamps the voltage drop across R394 to approximately 5.9V.

FET Q525 is turned on to divide the 5.9V by 100. The resultant 59mV is then applied to the input buffer. Op Amp U322 is configured for x50 gain. Measure 2.95V (50 x 59mV) at the output of U322.

High suspect components R394 (100 to 1 ratio).

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 306.1 – Ohms cal switch

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Cannot measure 0V ±0.001V at A/D IN. |
| Description | On U325, OHM CAL is connected to common by closing the analog switches at pins 1 and 12. Analog switch U320 (/OHM CAL pulled low) routes this 0V signal to the A/D buffer. Op Amp U322 is set up for x1 gain. Measure 0V at the output of U322. |
| High suspect components | U320. |

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 307.1 – Cal divider; zero reference for test 307.2

Type Circuit Exercise

Description This measurement is exactly the same as test 301.1. Although the reading is very close to 0V, it is not exactly zero due to offsets in the input buffer and A/D buffer circuits. This reading is used as the zero reference for test 307.2.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 307.2 – Cal divider; A/D mux/10

| | |
|--------------------------------|--|
| Type | Pass/Fail |
| Failure analysis | Cannot measure 3.8V ±0.38V at A/D IN. |
| Description | Uses the 0.98mA ohms source and parallel combination of R355, R356 and R357 as a load (same as test 304.2). The 0.78V output of the input buffer is divided by 10 (R342 and R343) and routed through U319 (/CAL pulled low) to the A/D buffer. The 7.8 mV is applied to the non-inverting input of Op Amp U322, which is configured for x50 gain. Measure 3.8V (7.8mV x 50) at A/D IN. |
| High suspect components | U319, R342 and R343. |

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 | U305 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 307.3 – Cal divider; A/D mux/buffer (x-0.5)

Type Pass/Fail

Failure analysis Cannot measure $-2.9V \pm 0.4V$ at A/D IN.

Description Uses the 9.2mA ohms source basically the same way as test 305.2. A no load condition causes the 5.9V open circuit ohms circuit to be operational. This voltage is routed through the 9.9MΩ leg of R394 and Q525 to the non-inverting input of Op Amp U341. The unity gain amplifier provides 5.9V at its output (BSCOM).

BSCOM is routed through Q304 and U319 (/ /2 pulled low) to the inverting input of Op Amp U322. Analog switch U319 (/ZERO pulled low) is also closed. This configuration around U322 produces a gain of -0.5. Measure -2.9V ($5.9V \times -0.5$) at A/D IN.

High suspect components U341, Q304, Q341, and R421.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 308.1 – 4-digit mode; A/D MUX signal path

Type Pass/Fail

Failure analysis Cannot measure 0.78V ±0.078V at A/D IN.

Description The ohms source is configured the same as in tests 304.2 and 307.2. The output of U335 is 0.78V, which is the same as bootstrap common (BSCOM). In 4-digit mode, BSCOM is routed through U319 (/4 DIGIT pulled low) to the non-inverting input of Op Amp U322, which is configured for x1 gain. Measure 0.78V at the output of U322.

High suspect components U319 and R212.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 0 Q6: 0 Q7: 0 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 | U305 | Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 308.2 – 4-digit mode; A/D MUX zero path

Type Pass/Fail

Failure analysis Cannot measure 0V ±0.01V at A/D IN.

Description Common for the 4-digit mode is routed through U317 (4 DIGIT pulled low) and U319 (/4 DIGIT pulled low) to the non-inverting input of Op Amp U322, which is configured for x1 gain. Measure 0V at the output of U322.

High suspect components U317 (4 DIGIT)

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 309.1 – Amps; 200µA range

Type Pass/Fail
Failure analysis Cannot measure 0.089V ±0.0089V at A/D IN.

Description The 89µA ohms source is switched through U323 (/ACAL pulled low) and the 200uA range switch U317 (/200µA pulled low). Current flows through thick film R344 (all three resistors), R592 and R591 to common. The resulting voltage drop, which applies to all of the 309 series tests, is switched by U320 (/DCA pulled low) of the A/D MUX to the non-inverting input of Op Amp U322, which is configured for x1 gain. Measure 89mV (89µA x 1000.01ohm) at A/D IN.

High suspect components U323, U317, R344, R592, R591 and U320.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 0 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 | Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 309.2 – Amps; 2mA range

Type Pass/Fail

Failure analysis Cannot measure $0.098V \pm 0.0098V$ at A/D IN.

Description The 0.98A ohms source is switched through U323 (/ ACAL pulled low), U317 (/2mA pulled low), the 90Ω and 9Ω legs of R344, R592 and R591 to common. Op Amp U322 is configured for x1 gain. Measure 98mV ($0.98mA \times 100.01\Omega$) at A/D IN.

High suspect components U317, R344, R592 and R591.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 309.3 – Amps; 20mA range

| | |
|--------------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Cannot measure $0.092V \pm 0.0092V$ at A/D IN. |
| Description | The 9.2mA ohms source is switched through U323 (/ACAL pulled low), Q311, the 9Ω leg of R344, R592 and R591 to common. Op Amp U322 is configured for x1 gain. Measure 92mV ($9.2mA \times 10.01\Omega$) at A/D IN. |
| High suspect components | Q311, R344, R592 and R591. |
| Bit pattern | |

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 309.4 – Amps; reference measurement for tests 309.5 and 309.6

Type Circuit Exercise

Description The 9.2mA ohms source is applied through U323 (/ACAL pulled low) directly to the amps protection diodes CR305 and CR309. None of the amps switches or FETS are closed. This measurement determines circuit trace resistance loss between common at the ohms source and common at R591. Op Amp U322 is configured for x50 gain. Measure approximately 10 mV at A/D IN which is used as the zero reference for tests 309.5 and 309.6.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|---------------------|--|---------------------|--|---------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 309.5 – Amps; 200mA range

Type Pass/Fail

Failure analysis Cannot measure (0.475V + Test 309.4) ±0.0475V at A/D.

Description The 9.2mA ohms source is switched through U323 (/ACAL pulled low), Q309 and Q307 (/200mA = +15v), R592 and R591 to common. Op Amp U322 is configured for x50 gain. Measure approximately 475mV at A/D IN (9.2mA × 1.01Ω × 50) + (zero reference reading from test 309.4).

High suspect components Q309, Q307, R592 and R591.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 309.6 – Amps; 2A range

Type Pass/Fail

Failure analysis Cannot measure (0.0462V + Test 309.4) ±0.00462V at A/D IN.

Description The 9.2mA ohms source is switched through U323 (/ACAL pulled low), Q310 and Q305 (/2A = +15v) and R591 to common. Op Amp U322 is configured for x50 gain. Measure approximately 46mV at A/D IN (9.2mA x 0.1Ω x 50) + (zero reference reading from test 309.4).

High suspect components Q310, Q305 and R591.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 310.1 – Amps protection

| | |
|--------------------------------|--|
| Type | Pass/Fail |
| Failure analysis | Cannot measure 1.7V ±0.3V at A/D IN. |
| Description | The 9.2mA ohms source is set up to source current on the 200µA range as in test 309.1. The load resistance for the 200µA range is 1000.01Ω. Diodes CR305 and CR309 clamp the amps circuit voltage to three diode drops. This voltage is applied to Op Amp U322 through U320 (/DCA pulled low) in a similar manner as in the 309 series tests. Op Amp U322 is configured for x1 gain. Measure 1.7V at A/D IN. |
| High suspect components | CR309 and CR305. |
| Bit pattern | |

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U302 Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 400.1 – DAC; -4.21V output

Type Pass/Fail

Failure analysis DAC output not $-4.21V \pm 0.4V$.

Description The TRIG bits for OUT B of the DAC (U531) are programmed to produce $-4.21V$ at PRE-COM+ (pin 1 of U528). This signal is routed through R560 and U532 (DAC line pulled low). This line, now called ACF, is selected by multiplexer U511. The output (OUT) of the multiplexer is routed through buffer U342 and resistor R223 (where the line is called ACV/A). The signal on ACV/A is then routed through U320 (/AC pulled low) and applied to Op Amp U322. Measure $-4.21v$ at A/D IN.

High suspect components Q310, Q305 and R591.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 0 Q7: 0 Q8: 0 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 400.2 – DAC; -2.08V output

| | |
|-------------------------|--|
| Type | Pass/Fail |
| Failure analysis | DAC output not $-2.08V \pm 0.34V$. |
| Description | Same as test 400.1 except OUT B of the DAC is configured for -2.08V. Measure -2.08V at A/D IN. |

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|---------------------|--|---------------------|--|---------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 400.3 – DAC; 0V output

Type Pass/Fail

Failure analysis DAC output not $0.001V \pm 0.28V$.

Description Same as test 400.1 except OUT B of the DAC is configured for 0V. Measure 0V at A/D IN.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 400.4 – DAC; 2.25V output

| | |
|-------------------------|--|
| Type | Pass/Fail |
| Failure analysis | DAC output not 2.25V ±0.34V. |
| Description | Same as test 400.1 except OUT B of the DAC is configured for 2.25V. Measure 2.25V at A/D IN. |

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 400.5 – DAC; 4.33V output

Type Pass/Fail

Failure analysis DAC output not 4.33V ±0.4V.

Description Same as test 400.1 except OUT B of the DAC is configured for 4.33V. Measure 4.33V at A/D IN.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 401.1 – Signal switching; zero cal switch

Type Pass/Fail

Failure analysis Cannot measure 0V ±0.001V at A/D IN.

Description Common is routed to the ACF line through U526 (SHORT pulled low). ACF is then routed through multiplexer U511. The output of the multiplexer (OUT) follows the same path to the A/D buffer (U322) as the 400 series tests. U322 is configured for x1 gain. Measure 0V at A/D IN.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 0 Q7: 0 Q8: 0 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 402.1 – Signal switching; frequency switch

Type Pass/Fail

Failure analysis Cannot measure $0.032V \pm 0.005V$ at A/D IN.

Description OUT B of the DAC (U531) is set up to output 4.33V at PRECOMP+ (U528 pin 1). The operation of the frequency switch, U522 (FREQ pulled low), is verified by dividing the PRECOMP+ voltage by the voltage ratio across R560 and R558. The “on” resistance (approximately 25Ω) of the analog switch (U522) is added to the resistance of R558 since it is part of the ratio. Again, as in the 400 series tests, this voltage is routed to the A/D buffer (U322) which is configured for x1 gain. Measure 32mV at A/D IN.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 403.1 – Signal switching; ground switch

| | |
|-------------------------|---|
| Type | Pass/Fail |
| Failure analysis | Cannot measure $0.001V \pm 0.005V$ at A/D IN. |
| Description | Common at pin 9 of U511 is multiplexed to pin 8 (OUT) and measured in the same manner as the previous 400 series tests. Measure 0V at A/D IN. |

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|---------------------|--|---------------------|--|---------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 404.1 – Absolute value (x1 gain); -full-scale DAC output

Type Pass/Fail

Failure analysis Cannot measure 4.21V ±0.4V at A/D IN.

Description DAC U531 is programmed to generate -4.21 VDC at PRECOMP+. That signal is then applied to ACF through R560 and U532 (DAC line pulled low). ACF is routed to AMP IN via U526, Q516, and the AC input buffer.

AMP IN is tied to the inverting and non-inverting paths of the variable gain amplifier (VGA). NETOUT (output of U519) is routed to the Zero-Crossing Amplifier which, based on the polarity, generates the appropriate COMP- signal that is applied to comparator U507. The comparator selects the path that the AMP IN signal will follow through the VGA by closing the appropriate analog switches of U509.

The negative (inverting) AMP IN path is through R530, U515, U509, Q501, and U516 to pin 12 of the multiplexer (U511). The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal on ACV/A is switched through U320 (/AC pulled low) to the A/D buffer (U322) which is configured for x1 gain. Measure +4.21V at A/D IN.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 1 Q2: 1 Q3: 1 Q4: 0 Q5: 1 Q6: 0 Q7: 0 Q8: 0 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 404.2 – Absolute value (x1 gain); -half scale DAC output

| | |
|-------------------------|--|
| Type | Pass/Fail |
| Failure analysis | Cannot measure 2.08V ±0.34V at A/D IN. |
| Description | ADC U531 is programmed to generate -2.08 VDC at PRECOMP+. This signal follows the same path as test 404.1. Measure +2.08V at A/D IN. |
| Bit pattern | |

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 404.3 – Absolute value (x1 gain); zero DAC output

Type Pass/Fail

Failure analysis Cannot measure 0.001V ±0.28V at A/D IN.

Description DAC U531 is programmed to generate +0.001 VDC at PRECOMP+. This signal follows the same path to the variable gain amplifier (VGA) as test 404.1. However, for this test AMP IN is positive. Thus, the COMP- signal applied to comparator U507 selects the non-inverting path for the AMP IN signal.

The positive (non-inverting) AMP IN path is through R530, Q509, Q507, U519, R531, U509, Q501, and U516 to pin 12 of the multiplexer (U511). The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal on ACV/A is switched through U320 (/AC pulled low) to the A/D buffer (U322) which is configured for x1 gain. Measure +0.001V at A/D IN.

High suspect components Q310, Q305 and R591.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 404.4 – Absolute value (x1 gain); +half-scale DAC output

| | |
|-------------------------|--|
| Type | Pass/Fail |
| Failure analysis | Cannot measure 2.25V ±0.34V at A/D IN. |
| Description | DAC U531 is programmed to generate +2.25 VDC at PRECOMP+. This signal follows the same path as test 404.3. Measure +2.25V at A/D IN. |
| Bit pattern | |

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 404.5 – Absolute value (x1 gain); +full-scale DAC output

Type Pass/Fail

Failure analysis Cannot measure 4.33V ±0.4V at A/D IN.

Description DAC U531 is programmed to generate +4.33 VDC at PRECOMP+. This signal follows the same path as test 404.3. Measure +4.33V at A/D IN.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 405.1 – Absolute value (x1 gain); large +DAC output

Type Circuit Exercise

Description

DAC U531 is programmed to generate +0.51 VDC at PRECOMP+. The signal at PRECOMP+ is routed to ACF via R560 and U532 (DAC line pulled low). The signal at ACF is then switched through multiplexer U511. The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal at ACV/A is routed through U320 (/AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain. Measure the actual voltage value at A/D IN (around +0.51V). This DAC voltage value is measured and stored. This voltage will be applied to the variable gain amplifier (VGA) that will be set for x10 gain in test 405.2. The applied value to the x10 VGA and the measured output value can be compared to check accuracy of the VGA.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 405.2 – Absolute value x10 gain comparison; large +DAC output

Type Pass/Fail

Failure analysis Voltage at A/D IN not the same as test 405.1.

Description DAC U531 is programmed to generate +0.51 VDC at PRECOMP+. That signal is then applied to ACF through R560 and U532 (DAC line pulled low). ACF is routed to AMP IN via U526, Q516, and the AC input buffer.

AMP IN is tied to the inverting and non-inverting paths of the variable gain amplifier (VGA). NETOUT (output of U519) is routed to the Zero-Crossing Amplifier which, based on the polarity, generates the appropriate COMP- signal that is applied to comparator U507. The comparator selects the path that the AMP IN signal will follow through the VGA by closing the appropriate analog switches of U509.

The positive (non-inverting) AMP IN signal path with the VGA at x10 is through R530, Q508, Q507, U519, R531, U509, Q501, and U516 to pin 12 of multiplexer U511. The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal at ACV/A is routed through U320 (/AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain.

Measure the voltage at A/D IN. It should be same value that was measured in test 405.1.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 405.3 – Absolute value x10 gain comparison; small +DAC Output

Type Circuit Exercise

Description This test is the same as test 405.1 except that DAC U531 is programmed to generate +0.190 VDC at PRECOMP+. As in test 405.1, measure the actual voltage value at A/D IN (around +0.190V) and compare it to the measurement in the next test.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 405.4 – Absolute value x10 gain comparison; small +DAC output

Type Pass/Fail

Failure analysis Voltages at A/D IN not the same as test 405.3.

Description This test is the same as test 405.2 except that DAC U531 is programmed to generate +0.190 VDC at PRECOMP+. As in test 405.1, measure the voltage at A/D IN. It should be same value that was measured in test 405.3.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 405.5 – Absolute value x10 gain comparison; small –DAC output

Type Circuit Exercise

Description This test is the same as test 405.1 except that DAC U531 and Op Amp pair U528 are set up to generate -0.210 VDC at PRECOMP+. As in test 405.1, measure the actual voltage value at A/D IN (around -0.210V) and compare it to the measurement in the next test.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|---------------------|--|---------------------|--|---------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 405.6 – Absolute value x10 gain comparison; small –DAC output

Type Pass/Fail

Failure analysis Voltage at A/D IN not the same as test 405.5.

Description DAC U531 is programmed to generate -0.210 VDC at PRECOMP+. This signal follows the same path to the variable gain amplifier (VGA) as test 405.2. However, since AMP IN is negative, comparator U507 will select the inverting path for the AMP IN signal.

The negative (inverting) AMP IN signal path with the VGA at x10 is through R530, U515, U509, Q501, and U516 to pin 12 of multiplexer U511. The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal at ACV/A is routed through U320 (/AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain.

Measure the voltage at A/D IN. It should be same value that was measured in test 405.5.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 405.7 – Absolute value x10 gain comparison; large -DAC output

Type Circuit Exercise

Description This test is the same as test 405.1 except that DAC U531 is programmed to generate -0.490 VDC at PRECOMP+. As in test 405.1, measure the actual voltage value at A/D IN (around -0.490V) and compare it to the measurement in the next test.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 405.8 – Absolute value x10 gain comparison; large -DAC output

Type Pass/Fail

Failure analysis Voltage a A/D IN not the same as test 405.7.

Description This test is the same as test 405.6 except that DAC U531 is programmed to generate -0.490 VDC at PRECOMP+. As in test 405.6, measure the voltage at A/D IN. It should be same value that was measured in test 405.7.

High suspect components Q310, Q305 and R591.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 406.1 – Test buffer; measure DAC output for test 406.6

Type Circuit Exercise

Description DAC U531 is programmed to provide -1.13 VDC at PRECOMP+. The signal at PRECOMP+ is routed to ACF via R560 and U532 (DAC line pulled low). The signal at ACF is then switched through multiplexer U511. The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal at ACV/A is routed through U320 (/AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain.

Measure the actual voltage value at A/D IN (around -1.13V). This DAC voltage value is measured and stored. This voltage will be used in tests 406.2 and 406.3. In test 406.6, circuit accuracy is checked by comparing the applied voltage value to the measured output (SELFTTEST OUT) value.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 406.2 – Test buffer output (-1.13V)

Type Circuit Exercise

Description DAC U531 is programmed to generate -1.13 VDC at PRECOMP+. The signal at PRECOMP+ is routed to ACF via R560 and U532 (DAC line pulled low). ACF is routed to AMP IN through U526, Q516, and the AC input buffer. The signal at AMP IN is routed through U522 (SELFTTEST1 pulled low) and then applied to the inverting x5 gain amplifier (U523, R542 and R533).

The amplified and inverted AMP IN voltage from U523 is stored in C529 and applied to buffer Q505. The voltage value at SELFTTEST OUT is the sum of the voltage on C529 and the V_{GS} drop across Q505. The signal on SELFTTEST OUT is then applied to pin 11 of multiplexer U511. The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal at ACV/A is routed through U320 (/AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain. Measure the voltage at A/D IN. The computed voltage level at A/D IN is as follows:

$$V_{A/D\ IN} = |(A \times 4.8446) + B| \quad \text{where; } \begin{array}{l} A \text{ is measured value from test 406.1} \\ B \text{ is the } V_{GS} \text{ drop across Q505} \end{array}$$

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|---------------------|--|---------------------|--|---------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 406.3 – Read test buffer for test 406.6

| | |
|--------------------|--|
| Type | Circuit Exercise |
| Description | Same as test 406.2 except the value is read and stored for use for the comparison calculation in test 406.6. |
| Bit pattern | |

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 406.4 – Test buffer; read DAC output for test 406.6

Type Circuit Exercise

Description This test is the same as test 406.1 except that DAC U531 is programmed to generate -0.01 VDC at PRECOMP+.

Measure the actual voltage value at A/D IN (around -0.01V). This DAC voltage value is measured and stored. This voltage will be used in tests 406.5 and 406.6.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 406.5 – Test buffer output (-0.01V)

Type Circuit Exercise

Description This test is the same as test 406.2 except that DAC U531 is programmed to generate -0.01 VDC at PRECOMP+.

Measure the voltage at A/D IN. The computed voltage level at A/D IN is as follows:

$$V_{A/D\ IN} = |(A \times 4.8446) + B|$$

where; A is measured value from test 406.4
 B is the V_{GS} drop across Q505

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 406.6 – Voltage comparison

Type Pass/Fail

Failure analysis Voltage comparison is not less than 500mV.

Description Same as test 406.5 except the value is stored and used for the comparison calculation in this test. The measurement compares the DAC voltages to the test buffer voltages. The comparison is calculated as follows:

$$|[(V_{\text{TEST406.1}} - V_{\text{TEST406.4}}) \times 4.8446] - (V_{\text{TEST406.3}} - V_{\text{TEST406.6}})|$$

The absolute value of the difference should be less than 500mV.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 1 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 407.1 – Front end; 2V range

Type

Pass/Fail

Failure analysis

Cannot measure $7V \pm 0.15V$ at A/D IN.

Description

The signal at BUFF is routed through R233, K503, K500, the input protection circuit and Q513 to the input buffer (Q512 and U520). The buffered signal is tied to AMP IN.

The signal at AMP IN is then routed to the variable gain amplifier (VGA) and, being positive, follows the non-inverting x1 path that consists of R530, Q509, Q507, U519, R531, U509, Q501, and U516 to pin 12 of multiplexer U511.

The output (OUT) of the multiplexer is routed through buffer U342 to ACV / A. The signal at ACV / A is routed through U320 (/ AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 1 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 407.2 – Front end; 200V range

Type Pass/Fail

Failure analysis Cannot measure $0.7V \pm 0.2V$ at A/D IN.

Description VRIN is buffered by U517 and tied to BUFF. The signal at BUFF is routed through R233 to pin 1 of NET1 (R557). The voltage at pin 4 of NET1 is routed through U526 (DCF pulled low) and Q516, and applied to the input buffer (Q512 and U520). The buffered signal is tied to AMP IN.

The signal at AMP IN is then routed to the variable gain amplifier (VGA) and, being positive, follows the non-inverting x10 path that consists of R530, Q508, Q507, U519, R531, U509, Q501, and U516 to pin 12 of multiplexer U511.

The output (OUT) of the multiplexer is routed through buffer U342 to ACV / A. The signal at ACV / A is routed through U320 (/ AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 407.3 – Front end; 750V range

Type Pass/Fail
Failure analysis Cannot measure 0.14V ±0.04V at A/D IN.

Description VRIN is buffered by U517 and tied to BUFF. The signal at BUFF is routed through R233 to pin 1 of NET1 (R557). The voltage at pin 4 of NET1 is routed through U526 (DCF pulled low) and Q516, and applied to the input buffer (Q512 and U520). The buffered signal is tied to AMP IN.

The signal at AMP IN is then routed to the variable gain amplifier (VGA) and, being positive, follows the non-inverting x10 path that consists of R530, Q508, Q507, U519, R531, U509, Q501, and U516 to pin 12 of multiplexer U511.

The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal at ACV/A is routed through U320 (/AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 0 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 408.1 – ÷200 correction factor; circuit setup for test 408.2

Type Circuit Exercise

Description The DAC (U531) is programmed with “1s” and OUT A is routed to C554. The signal at BUFF is routed through R233 and applied to NET1 (R557). The signal at pin 4 of NET1 is routed through U526 (DCF pulled low) and Q516, and applied to the input buffer (Q512 and U520). The buffered signal is tied to AMP IN.

The signal at AMP IN is then routed to Q510 via U522 (SELFTTEST1 pull low) and the x5 inverting amplifier (U523, R542 and R533).

The actions of this test set up the conditions for the next test.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 408.2 – ÷200 correction factor; signal stored for test 408.3

Type Circuit Exercise

Description The SELFTEST control line turns on Q518 driving pin 4 of NET1 (R557) to ground. At the same time, the SELFTEST control line and multivibrator U503 generates a pulse that turns on Q510 allowing the signal to be stored on C529. No measurement is made during this test.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 408.3 – ÷200 correction factor; setup for test 408.5 and A/D measurement for test 408.6

Type

Circuit Exercise

Description

The DAC (U531) is programmed with “0s” (full compensation) and OUT A is routed to C554. The signal at BUFF is routed through R233 and applied to NET1 (R557). The voltage at pin 4 of NET1 is routed through U526 (DCF pulled low) and Q516, and applied to the input buffer (Q512 and U520). The buffered signal is tied to AMP IN.

The signal at AMP IN is then routed to Q510 via U522 (SELFTTEST1 pull low) and the x5 inverting amplifier (U523, R542 and R533).

The voltage on C529 is buffered by Q505 and tied to SELFTTEST OUT. The signal at SELFTTEST OUT is then switched through multiplexer U511. The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal at ACV/A is routed through U320 (/AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain.

Measure the output at A/D IN.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 408.4 – ÷200 correction factor

Type Circuit Exercise

Description Same as Test 408.3, but no measurement taken.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|---------------------|--|---------------------|--|---------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 408.5 – ÷200 correction factor; signal stored for test 408.6

Type Circuit Exercise

Description The SELFTEST control line turns on Q518 driving the pin 4 of NET1 (R557) to ground. At the same time, the SELFTEST control line and multivibrator U503 generates a pulse that turns on Q510 allowing the signal to be stored on C529. No measurement is made during this test.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 408.6 – ÷200 correction factor; signal comparisons

| | |
|-------------------------|---|
| Type | Pass/Fail |
| Failure analysis | The measurement in step 408.3 is not less than the measurement in step 408.6. |
| Description | Same as test 408.2. Measure the output at A/D IN. |
| Bit pattern | |

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 409.1 – ÷750 correction factor; circuit setup for test 409.2

Type Circuit Exercise

Description The DAC (U531) is programmed with “1s” and OUT A is routed to C556. The signal at BUFF is routed through R233 and applied to NET1 (R557). The signal at pin 4 of NET1 is routed through U526 (DCF pulled low) and Q516, and applied to the input buffer (Q512 and U520). The buffered signal is tied to AMP IN.

The signal at AMP IN is then routed to Q510 via U522 (SELFTTEST1 pull low) and the x5 inverting amplifier (U523, R542 and R533).

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|---------------------|--|---------------------|--|---------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 0 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 409.2 – ÷750 correction factor; signal stored for test 409.3

Type Circuit Exercise

Description The SELFTEST control line turns on Q518 driving the signal on pin 4 of NET1 (R557) to ground. At the same time, the SELFTEST control line and multivibrator U503 generates a pulse that turns on Q510 allowing the signal to be stored on C529. No measurement is made during this test.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 0 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 409.3 – ÷750 correction factor; setup for test 409.5 and A/D measurement for test 409.6

Type Circuit Exercise

Description The DAC (U531) is programmed with “0s” and OUT A is routed to C556. The rest of this test is the same as test 408.3.

Measure the output at A/D IN.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|---------------------|--|---------------------|--|---------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 0 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 409.4 – ÷750 correction factor

Type Circuit Exercise
Description Same as test 408.3 but no measurement taken.
Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|---------------------|--|---------------------|--|---------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 0 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 409.5 – ÷750 correction factor; signal stored for test 409.6

Type Circuit Exercise

Description The SELFTEST control line turns on Q518 driving pin 4 of NET1 (R557) to ground. At the same time, the SELFTEST control line and multivibrator U503 generates a pulse that turns on Q510 allowing the signal to be stored on C529. No measurement is made during this test.

Bit pattern

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 0 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 409.6 – ÷750 correction factor; signal comparisons

| | |
|-------------------------|---|
| Type | Pass/Fail |
| Failure analysis | The measurement in step 409.3 is not less than the measurement is step 409.6. |
| Description | Same as test 409.2. Measure the output at A/D IN. |
| Bit pattern | |

| DC_STB Registers | | R1_STB Registers | | R2_STB Registers | |
|------------------|--|------------------|--|------------------|--|
| U801 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 | Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 1 Q8: 0 |
| U800 | Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 | Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 | Q1: 0 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 0 |
| U300 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 | Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 | Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U303 | Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | | U501 | Q1: 1 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 410.1 – True RMS converter

Type Pass/Fail

Failure analysis Cannot measure 7V ±0.18V at A/D IN.

Description VRIN is buffered by U517 and tied to BUFF. The signal at BUFF is routed through R233, K503, K500, the input protection circuit and Q513 to the input buffer (Q512 and U520). The buffered signal is tied to AMP IN.

The signal at AMP IN is then routed to the variable gain amplifier (VGA) and, being positive, follows the non-inverting x1 path that consists of R530, Q509, Q507, U519, R531, U509, Q501, and U516 to pin 15 of the TRMS converter U517.

The output of the U517 is routed to the multiplexer U511 through R219. The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal at ACV/A is routed through U320 (/AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain. Measure the output at A/D IN.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 0 Q8: 1 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 0 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 411.1 – Filter; true RMS

Type

Pass/Fail

Failure analysis

Cannot measure 7V ±0.18V at A/D IN.

Description

VRIN is buffered by U517 and tied to BUFF. The signal at BUFF is routed through R233, K503, K500, the input protection circuit and Q513 to the input buffer (Q512 and U520). The buffered signal is tied to AMP IN.

The signal at AMP IN is then routed to the variable gain amplifier (VGA) and, being positive, follows the non-inverting x1 path that consists of R530, Q509, Q507, U519, R531, U509, Q501, and U516 to pin 15 of the TRMS converter U517.

The output of the U517 is routed through analog switch U510 to the filter that consists of components R220, R221, R222, C581, C582, C583, and U523. The output of the filter is connected to the multiplexer (U511) at pin 5. The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal at ACV/A is routed through U320 (/AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain. Measure the output at A/D IN.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 0 Q8: 1 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 0 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 411.2 – Filter; variable gain amplifier

Type Pass/Fail

Failure analysis Cannot measure $7V \pm 0.16V$ at A/D IN.

Description VRIN is buffered by U517 and tied to BUFF. The signal at BUFF is routed through R233, K503, K500, the input protection circuit and Q513 to the input buffer (Q512 and U520). The buffered signal is tied to AMP IN.

The signal at AMP IN is then routed to the variable gain amplifier (VGA) and, being positive, follows the non-inverting x1 path that consists of R530, Q509, Q507, U519, R531, U509, Q501, and U516 through analog switch U532 (RMS pulled low) to the filter. The filter consists of components R220, R221, R222, C581, C582, C583, and U523.

The output of the filter is connected to the multiplexer (U511) at pin 5. The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal at ACV/A is routed through U320 (/AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain. Measure the output at A/D IN.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U505 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: 0 Q8: 1 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 0 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 1 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 1 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

Test 412.1 – AC amps switch

Type Pass/Fail
Failure analysis Cannot measure 1.7V ±0.3V at A/D IN.

Description The 9.2mA ohms source is turned on to dump current through switch U323 (ACAL pulled low) to the amps protection diodes (CR305 and CR309). The three diode voltage drop is routed through U317 (/200uA pulled low), U320 (/ACA pulled low), U510 (REL3 pulled low), U526 and Q516 to the input buffer (Q512 and U520). The buffered signal is tied to AMP IN.

The signal at AMP IN is then routed to the variable gain amplifier (VGA) and, being positive, follows the non-inverting x1 path that consists of R530, Q509, Q507, U519, R531, U509, Q501, and U516 to pin 12 of multiplexer U511.

The output (OUT) of the multiplexer is routed through buffer U342 to ACV/A. The signal at ACV/A is routed through U320 (/AC pulled low) and applied to the A/D buffer (U322), which is configured for x1 gain. Measure 1.7V at A/D IN.

Bit pattern

| DC_STB Registers | R1_STB Registers | R2_STB Registers |
|---|---|---|
| U801 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 0 | U307 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 0 Q7: 1 Q8: 1 | U505 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U800 Q1: 1 Q2: 1 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 1 Q8: 1 | U305 Q1: 1 Q2: 0 Q3: 1 Q4: 0 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U500 Q1: 1 Q2: 1 Q3: 0 Q4: 1 Q5: 1 Q6: 0 Q7: 0 Q8: 1 |
| U300 Q1: 1 Q2: 1 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 1 | U302 Q1: 0 Q2: 0 Q3: 0 Q4: 1 Q5: 1 Q6: 1 Q7: 1 Q8: 0 | U530 Q1: 1 Q2: 0 Q3: 0 Q4: 0 Q5: 0 Q6: 0 Q7: 0 Q8: 0 |
| U303 Q1: 0 Q2: 1 Q3: 1 Q4: 1 Q5: 0 Q6: 1 Q7: X Q8: X | | U501 Q1: 0 Q2: 0 Q3: 1 Q4: 1 Q5: 1 Q6: 1 Q7: X Q8: X |

Note: Tables 2-10 through 2-12 provide functional descriptions of the register bits.

3

Disassembly

3.1 Introduction

The information in this section explains how to disassemble the Model 2001. Also discussed are handling and cleaning considerations as well as the procedure to change the main CPU firmware in the event of an upgrade. This section is organized as follows:

- 3.2 **Handling and cleaning precautions** — Covers general precautions to take when troubleshooting inside the unit, and cleaning procedures when replacing parts.
- 3.3 **Static-sensitive devices** — Explains handling procedures for static-sensitive devices.
- 3.4 **Case cover and shield removal** — Explains how to remove the case cover. Also covered is the removal of the top shield of the analog board to allow access to analog circuitry for troubleshooting.
- 3.5 **PC-board removal** — Provides the procedures for removing the digital board, A/D converter board and the analog board.
- 3.6 **Front panel disassembly** — Explains how to remove the display board and/or the front panel switch pad.
- 3.7 **Cooling fan removal** — Explains how to remove the cooling fan from the chassis.

3.8 **Firmware replacement** — Provides the procedure to change firmware.

3.9 **Instrument re-assembly** — Provides some general guidelines to follow when re-assembling the Model 2001.

3.10 **Assembly drawings** — Provides mechanical drawings to assist in the disassembly and re-assembly of the Model 2001.

3.2 Handling and cleaning precautions

When servicing the instrument, care should be taken not to indiscriminately touch PC board traces to avoid contaminating them with body oils or other foreign matter. Mother board areas covered by the shield have high impedance devices or sensitive circuitry where contamination could cause degraded performance.

3.2.1 PC-board handling

Observe the following precautions when handling PC-boards:

- Wear clean cotton gloves.
- Handle PC-boards only by the edges and shields.
- Do not touch any board traces or components not associated with the repair.
- Do not touch areas adjacent to electrical contacts.

- Use dry nitrogen gas to clean dust off PC-boards.

3.2.2 Solder repairs

Observe the following precautions when it is necessary to use solder on a circuit board:

- Use an OA-based (organic activated) flux, and take care not to spread the flux to other areas of the circuit board.
- Remove the flux from the work areas when the repair has been completed. Use pure water along with clean foam-tipped swabs or a clean soft brush to remove the flux.
- Once the flux has been removed, swab only the repaired area with methanol, then blow dry the board with dry nitrogen gas.
- After cleaning, the board should be allowed to dry in a 50°C low-humidity environment for several hours.

3.3 Special handling of static sensitive devices

CMOS devices operate at very high impedance levels for low power consumption. As a result, any static that builds up on your person or clothing may be sufficient to destroy these devices, if they are not handled properly. Use the following precautions to avoid damaging them:

CAUTION

Many CMOS devices are installed in the Model 2001. In general, it is recommended that all semiconductor devices be handled as static-sensitive.

1. ICs should be transported and handled only in containers specially designed to prevent static build-up. Typically, these parts will be received in anti-static containers of plastic or foam. Keep these devices in their original containers until ready for installation.

2. Remove the devices from their protective containers only at a properly grounded work station. Also, ground yourself with a suitable wrist strap.
3. Handle the devices only by the body; do not touch the pins.
4. Any printed circuit board into which the device is to be inserted must also be grounded to the bench or table.
5. Use only anti-static type solder sucker.
6. Use only grounded tip solder irons.
7. Once the device is installed in the PC board, it is normally adequately protected, and normal handling can resume.

3.4 Case cover and shield removal

If it is necessary to troubleshoot the instrument or to replace a component, use the following procedures as required. The first procedure removes the case cover, and the second procedure removes the top shield of the analog board allowing access to analog circuitry.

3.4.1 Case cover removal

WARNING

Before removing the case cover, disconnect the line cord and any test leads from the instrument.

To remove the case cover, refer to drawing 2001-054 and perform the following steps:

1. **Remove Handle**— The handle serves as an adjustable tilt-bail. Its position is adjusted by gently pulling it away from the sides of the instrument case and swinging it up or down. To remove the handle, swing the handle below the bottom surface of the case and back until the orientation arrows on the handles line up with the orientation arrows on the mounting ears. With the arrows lined up, pull the ends of the handle out of the case.
2. **Remove Mounting Ears**— Each mounting ear is secured to the chassis with a single screw. Remove the two screws and pull down and out on each mounting ear. Note: When re-installing the mounting ears, make sure to mount the right ear to the right side of the chassis, and the left ear to the left

side of the chassis. Each ear is marked "RIGHT" or "LEFT" on its inside surface.

3. **Remove Rear Bezel** — The rear bezel is secured to the chassis by two captive screws. To remove the rear bezel, loosen the two screws and pull the bezel away from the case.
4. **Remove Grounding Screw** — Remove the grounding screw for the case cover. This screw is located on the bottom side of the instrument at the rear.
5. **Remove Chassis** — Grasp the front bezel of the instrument and carefully slide the chassis forward, out of the metal case.

The internal pc-board assemblies are now accessible.

3.4.2 Analog board top shield removal

Most of the analog circuitry is located under the top shield for the analog board. The top shield (shown in drawing 2001-050) is secured to the analog board by a single screw. To remove the top shield, simply loosen the screw and carefully lift the shield out of the chassis.

3.5 PC-boards removal

There are three pc-boards mounted in the chassis; the digital board, the A/D converter board and the analog board. The removal of these three boards are covered in this paragraph. The display board is mounted in the front panel assembly. The removal of the display board is covered in paragraph 3.6.

Any pc-board can be removed without having to remove any of the other boards. Note that the A/D converter board plugs into the analog board and can be left installed when removing the analog board.

NOTE

Before performing any of the following procedures to remove a pc-board, remove the case cover as explained in paragraph 3.4.1.

3.5.1 Digital board

The digital board is removed through the bottom of the chassis (see drawing 2001-053). Note that the power switch pushrod does not have to be removed in order to remove the digital board.

Perform the following steps to remove the digital board:

1. **Unplug Cables** — Turn the chassis upside-down and unplug the following cables from the digital board:
 - A. Unplug the display board ribbon cable from connector J1033.
 - B. Unplug the transformer cable from connector J1032.
 - C. Unplug the analog board ribbon cable from connector J1027. This cable connection is located under the power switch pushrod.
 - D. Unplug the fan cable from connector J1037. This two conductor cable connection is located at the rear of the digital board in front of the IEEE connector.
2. **Unfasten PC-Board** — Remove the following screws and nuts to unfasten the digital board from the chassis:
 - A. At the rear panel, remove the two nuts that secure the IEEE connector to the chassis.
 - B. Remove the screw that connects ground of the +5V regulator (U629) to the chassis. The regulator is located at the front of the digital board behind the large electrolytic capacitor (C611).
 - C. Remove the four screws that secure the digital board to the chassis. One screw is located at the rear of the digital board in front of the bank of 12 capacitors. Another screw is located next to the +5V regulator (U629). The other two screws are located near the connector for the scanner card.
3. **Remove Digital Board** — The board is held in place by edge guides on each side. Slide the digital board forward until the board edges clear the guides, and then carefully pull the board out of the chassis.

3.5.2 A/D converter board

The A/D converter board is located under the analog board top shield (see drawing 2001-050).

Perform the following steps to remove the A/D converter board:

1. Remove Analog Top Shield — Position the chassis right-side-up. The top shield is secured to the analog board by a single screw. To remove the top shield, simply loosen the screw and carefully lift the shield out of the chassis.
2. Remove A/D Converter Board — The A/D converter board is located near the front of the instrument and is plugged into the analog board at connector J1026. The board rests on three standoffs. Each standoff has a retaining clip to hold the board securely in place. Gently pull each retaining clip away and lift the board up until it clears the clip. With the board clear of the three retaining clips, unplug the board and pull it out of the chassis.

3.5.3 Analog board

The analog board is removed through the top of the chassis (see drawing 2001-051). Perform the following steps to remove the analog board:

1. Remove Analog Top Shield — The top shield is secured to the analog board by a single screw. To remove the top shield, simply loosen the screw and carefully lift the shield out of the chassis.
2. Remove Pushrods — Remove the pushrods for the INPUTS switch and the POWER switch as follows:
 - A. Using suitable pliers, grasp the INPUTS pushrod near the switch and pull forward until it disengages from the switch shaft. Remove the pushrod from the chassis.
 - B. Turn the chassis upside-down. Grasp the rear end of the POWER pushrod and pull upward until it disengages from the switch shaft. Remove the pushrod from the chassis.
 - C. Return the chassis to the up-right position.
3. Remove Power Transformer — Remove the power transformer (see drawing 2001-052) as follows:
 - A. Disconnect the transformer ground. A kep nut is used to connect this green ground wire to a threaded stud on the chassis.
 - B. Unplug the transformer. There are three plugs for the transformer. Two are located on the analog board at connectors J1024 and J1025, and the third is located on the digital board at connector J1032. Turn the chassis upside-down to gain access to the plug on the digital board.

When finished, return the chassis to the up-right position.

- C. The transformer is secured to the side of the chassis by a single screw. Remove this screw and pull the transformer out of the chassis.
4. Remove AC Power Receptacle — Remove the AC power receptacle as follows:
 - A. Disconnect the receptacle ground wire. A kep nut is used to connect this green ground wire to a threaded stud on the chassis.
 - B. Unplug the AC power receptacle cable. The connector for this cable is located on the analog board next to the power receptacle.
 - C. A spring clip on each side of the receptacle is used to secure it to the rear panel of the chassis. Press both clips inward and, at the same time, push the receptacle out of the access hole in the rear panel of the chassis.
5. Unplug Cable to Digital Board — On the left side of the analog board there is a ribbon cable going to the digital board. Turn the chassis upside-down and unplug this cable at connector J1027 on the digital board. Return the chassis to the right-side-up position.
6. Disconnect Input Terminals — There are 10 input terminal connections (five for the front and five for the rear). Nine of these terminal wires are disconnected by simply pulling them off the pin connector on the input terminals. The front panel AMPS terminal wire must be unsoldered from the analog board. The solder connection for this white/blue wire is located next to the INPUTS switch.

Terminal wire color identification for re-assembly is provided as follows:

| | Front | Rear |
|----------|--------|--------------|
| INPUT HI | Red | White/Red |
| INPUT LO | Black | White/Black |
| SENSE HI | Yellow | White/Yellow |
| SENSE LO | Grey | White/Grey |
| AMPS | White | White/Blue |

7. Remove Regulator Clip — A metal clip is used to transfer heat from two power supply devices (R101 and Q528) to the chassis. The clip is located on the left side of the chassis towards the rear. The clip is removed by pulling it upward. You may need to use a small flat-bladed screwdriver to pry it up.

CAUTION

The regulator clip allows the chassis to serve as a heat sink for R101 and Q528. To prevent damage to these devices (due to overheating), do not fail to install the clip when re-assembling the Model 2001.

8. Unfasten Analog Board — The analog board is secured to the chassis at the rear panel by the two BNC connectors (External Trigger and Meter Complete). At the rear panel, remove the nuts and lock washers for the BNC connectors.
9. Remove Analog Board — The board is held in place by edge guides on each side of the chassis. Slide the analog board forward until the board edges clear the guides, and then carefully lift the board out of the chassis. The bottom shield on the analog board can be removed by simply pulling it off the board.

NOTE

With the analog board removed, the cooling fan can be removed as explained in paragraph 3.7.

3.6 Front panel disassembly

Use the following disassembly procedure to remove the display board and/or the pushbutton switch pad. Drawing 2001-052 shows how the front panel separates from the chassis, and drawing 2001-040 shows an exploded view of the front panel assembly.

NOTE

Before performing the following procedure to remove and disassemble the front panel, remove the case cover as explained in paragraph 3.4.1.

Perform the following steps to remove and disassemble the front panel:

1. Unplug Display Cable — Turn the chassis upside-down and unplug the display cable from the digital board at connector J1033.
2. Remove Front Panel Assembly — The front panel assembly has four retaining clips that snap onto

the chassis over four pem nut studs. Two retaining clips are located on each side of the front panel. Pull the retaining clips outward and, at the same time, pull the front panel assembly forward until it separates from the chassis.

3. Remove Display Board — The display board is held in place by a pc board stop. This is simply a plastic bar that runs along the bottom edge of the display board. Using a thin bladed screw driver, pry the plastic bar upward until it separates from the casing of the front panel. Pull the display board out of the front panel.
4. Remove Switch Pad — The conductive rubber switch pad simply pulls out of the front panel.

3.7 Cooling fan removal

The cooling fan, which is mounted to the rear panel of the chassis (see drawing 2001-060), does not need to be removed in order to clean the filter. To clean the filter, refer to paragraph 1.4. If, however, the fan needs to be removed, perform the following procedure.

NOTE

In order to remove the cooling fan, the case cover must be removed (see paragraph 3.4.1) and the analog board must be removed (see paragraph 3.5.3).

1. Disconnect Fan Cable — Turn the chassis upside-down and unplug the fan cable from connector J1037. This two conductor cable connection is located at the rear of the digital board in front of the IEEE connector. Return the chassis to the right-side-up position.
2. Remove Mounting Nuts — The fan is secured to the chassis by two mounting nuts. Remove these nuts and pull the fan out of the chassis.

3.8 Main CPU firmware replacement

Changing the firmware may be necessary as upgrades become available. The firmware revision level for the main CPU is displayed during the power-on sequence. The firmware for the main CPU is located in EPROM

U611, a leadless IC which resides in a chip carrier on the digital board.

Perform the following steps to replace the CPU firmware:

WARNING

Disconnect the instrument from the power line and remove all test leads before changing the firmware.

1. Remove the case cover as explained in paragraph 3.4.1.
2. Turn the instrument upside down to gain access to the digital board.
3. Locate U611 (EPROM) on the digital board. It is the only device installed in a chip carrier (socket).

CAUTION

EPROM U611 is a static sensitive device. Be sure to adhere to the handling precautions explained in paragraph 3.3.

4. Using an appropriate chip extractor, remove U611 from the chip carrier.
5. Position the new EPROM on the chip carrier. Make sure the notched corner of the chip is aligned with the notch in the chip carrier.
6. With the EPROM properly positioned, push down on the chip until it completely seats into the chip carrier.

3.9 Instrument re-assembly

The instrument can be re-assembled by reversing the previous disassembly procedures. Make sure that all parts are properly seated and secured, and that all connections are properly made. To ensure proper operation, shields must be replaced and fastened securely.

WARNING

To ensure continued protection against safety hazards, verify that power line ground (green wire attached to AC power receptacle) and the power transformer ground are connected to the chassis.

3.10 Assembly drawings

The following assembly drawings are provided to assist in disassembly and re-assembly of the instrument. Also, the Keithley part numbers for most mechanical parts are provided in these drawings.

Front Panel Assembly; 2001-040

Analog Shield Assembly; 2001-050

Chassis Assembly (Analog Board); 2001-051

Chassis Assembly (Front Panel and Miscellaneous); 2001-052

Chassis Assembly (Digital Board); 2001-053

Chassis Assembly (Case Cover and Handle); 2001-054

Chassis Assembly (Fan, Banana Jacks and Miscellaneous); 2001-060

4

Replaceable Parts

4.1 Introduction

This section contains replacement parts information for the Model 2001.

4.2 Parts lists

The following parts lists for the Model 2001 are provided:

Table 4-1 A/D converter board parts list

Table 4-2 Analog board parts list

Table 4-3 Digital board parts list

Table 4-4 Display board parts list

Table 4-5 Miscellaneous parts list

Note: For part numbers to the various mechanical parts and assemblies, use the Miscellaneous parts list (Table 4-5) and the assembly drawings provided at the end of Section 3.

4.3 Ordering information

To place an order, or to obtain information concerning replacement parts, contact your Keithley representative or the factory (see inside front cover for addresses). When ordering parts, be sure to include the following information:

- Instrument model number (Model 2001)
- Instrument serial number
- Part description
- Circuit description (if applicable)
- Keithley part number

4.4 Factory service

To return your instrument for repair or calibration, call 1-800-408-8165 or complete the form at tek.com/services/repair/rma-request. When you request service, you need the serial number and firmware or software version of the instrument.

To see the service status of your instrument or to create an on-demand price estimate, go to tek.com/service-quote.

Table 4-1

Model 2001 A/D board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|--------------------------------------|---|-------------------------------|
| | CHOKE 21-030-J DIODE, ZENER, 6.4V, IN5479 SOCKET, 68-PIN QUAD | CH-55 DZ-73-1 SO-128-68 |
| C800-805,807,809,815, 819,820,830 | CAP,.1UF, 20%,50V,CERAMIC(1206) | C-418-.1 |
| C808,818 | CAP,1UF,20%,50V, CERAMIC | C-237-1 |
| C812,814,824,826-829 | CAP, 10UF,20%, 25V, TANTALUM (D7243) | C-440-10 |
| C817 | CAP, 150PF, 5%, 100V,CERAMIC (0805) | C-465-150P |
| C821 | CAP,.33UF,10%, 50V CERAMIC (1812) | C-464-.33 |
| C822,823 | CAP, 27PF, 10%, 100V, CERAMIC(1206) | C-451-27P |
| C825 | CAP, .01UF, 10%,100V POLYPROPYLENE | C-306-.01 |
| C831 | CAP, 33PF, 10%, 100V, CERAMIC (1206) | C-451-33P |
| CR801 | DIODE, DUAL SWITCHING, BAV99L(SOT-23) | RF-82 |
| P1026 | CONNECTOR, FEMALE 25 PIN | CS-767-25 |
| Q800 | TRANS, PNP, MMBT3906L(SOT-23) | TG-244 |
| Q801 | TRANS, NPN, MMBT3904 (SOT-23) | TG-238 |
| Q802-806,814 | TRANS,N CHAN MOSPOW FET,2N7000 (TO-92) | TG-195 |
| Q807,809,811 | TRANS, SELECTED TG-128 (T0-92) | 31841A |
| Q808,813 | TRANS,N CHANNEL JFET,SELECTED J210 | TG-167-1 |
| Q810 | TRANS,N CHANNEL JFET,5432 (TO-92) | TG-198 |
| Q812 | IC, +5V REGULATOR, 78L05AC, (T0-92) | IC-603 |
| R800,813,838,839 | RES, 100K, 5%, 125mW, METAL FILM (1206) | R-375-100K |
| R801 | RES, 475, 1%, 125mW, METAL FILM (1206) | R-391-475 |
| R802-805 | RES, 2.21K, 1%, 125mW, METAL FILM (1206) | R-391-2.21K |
| R806,827 | RES, 33.2K, 1%, 125mW, METAL FILM (1206) | R-391-33.2K |
| R808,811,812,859,862 | RES,10K,5%,125MW,METAL FILM(1206) | R-375-10K |
| R810,820 | RES, 2.7K, 5%, 125mW, METAL FILM (1206) | R-375-2.7K |
| R814 | RES, 5.1K,5%, 125MW, METAL FILM (1206) | R-375-5.1K |
| R815,829 | RES, 82.5, 1%, 125mW, METAL FILM (1206) | R-391-82.5 |
| R818,823 | RES, 2.74K, 1%, 1/8W,METAL FILM | R-88-2.74K |
| R819 | RES, 18.7, 1%, 125mW, METAL FILM (1206) | R-391-18.7 |
| R821,822,864 | RES,1K,5%,125MW,METAL FILM(1206) | R-375-1K |
| R824,830 | RES, 4.75K, 1%, 125mW, METAL FILM (1206) | R-391-4.75K |
| R826 | RES,3.92K, 1%, 125mW, METAL FILM (1206) | R-391-3.92K |
| R828,861 | RES, 26.7K, 1%, 125mW,METAL FILM (1206) | R-391-26.7K |
| R833-836 | RES,1K,.1%,1/10W,METAL FILM | R-263-1K |
| R837,846 | RES, 19K, .1%, 1/10W, METAL FILM | R-263-19K |
| R840 | RES, 40K, .1%, 1/10W, METAL FILM | R-263-40K |
| R841 | RES, 57.8K, .1%, 1/10W METAL FILM | R-263-57.8K |
| R842 | RES, 920K, .1%, 1/10W METAL FILM | R-168-920K |
| R843 | RES, 1.2K, .1%, 1/10W, METAL FILM | R-263-1.2K |
| R844 | RES, 4.M, .1% 1/8W METAL FILM | R-402-4M |

Table 4-1 (continued)
 Model 2001 A/D board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|-----------------------|--|--------------------------|
| R845 | RES,2K,.1%,1/10W,METAL FILM | R-263-2K |
| R847 | RES, 3.2K,.1%, 1/10W, METAL FILM | R-263-3.2K |
| R848,851-853 | RES, 49.9, 1%, 125mW, METAL FILM (1206) | R-391-49.9 |
| R849,855,858,865 | RES, 100, 1%, 125mW, METAL FILM (1206) | R-391-100 |
| R850 | RES,100,1%,1/8W,METAL FILM | R-88-100 |
| R854 | RES,1.62K,1%,1/8W,METAL FILM | R-88-1.62K |
| R856,857 | RES,10,5%,125MW,METAL FILM(1206) | R-375-10 |
| R860 | RES, 150K, 5%, 125MW, METAL FILM (1206) | R-375-150K |
| R863 | RES, 3.01K, 1%, 125MW, METAL FILM(1206) | R-391-3.01K |
| U800,801 | IC, 8 STAGE SHIFT /STORE,MC14094BD(SOIC) | IC-772 |
| U802 | IC, OP-AMP, NE5534D (SOIC) | IC-802 |
| U803,804 | IC, VOLT. COMPARATOR,LM311M (SOIC) | IC-776 |
| U806 | IC, VOLT COMPARATOR LM393D(SOIC) | IC-775 |
| U807 | IC, QUAD COMPARATOR,LM339D (SOIC) | IC-774 |
| U808 | PROGRAM | 2001-802-** |
| U809 | IC,OP-AMP,OPA602AP | IC-703 |
| U810,811 | IC, OP-AMPLT1097 | IC-803 |
| U812 | IC, DUAL D-TYPE F/F, 74HC74(SOIC) | IC-773 |
| U813 | IC, OPA177GS (SOIC) | IC-960 |
| VR801 | DIODE,ZENER 6.4V,IN4579 (DO-7) | DZ-73 |
| Y800 | OSCILLATOR CMOS, 7.68 MHZ | CR-31 |

** Order present firmware revision level for main CPU (i.e., 2001-802-A05).

Table 4-2
Model 2001 analog board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|--|---|---|
| | COM CONN, TEST POINT CONTACT, FUSE FUSE HOLDER HEAT SINK (USE WITH Q301,302,U102,107,108) L.E.D. MOUNT (USE WITH Q529,530) SPRING, COMPRESSION | CS-553 2001-314 FH-32 HS-41 MK-21-1 SP-5 |
| C100,111,113 | CAP, 10UF,20%, 25V, TANTALUM (D7243) | C-440-10 |
| C101,104 | CAP, 2200UF, 20%, 35V ALUM ELEC | C-468-2200 |
| C102 | CAP, 2.2UF, 20%, 35V, TANTALUM (C6032) | C-476-2.2 |
| C103 | CAP,1UF, 20%, 50V, TANTALUM (1812) | C-431-1 |
| C105, 118,119 | CAP,.1UF, 20%,50V,CERAMIC(1206) | C-418-.1 |
| C106 | CAP, 2200UF, 20%, 16V ALUM ELEC | C-473-2200 |
| C107 | CAP,.01UF,20%,500V,CERAMIC | C-22-.01 |
| C108 | CAP, 1000UF, 20%, 50V ALUM ELEC | C-469-1000 |
| C114,115 | CAP, 470UF, 20%, 63V ALUM ELEC | C-477-470 |
| C116,117 | CAP, 1000UF, 20%,35V ALUM ELEC | C-468-1000 |
| C201,202 | CAP, .01uF, 20%, 50V, CERAMIC (1206) | C-418-.01 |
| C203,204,200,205,218,220, 221 | CAP,.1UF, 20%,50V,CERAMIC(1206) | C-418-.1 |
| C206,207,208,211,212,219 | CAP, 1000pF, 20%, 50V, CERAMIC (1206) | C-418-1000P |
| C209 | CAP, 33PF, 10%, 100V, CERAMIC (1206) | C-451-33P |
| C210 | CAP, 47PF, 10%, 100V, CERAMIC(1206) | C-451-47P |
| C213 | CAP, 4.7PF, 5%, 50V, MONO-CERAMIC(0805) | C-452-4.7P |
| C214 | CAP,100PF, 5%, 100V, CERAMIC(0805) | C-465-100P |
| C215 | CAP, 150PF, 5%, 100V,CERAMIC (0805) | C-465-150P |
| C216 | CAP, 6.2PF, .25PF, TOL, 1000V, CERAMIC | C-349-6.2P |
| C217 | CAP, 1UF, 20%, 100V, CERAMIC | C-487-1 |
| C306,307,347,348,350-353, 356-365 | CAP,.1UF, 20%,50V,CERAMIC(1206) | C-418-.1 |
| C316 | CAP, 20PF, 5%, 500V, DIPPED MICA | C-236-20P |
| C320 | CAP, 33PF, 10%, 100V, CERAMIC (1206) | C-451-33P |
| C322,324,326,327 | CAP,.68uF, 20%,50V POLYESTER FILM | C-344-.68 |
| C329 | CAP,27PF,10%,200V,CERAMIC | C-451-27P |
| C330 | CAP,47UF,20%,50V,TANTALUM (1812) | C-431-47 |
| C336,337,341 | CAP, 1000pF, 20%, 50V, CERAMIC (1206) | C-418-1000P |
| C343 | CAP, 6800P, 5%, 100V, POLYESTER | C-424-6800P |
| C401,404,405,407,411-426, 428,430-433,435 | CAP,.1UF, 20%,50V,CERAMIC(1206) | C-418-.1 |
| C408 | CAP,.15UF,20%,50V,CERAMIC(1206) | C-418-.15 |
| C427 | CAP, .01uF, 20%, 50V, CERAMIC (1206) | C-418-.01 |
| C502,572 | CAP, 10UF,20%, 25V, TANTALUM (D7243) | C-440-10 |
| C504,570 | CAP, 1000pF, 20%, 50V, CERAMIC (1206) | C-418-1000P |
| C513 | CAP,2.2PF,.5%,1500V,CERAMIC | C-308-2.2P |

Table 4-2 (continued)
 Model 2001 analog board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|----------------------------------|---|-------------------|
| C522 | CAP,10PF,10%,1000V,CERAMIC | C-64-10P |
| C529 | CAP, 10000PF, 20%, 63V, POLY-FILM | C-471-10000P |
| C531 | CAP,22PF,10%,1000V,CERAMIC | C-64-22P |
| C533,578 | CAP,100PF,10%,1000V,CERAMIC | C-64-100P |
| C539,543,584-586,588-590,597,599 | CAP,.1UF, 20%,50V,CERAMIC(1206) | C-418-.1 |
| C544,571,201,202,427 | CAP, .01uF, 20%, 50V, CERAMIC (1206) | C-418-.01 |
| C553 | CAP, 820PF, 1%, 300V, GLASS | C-486-820P |
| C554 | CAP, 91PF,1%,300V, MICA | C-474-91P |
| C555 | CAP,3600PF, 1%, 500V,MICA | C-278-3600P |
| C556 | CAP, 270PF, 1%, 300V, MICA | C-462-270P |
| C557 | CAP, 10PF, 1%, 2000V GLASS | C-485-10P |
| C558 | CAP, 6.2PF, .25PF, TOL, 1000V, CERAMIC | C-349-6.2P |
| C563 | CAP, .1UF, 20%, 1000V, MET POLYCARB | C-490-.1 |
| C566 | CAP,1UF, 20%, 50V, TANTALUM (1812) | C-431-1 |
| C569 | CAP, 2.7pF, .25pF TOL, 1000V, CERAMIC | C-367-2.7P |
| C574 | CAP, 27PF, 10%, 100V, CERAMIC(1206) | C-451-27P |
| C575,594 | CAP,100PF,2.5%,630V,POLYPROPYLENE | C-405-100P |
| C576 | CAP, 2.2UF,20%, 35V TANTALUM (C6032) | C-476-2.2 |
| C579 | CAP,47PF,10%,1000V,CERAMIC | C-64-47P |
| C580 | CAP, 2.2UF, 20%, 63V, POLYCARB | C-480-2.2 |
| C581-583 | CAP, .33UF, 20%, 63V, POLYCARBONATE | C-482-.33 |
| C587,591,595 | CAP, 150PF, 5%, 100V,CERAMIC (0805) | C-465-150P |
| C593 | CAP, 150PF, 5%, 100V,CERAMIC (0805) | C-465-150P |
| C598 | CAP, 100UF, 20%, 10V, ALUM ELEC | C-483-100 |
| CR100 | DIODE, BRIDGE, 5 AMP / 400V, EDI-PE40 | RF-88 |
| CR101,108 | DIODE,BRIDGE,VM18 | RF-52 |
| CR102,103,113,114,117,118 | DIODE, SWITCHING, 250MA,BAV103 (SOD-80) | RF-89 |
| CR104 | DIODE, DUAL SWITCHING, BAV99L(SOT-23) | RF-82 |
| CR106 | DIODE,SILICON,W04M (CASE WM) | RF-46 |
| CR109-112 | DIODE,CONTROLLED AVALANCHE,BYD17GSOD-87 | RF-91 |
| CR305 | DIODE, BRIDGE PE05 (CASE KBU) | RF-48 |
| CR309 | DIODE, SILICON, 5400 (267-01) | RF-34 |
| CR317,318 | DIODE,SILICON,IN4006 (D0-41) | RF-38 |
| CR321,323,324,327 | DIODE, SWITCHING, MMBD914 (SOT-23) | RF-83 |
| CR322 | DIODE,CONTROLLED AVALANCHE,BYD17GSOD-87 | RF-91 |
| CR331-337 | DIODE,IN3595 (DO-7) | RF-43 |
| CR400-403 | DIODE, SWITCHING, MMBD914 (SOT-23) | RF-83 |
| CR501,504 | DIODE, DUAL MIXER, MMBD352L (SOT-23) | RF-86 |
| CR507,508,512,536,537 | DIODE, SWITCHING, MMBD914 (SOT-23) | RF-83 |
| CR509,510,518-520 | DIODE,CONTROLLED AVALANCHE,BYD17GSOD-87 | RF-91 |
| CR511,523,524,535 | DIODE, DUAL SWITCHING, BAV99L(SOT-23) | RF-82 |
| CR513,514,521,526-528 | DIODE, SWITCHING, 250MA,BAV103 (SOD-80) | RF-89 |
| CR515,516 | DIODE, SCHOTTKY, MMBD301 (SOT-23) | RF-90 |
| CR517 | DIODE,SILICON,IN4148 (DO-35) | RF-28 |
| CR531-534,538,539 | DIODE,IN3595 (DO-7) | RF-43 |
| CR540,541 | DIODE,SCHOTTKY, BAT42 | RF-78 |

Table 4-2 (continued)
 Model 2001 analog board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|--|--|--------------------------|
| E300 | SURGE ARRESTOR, CG3-1.5L | SA-4 |
| F100 | FUSE, .5A, 250V | FU-71 |
| F300 | FUSE, 2A,250V, FAST-BLO(5X20MM) | FU-48 |
| J1002 | CONN, MOLEX, 3-PIN | CS-772-3 |
| J1008-1011,J1017-1021 | CRIMP CONTACT ROUND | CS-760 |
| J1022,1023 | CONN, BNC | CS-547 |
| J1024,1025 | CONN, MALE, 5-PIN (MOLEX 42491) | CS-784-5 |
| J1026 | HEADER, DUAL BODY / STRAIGHT PIN | CS-765-25 |
| K100 | RELAY, MINIATURE, G6A-274P-ST-US-DC24 | RL-160 |
| K101 | RELAY, MINIATURE, G6A-274P-ST-US-DC9 | RL-159 |
| K300 | RELAY, REED HI VOLTAGE | RL-119 |
| K500,502,503 | RELAY, REED, HI-VOLT / ISOLATION,848-1 | RL-152 |
| K501 | RELAY, MINATURE (DPDT), DK1A1BE-6V | RL-153 |
| L100 | CHOKER, 100MHZ | CH-50 |
| P1027 | CABLE ASSEMBLY, 20 CONDUCTOR | CA-27-16C |
| Q101,106 | TRANS, NPN, MMBT3904 (SOT-23) | TG-238 |
| Q102,104 | TRANS, N-MOSFET, VN0605T (SOT-23) | TG-243 |
| Q103 | TRANS, P-CHAN, MOSFET, TP0610T(SOT-23) | TG-259 |
| Q105 | TRANS, PNP, MMBT3906L(SOT-23) | TG-244 |
| Q301 | TRANS,NPN DARLINGTON, TIP101(TO 220) | TG-230 |
| Q302 | TRANS,PNP DARLINGTON, TIP106(TO 220) | TG-231 |
| Q304,306,342 | TRANS, N-CHAN JFET, SST109 (SOT-23) | TG-270 |
| Q305,307 | TRANS, N-HEXFET, IRFR020 (D-PAK) | TG-239 |
| Q308,313 | TRANS,N CHANNEL JFET (TO-92) | TG-225 |
| Q309,310 | TRANS, N-CHANNEL FET, BUZ71 (TO-220) | TG-196 |
| Q311 | TRANS,N CHANNEL JFET,5432 (TO-92) | TG-198 |
| Q312,320,324,328,329 | TRANS, SELECTED TG-128 (TO-92) | 31841A |
| Q314,322,325 | TRANS,NPN COMP SILICON AMP,2N5089 | TG-62-1 |
| Q315 | TRANS, NPN, MMBT3904 (SOT-23) | TG-238 |
| Q317 | TRANS, N-CHAN JFET, SST4391 (SOT-23) | TG-250 |
| Q321,323 | TRANS,N-CHAN FET, BUK 456-1000B (TO-220) | TG-247 |
| Q326 | TRANS, PNP, MMBT3906L(SOT-23) | TG-244 |
| Q330 | TRANS, DUAL N-CHAN JFET, IFN146 (TO-71) | TG-254 |
| Q331,333 | SELECTED TG-166 | 2001-601A |
| Q337-340 | TRANS,P-FET, MTP2N90 | TG-232 |
| Q341 | TRANS, N-CHAN JFET, SST4393 (SOT-23) | TG-263 |
| Q500,502-504,518-520,547, 550 | TRANS, N-MOSFET, VN0605T (SOT-23) | TG-243 |
| Q501,505,507-509,513, 516,522,523,538,544,551 | TRANS, N-CHAN JFET, SST4416 (SOT-23) | TG-241 |

Table 4-2 (continued)
 Model 2001 analog board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|---------------------------|---|-------------------|
| Q506,511 | TRANS,N-CHAN FET, BUK 456-1000B (TO-220) | TG-247 |
| Q510 | TRANS, N-CHAN JFET, SST4391 (SOT-23) | TG-250 |
| Q512 | TRANS, N-CHAN. DUAL JFET, U441 | TG-235 |
| Q514 | TRANS, N-CHAN JFET SMP4338(SOT-23) | TG-257 |
| Q515,517 | TRANS, N-CHANNEL FET, J210(TO-92) | TG-176 |
| Q525 | TRANS,N CHANNEL JFET,SELECTED J210 | TG-167-1 |
| Q527 | TRANS, SELECTED TG-128 (TO-92) | 31841A |
| Q528 | TRANS, N-CHAN MOSFET, MTG9N50E (TO-218) | TG-291 |
| Q529,530 | DIODE CURRENT REG CR200(TO-46) | TG-218 |
| Q531,536,537 | TRANS, PNP, MMBT3906L(SOT-23) | TG-244 |
| Q532,540,545 | TRANS, NPN, MMBT3904 (SOT-23) | TG-238 |
| Q533 | TRANS, N-CHAN DMOS FET TN2504N8 (SOT-89) | TG-261 |
| Q534,535 | TRANS, P-CHAN, MOSFET, TP0610T(SOT-23) | TG-259 |
| Q539 | TRANS, N-CHAN JFET, SST4393(SOT-23) | TG-263 |
| Q542,546 | TRANS, P CHANNEL JFET, J270 (TO-92) | TG-166-1 |
| Q543 | TRANS,CURRENT REGULATOR,CR430 | TG-219 |
| Q548,549 | TRANS,N CHANNEL FET,2N4392 (TO-92) | TG-128-1 |
| R100 | RES, 470, 5%, 10W, VERTICAL MOUNT | R-401-470 |
| R102,129 | RES,243K, 1%, 125MW, METAL FILM(1206) | R-391-243K |
| R103 | RES, 140K, 1%, 125MW, METAL FILM(1206) | R-391-140K |
| R104,117,120 | RES, 499K, 1%, 125MW, METAL FILM(1206) | R-391-499K |
| R105 | RES, 100K, 1%, 125mW, METAL FILM (1206) | R-391-100K |
| R107 | RES, 562K, 1%, 125MW, METAL FILM (1206) | R-391-562K |
| R108 | RES, 33, 5%, 250mW, METAL FILM (1210) | R-376-33 |
| R109 | RES, 475, 1%, 125mW, METAL FILM (1206) | R-391-475 |
| R110 | RES, 2.49K, 1%, 125MW, METAL FILM (1206) | R-391-2.49K |
| R111 | RES, 59K, 1%,125MW,METAL FILM(1206) | R-391-59K |
| R114 | RES, 1M, 5%, 1/2W, FLAME PROOF | R-394-1M |
| R116,118 | RES, 20K, 5%, 125MW, METAL FILM (1206) | R-375-20K |
| R122 | RES, 100K, 5%, 125mW, METAL FILM (1206) | R-375-100K |
| R123 | RES, 20K, 5%, 250MW, METAL FILM (1210) | R-376-20K |
| R124-128 | RES,10K,5%,125MW,METAL FILM(1206) | R-375-10K |
| R200 | RES, 1.8M, 5%, 125MW, METAL FILM (1206) | R-375-1.8M |
| R201 | RES, 1.2M, 5%, 125MW, METAL FILM(1206) | R-375-1.2M |
| R203,222 | RES, 68K, 5%, 125MW METAL FILM (1206) | R-375-68K |
| R204,242,243,245,R267-269 | RES, 200K, 5%, 125MW, METAL FILM(1206) | R-375-200K |
| R209,211,223,232,249,255 | RES, 2K, 5%, 125MW, METAL FILM(1206) | R-375-2K |
| R210,277 | RES, 137, 1%, 125MW, METAL FILM (1206) | R-391-137 |
| R212,R235,238 | RES, 20K, 5%, 125MW, METAL FILM (1206) | R-375-20K |
| R213 | RES, 10K, 5%, 250MW, METAL FILM(1210) | R-376-10K |
| R214,225,251-253,256,280 | RES,10K,5%,125MW,METAL FILM(1206) | R-375-10K |
| R215 | RES NET, 500, 24.5K,0/1%, 125MW THIN FILM | TF-234 |
| R216,217 | RES, 15, 5%, 125MW, METAL FILM(1206) | R-375-15 |
| R218,282 | RES, 15K, 1%, 125mW, METAL FILM (1206) | R-391-15K |
| R219-221 | RES, 120K, 5%, 125MW, METAL FILM(1206) | R-375-120K |
| R226,230 | RES, 22K, 5%, 125MW, METAL FILM(1206) | R-375-22K |

Table 4-2 (continued)
 Model 2001 analog board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|----------------------------------|--|-------------------|
| R227,261-264,281,283,284,288,289 | RES,1K,5%,125MW,METAL FILM(1206) | R-375-1K |
| R228,240 | RES,4.7K,5%,125MW,METAL FILM(1206) | R-375-4.7K |
| R229 | RES, 470,5%, 125MW, METAL FILM(1206) | R-375-470 |
| R231,286 | RES, 620, 5%, 250mW, METAL FILM (1210) | R-376-620 |
| R233,278 | RES, 4.99K, 1%, 125mW,METAL FILM (1206) | R-391-4.99K |
| R234 | RES, 220, 5%, 125MW, METAL FILM (1206) | R-375-220 |
| R236 | RES, 3.9M, 5%, 125MW, METAL FILM(1206) | R-375-3.9M |
| R237,254,265,266 | RES, 1M, 5%, 125MW, METAL FILM (1206) | R-375-1M |
| R239,248,285 | RES, 68, 5%, 125MW, METAL FILM(1206) | R-375-68 |
| R241,248 | RES, 1.5K, 5%, 250MW, METAL FILM(1210) | R-376-1.5K |
| R246,290 | RES, 100K, 1%, 125mW, METAL FILM (1206) | R-391-100K |
| R247 | RES, 680K, 5%,125mW, METAL FILM (1206) | R-375-680K |
| R257,258 | RES, 100, 5%, 125MW, METAL FILM (1206) | R-375-100 |
| R259,260,292 | RES, 150, 5%, 125MW, METAL FILM (1206) | R-375-150 |
| R270 | RES, 2.7K, 5%, 125mW, METAL FILM (1206) | R-375-2.7K |
| R271-273 | RES, 3.3K 5%, 125MW METAL FILM (1206) | R-375-3.3K |
| R274 | RES,47K,5%,125MW,METAL FILM(1206) | R-375-47K |
| R275 | RES,1K, 5% 250MW, METAL FILM (1210) | R-376-1K |
| R276,250 | RES, 20K, 5%, 250MW, METAL FILM (1210) | R-376-20K |
| R279 | RES, 665, 1%, 125MW, METAL FILM(1206) | R-391-665 |
| R287 | RES, 487K, 1%, 125mW, METAL FILM (1206) | R-391-487K |
| R291 | RES, 3M, 5%, 125MW, METAL FILM (1206) | R-375-3M |
| R303-306,324 | RES, 270,5%, 250mW, METAL FILM (1210) | R-376-270 |
| R308,319 | RES, 33, 5%, 250mW, METAL FILM (1210) | R-376-33 |
| R309,318 | RES,100K,1%,125mW,METAL FILM (1206) | R-391-100K |
| R316,317,333,337,361 | RES,4.7K,5%,125MW,METAL FILM(1206) | R-375-4.7K |
| R326 | RES, 9.09K, .1%, 1 / 10W, METAL FILM | R-263-9.09K |
| R327 | RES, 46.4K, 1%, 1 / 8W, METAL FILM | R-377-46.4K |
| R331,341 | RES, 220, 5%, 125MW, METAL FILM (1206) | R-375-220 |
| R332 | RES, 100K, 5%, 250MW, METAL FILM(1210) | R-376-100K |
| R334 | RES, 23.2K, 1%, 1 / 8W METAL FILM | R-377-23.2K |
| R335 | RES, 2.274K, .1%, 1 / 10W, METALFILM | R-263-2.274K |
| R340,386 | RES, 150, 5%, 125MW, METAL FILM (1206) | R-375-150 |
| R342 | RES, 90K, .1%, 1 / 10W, METAL FILM | R-263-90K |
| R343 | RES,10K,.1%,1 / 10W, METAL FILM | R-263-10K |
| R344 | RES NET, 900,90,9, 10% | TF-168-1 |
| R348 | RES, 82K, 5%, 125MW, METAL FILM(1206) | R-375-82K |
| R349 | RES, 2.7K, 5%, 125mW, METAL FILM (1206) | R-375-2.7K |
| R350 | RES, 41.2K, 1%, 125mW, METAL FILM (1206) | R-391-41.2K |
| R353 | RES, 182, 1%, 125MW, METAL FILM (1206) | R-391-182 |
| R354 | RES, 100M, 1%, 1 / 2W, THICK FILM | R-408-100M |
| R356 | RES,750,.5%,3W,METAL FOIL | R-422-750 |
| R358 | RES,7.15K, .1%, .2W, WIREWOUND | R-406-7.15K |
| R359,362 | RES, 13K, 5%,125MW, METAL FILM(1206) | R-375-13K |
| R363,387 | RES, 10K, 5%, 6.5W, WIREWOUND | R-336-10K |
| R364,373 | RES, 200K, 5%, 250MW, METAL FILM (1210) | R-376-200K |

Table 4-2 (continued)
 Model 2001 analog board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|--------------------------|---|-------------------|
| R365 | RES, 78.7K, .1%, .2W, WIREWOUND | R-406-78.7K |
| R366 | RES,1M,0.1%,1 / 4W,METAL FILM | R-433-1M |
| R367 | RES,22M,5%,1 / 4W,COMPOSITION OR FILM | R-76-22M |
| R368 | RES, 4.99K, 1%, 125mW,METAL FILM (1206) | R-391-4.99K |
| R369 | RES, 36, 5%, 250MW, METAL FILM(1210) | R-376-36 |
| R370,382 | RES, 10K, 5%, 250MW, METAL FILM(1210) | R-376-10K |
| R371 | RES, 3.3K 5%, 125MW METAL FILM (1206) | R-375-3.3K |
| R372,392 | RES,2.2M,10%,1 / 2W, COMPOSITION | R-1-2.2M |
| R375 | RES, 2.2,5%, 125MW, METAL FILM(1206) | R-403-2.2 |
| R377 | RES, 68, 5%, 125MW, METAL FILM(1206) | R-375-68 |
| R379,380 | RES, 1M, 5%, 125MW, METAL FILM (1206) | R-375-1M |
| R381 | RES, 100, 5%, 125MW, METAL FILM (1206) | R-375-100 |
| R384 | RES, 68K, 5%, 125MW METAL FILM (1206) | R-375-68K |
| R385,396 | RES, 510, 5%, 250MW, METAL FILM(1210) | R-376-510 |
| R394 | RES NET, 100K, 9.9M, METAL FILM | TF-251 |
| R398 | RES, 1K, .1%, 1W, WIREWOUND | R-249-1 |
| R399 | RES, 150, 10%, 1W, METAL FILM | R-411-150 |
| R400 | RES, 150, 10%, 1 / 2W, METAL FILM | R-411-150 |
| R401 | RES, 500, 1%, 1 / 2W, METAL FILM | R-411-500 |
| R402,404 | RES, 2.15K, 1%, 125MW, METAL FILM(1206) | R-391-2.15K |
| R403,424 | RES, 100K, 5%, 250MW, METAL FILM(1210) | R-376-100K |
| R408,409 | RES, 1.5K, 5%, 250MW, METAL FILM(1210) | R-376-1.5K |
| R410,411 | RES, 470,5%, 125MW, METAL FILM(1206) | R-375-470 |
| R413,422,423,425,426,428 | RES, 100K, 5%, 125mW, METAL FILM (1206) | R-375-100K |
| R414,421 | RES,100K,1%,125mW,METAL FILM(1206) | R-391-100K |
| R415,419,420 | RES, 200K, 5%, 250MW, METAL FILM (1210) | R-376-200K |
| R416-418 | RES, 68K, 5%, 125MW METAL FILM (1206) | R-375-68K |
| R427 | RES, 2K, 5%, 125MW, METAL FILM(1206) | R-375-2K |
| R429 | RES, 1M, 5%, 125MW, METAL FILM (1206) | R-375-1M |
| R432-441,443 | RES,1K,5%,125MW,METAL FILM(1206) | R-375-1K |
| R442 | RES, 330, 5%, 125MW, METAL FILM(1206) | R-375-330 |
| R444 | RES, 39K, 5%, 250mW, METAL FILM (1210) | R-376-39K |
| R446,445 | RES,4.7K,5%,125MW,METAL FILM(1206) | R-375-4.7K |
| R447-R449 | RES,10K,5%,125MW,METAL FILM(1206) | R-375-10K |
| R501,560 | RES,10K,1%,125mW,METAL FILM(1206) | R-391-10K |
| R503 | RES, 150K, 5%, 125MW, METAL FILM (1206) | R-375-150K |
| R504,582,536 | RES, 33K, 5%, 125MW, METAL FILM(1206) | R-375-33K |
| R505,512,517,570,571,577 | RES, 1M, 5%, 125MW, METAL FILM (1206) | R-375-1M |
| R506,566,537 | RES, 15K, 1%, 125mW, METAL FILM (1206) | R-391-15K |
| R507 | RES,4.7K,5%,125MW,METAL FILM(1206) | R-375-4.7K |
| R513 | RES, 10M, 5%, 125MW, METAL FILM(1206) | R-375-10M |
| R514 | RES, 470,5%, 125MW, METAL FILM(1206) | R-375-470 |
| R515,521 | RES, 22K, 5%, 125MW, METAL FILM(1206) | R-375-22K |
| R516 | RES, 120K, 5%, 250mW, METAL FILM (1210) | R-376-120K |
| R520 | RES, 330, 5%, 125MW, METAL FILM(1206) | R-375-330 |
| R522 | RES, 2.15K, 1%, 125MW, METAL FILM(1206) | R-391-2.15K |
| R526 | RES, 100, 5%, 125MW, METAL FILM (1206) | R-375-100 |

Table 4-2 (continued)

Model 2001 analog board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|----------------------|--|-------------------|
| R527,535,565 | RES,7.5K,5%,125MW,METAL FILM(1206) | R-375-7.5K |
| R530 | RES NET,250K,9.34K,1K,10.233K,15K,7K | TF-226 |
| R531 | RES NET, 1K,1K | TF-227 |
| R533 | RES, 4.99K, 1%, 125mW,METAL FILM (1206) | R-391-4.99K |
| R538,540,545 | RES,10K,5%,125MW,METAL FILM(1206) | R-375-10K |
| R541 | RES,49.9K,1%,125MW, METAL FILM (1206) | R-391-49.9K |
| R542 | RES, 1K, 1%, 125mW, METAL FILM (1206) | R-391-1K |
| R544 | RES, 100K, 1%, 125mW, METAL FILM (1206) | R-391-100K |
| R546,561,580 | RES, 6.65K, 1%, 125MW, METAL FILM(1206) | R-391-6.65K |
| R548,549 | RES, 1K,1%,1/2W FUSIBLE METAL FILM | R-370-1K |
| R550,R556 | RES, 499K, 1%, 125MW, METAL FILM(1206) | R-391-499K |
| R551 | RES, 90.9K, 1%, 125mW, METAL FILM (1206) | R-391-90.9K |
| R554,555 | RES, 68K, 5%, 125MW METAL FILM (1206) | R-375-68K |
| R557 | RES NET, 1100K@.990W,11.111K@.010W,1% | TF-225 |
| R558 | RES, 49.9, 1%, 125mW, METAL FILM (1206) | R-391-49.9 |
| R559 | RES, 11K, 5%,250MW,METAL FILM(1210) | R-376-11K |
| R562 | RES,100K,5%,1/4W,COMPOSITION OR FILM | R-76-100K |
| R563 | RES, 2.74K, .1%, 1/10W, METAL FILM | R-263-2.74K |
| R573 | RES, 3.3K 5%, 125MW METAL FILM (1206) | R-375-3.3K |
| R575,576 | RES, 487K, 1%, 125mW, METAL FILM (1206) | R-391-487K |
| R581 | RES, 33, 5%, 250mW, METAL FILM (1210) | R-376-33 |
| R583 | RES, 100K, 5%, 250MW, METAL FILM(1210) | R-376-100K |
| R584 | RES, 1M, 5%, 250MW METAL FILM (1210) | R-376-1M |
| R585,593 | RES, 200K, 5%, 250MW, METAL FILM (1210) | R-376-200K |
| R591 | RES, .1, 1%, 2W, 4-TERMINAL MOLDED | R-342-.1 |
| R592 | RES, .91, .1, 1/4W WIREWOUND | R-95-.91 |
| R596,597 | RES, 2K, 5%, 125MW, METAL FILM(1206) | R-375-2K |
| R599 | RES,10K,5%,125MW,METAL FILM(1206) | R-375-10K |
| R600 | RES,330,5%,125MW,METAL FILM (1206) | R-375-330 |
| R601 | RES,1.2M,5%,125MW,METAL FILM (1206) | R-375-200K |
| R602 | RES,200K,5%,125MW,METAL FILM (1206) | R-375-1.2M |
| S100 | SWITCH,PUSHBUTTON (6 POLE) | SW-466 |
| S300 | SWITCH, PUSHBUTTON, 8 POLE | SW-468 |
| U100 | IC, MOSFET DRIVER, TLP590A | IC-812 |
| U102 | IC,NEG VOLTAGE REG -15V,500MA,79M15 | IC-195 |
| U103 | IC,VOLTAGE REGULATOR,LM317T | IC-317 |
| U105,109 | IC, OPTO-COUPLER, HIGH EMI, H11AV1A | IC-845 |
| U106 | IC, VOLT. COMPARATOR,LM311M (SOIC) | IC-776 |
| U107 | IC,POS VOLTAGE REG +15V,500MA,7815 | IC-194 |
| U108 | IC,+5V VOLTAGE REGULATOR,LM2940CT | IC-576 |
| U110 | IC, TIMING CIRCUIT, MC1455D (SOIC) | IC-847 |
| U300,302,303,305,307 | IC, 8 STAGE SHIFT /STORE,MC14094BD(SOIC) | IC-772 |
| U301 | IC, DUAL D-TYPE F /F, 74HC74(SOIC) | IC-773 |

Table 4-2 (continued)
 Model 2001 analog board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|-----------------------|--|--------------------------|
| U304,306,309,310,316 | IC, QUAD COMPARATOR,LM339D (SOIC) | IC-774 |
| U308,334 | IC, TRI-2CH MULTI/DEMUX, 4053 (SOIC) | IC-770 |
| U311-315 | IC,OPTOCOUPLER,TLP582 | IC-689 |
| U317 | IC, CMOS ANAL. SWITCH, DG411DY(SOIC) | IC-785 |
| U318-320,323 | IC,CMOS ANALOG SWITCH DG211DY(SOIC) | IC-768 |
| U321 | IC, HEX LEVEL SHIFTER, MC14504B (SOIC) | IC-771 |
| U322 | IC,22V OP-AMP, LT1007ACN8 | IC-422 |
| U324,328 | IC,OP-AMP,AD707,(SOIC) | IC-712 |
| U325,332 | IC, SELECTED IC-739, MC14052B | 2001-600A |
| U327 | IC, OP-AMP, LTC1050CS8(SOIC) | IC-791 |
| U329 | IC, PRECISION REFERENCE, LM399 | 196-600A |
| U330 | IC,SWITCHING CAP BLOCK, LTC1043CN | IC-745 |
| U331 | IC, OP-AMP, LF351M(SOIC) | IC-815 |
| U333 | IC, OP-AMP, AD705JR(SOIC) | IC-814 |
| U335 | IC, OP-AMP, LT1007CN8 | IC-744 |
| U336-339 | IC, TLP591B | IC-877 |
| U340 | IC, VOLT COMPARATOR LM393D(SOIC) | IC-775 |
| U341 | IC, BIFET OP-AMP, AD548 (SOIC) | IC-876 |
| U342 | IC, 20V OP-AMP, LT1097S8 (SOIC) | IC-767 |
| U500,501,505,530 | IC, 8 STAGE SHIFT /STORE,MC14094BD(SOIC) | IC-772 |
| U502 | IC, -5V REGULATOR, 79L05ACM (SOIC) | IC-787 |
| U503 | IC, RETRIG., MULTIVIB, 74HC123AM (SOIC) | IC-788 |
| U506 | IC, VOLT COMPARATOR LM393D(SOIC) | IC-775 |
| U507 | IC, VOLT. COMPARATOR, LT1016CS8(SOIC) | IC-797 |
| U508,513,536 | IC, QUAD 2-INPUT NAND, 74HC00M (SOIC) | IC-781 |
| U509 | IC, MCHAN LAT DMOS QUAD FET, SD5400CY (SOIC) | IC-893 |
| U510,U515,532 | IC,CMOS ANALOG SWITCH DG211DY(SOIC) | IC-768 |
| U511 | IC, 8-CHAN ANA MULTIPLEXER,DG408DY(SOIC) | IC-844 |
| U512 | IC, VOLT. COMPARATOR,LM311M (SOIC) | IC-776 |
| U514,529 | IC, OP-AMP, AD847JR (SOIC) | IC-779 |
| U516,519 | IC,OP-AMP, AD848JR (SOIC) | IC-784 |
| U517 | IC,TRMS TO DC CONVERTER, 637JR (SOLIC) | IC-796 |
| U518,537 | IC,MOSFET DRIVER, TLP590A | IC-812 |
| U520 | IC, OP-AMP LT1223C58(SOIC) | IC-873 |
| U521,524 | IC, 20V OP-AMP, LT1097S8 (SOIC) | IC-767 |
| U522 | IC, CMOS ANAL. SWITCH, DG411DY(SOIC) | IC-785 |
| U523 | IC, DUAL OP-AMP, LF353M (SOIC) | IC-842 |
| U525 | IC, OP-AMP, LTC1050CS8(SOIC) | IC-791 |
| U526 | IC, CMOS ANAL SWITCH, DG444DY, (SOIC) | IC-866 |
| U527 | IC, QUAD COMPARATOR,LM339D (SOIC) | IC-774 |
| U528 | IC, DUAL OP-AMP, 1458 (SOIC) | IC-811 |
| U531 | IC, DUAL 8-BIT DAC, MP7528JS(SOIC) | IC-810 |
| U533 | IC, SUPPLY VOLT SUPERVISOR,TL7705A(SOIC) | IC-860 |
| U534 | IC, OP-AMP, BIFET, AD548(SOIC) | IC-894 |
| U535 | IC, MOSFET DRIVER, TSC428CBA (SOIC) | IC-872 |
| U538 | IC,TLP591B | IC-877 |

Table 4-2 (continued)
 Model 2001 analog board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|-----------------------|---------------------------------------|--------------------------|
| VR100 | DIODE, ZENER 22V, BZX84C22 (SOT-23) | DZ-86 |
| VR101 | DIODE, ZENER 6.2V, BZX84B6V2 (SOT-23) | DZ-87 |
| VR102 | DIODE, ZENER, 39V, MLL4716(MLL-34) | DZ-95 |
| VR300,304 | DIODE,ZENER 5.1V, BZX84C5V1 (SOT-23) | DZ-88 |
| VR302,307 | DIODE,ZENER 6.44V,IN4577AGED (DO-7) | DZ-58 |
| VR305,306 | DIODE, ZENER, 22V, BZV55C22 (SOD-80) | DZ-96 |
| VR308,309 | DIODE, ZENER 15V, IN5352 (CASE 17) | DZ-76 |
| VR310,311 | DIODE, ZENER 6.2V, BZX84B6V2 (SOT-23) | DZ-87 |
| VR502 | DIODE, ZENER, 8.2V, MMBZ5237 (SOT-23) | DZ-92 |
| VR503,505 | DIODE,ZENER 15V,1N4744A (TO-41) | DZ-75 |
| VR504,507,508 | DIODE, ZENER, 4.3V,BZX84C4V3 (SOT-23) | DZ-85 |
| VR506,509 | DIODE,ZENER 5.1V, BZX84C5V1 (SOT-23) | DZ-88 |
| VR510,511 | DIODE, ZENER 3.3V, MMBZ5226BL(SOT-23) | DZ-94 |
| VR512 | DIODE, ZENER 6.2V, BZX84B6V2 (SOT-23) | DZ-87 |
| VR513 | DIODE ZENER, 10V, IN5240C(DO-35) | DZ-93 |
| W100 | JUMPER | J-15 |

Table 4-3

Model 2001 digital board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|---|--|---|
| | CLIP, GROUND CONN,BERG SOCKET (USE WITH U608) SOCKET, 44 PIN QUAD (USE WITH U611) VACUUM FLUORESCENT DISPLAY | 2001-352B CS-339 SO-134-32 SO-128-44 DD-51C |
| C101 | CAP,1,20%,250V,ALUMINUM ELECTROLYTIC | C-400-1 |
| C102 | CAP,10UF,20%,25V,TANTALUM (D7243) | C-440-10 |
| C602-607,620,636-640,661, 665-667,C670 | CAP,.1UF, 20%,50V,CERAMIC(1206) | C-418-.1 |
| C609 | CAP, .1UF, 20%,100V, CERAMIC (1812) | C-436-.1 |
| C611 | CAP, 15000uF, 20%, 16V, ALUM ELECT. | C-450-15000 |
| C613,619,632 | CAP, 10UF,20%, 25V, TANTALUM (D7243) | C-440-10 |
| C617,618 | CAP, 33PF, 10%, 100V, CERAMIC (1206) | C-451-33P |
| C621-623,626-628,664,668 | CAP, .01uF, 20%, 50V, CERAMIC (1206) | C-418-.01 |
| C624,630,633 | CAP, 1000UF, + /-20%, 16V, ALUMINUM | C-488-1000 |
| C625 | CAP, 47UF,10%,16V,ALUM ELEC | C-321-47 |
| C631 | CAP, 3.3UF, 20%, 50V, POLY-FILM | C-470-3.3 |
| C641-659,671,672 | CAP,270PF,20%,100V,CERAMIC / FERRITE | C-386-270P |
| C668 | CAP, .01uF, 20%, 50V, CERAMIC (1206) | C-418-.01 |
| C669 | CAP, 47PF, 10%, 100V, CERAMIC(1206) | C-451-47P |
| C901 | CAP,22UF, 20%, 6.3,TANTALUM(C6032) | C-417-22 |
| C902,904,907,908,910 | CAP, .1UF, 20%,100V, CERAMIC (1812) | C-436-.1 |
| C903,905,906,909,911 | CAP,.1UF, 20%,50V,CERAMIC(1206) | C-418-.1 |
| CR101,102 | DIODE,SWITCHING,MMBD914(SOT-23) | RF-83 |
| CR103-106 | DIODE,SWITCHING,250MA,BAV103 (SOD-80) | RF-89 |
| CR602-619,626 | DIODE, SWITCHING, 250MA,BAV103 (SOD-80) | RF-89 |
| CR622 | DIODE, BRIDGE PE05 (CASE KBU) | RF-48 |
| CR624,625 | DIODE,SILICON,IN4006 (D0-41) | RF-38 |
| CR627,628 | DIODE,ARRAY,MMAD1103,(SOIC) | RF-80 |
| J1027 | CONN,HEADER STRAIGHT SOLDER PIN | CS-368-20 |
| J1028 | CONN,RIGHT ANGLE,24PIN | CS-507 |
| J1029,1030 | CONN, MICRODIN W / GND FINGERS | CS-792 |
| J1031 | CONN, RT ANGLE, MALE, 9 PIN | CS-761-9 |
| J1032 | CONN, RT. ANGLE, MALE MOLEX .156 | CS-715-4 |
| J1033 | CONN, HEADER STRAIGHT SOLDER PIN | CS-368-16 |
| J1034 | CONN, MALE RT ANGLE, 32-PIN | CS-456 |
| J1037 | FOR FN-26 CONN, MALE 3 PIN | CS-612-1 |
| L603-607 | CHOKE, SHIELD BEAD | CH-52 |
| P1033 | CABLE ASSEMBLY | CA-62-4A |

Table 4-3 (continued)
 Model 2001 digital board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|--|--|---|
| Q101,102 Q602-607 Q608 | TRANS,NPN TRANS,N CHAN MOSPOW FET,2N7000 (TO-92) TRANS,N-CHANNEL FET,TN06L TG-216 | TG-271 TG-195 TG-216 |
| R101 R102 R103 | RES,240,250MW,METAL FILM(1210) RES,1K,250MW,METAL FILM(1210) RES,1M,125MW,METAL FILM(1210) | R-376-240 R-376-1K R-375-1M |
| R601,603-605,610,R672 R606,607 R616,621,625,629,R631 R639 R644 R648-650,655-657 R663,677 R665 R667,669 R668 R670,675 | RES, 2K, 1%, 125mW, METAL FILM (1206) RES, 4.7K, 5%, 250MW, METAL FILM(1210) RES,10,5%,125MW,METAL FILM(1206) RES, 680K, 5%,125mW, METAL FILM (1206) RES NET,4.7K,2%,1.875W(SOMIC) RES, 5.1K,5%, 125MW, METAL FILM (1206) RES,4.7K,5%,125MW,METAL FILM(1206) RES, 470,5%, 125MW, METAL FILM(1206) RES, 560, 5%, 250mW, METAL FILM (1210) RES, 10K, 5%, 250MW, METAL FILM(1210) RES,100,5%,250MW,METAL FILM(1210) | R-391-2K R-376-4.7K R-375-10 R-375-680K TF-219-4.7K R-375-5.1K R-375-4.7K R-375-470 R-376-560 R-376-10K R-376-100 |
| R705 R706,708,711,729 R707 R709 R710,716 R712 R713 R714 R715,743-748,752-755,757, 768-770 R717,720 R718,719,730 R721 R732-742,749,771 R758-763 R772 | RES, 15K, 1%, 125mW, METAL FILM (1206) RES, 10K, 1%, 125mW, METAL FILM (1206) RES, 150, 5%, 250MW, METAL FILM (1210) RES, 14K, 1%, 125mW, METAL FILM (1206) RES, 1M, 5%, 250MW METAL FILM (1210) RES, 100K, 1%, 125mW, METAL FILM (1206) RES, 200K, 1%, 125MW, METAL FILM (1206) RES, 4.7K, 5%, 250MW, METAL FILM(1210) RES, 100, 5%, 125MW, METAL FILM (1206) RES, 10K, 5%, 250MW, METAL FILM(1210) RES,1K, 5% 250MW, METAL FILM (1210) RES, 2.15K, 5%, 250MW, METAL FILM (1210) RES,10K,5%,125MW,METAL FILM(1206) RES, 39, 5%, 125MW, METAL FILM(1206) RES,47K,5%,125MW,METAL FILM(1206) | R-391-15K R-391-10K R-376-150 R-391-14K R-376-1M R-391-100K R-391-200K R-376-4.7K R-375-100 R-376-10K R-376-1K R-376-2.15K R-375-10K R-375-39 R-375-47K |
| R901 R902 | RES NET, 15K, 2%, 1.875W(SOMIC) RES, 13K, 5%,125MW, METAL FILM(1206) | TF-219-15K R-375-13K |
| T101 | TRANSFORMER | TR-292A |
| TP601-603 | CONN,TEST POINT | CS-553 |

Table 4-3 (continued)
 Model 2001 digital board, parts list

| Circuit Desig. | Description | Keithley Part No. |
|------------------|---|-------------------|
| U608 | IC,(8KX8)HI SPEED STATIC CMOS RAM,6264 | LSI-66 |
| U609,610,635,636 | IC,32KX8 STAT CMOS RAM,D43256C(SOMETRIC) | LSI-93-100 |
| U611 | PROGRAM | 2001-800-** |
| U612 | IC,350MA SATURATED SINK DRIVER UDN-2596A | IC-578 |
| U614 | IC,OCT BFR/LINE DRIVE,74HCT244(SOLIC) | IC-651 |
| U615,630 | IC, QUAD 2 IN NOR, 74HCT02 (SOIC) | IC-809 |
| U616 | IC, QUAD 2 INPUT OR, 74HCT32 (SOIC) | IC-808 |
| U617 | IC, SERIAL E EPROM, X24C16(8-PIN DIP) | IC-736 |
| U618 | PROGRAM | 2001-801-** |
| U619,629 | IC,+5V VOLTAGE REGULATOR,LM2940CT | IC-576 |
| U620 | IC, DUAL POWER-SUPPLY SUPER, TL7770-5 | IC-805 |
| U621 | IC,OCTAL INTERFACE BUS,75160(SOLIC) | IC-646 |
| U622 | IC, GPIB ADAPTER, 9914A (PLCC) | LSI-123 |
| U623 | IC,OCTAL INTER BUS TRANS,75161(SOLIC) | IC-647 |
| U625 | MOD,DC-AC/DC, 5DV-5VAC/60DC,E705-E905VF,MO-30 | 182-170B |
| U626 | IC, 16-BIT MICRO, MC68302FE | LSI-106 |
| U627 | IC, 18V OP-AMP, TLC 271 | IC-347 |
| U628 | IC, VOLT COMPARATOR LM393D(SOIC) | IC-775 |
| U631 | IC,16-BIT MICRO,MC68302FC | LSI-144 |
| U634 | IC,SERIAL EEPROM, X24164(8-PIN DIP) | IC-885 |
| U637 | PROGRAM | 2001-803-** |
| U638 | PROGRAM | 2001-804-** |
| U901,904,905 | IC, LATCHED DRIVERS,UCN-5812EPF-1(PLCC) | IC-732 |
| U902 | PROGRAM | 7001-800-** |
| U903 | IC, 32-BIT, SERIAL UCN5818EPF-1(PLCC) | IC-830 |
| VR601 | DIODE, ZENER, 8.2V, MMBZ5237 (SOT-23) | DZ-92 |
| VR602,603 | DIODE,ZENER,4.7V,IN4732A(D0-41) | DZ-67 |
| W602,603 | JUMPER | J-15 |
| W605,606 | CONN,3 PIN | CS-339-3 |
| W606 | CONNECTOR, JUMPER | CS-476 |
| Y602 | CRYSTAL, 16MHZ | CR-30-16M |
| Y603 | OSCILLATOR CMOS 4,MHZ(SMT) | CR-34 |

** Order present firmware revision level for main CPU (i.e., 2001-801-A05).

Table 4-4
Model 2001 miscellaneous, parts list

| Description | Keithley Part no. |
|--|-------------------|
| BEZEL, REAR | 428-303 |
| BRACKET, REAR PANEL | 2001-328 |
| BUMBER | FE-27A |
| CARD GUIDE, LONG | 2001-315 |
| CARD GUIDE, SHORT | 2001-316 |
| CHOKE | CH-58-1 |
| CLIP, REGULATOR | 2001-343 |
| CONDUCTIVE RUBBER SWITCH | 2001-318 |
| CONNECTOR | CS-236 |
| CONNECTOR | CS-276 |
| COVER | 2001-360 |
| DISPLAY LENS | 2001-317 |
| FILTER, FAN | 2001-353 |
| FOOT | 428-319 |
| FOOT, EXTRUDED | FE-22 |
| FOOT, RUBBER | FE-6 |
| FRONT PANEL ASSEMBLY | 2001-061 |
| FRONT PANEL | 2001-302 |
| FRONT / REAR SWITCH ROD | 2001-322 |
| FUSE, 2A,250V, FAST-BLO(5X20MM) | FU-48 |
| GROMMET | GR-48-1 |
| HANDLE | 428-329 |
| HANDLE TO CASE FASTENER | FA-230-2 |
| HOLDER, FERRITE | 2001-367 |
| IEEE CONNECTOR, HARDWARE KIT | CS-713 |
| INSULATOR, REGULATOR | 2001-359 |
| JACK, CURRENT INPUT | 2001-312 |
| LEXAN, ANALOG BOTTOM SHIELD (FOR 2001-339) | 2001-340 |
| LEXAN SHIELD, CHASSIS LEFT | 2001-326 |
| LEXAN SHIELD, CHASSIS-RIGHT | 2001-336 |
| LINE CORD | CO-7 |
| LUG | LU-88 |
| MOUNTING EAR, LEFT | 428-338 |
| MOUNTING EAR, RIGHT | 428-328 |
| OVERLAY, INPUTS | 2001-310 |
| PC BOARD STOP | 2001-335 |
| PLASTIC PLUG (FOR SCANNER COVER PLATE) | FA-240 |
| POWER ROD | 2001-320 |
| PRINTED, FRONT PANEL | 2001-356 |
| SHIELDED, ANALOG BOTTOM SHIELD | 2001-339 |
| SHIELDED, ANALOG TOP SHIELD | 2001-338 |
| REAR BEZEL TO CHASSIS CAPTIVE PANEL SCREW | FA-232-1 |
| RFI CLIP, CHASSIS | 2001-366-14 |
| RFI CLIP, CHASSIS | 2001-366-5 |
| TRANSFORMER | TR-280 |
| TRANSFORMER BRACKET | 2001-308 |

Table 4-4 (continued)

Model 2001 miscellaneous, parts list

| Description | Keithley Part no. |
|--|------------------------------|
| "D" CONN. REAR OF DIGITAL BOARD SCREWLOCK, FEMALE #12 PVC- 4 1/8" FAN, DC BRUSHLESS, 12VDC, 100mA | CS-725 FN-26 |
| CONN, AC RECEPTACLE (LINE FILTER) | LF-6-1 |
| BANANA JACK, PUSH-IN, RED | BJ-13-2 |
| BANANA JACK, PUSH-IN, BLACK | BJ-13-0 |
| BANANA JACK, PUSH-IN, WHITE | BJ-13-9 |
| CONN, MOLEX HEADER | CS-716-3 |
| CONNECTOR, HOUSING | CS-638-3 |

A

Model 2001 Specifications

Model 2001 specifications are available for download from the Keithley [Product Support and Downloads web page](http://tek.com/support/product-support) (tek.com/support/product-support).

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