Agilent U2300A Series USB Multifunction Data Acquisition Devices

Service Guide

Agilent Technologies

Notices

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	Direct current
	Warning

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General Safety Information

WARNING

- Do not use the device if it is damaged.Before you use the device, inspect the case. Look for cracks or missing plastic. Do not operate the device around explosive gas, vapor or dust.
- Do not apply more than the rated voltage (as marked on the device) between terminals, or between terminal and external ground.
- Always use the device with the cables provided.
- Observe all markings on the device before connecting to the device.
- Turn off the device and application system power before connecting to the I/O terminals.
- When servicing the device, use only specified replacement parts.
- Do not operate the device with the removable cover removed or loosened.
- Do not connect any cables and terminal block prior to performing self-test process.
- Use only the power adapter supplied by the manufacturer to avoid any unexpected hazards.

CAUTION

- Do not load the output terminals above the specified current limits. Applying excessive voltage or overloading the device will cause irreversible damage to the circuitry.
- Applying excessive voltage or overloading the input terminal will damage the device permanently.
- If the device is used in a manner not specified by the manufacturer, the protection provided by the device may be impaired.
- Always use dry cloth to clean the device. Do not use ethyl alcohol or any other volatile liquid to clean the device.
- Do not permit any blockage of the ventilation holes of the device.

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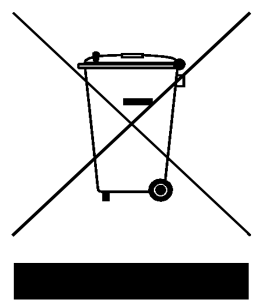
This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category:

With reference to the equipment types in the WEEE directive Annex 1, this instrument is classified as a “Monitoring and Control Instrument” product.

The affixed product label is shown as below:



Do not dispose in domestic household waste

To return this unwanted instrument, contact your nearest Agilent office, or visit:

http://www.agilent.com/environment/product

for more information.

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Characteristics and Specifications

This chapter specifies the specifications of the U2300A DAQ devices.

Product Specifications

Basic Multifunction DAQ Device Specifications

Table 1-1 Product specifications for basic multifunction DAQ device (U2351A, U2352A, U2353A, and U2354A)

Analog Input				
Model Number	**U2351A**	**U2352A**	**U2353A**	**U2354A**
Resolution	16 bits, no missing codes			
Number of channels	16 SE/8 DI (software selectable/channel)			
Maximum sampling rate	250 kSa/s		500 kSa/s	
Scan list memory	Up to 100 selectable channels entries			
Programmable bipolar input range	±10 V, ±5 V, ±2.5 V, ±1.25 V			
Programmable unipolar input range	0 to 10 V, 0 to 5 V, 0 to 2.5 V, 0 to 1.25 V			
Input coupling	DC			
Input impedance	1 GΩ / 100 pF			
Operational common mode voltage range	±7.5 V maximum[4]			
Overvoltage protection	Power on: Continuous ±30 V, Power off: Continuous ±15 V			
Trigger sources	External analog/digital trigger, SSI/star trigger[1]			
Trigger modes	Pre- trigger, delay-trigger, post-trigger and middle-trigger			
FIFO buffer size	Up to 8 MSa			

Analog Output				
Model Number	**U2351A**	**U2352A**	**U2353A**	**U2354A**
Resolution	16 bits	N/A	16 bits	N/A
Number of channels	2	N/A	2	N/A
Maximum update rate	1 MSa/s	N/A	1 MSa/s	N/A
Output ranges	0 to 10 V, ±10 V, 0 to AO_EXT_REF, ±AO_EXT_REF[2]	N/A	0 to 10 V, ±10 V, 0 to AO_EXT_REF, ±AO_EXT_REF[2]	N/A
Output coupling	DC	N/A	DC	N/A
Output impedance	0.1 Ω Typical	N/A	0.1 Ω Typical	N/A
Stability	Any passive load up to 1500 pF	N/A	Any passive load up to 1500 pF	N/A
Power-on state	0 V steady state	N/A	0 V steady state	N/A
Trigger sources	External analog/digital trigger, SSI/star trigger[1]	N/A	External analog/digital trigger, SSI/star trigger[1]	N/A
Trigger modes	Post-trigger and delay-trigger	N/A	Post-trigger and delay-trigger	N/A
FIFO buffer size	1 channel: Maximum 8 MSa 2 channels: Maximum 4 MSa/ch	N/A	1 channel: Maximum 8 MSa 2 channels: Maximum 4 MSa/ch	N/A
Function generation mode	Sine-wave, square-wave, triangle, sawtooth and noise waveform	N/A	Sine-wave, square-wave, triangle, sawtooth and noise waveform	N/A

Digital I/O	
Model Number	**U2351A | U2352A | U2353A | U2354A**
Number of bits	24-bit programmable input/output
Compatibility	TTL
Input voltage	V_{IL} = 0.7 V maximum, I_{IL} = 10 µA maximum V_{IH} = 2.0 V minimum, I_{IH} = 10 µA maximum
Input voltage range	–0.5 V to +5.5 V
Output voltage	V_{OL} = 0.45 V maximum, I_{OL} = 8 mA maximum V_{OH} = 2.4 V minimum, I_{OH} = 400 µA maximum

General Purpose Digital Counter	
Model Number	**U2351A | U2352A | U2353A | U2354A**
Maximum count	(2^{31}-1) bits
Number of channels	Two independent up/down counter
Compatibility	TTL
Clock source	Internal or external
Base clock available	48 MHz
Maximum clock source frequency	12 MHz
Input frequency range	0.1 Hz to 6 MHz at 50% duty cycle
Pulse width measurement range	0.167 µs to 178.956 s

Analog Trigger	
Model Number	**U2351A | U2352A | U2353A | U2354A**
Trigger source	All analog input channels, External analog trigger (EXTA_TRIG)
Trigger level	±Full Scale for internal; ±10 V for external
Trigger conditions	Above high, below low and window (software selectable)
Trigger level resolution	8 bits
Bandwidth	400 kHz
Input Impedance for EXTA_TRIG	20 kΩ
Coupling	DC
Overvoltage Protection	Continuous for ± 35 V maximum

Digital Trigger	
Model Number	**U2351A | U2352A | U2353A | U2354A**
Compatibility	TTL/CMOS
Response	Rising or falling edge
Pulse width	20 ns minimum

Calibration[3]	
Model Number	**U2351A | U2352A | U2353A | U2354A**
On board reference voltage	5 V
Temperature drift	±2 ppm/°C
Stability	±6 ppm/1000 hours

General	
Model Number	**U2351A | U2352A | U2353A | U2354A**
Remote interface	Hi-Speed USB 2.0
Device class	USBTMC Class Device [5][6]
Programmable interface	Standard Commands for Programmable Instruments (SCPI) and IVI-COM

[1] System Synchronous Interface (SSI) and Star-trigger commands are used when modular devices are used in instrument chassis.

[2] Maximum external reference voltage for analog output (AO_EXT_REF) is ±10 V.

[3] 20 minutes warm-up time is recommended.

[4] Refer to Figure 1-1 for more information.

[5] Compatible with Microsoft Windows operating systems only.

[6] Requires a direct USB connection to the PC so the appropriate driver can be installed in the USB modular instrument or USB DAQ module.

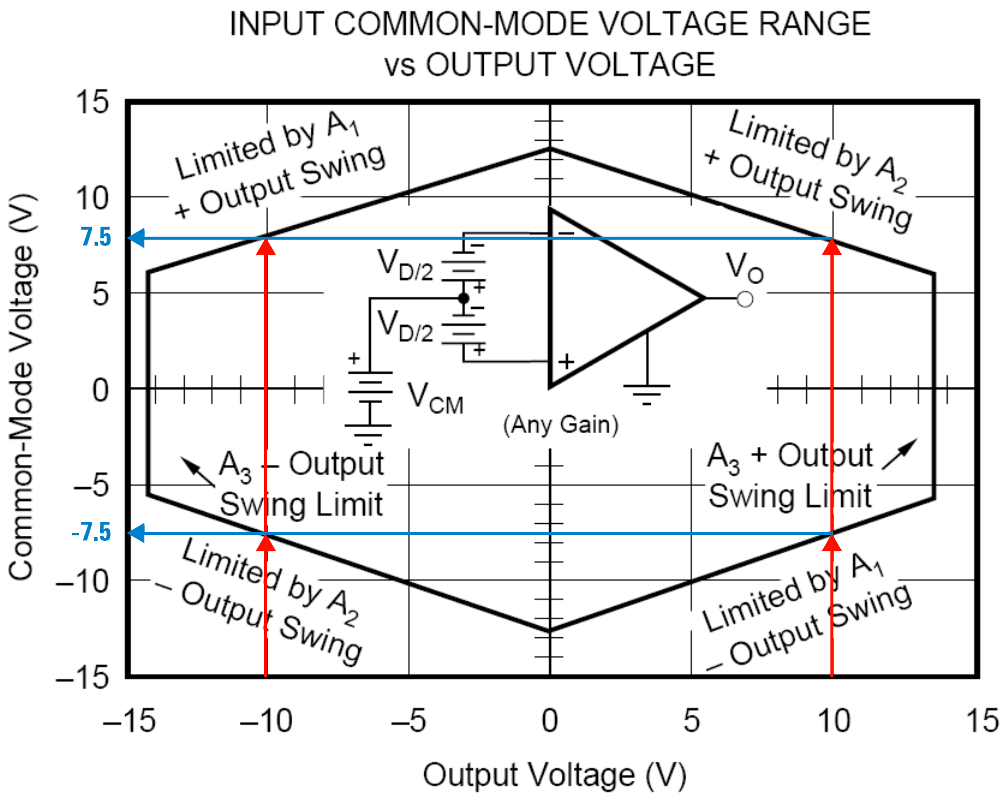

Figure 1-1 Operational common mode voltage range

This graph shows that the common mode voltage range is tightly linked with the output voltage. The output voltage range of the DAQ devices is ±10 V. Therefore, the common mode voltage range is ±7.5 V. Any operation beyond these voltage ranges may produce unexpected and unreliable results, and should be avoided.

High Density Multifunction DAQ Device Specifications

Table 1-2 Product specifications for high density multifunction DAQ device (U2355A, U2356A and U2331A)

Analog Input			
Model Number	**U2355A**	**U2356A**	**U2331A**
Resolution	16 bits, no missing codes		12 bits, no missing codes
Number of channels	64 SE/32 DI (software selectable/channel)		
Maximum sampling rate	250 kSa/s	500 kSa/s	3 MSa/s (single channel) 1 MSa/s (multi channels)
Scan list memory	Up to 100 selectable channels entries		
Programmable bipolar input range	±10 V, ±5 V, ±2.5 V, ±1.25 V		±10 V, ±5 V, ±2.5 V, ±1.25 V, ±1 V, ±0.5 V, ±0.25 V, ±0.2 V, ±0.05 V
Programmable unipolar input range	0 to 10 V, 0-5 V, 0-2.5 V, 0-1.25 V		0-10 V, 0-5 V, 0-4 V, 0-2.5 V, 0-2 V, 0-1 V, 0-0.5 V, 0-0.4 V, 0-0.1V
Input coupling	DC		
Input impedance	1 GΩ / 100 pF		
Operational common mode voltage range	±7.5 V maximum		
Overvoltage protection	Power on: Continuous ±30 V, Power off: Continuous ±15 V		
Trigger sources	External analog/digital trigger, SSI/star trigger[1]		
Trigger modes	Pre-trigger, delay-trigger, post-trigger and middle-trigger		
FIFO buffer size	Up to 8 MSa		

Analog Output			
Model Number	**U2355A**	**U2356A**	**U2331A**
Resolution	12 bits		
Number of channels	2		
Maximum update rate	1 MSa/s		
Output ranges	0 to 10 V, ±10 V, 0 to AO_EXT_REF, ±AO_EXT_REF[2]		
Output coupling	DC		
Output impedance	0.1 Ω Typical		
Stability	Any passive load up to 1500 pF		
Power on state	0 V steady state		
Trigger sources	External analog/digital trigger, SSI/star trigger[1]		
Trigger modes	Post-trigger and delay-trigger		
FIFO buffer size	1 channel: Maximum 8 MSa, 2 channels: Maximum 4 MSa/ch		
Function generation mode	Sine-wave, square-wave, triangle, sawtooth and noise waveform		

Digital I/O	
Model Number	**U2355A | U2356A | U2331A**
Number of bits	24-bit programmable input/output
Compatibility	TTL
Input voltage	V_{IL} = 0.7 V max, I_{IL} = 10 µA max V_{IH} = 2.0 V min, I_{IH} = 10 µA max
Input voltage range	–0.5 V to +5.5 V
Output voltage	V_{OL} = 0.45 V max, I_{OL} = 8 mA max V_{OH} = 2.4 V min, I_{OH} = 400 µA max

General Purpose Digital Counter	
Model Number	**U2355A | U2356A | U2331A**
Maximum count	(2^{31}-1) bits
Number of channels	Two independent up/down counter
Compatibility	TTL
Clock source	Internal or external
Base clock available	48 MHz
Maximum clock source frequency	12 MHz
Input frequency range	0.1 Hz to 6 MHz at 50% duty cycle
Pulse width measurement range	0.167 µs to 178.956 s

Analog trigger	
Model Number	**U2355A | U2356A | U2331A**
Trigger source	All analog input channels, External analog trigger (EXTA_TRIG)
Trigger level	±Full Scale for internal; ±10 V for external
Trigger conditions	Above high, below low and window (software selectable)
Trigger level resolution	8 Bits
Bandwidth	400 kHz
Input Impedance for EXTA_TRIG	20 kΩ
Coupling	DC
Overvoltage Protection	Continuous for ±35 V maximum

Digital Trigger	
Model Number	**U2355A | U2356A | U2331A**
Compatibility	TTL/CMOS
Response	Rising or falling edge
Pulse width	20 ns minimum

Calibration[3]	
Model Number	**U2355A | U2356A | U2331A**
On board reference	5 V
Temperature drift	±2 ppm/°C
Stability	±6 ppm/1000 hours

General	
Model Number	**U2355A | U2356A | U2331A**
Remote interface	Hi-Speed USB 2.0
Device class	USBTMC Class Device
Programmable interface	Standard Commands for Programmable Instruments (SCPI) and IVI-COM

[1] System Synchronous Interface (SSI) and Star-trigger commands are used when modular devices are used in instrument chassis.

[2] Maximum external reference voltage for analog output (AO_EXT_REF) is ±10 V.

[3] 20 minutes warm-up time is recommended.

Electrical Measurement Specifications

Basic Multifunction USB DAQ Device

Analog Input Measurement[1]				
Model Number	**U2351A | U2352A**		**U2353A | U2354A**	
Function	**23 °C ± 5 °C**	**0 °C to 18 °C 28 °C to 45 °C**	**23°C ± 5°C**	**0°C to 18°C 28°C to 45°C**
Offset Error	±1 mV	±5 mV	±1 mV	±5 mV
Gain Error	±2 mV	±5 mV	±2 mV	±5 mV
–3 dB small signal bandwidth[2]	760 kHz		1.5 MHz	
1% THD large signal bandwidth[2]	300 kHz		300 kHz	
System noise	1 mVrms	2 mVrms	1 mVrms	2.5 mVrms
CMRR	62 dB		62 dB	
Spurious-free dynamic range (SFDR)[3]	88 dB		82 dB	
Signal-to-noise and distortion ratio (SINAD)[3]	80 dB		78 dB	
Total harmonic distortion (THD)[3]	–90 dB		–82 dB	
Signal-to-noise ratio (SNR)[3]	80 dB		78 dB	
Effective number of bits (ENOB)[3]	13		12.6	

Analog Output Measurement[1]		
Model Number	**U2351A | U2353A**	
Function	**23 °C ± 5 °C**	**0 °C to 18 °C 28 °C to 45 °C**
Offset Error	±1 mV	±4 mV
Gain Error	±4 mV	±5 mV
Slew rate	19 V/µs	
Rise time	0.9 µs	
Fall time	0.9 µs	
Settling time to 1% output error	4 µs	
Driving capability	5 mA	
Glitch energy	5 ns-V (Typical), 80 ns-V (Maximum)	

[1] Specifications are for 20 minutes of warm-up time, calibration temperature at 23 °C and input range of ±10 V.

[2] Specifications are based on the following test conditions.

Bandwidth Test	Model Number	Test Conditions (DUT setting at ±10 V bipolar)	
• –3 dB small signal bandwidth • 1% THD large signal bandwidth	U2351A U2352A	Sampling Rate: Input voltage: • –3 dB small signal bandwidth • 1% THD large signal bandwidth	250 kSa/s 10% FSR FSR –1 dB FS
	U2353A U2354A	Sampling Rate: Input voltage: • –3 dB small signal bandwidth • 1% THD large signal bandwidth	 500 kSa/s 10% FSR FSR –1 dB FS

[3] Specifications are based on the following test conditions.

Dynamic Range Test	Model Number	Test Conditions (DUT setting at ±10 V bipolar)	
SFDR, THD, SINAD, SNR, ENOB	U2351A U2352A	Sampling Rate: Fundamental Frequency: Number of points: Fundamental input voltage:	250 kSa/s 2.4109 kHz 8192 FSR –1 dB FS
	U2353A U2354A	Sampling Rate: Fundamental Frequency: Number of points: Fundamental input voltage:	500 kSa/s 4.974 kHz 16384 FSR –1 dB FS

High Density Multifunction USB DAQ Device

Analog Input Measurement[1]						
Model Number	**U2355A**		**U2356A**		**U2331A**	
Function	**23 °C ± 5 °C**	**0 °C - 18 °C 28 °C - 45 °C**	**23 °C ± 5 °C**	**0 °C to 18 °C 28 °C to 45 °C**	**23 °C ± 5 °C**	**0 °C to 18 °C 28 °C to 45 °C**
Offset Error	±1 mV	±2 mV	±1 mV	±2 mV	±2 mV	±3 mV
Gain Error	±2 mV	±3 mV	±2 mV	±6 mV	±6 mV	±7.5 mV
–3 dB small signal bandwidth[2]	760 kHz		1.3 MHz		1.2 MHz	
1% THD large signal bandwidth[2]	400 kHz		400 kHz		N/A	
System noise	1 mVrms	2 mVrms	1 mVrms	4 mVrms	3 mVrms	5 mVrms
CMRR	64 dB		61 dB		62 dB	
Spurious-free dynamic range (SFDR)[3]	88 dB		86 dB		71 dB	
Signal-to-noise and distortion ratio (SINAD)[3]	80 dB		78 dB		72 dB	
Total harmonic distortion (THD)[3]	–90 dB		–84 dB		–76 dB	
Signal-to-noise ratio (SNR)[3]	80 dB		78 dB		72 dB	
Effective number of bits (ENOB)[3]	13		12.6		11.6	

Analog Output Measurement[1]				
Model Number	**U2355A | U2356A**		**U2331A**	
Function	**23 °C ± 5 °C**	**0 °C to 18 °C 28 °C to 45 °C**	**23 °C ± 5 °C**	**0 °C to 18 °C 28 °C to 45 °C**
Offset Error	±1 mV	±4 mV	±1.5 mV	±3mV
Gain Error	±4 mV	±5 mV	±4 mV	±5 mV
Slew rate	19 V/μs		19 V/μs	
Rise time	0.9 μs		0.9 μs	
Fall time	0.9 μs		0.9 μs	
Settling time to 1% output error	4 μs		4 μs	
Driving capability	5 mA		5 mA	
Glitch energy	5 ns-V (Typical), 80 ns-V (Maximum)		5 ns-V (Typical), 80 ns-V (Maximum)	

[1] Specifications are for 20 minutes of warm-up time, calibration temperature at 23 °C and input range of ±10 V.

[2] Specifications are based on the following test conditions.

Bandwidth Test	Model Number	Test Conditions (DUT setting at ±10 V bipolar)	
• –3 dB small signal bandwidth • 1% THD large signal bandwidth	U2355A	Sampling Rate: Input voltage: • –3 dB small signal bandwidth • 1% THD large signal bandwidth	250 kSa/s 10% FSR FSR –1 dB FS
	U2356A	Sampling Rate: Input voltage: • –3 dB small signal bandwidth • 1% THD large signal bandwidth	 500 kSa/s 10% FSR FSR –1 dB FS
	U2331A	Sampling Rate: Input voltage: • –3 dB small signal bandwidth • 1% THD large signal bandwidth	 3 MSa/s 10% FSR FSR –1 dB FS

[3] Specifications are based on the following test conditions.

Dynamic Range Test	Model Number	Test Conditions (DUT setting at ±10 V bipolar)	
SFDR, THD, SINAD, SNR, ENOB	U2355A	Sampling Rate: Fundamental Frequency: Number of points: Fundamental input voltage:	250 kSa/s 2.4109 kHz 8192 FSR –1 dB FS
	U2356A	Sampling Rate: Fundamental Frequency: Number of points: Fundamental input voltage:	500 kSa/s 4.974 kHz 16384 FSR –1 dB FS
	U2331A	Sampling Rate: Fundamental Frequency: Number of points: Fundamental input voltage:	3 MSa/s 29.892 kHz 65536 FSR –1 dB FS

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2
Calibration

This chapter includes the equipments required for the calibration procedure and describe the hardware connection for analog input and analog output. The self-calibration procedure, performance verification procdure and adjustment procedure are also included.

Introduction

Prior to checking the performace of the instrument, ensure that you have all the equipments listed in the following to perform the verification procedure for analog input and analog output.

Equipment Checklist

- ✔ Agilent U2300A Series USB Multifunction DAQ devices
- ✔ Agilent Digital Multimeter (DMM) 34401A/34410A
- ✔ Fluke Calibrator 5520A/5720A
- ✔ Computer with Agilent IO Library Suites installed
- ✔ U2901A Terminal Block
- ✔ USB Mini-B Cable
- ✔ U2901A SCSI Cable

Follow the following steps to ensure the instrument gives accurate analog input readings and analog outputs.

1. Perform the self-calibration procedure. See "Self-Calibration".
2. Perform the performance verification procedure. See "Performance Verification Procedure", "Analog Input Connection" for information on analog input connection and "Analog Output Connection" for information on analog output connection.
3. If the instrument gives accurate readings or accurate outputs, adjustment procedure is not necessary. If the instrument does not give accurate readings or accurate outputs, perform the adjustment procedure. See "Adjustment Procedures".
4. After perform the adjustment procedure, repeat the self-calibration procedure and then perform the verification procedure.
5. If the instrument still does not give accurate readings or accurate outputs, repeat step 3 and step 4.

Types Of Signal Sources

Ground-referenced signal sources

A ground-referenced signal source is defined as a signal source that is connected in some way to the building's grounding system. This means that the signal source is connected to a common ground point with respect to the U2300A series DAQ (assume the host PC which is connected with DAQ is in the same power ground).

Floating signal sources

A floating signal source is a signal that is not connected to the building's grounding system. It is also a device with an isolated output. Example of floating signal sources are optical isolator output, transformer output, and thermocouple.

Input Configurations

Single-ended connections

A single-ended connection is applicable when the analog input signal is referenced to a ground and can be shared with other analog input signals. There are two different types of single-ended connections, which are RSE and NRSE configuration.

- **Referenced Single-Ended (RSE) mode**
  In referenced single-ended mode, all the input signals are connected to the ground provided by the U2300A series DAQ and suitable for connections with floating signal sources. The following figure illustrates the RSE mode.

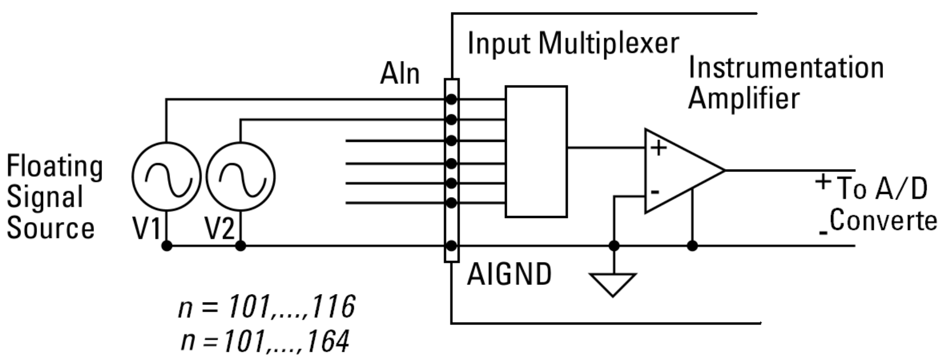


Figure 2-1 Floating source and RSE input connections

NOTE When more than two floating sources are connected, these sources are referenced to the same common ground.

- **Non-Referenced Single-Ended (NRSE) Mode**
  In NRSE mode, the DAQ device does not provide the grounding point. The ground reference point is provided by the external analog input signal. You can connect the signals in NRSE mode to measure ground-referenced signal sources, which are connected to the same grounding point. The following figure illustrates the connection. The signal local ground reference is connected to the negative input of the instrumentation Amplifier (AI_SENSE pin on connector1). Hence, any potential difference of the common mode ground between signal ground and the signal ground on DAQ board will be rejected by the instrumentation amplifier.

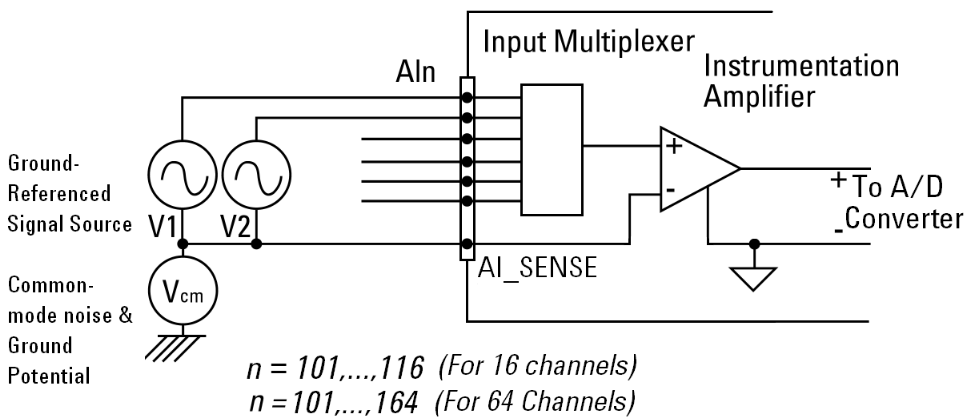


Figure 2-2 Ground-referenced sources and NRSE input connections

Differential Input Mode

The differential input mode provides two inputs that respond to the difference of the signal voltage. The analog input of the U2300A series DAQ has its own reference ground or signal return path. The differential mode can be used for the common-mode noise rejection if the signal source is ground-referenced. The following figure shows the connection of ground-referenced signal sources under differential input mode.

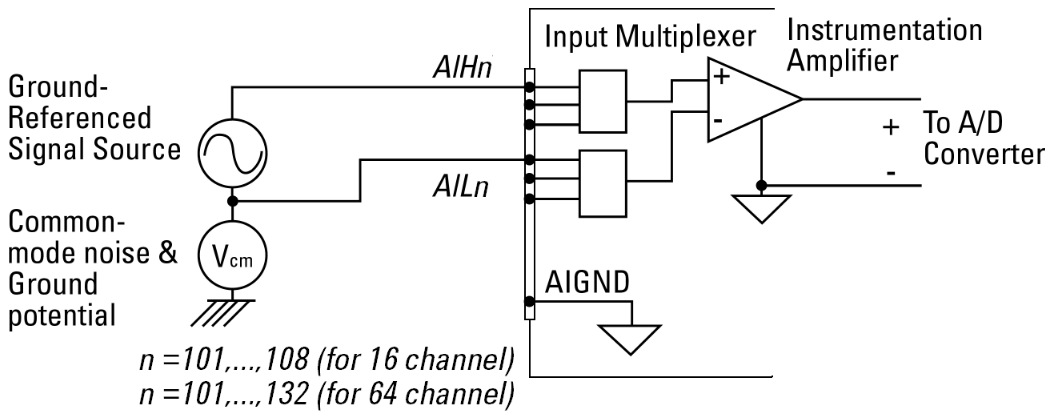


Figure 2-3 Ground-referenced source and differential input mode

The following figure illustrates the connection of a floating signal source to the U2300A series DAQ in differential input mode. For floating signal sources, additional resistor is needed at each channel to provide a bias return path. The resistor value is equivalent to about 100 times the source impedance. If the source impedance is less than 100 W, you can connect the negative polarity of the signal directly to AI_GND, as well as the negative input of the Instrumentation Amplifier. The noise couples in differential input mode are less compared to the single-ended mode.

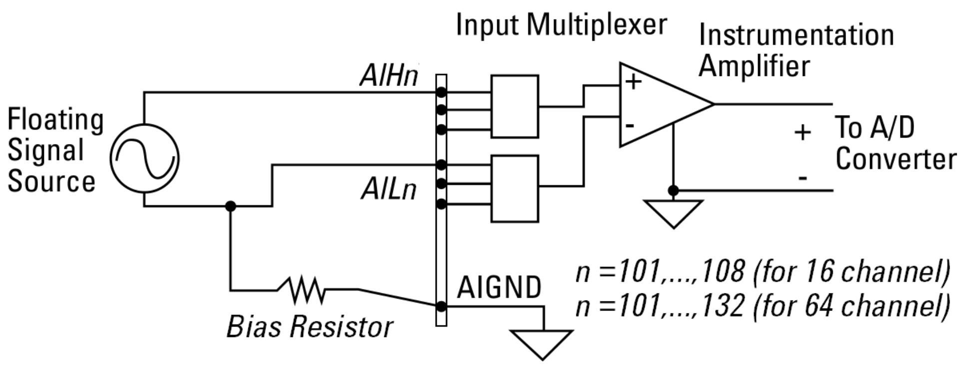


Figure 2-4 Floating source and differential input

NOTE

- Agilent U2300A series DAQ is designed with high input impedance. Please ensure that all the connection are connected properly before acquiring any data. Failing to do so may cause data fluctuation or erroneous readings.
- Unused pins at multiplexing DAQ inputs can be treated as floating source with infinite output impedance. Therefore, necessary grounding system is required in user application system.

Hardware Connection

The connection to verify the analog input readings and analog outputs are different. To verify the analog input readings, see "Analog Input Connection" for descriptions on the way to connect the instruments. To verify the analog outputs, see "Analog Output Connection" for descriptions on hardware setup.

Analog Input Connection

The equipments required for analog input connection are the DAQ device, Fluke calibrator, terminal block, USB mini-B cable and SCSI cable. Follow the follwing step-by-step instruction for analog input connection.

1 Connect the DAQ device to a PC with a USB mini-B cable and connect the DAQ device to a U2901A terminal block using the U2901A SCSI cable.

NOTE

- Ensure that the PC has the DAQ device's driver and the Agilent IO Libraries 14.2 or higher installed. Note that the Agilent Measurement Manager software comes with the standard purchase of the U2300A Series DAQ devices.
- If you do not have the DAQ device's driver and the Agilent IO Libraries 14.2 or higher installed, refer to the *Agilent U2300A Series Data Acquisition Devices and Agilent Measurement Manager Quick Start Guide*, for more information on the installation.

2 Short all the DAQ device's analog input channels. Refer to "Connector Pins Configuration" for the pins assignment.

3 Connect the DAQ device's analog input channels to the calibrator output.

4 Connect the DAQ device's analog input ground (AI_GND) to the calibrator ground. See Figure 2-1. Note that the analog inputs shown in the figure uses U2351A as an example.

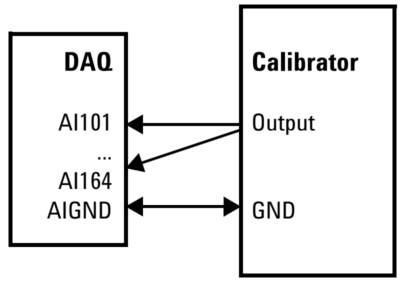


Figure 2-5 The analog input and calibrator connection

Setup diagram

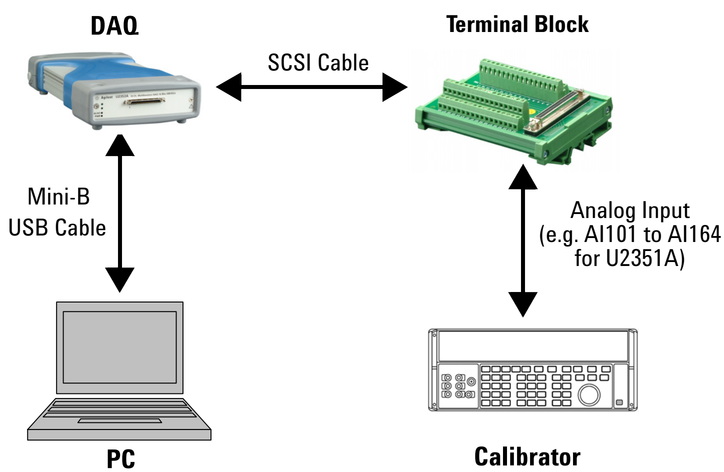


Figure 2-6 The analog input and calibrator connection

Analog Output Connection

The equipments required for analog output connection are the DAQ device, DMM, terminal block, USB mini-B cable and SCSI cable. Follow the follwing step-by-step instruction for analog input connection.

1 Connect the DAQ device to a PC with a USB mini-B cable and connect the DAQ device to a U2901A terminal block using the U2901A SCSI cable.

NOTE

- Ensure that the PC has the DAQ device's driver and the Agilent IO Libraries 14.2 or higher installed. Note that the Agilent Measurement Manager software comes with the standard purchase of the U2300A Series DAQ devices.
- If you do not have the DAQ device's driver and the Agilent IO Libraries 14.2 or higher installed, refer to the *Agilent U2300A Series Data Acquisition Devices and Agilent Measurement Manager Quick Start Guide*, for more information on the installation.

2 Connect a wire at each pin you would like to test on the U2901A terminal block. (Refer to "Connector Pins Configuration" for the pins assignment)

3 Connect the DAQ device's analog output channel 1 (AO201) to the DMM input.

4 Connect the DAQ device's analog output ground (AO_GND) to DMM GND.

5 Repeat steps 3 and 4 for analog output channel 2 (AO202).

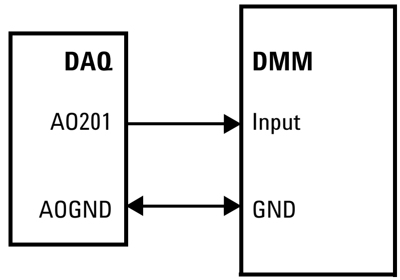


Figure 2-7 The analog input and DMM connection

Setup diagram

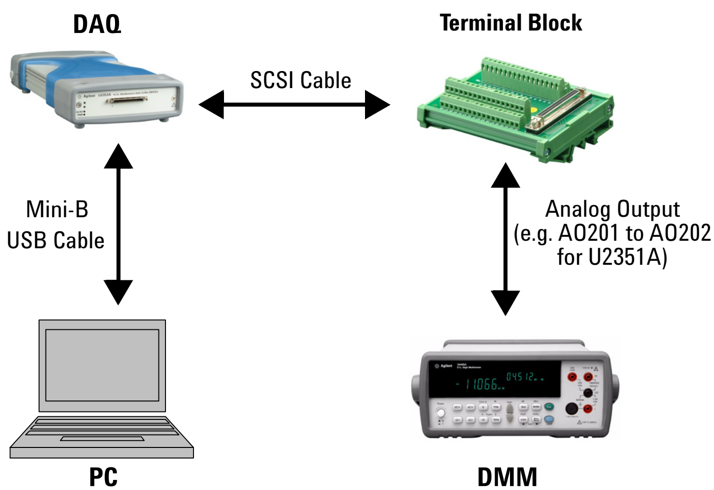


Figure 2-8 The analog output and DMM connection

Self-Calibration

Self-calibration can be operated using the following SCPI command via Agilent Connection Expert.

```
CALibration:BEGin
```

In calibration mode, the command will initiate a voltage adjustment in sequence for the specified Digital Analog Converter (DAC) channel. This sequence sets a zero and gain adjustment constant for each DAC output.

The function of DAQ device will not carry on until the self-calibration has completed. You can query the status of the self-calibration performed using the following SCPI command.

```
*OPC?
```

Two ways of performing the self-calibration will be introduced in this section. The first option is to use the Agilent Connection Expert to send the SCPI commands and the second option is to use the Agilent Measurement Manager application software.

Option 1: Self-calibration with Agilent Connection Expert

WARNING

- **Unplug all cables that are connected to the DAQ device before performing self-calibration.**
- **Any cables connected to the DAQ device may cause the failure of the self-calibration process.**

1 Power on the DAQ and disconnect all connections from DAQ device. Warm it up for 30 minutes to ensure that it is operating at stable condition.

2 Go to **Start > All Programs > Agilent IO Libraries Suite > Agilent Connection Expert** to launch the Agilent Connection Expert.

3 Connect the DAQ device to the PC with mini-B type USB cable. The connected DAQ device will be visible in the **Instrument I/O on this PC** panel as illustrated in Figure 2-5.

4 Select the DAQ device that you wish to send the SCPI commands to and then click the **Interactive IO** icon on the toolbar to launch the Agilent Interactive IO. See Figure 2-5.

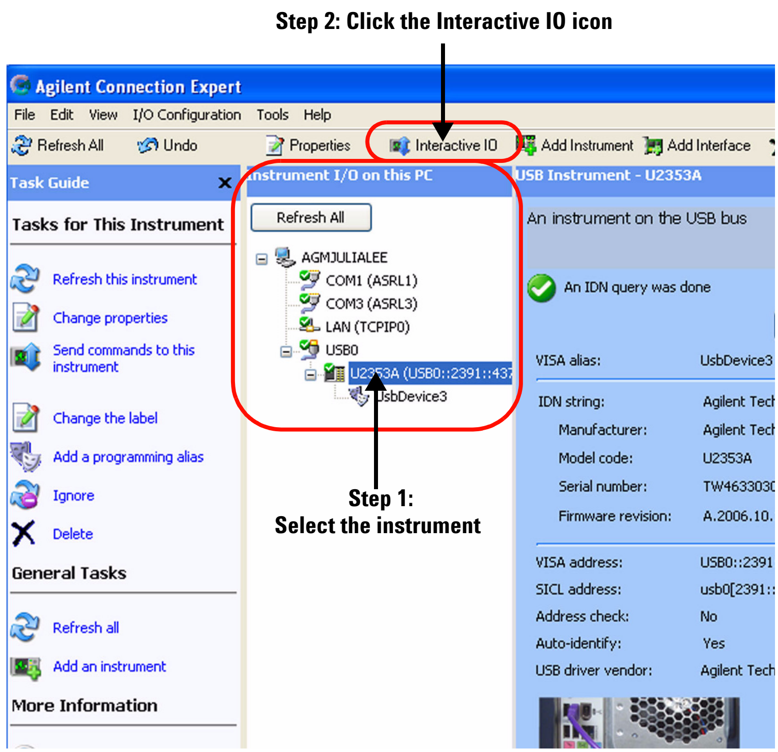


Figure 2-9 Launch the Interactive IO in Agilent Connection Expert

5 The **Agilent Interactive IO** dialog box will appear as shown in Figure 2-6. Click **Send & Read** to send the "`*IDN?`" default command. This instrument's response should appear in the **Instrument Session History** panel.

6 Successful communication between the Agilent Connection Expert and the connected hardware will be shown in the **Instrument Session History** panel. The users may now send other SCPI commands to the instrument.

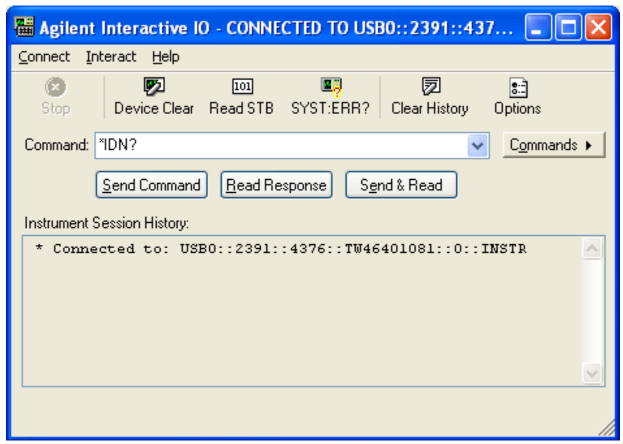


Figure 2-10 Interactive IO dialog box

7 Ensure that the DAQ device has been warmed up for 30 minutes. Send the SCPI commands "*RST" and "*CLS" to clear the register in DAQ device.

8 Send "CAL:BEG" to start the self-calibration process. This process may take a few minutes to complete.

9 Send "*OPC?" to check the operation complete status.

10 If "*OPC?" return 1, send "SYST:ERR?" to check if any system error has occurred during the self-calibration process. If there is no system error, the self-calibration process is done. Otherwise, the self-calibration process is failed.

Option 2: Self-calibration with Agilent Measurement Manager

WARNING

- **Unplug all cables that are connected to the DAQ device before performing self-calibration.**
- **Any cables connected to the DAQ device may cause the failure of the self-calibration process.**

1 Power on the DAQ device and disconnect all connections from it. Warm it up for 30 minutes to ensure that it is operating at stable condition.
2 Connect the DAQ device to the PC with mini-B type USB cable. Launch the Agilent Measurement Manager and select the DAQ device you wish to do the self-calibration process.
3 Go to **Tools** and select **Self Calibration**.
4 The **Self Calibration Form** dialog box will appear as shown below.

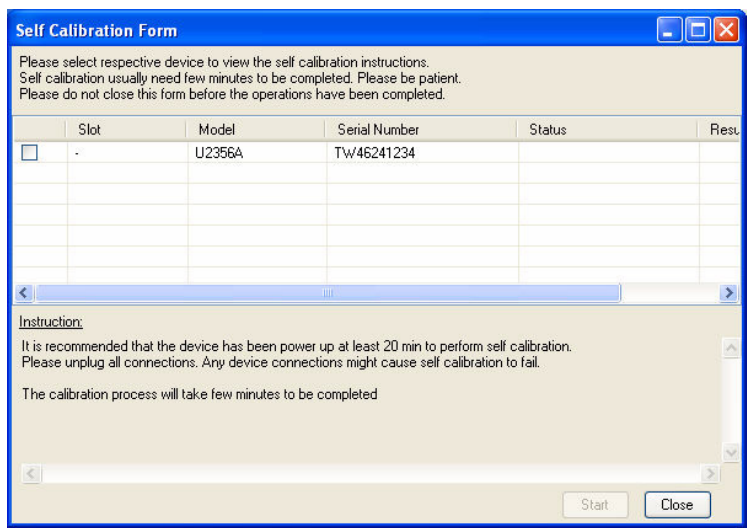


Figure 2-11 Self Calibration Form dialog box in Agilent Measurement Manager

5 Select the instrument that you would like to perform self-calibration and the **Start** button will be enabled. Click **Start** to proceed. See Figure 2-8.

6 The calibration process will take a few minutes to be completed. Once done, the status and results of the process will be displayed as shown in Figure 2-9.

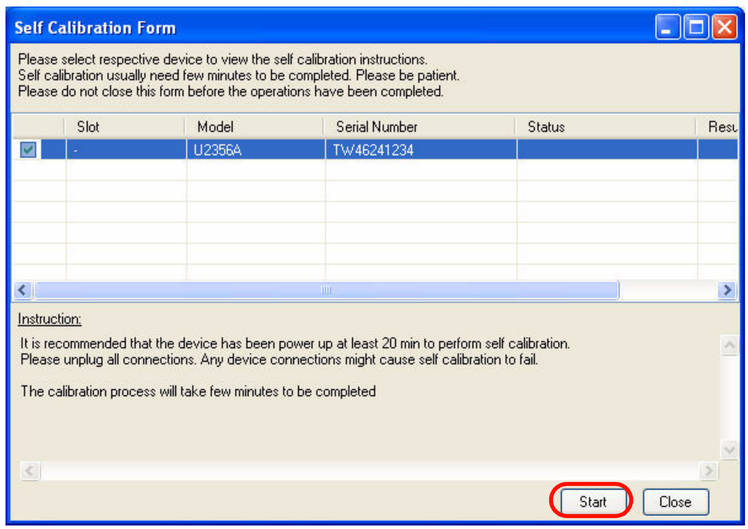


Figure 2-12 Self Calibration Form dialog box in Agilent Measurement Manager with a device being selected

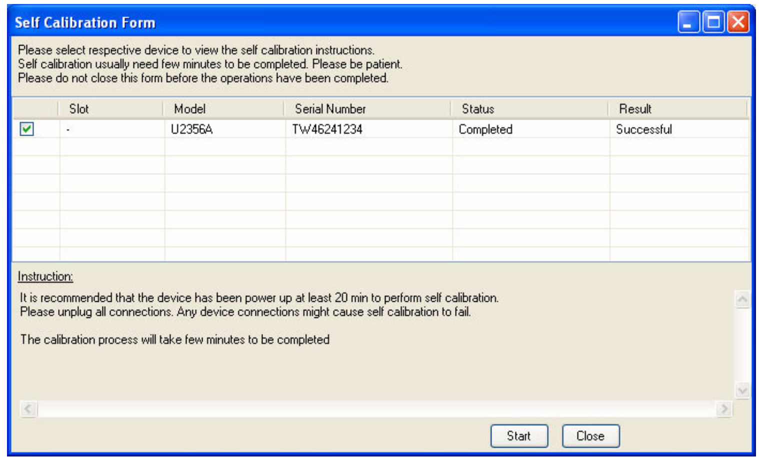


Figure 2-13 Self Calibration Form dialog box in Agilent Measurement Manaer showing the status and resultof the self-calibration process

Adjustment Procedures

DAQ on-board 5 V calibration

If in the performance verification procedure is not accurate, adjustment procedure is required. The following flowchart shows the steps for 5 V calibration.

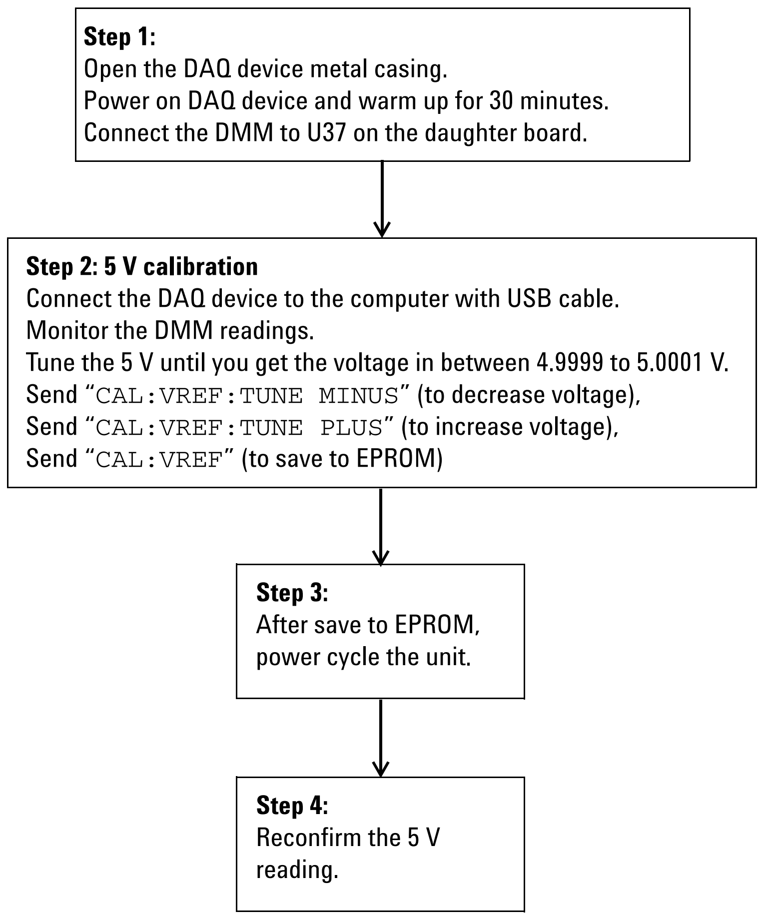
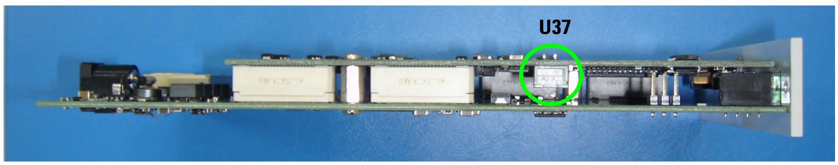
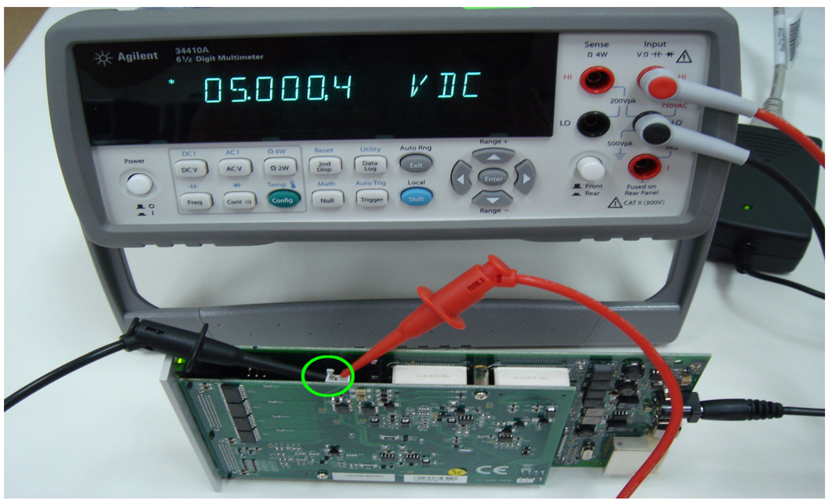


Figure 2-14 The flowchart showing the steps for 5 V calibration

Table 2-3 Step-by-step descriptions for Figure 2-10

Step	Descriptions
Step 1	Before power on the DAQ device, open the DAQ device's metal casing. Refer to "Dismantle Procedures" for more information to disassemble the unit. Then, power on the DAQ device and warm it up for approximately 30 minutes. Connect the DMM to **U37** on the daughter board. The following images shows the location of **U37** and the way to connect it.  
Step 2	Ensure that the DAQ device's driver is installed in the computer before connecting it to the computer. The driver can be obtained from the *Agilent USB Modular Instrument U2300A & U2700A Series Product Reference CD-ROM*. Measure the voltage difference at **U37** with the DMM. If the measured voltage is more than 5 V, send the command "`CAL:VREF:TUNE MINUS`" to decrease the voltage, otherwise if the measured voltage is less than 5 V, send the command "`CAL:VREF:TUNE PLUS`" to increase the voltage. Tune the voltage until the measured voltage is in the range of 4.9999 V and 5.0001 V. When the tuning process is done, send "`CAL:VREF`" to save it in the EPROM.
Step 3	Power cycle the DAQ device by turning on and off the DAQ device.
Step 4	Measure the voltage at **U37** again to ensure the measured voltage is in the range of 4.9999V to 5.0001 V. If there is any problem occurs, the DMM will not measure the voltage in the specified range. Proceed to self calibration procedure.

Performance Verification Procedure

Prior to calibrate the instrument, check the performance of the instrument to see if any adjustment is required, "Step 2: DAQ configuration and verification test".

This is to ensure that the DAQ device gives accurate readings or outputs. The performance verification procedure for analog input and analog output are automated and are verify using the *Automated Calibration* software.

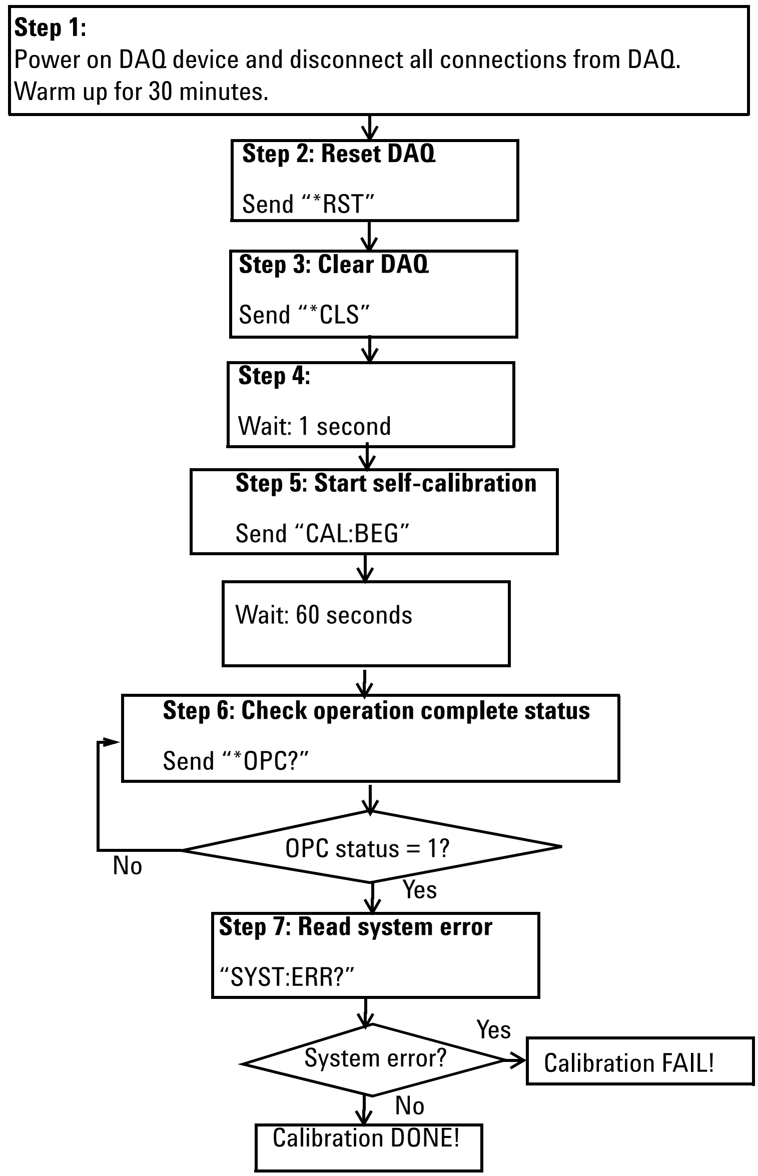
The performance verification procedure involve two steps:

Step 1: DAQ self-calibration

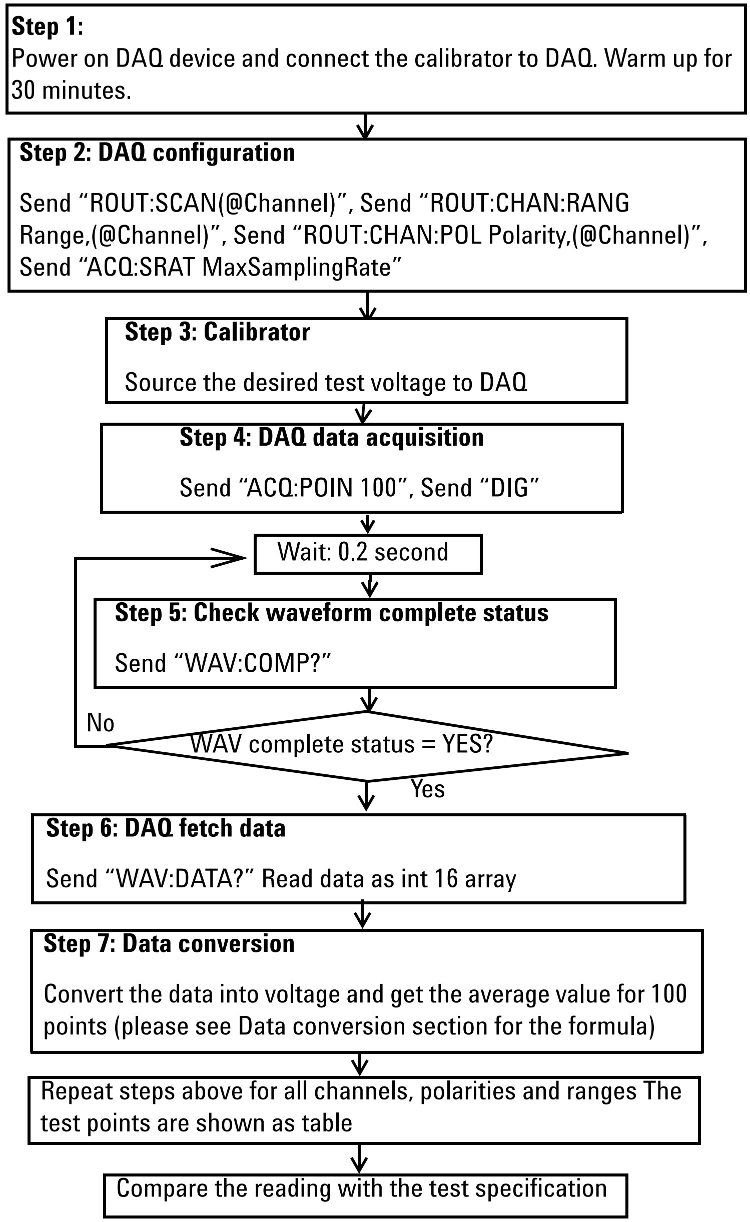
Step 2: DAQ configuration and verification test

Analog Output

Step 1: DAQ self-calibration

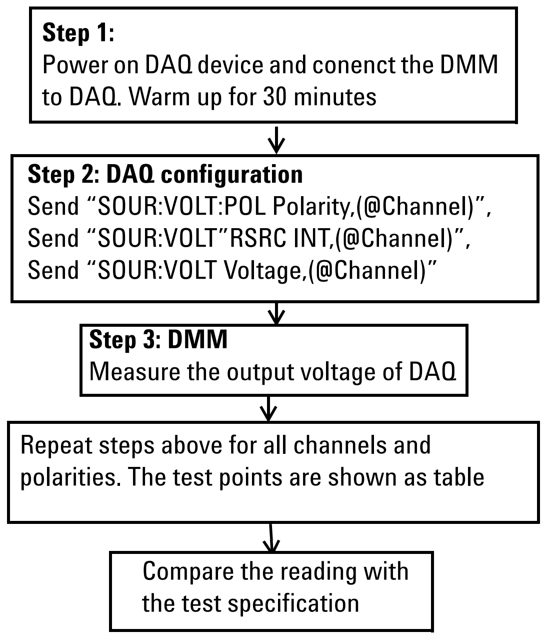


Step 2: DAQ configuration and verification test



NOTE Byte ordering must use LSB first.

Analog Output



A/D Data Conversion

A/D data conversion converts analog voltage into digital information. The following section illustrates the format of acquired raw data for the A/D conversion.

Below is the illustrated example of the acquired raw data scan list for CH 101, CH 102, and CH 103.

#800000200	**<byte>**	**<byte>**	**<byte>**	**<byte>**	**<byte>**	**<byte>**	**<byte>**	**<byte>**	**...**
Data length indicator, The next 8 bytes (0000 0200) specifying the actual data length only, not actual data. Data length (200 bytes long)	1st data LSB	1st data MSB	1st data LSB	1st data MSB	1st data LSB	1st data MSB	2nd data LSB	2nd data MSB	...
	CH 101		CH 102		CH 103		CH 101		...

16-bit Data Format

LSB	MSB
DDDD DDDD	DDDD DDDD

12-bit Data Format

LSB	MSB
DDDD XXXX	DDDD DDDD

D - Data bits

X - Unused bits

Raw data conversion

To convert the data into an actual float number, we need the voltage range and polarity information. Below are the calculations on the raw data conversion for both bipolar and unipolar.

To perform a sample calculation of the conversion, take the U2356A as an example. The resolution of U2356A is 16 bits and the range is taken as 10 V. The Int16b value calculated using conversion algorithm is 12768.

Hence, the 16 bits binary read back calculation will be as follows.

LSB MSB
<11100000> <00110001>
= 12768

NOTE

The raw data provided by U2300A series DAQ devices is in the byte order of LSB first.

Bipolar:

$$\text{Converted value} = \left(\frac{2 \times \text{Int16 value}}{2^{\text{resolution}}}\right) \times \text{Range}$$

$$\text{Example of converted value} = \left(\frac{2 \times 12768}{2^{16}}\right) \times 10 = 3.896 \text{ V}$$

Unipolar:

$$\text{Converted value} = \left(\frac{\text{Int16 value}}{2^{\text{resolution}}} + 0.5\right) \times \text{Range}$$

$$\text{Example of converted value} = \left(\frac{12768}{2^{16}} + 0.5\right) \times 10 = 6.948 \text{ V}$$

NOTE

The converted value is of float type. As such, you may need to type cast the Int16 value to float in your programming environment.

To perform a sample calculation of the conversion, take the U2331A as an example. The resolution of U2331A is 12 bits and the range is taken as 10 V. The Int12b value calculated using conversion algorithm is 12768.

LSB MSB
<11100000> <00110001>
= 12768

There are unused bits in the 12-bit data format. Therefore, there is a need to perform a 4-bit right shift operation. Hence, the 12 bits binary read back calculation will be as follows.

LSB MSB
<00011110> <00000011>
= 798

NOTE The raw data provided by U2300A series DAQ devices is in the byte order of LSB first.

Bipolar:

$$\textbf{Converted value} = \left(\frac{2 \times \text{Int16 value}}{2^{\text{resolution}}}\right) \times \text{Range}$$

$$\textbf{Example of converted value} = \left(\frac{2 \times 798}{2^{12}}\right) \times 10 = 3.896\ \text{V}$$

Unipolar:

$$\textbf{Converted value} = \left(\frac{\text{Int16 value}}{2^{\text{resolution}}} + 0.5\right) \times \text{Range}$$

$$\textbf{Example of converted value} = \left(\frac{798}{2^{12}} + 0.5\right) \times 10 = 6.948\ \text{V}$$

NOTE

- The converted value is of float type. As such, you may need to type cast the Int12 value to float in your programming environment.
- For the U2331A, there is a need to perform a 4-bit right shift operation. This is because it is equipped with 12-bit ADC, and the last 4 bits are truncated.

3
Dismantle Procedures

This chapter describes the step-by-step disassemble procedures and list the available replacement parts for U2300A Series DAQ devices,

General Disassemble

This chapter provides the step-by-step guides on how to dismantle the module and install the replacement assembly. To assemble back the module, follow the instructions in reverse order.

NOTE The parts shown in the following figures are representative and may look different than what you have in your module.

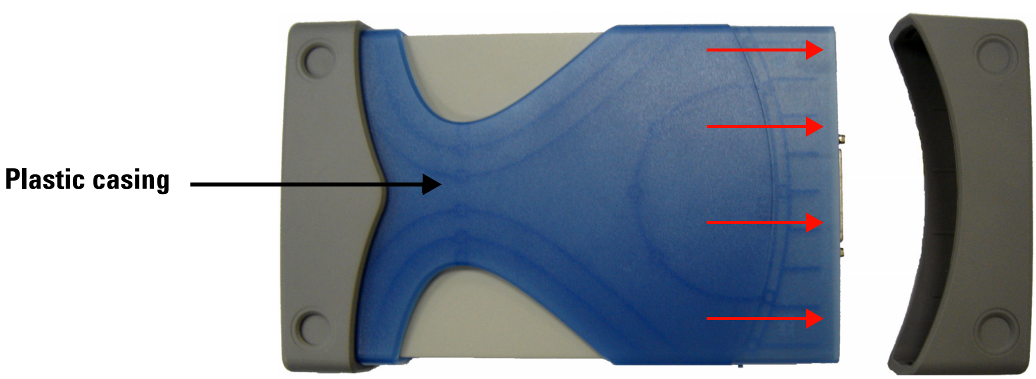
The removable assemblies include:

- Plastic casing
- Metal casing
- Rear metal casing
- Front metal casing, which is attached to the carrier board and measurement board

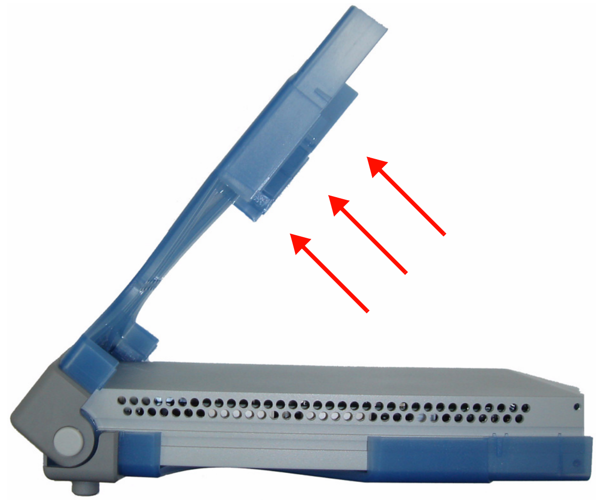
Mechanical Disassemble

Follow the instructions in this section for the instrument disassemble process.

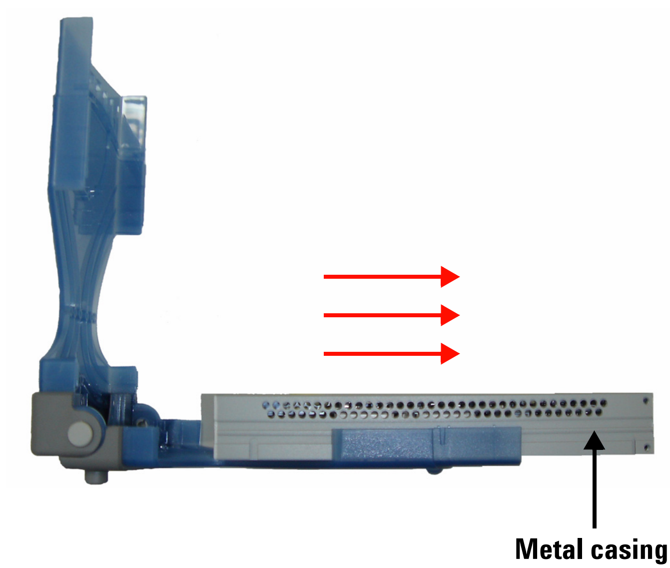
Step 1: Pull the bumper out to remove the plastic casing.



Step 2: Flip the plastic casing open.



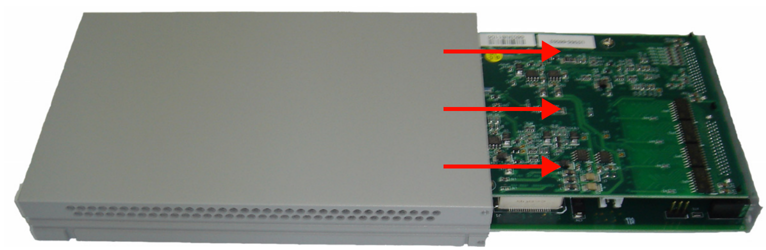
Step 3: Slide the metal casing out of the plastic casing.



Step 4: Unscrew all the following indicated screws from metal casing.

Front metal piece

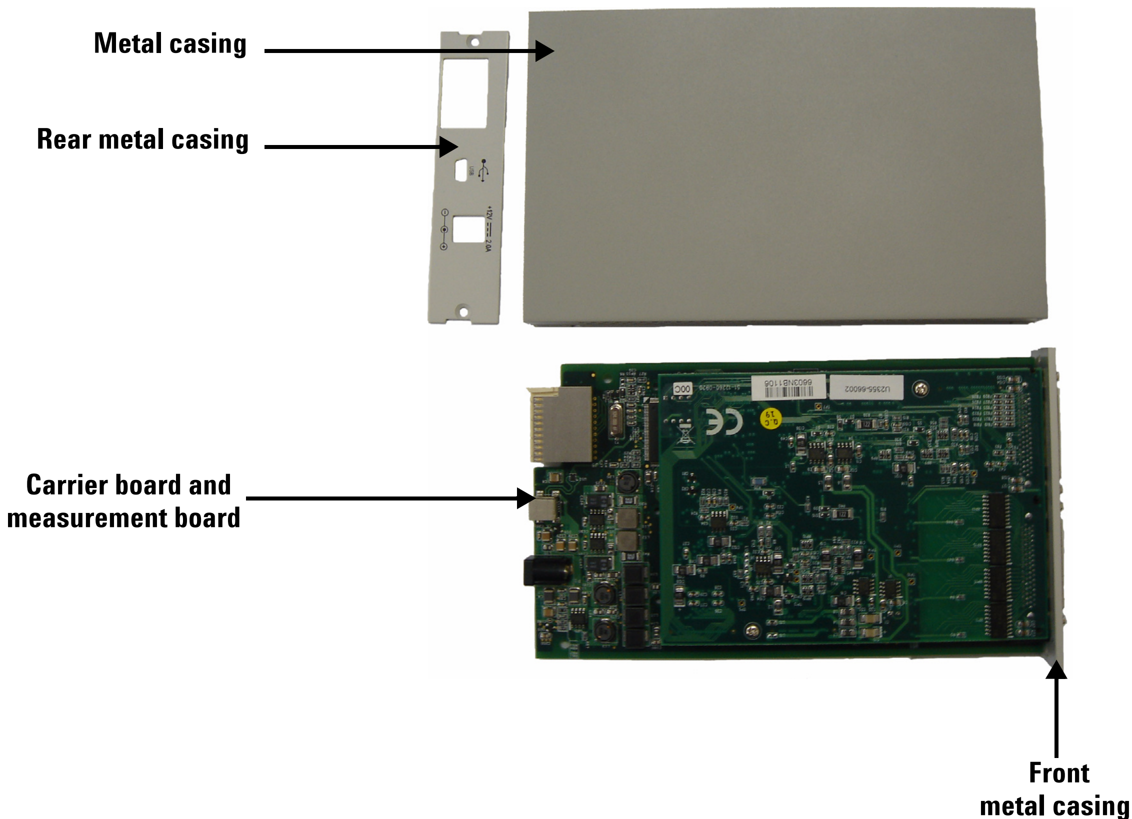
Step 5: Gently pull the front metal piece out, which is attached to the carrier and measurement boards.



Step 6: Unscrew all the following indicated screws from the metal casing and remove the rear metal piece.

Rear metal casing

Disassembled parts:



Replacement Parts

This section provides the information of orderable replacement parts for U2300A Series DAQ devices. The parts available for replacement are listed in the table below with the reference part numbers and the respective part names.

You can order the replacement parts from Agilent using the part number provided in the table below. To order replacement parts from Agilent, do the following:

1 Identify the Agilent part number of the required parts as shown in the replacement parts list.
2 Contact your nearest Agilent Sales Office or Service Center.
3 Provide the instrument model number and serial number.

Table 3-4 Replacement parts list

Part Number	Part Name
U2351-60002	Metal Casing
5190-0013	Plastic Cover
U2351-00201	Rear Metal Piece
U2351-61201	L-shape Mount

4
Troubleshooting and Self-Test Procedures

This chapter provides the information on general troubleshooting and self-test procedures.

Troubleshooting

This section provides suggestions for solving general problems that you may encounter with the instrument. It guides you on what to check in the following situations:

1. Power Indicator LED is not lit

Verify that the ac power cord is connected to the power inlet in the DAQ device.

2. Power Indicator LED is lit but the AO/ AI Indicator LED is not lit

Verify that the USB cable is connected to the PC and the USB inlet in the DAQ device.

3. Power Indicator LED is lit and AO/ AI Indicator LED is lit

Verify if the SCPI commands are correct with "`SYSTem:ERRor?`" command.

Refer to *U2300A Series USB Multifunction Programming Guide* for SCPI error messages.

4. Power Indicator LED is flashing

Verify that the green LED on the AC/DC adapter is steady. If the LED continues to flash, then there is a hardware defect. Please contact the Agilent Service Center for repair.

If the Agilent U2300A Series USB Multifunction DAQ module is installed in the U2781A 6-slot mainframe, then remove it temporarily and use the AC/DC adapter shipped with the Agilent U2300A Series USB Multifunction DAQ module to power it up.

NOTE If there is no response from the instrument, contact the nearest Agilent Service Center to obtain further assistance.

Self-Test Procedures

WARNING **Do not connect any cables and terminal block prior to performing self-test procedures.**

4 Go to **Start > All Programs > Agilent IO Libraries Suite > Agilent Connection Expert** to launch the Agilent Connection Expert.
5 Go to **Start > All Programs > Agilent T&M Toolkit > Agilent Interactive IO** to launch the Interactive I/O dialog box.
6 Send the SCPI command "`*TST?`" to the instrument to start perform the self-test of the instrument.
7 The command will return either "`+0`" to indicate all tests passes or "`+1`" to indicate one or more tests failed.
8 If the command returns "`+1`" , apply SCPI command "`SYSTem:ERRor?`" to enquire the error message.

NOTE Refer to *Agilent U2300A Series USB Multifunction Data Acquisition Programming Guide* for SCPI error messages.

A
Connector Pins Configuration

This appendix attached the pins configuration for all the U2300A Series DAQ devices.

Pins Configuration for U2331A, U2355A and U2356A

The U2300A Series DAQ is equipped with 68–pin very high density cable interconnect (VHDCI) type connectors.

AI101	(AIH101)	1	35	(AIL101)	AI133
AI102	(AIH102)	2	36	(AIL102)	AI134
AI103	(AIH103)	3	37	(AIL103)	AI135
AI104	(AIH104)	4	38	(AIL104)	AI136
AI105	(AIH105)	5	39	(AIL105)	AI137
AI106	(AIH106)	6	40	(AIL106)	AI138
AI107	(AIH107)	7	41	(AIL107)	AI139
AI108	(AIH108)	8	42	(AIL108)	AI140
AI109	(AIH109)	9	43	(AIL109)	AI141
AI110	(AIH110)	10	44	(AIL110)	AI142
AI111	(AIH111)	11	45	(AIL111)	AI143
AI112	(AIH112)	12	46	(AIL112)	AI144
AI113	(AIH113)	13	47	(AIL113)	AI145
AI114	(AIH114)	14	48	(AIL114)	AI146
AI115	(AIH115)	15	49	(AIL115)	AI147
AI116	(AIH116)	16	50	(AIL116)	AI148
	AI_SENSE	17	51	AI_GND	
AI117	(AIH117)	18	52	(AIL117)	AI149
AI118	(AIH118)	19	53	(AIL118)	AI150
AI119	(AIH119)	20	54	(AIL119)	AI151
AI120	(AIH120)	21	55	(AIL120)	AI152
AI121	(AIH121)	22	56	(AIL121)	AI153
AI122	(AIH122)	23	57	(AIL122)	AI154
AI123	(AIH123)	24	58	(AIL123)	AI155
AI124	(AIH124)	25	59	(AIL124)	AI156
AI125	(AIH125)	26	60	(AIL125)	AI157
AI126	(AIH126)	27	61	(AIL126)	AI158
AI127	(AIH127)	28	62	(AIL127)	AI159
AI128	(AIH128)	29	63	(AIL128)	AI160
AI129	(AIH129)	30	64	(AIL129)	AI161
AI130	(AIH130)	31	65	(AIL130)	AI162
AI131	(AIH131)	32	66	(AIL131)	AI163
AI132	(AIH132)	33	67	(AIL132)	AI164
	EXTA_TRIG	34	68	AI_GND	

Figure A-1 Pins Configuration of Connector 1 for U2331A, U2355A, U2356A

	AO201	1	35	AO_GND	
	AO202	2	36	AO_GND	
	AO_EXT_REF	3	37	AO_GND	
	NC	4	38	NC	
	D_GND	5	39	D_GND	
	EXTD_AO_TRIG	6	40	D_GND	
	EXTD_AI_TRIG	7	41	D_GND	
	RESERVED	8	42	RESERVED	
	RESERVED	9	43	RESERVED	
	RESERVED	10	44	RESERVED	
	RESERVED	11	45	RESERVED	
	RESERVED	12	46	D_GND	
	COUNT301_CLK	13	47	D_GND	
	COUNT301_GATE	14	48	D_GND	
	COUNT301_UPDOWN	15	49	D_GND	
	COUNT301_OUT	16	50	D_GND	
	COUNT302_CLK	17	51	D_GND	
	COUNT302_GATE	18	52	D_GND	
	COUNT302_UPDOWN	19	53	D_GND	
	COUNT302_OUT	20	54	D_GND	
	EXT_TIMEBASE	21	55	D_GND	
DIO502	Bit-7	22	56	Bit-6	DIO502
DIO502	Bit-5	23	57	Bit-4	DIO502
DIO502	Bit-3	24	58	Bit-2	DIO502
DIO502	Bit-1	25	59	Bit-0	DIO502
DIO504	Bit-3	26	60	Bit-2	DIO504
DIO504	Bit-1	27	61	Bit-0	DIO504
	D_GND	28	62	D_GND	
DIO503	Bit-3	29	63	Bit-2	DIO503
DIO503	Bit-1	30	64	Bit-0	DIO503
DIO501	Bit-7	31	65	Bit-6	DIO501
DIO501	Bit-5	32	66	Bit-4	DIO501
DIO501	Bit-3	33	67	Bit-2	DIO501
DIO501	Bit-1	34	68	Bit-0	DIO501

Figure A-2 Pins Configuration of Connector 2 for U2331A, U2355A, U2356A

NOTE (AIH101..132) and (AIL101..132) are for differential mode connection pair.

Pins Configuration for U2351A, U2352A, U2353A and U2354A

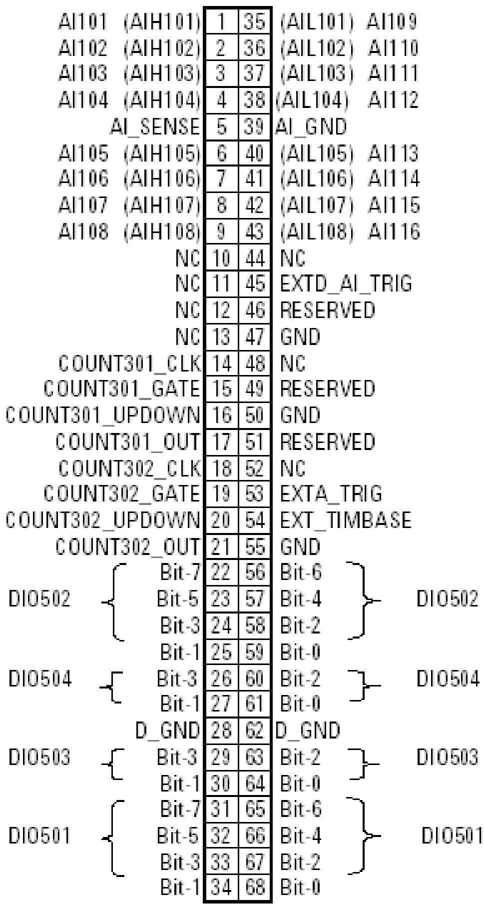


Figure A-3 Pins Configuration for U2352A, U2354A

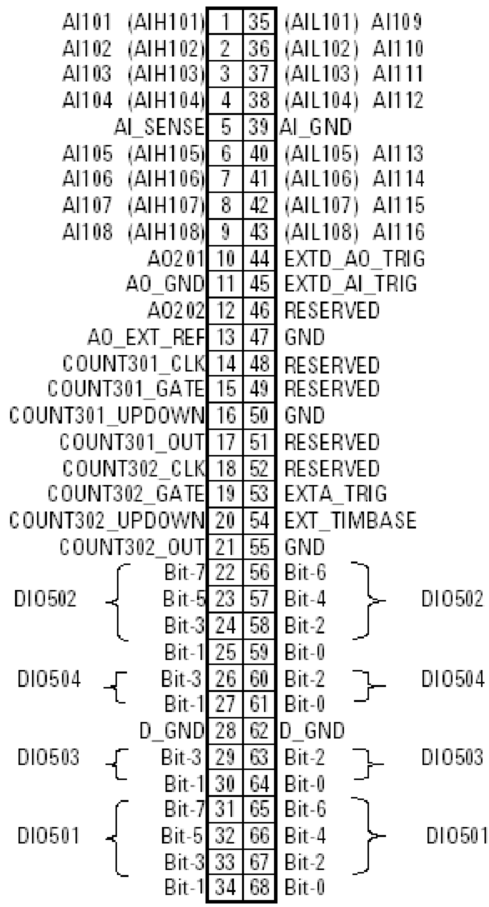


Figure A-4 Pins Configuration for U2351A, U2353A

NOTE (AIH101..108) and (AIL101..108) are for differential mode connection pair.

Table A-5 68-pin VHDCI connector pins descriptions

Signal Name	Direction	Reference Ground	Description
AI_GND	N/A	N/A	Analog input (AI) ground. All three ground references (AI_GND, AO_GND, and D_GND) are connected together on board.
For 16 Channels: AI<101..116> For 64 Channels: AI<101..164>	Input	AI_GND	**U2351A/U2352A/U2353A/U2354A** Analog input channels 101~116. Each channel pair, AI<i, i+8>(i = 101..108), can be configured either as two single-ended inputs or one differential input (marked as AIH<101..108> and AIL<101..108>). **U2331A/U2356A/U2355A** Analog input channels 101~164). Each channel pair, AI<i, i+32> (i = 101..132), is configured either as two single-ended inputs or one differential input (marked as AIH<101..132> and AIL<101..132>)
AI_SENSE	Input	AI_GND	Analog input sense. The reference pin for any AI<101..116> or AI<101..164> channels in NRSE input configuration.
EXTA_TRIG	Input	AI_GND	External AI analog trigger
AO201	Output	AO_GND	Analog output channel 1
AO202	Output	AO_GND	Analog output channel 2
AO_EXT_REF	Input	AO_GND	External reference for AO channels
AO_GND	N/A	N/A	Analog ground for AO
EXTD_AO_TRIG	Input	D_GND	External AO waveform trigger
EXTD_AI_TRIG	Input	D_GND	External AI digital trigger
RESERVED	Output	N/A	Reserved pins. Do not connect them to any signal.
COUNT<301,302>_CLK	Input	D_GND	Source of counter <301,302>
COUNT<301,302>_GATE	Input	D_GND	Gate of counter <301,302>
COUNT<301,302>_OUT	Input	D_GND	Output of counter <301,302>
COUNT<301,302>_UPDOWN	Input	D_GND	Up/Down of counter <301,302>
EXT_TIMEBASE	Input	D_GND	External Timebase
D_GND	N/A	N/A	Digital ground
DIO501<7,0>	PIO	D_GND	Programmable DIO of Channel 501
DIO502<7,0>	PIO	D_GND	Programmable DIO of Channel 502
DIO503<4,0>	PIO	D_GND	Programmable DIO of Channel 503
DIO504<4,0>	PIO	D_GND	Programmable DIO of Channel 504

B
Test Limits

This appendix provides the test limits for analog input and analog output when performing the verification procedure.

Analog Input

Analog Input U2351A, U2352A, U2353A, U2354A:								
Offset/ Gain Error (V)	Setting	Range (V)		Test Point (V)		Test Limit (V)		Test Result
	Polarity	Min	Max	Location	Value	Lower	Upper	Reading
0.001	BIP	–10	10	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.002	BIP	–10	10	Positive FS	9.98779	9.98579	9.98979	DAQ reading – Offset
0.002	BIP	–10	10	Negative FS	–9.98779	–9.98979	–9.98579	DAQ reading – Offset
0.001	BIP	–5	5	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.002	BIP	–5	5	Positive FS	4.99390	4.99190	4.99590	DAQ reading – Offset
0.002	BIP	–5	5	Negative FS	–4.99390	–4.99590	–4.99190	DAQ reading – Offset
0.001	BIP	–2.5	2.5	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.0015	BIP	–2.5	2.5	Positive FS	2.49695	2.49545	2.49845	DAQ reading – Offset
0.0015	BIP	–2.5	2.5	Negative FS	–2.49695	–2.49845	–2.49545	DAQ reading – Offset
0.001	BIP	–1.25	1.25	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.0015	BIP	–1.25	1.25	Positive FS	1.24847	1.24697	1.24997	DAQ reading – Offset
0.0015	BIP	–1.25	1.25	Negative FS	–1.24847	–1.24997	–1.24697	DAQ reading – Offset
0.0015	UNIP	0	10	Center FS	5.00000	4.99850	5.00150	Offset = DAQ reading – Calibrator source voltage
0.002	UNIP	0	10	Positive FS	9.99390	9.99190	9.99590	DAQ reading – Offset
0.002	UNIP	0	10	Negative FS	0.00610	0.00410	0.00810	DAQ reading – Offset
0.0015	UNIP	0	5	Center FS	2.50000	2.49850	2.50150	Offset = DAQ reading – Calibrator source voltage
0.002	UNIP	0	5	Positive FS	4.99695	4.99495	4.99895	DAQ reading – Offset
0.002	UNIP	0	5	Negative FS	0.00305	0.00105	0.00505	DAQ reading – Offset
0.001	UNIP	0	2.5	Center FS	1.25000	1.24900	1.25100	Offset = DAQ reading – Calibrator source voltage
0.001	UNIP	0	2.5	Positive FS	2.49847	2.49747	2.49947	DAQ reading – Offset
0.001	UNIP	0	2.5	Negative FS	0.00153	0.00053	0.00253	DAQ reading – Offset
0.001	UNIP	0	1.25	Center FS	0.62500	0.62400	0.62600	Offset = DAQ reading – Calibrator source voltage
0.001	UNIP	0	1.25	Positive FS	1.24924	1.24824	1.25024	DAQ reading – Offset
0.001	UNIP	0	1.25	Negative FS	0.00076	–0.00024	0.00176	DAQ reading – Offset

Analog Input
U2355A, U2356A:

Offset/ Gain Error (V)	Setting	Range (V)		Test Point (V)		Test Limit (V)		Test Result
	Polarity	Min	Max	Location	Value	Lower	Upper	Reading
0.001	BIP	–10	10	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.002	BIP	–10	10	Positive FS	9.98779	9.98579	9.98979	DAQ reading – Offset
0.002	BIP	–10	10	Negative FS	–9.98779	–9.98979	–9.98579	DAQ reading – Offset
0.001	BIP	–5	5	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.002	BIP	–5	5	Positive FS	4.99390	4.99190	4.99590	DAQ reading – Offset
0.002	BIP	–5	5	Negative FS	–4.99390	–4.99590	–4.99190	DAQ reading – Offset
0.001	BIP	–2.5	2.5	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.0015	BIP	–2.5	2.5	Positive FS	2.49695	2.49545	2.49845	DAQ reading – Offset
0.0015	BIP	–2.5	2.5	Negative FS	–2.49695	–2.49845	–2.49545	DAQ reading – Offset
0.001	BIP	–1.25	1.25	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.0015	BIP	–1.25	1.25	Positive FS	1.24847	1.24697	1.24997	DAQ reading – Offset
0.0015	BIP	–1.25	1.25	Negative FS	–1.24847	–1.24997	–1.24697	DAQ reading – Offset
0.001	UNIP	0	10	Center FS	5.00000	4.99900	5.00100	Offset = DAQ reading – Calibrator source voltage
0.0015	UNIP	0	10	Positive FS	9.99390	9.99240	9.99540	DAQ reading – Offset
0.0015	UNIP	0	10	Negative FS	0.00610	0.00460	0.00760	DAQ reading – Offset
0.001	UNIP	0	5	Center FS	2.50000	2.49900	2.50100	Offset = DAQ reading – Calibrator source voltage
0.0015	UNIP	0	5	Positive FS	4.99695	4.99545	4.99845	DAQ reading – Offset
0.0015	UNIP	0	5	Negative FS	0.00305	0.00155	0.00455	DAQ reading – Offset
0.001	UNIP	0	2.5	Center FS	1.25000	1.24900	1.25100	Offset = DAQ reading – Calibrator source voltage
0.001	UNIP	0	2.5	Positive FS	2.49847	2.49747	2.49947	DAQ reading – Offset
0.001	UNIP	0	2.5	Negative FS	0.00153	0.00053	0.00253	DAQ reading – Offset
0.001	UNIP	0	1.25	Center FS	0.62500	0.62400	0.62600	Offset = DAQ reading – Calibrator source voltage
0.001	UNIP	0	1.25	Positive FS	1.24924	1.24824	1.25024	DAQ reading – Offset
0.001	UNIP	0	1.25	Negative FS	0.00076	–0.00024	0.00176	DAQ reading – Offset

Analog Input U2331A:								
Offset/ Gain Error (V)	Setting	Range (V)		Test Point (V)		Test Limit (V)		Test Result
	Polarity	Min	Max	Location	Value	Lower	Upper	Reading
0.002	BIP	–10	10	Center FS	0.00000	-0.00200	0.00200	Offset = DAQ reading – Calibrator source voltage
0.006	BIP	–10	10	Positive FS	9.80469	9.79869	9.81069	DAQ reading – Offset
0.006	BIP	–10	10	Negative FS	–9.80469	–9.81069	–9.79869	DAQ reading – Offset
0.0015	BIP	–5	5	Center FS	0.00000	–0.00150	0.00150	Offset = DAQ reading – Calibrator source voltage
0.004	BIP	–5	5	Positive FS	4.90234	4.89834	4.90634	DAQ reading – Offset
0.004	BIP	–5	5	Negative FS	–4.90234	–4.90634	–4.89834	DAQ reading – Offset
0.0015	BIP	–2.5	2.5	Center FS	0.00000	–0.00150	0.00150	Offset = DAQ reading – Calibrator source voltage
0.002	BIP	–2.5	2.5	Positive FS	2.45117	2.44917	2.45317	DAQ reading – Offset
0.002	BIP	–2.5	2.5	Negative FS	–2.45117	–2.45317	–2.44917	DAQ reading – Offset
0.001	BIP	–1.25	1.25	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.0015	BIP	–1.25	1.25	Positive FS	1.22559	1.22409	1.22709	DAQ reading – Offset
0.0015	BIP	–1.25	1.25	Negative FS	–1.22559	–1.22709	–1.22409	DAQ reading – Offset
0.001	BIP	–1	1	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.001	BIP	–1	1	Positive FS	0.98047	0.97947	0.98147	DAQ reading – Offset
0.001	BIP	–1	1	Negative FS	–0.98047	–0.98147	–0.97947	DAQ reading – Offset
0.001	BIP	–0.5	0.5	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.001	BIP	–0.5	0.5	Positive FS	0.49023	0.48923	0.49123	DAQ reading – Offset
0.001	BIP	–0.5	0.5	Negative FS	–0.49023	–0.49123	–0.48923	DAQ reading – Offset
0.001	BIP	–0.25	0.25	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.001	BIP	–0.25	0.25	Positive FS	0.24512	0.24412	0.24612	DAQ reading – Offset
0.001	BIP	–0.25	0.25	Negative FS	–0.24512	–0.24612	–0.24412	DAQ reading – Offset
0.001	BIP	–0.2	0.2	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.001	BIP	–0.2	0.2	Positive FS	0.19609	0.19509	0.19709	DAQ reading – Offset
0.001	BIP	–0.2	0.2	Negative FS	–0.19609	–0.19709	–0.19509	DAQ reading – Offset
0.001	BIP	–0.05	0.05	Center FS	0.00000	–0.00100	0.00100	Offset = DAQ reading – Calibrator source voltage
0.001	BIP	–0.05	0.05	Positive FS	0.04902	0.04802	0.05002	DAQ reading – Offset
0.001	BIP	–0.05	0.05	Negative FS	–0.04902	–0.05002	–0.04802	DAQ reading – Offset

Analog Input
U2331A:

Offset/ Gain Error (V)	Setting	Range (V)		Test Point (V)		Test Limit (V)		Test Result
	Polarity	Min	Max	Location	Value	Lower	Upper	Reading
0.0015	UNIP	0	10	Center FS	5.00000	4.99850	5.00150	Offset = DAQ reading – Calibrator source voltage
0.004	UNIP	0	10	Positive FS	9.90234	9.89834	9.90634	DAQ reading – Offset
0.004	UNIP	0	10	Negative FS	0.09766	0.09366	0.10166	DAQ reading – Offset
0.0015	UNIP	0	5	Center FS	2.50000	2.49850	2.50150	Offset = DAQ reading – Calibrator source voltage
0.002	UNIP	0	5	Positive FS	4.95117	4.94917	4.95317	DAQ reading – Offset
0.002	UNIP	0	5	Negative FS	0.04883	0.04683	0.05083	DAQ reading – Offset
0.001	UNIP	0	4	Center FS	2.00000	1.99850	2.00150	Offset = DAQ reading – Calibrator source voltage
0.0015	UNIP	0	4	Positive FS	3.96094	3.95894	3.96294	DAQ reading – Offset
0.0015	UNIP	0	4	Negative FS	0.03906	0.03706	0.04106	DAQ reading – Offset
0.001	UNIP	0	2.5	Center FS	1.25000	1.24900	1.25100	Offset = DAQ reading – Calibrator source voltage
0.001	UNIP	0	2.5	Positive FS	2.47559	2.47409	2.47709	DAQ reading – Offset
0.001	UNIP	0	2.5	Negative FS	0.02441	0.02291	0.02591	DAQ reading – Offset
0.001	UNIP	0	2	Center FS	1.0000	0.99900	1.00100	Offset = DAQ reading – Calibrator source voltage
0.001	UNIP	0	2	Positive FS	1.98047	1.97947	1.98147	DAQ reading – Offset
0.001	UNIP	0	2	Negative FS	0.01953	0.01853	0.02053	DAQ reading – Offset
0.001	UNIP	0	1	Center FS	0.50000	0.49900	0.50100	Offset = DAQ reading – Calibrator source voltage
0.001	UNIP	0	1	Positive FS	0.99023	0.98923	0.99123	DAQ reading – Offset
0.001	UNIP	0	1	Negative FS	0.00977	0.00877	0.01077	DAQ reading – Offset
0.001	UNIP	0	0.5	Center FS	0.25000	0.24900	0.25100	Offset = DAQ reading – Calibrator source voltage
0.001	UNIP	0	0.5	Positive FS	0.49512	0.49412	0.49612	DAQ reading – Offset
0.001	UNIP	0	0.5	Negative FS	0.00488	0.00388	0.00588	DAQ reading – Offset
0.001	UNIP	0	0.4	Center FS	0.20000	0.19900	0.20100	Offset = DAQ reading – Calibrator source voltage
0.001	UNIP	0	0.4	Positive FS	0.39609	0.39509	0.39709	DAQ reading – Offset
0.001	UNIP	0	0.4	Negative FS	0.00391	0.00291	0.00491	DAQ reading – Offset
0.001	UNIP	0	0.1	Center FS	0.05000	0.04900	0.05100	Offset = DAQ reading – Calibrator source voltage
0.001	UNIP	0	0.1	Positive FS	0.09902	0.09802	0.10002	DAQ reading – Offset
0.001	UNIP	0	0.1	Negative FS	0.00098	–0.00002	0.00198	DAQ reading – Offset

Analog Output

Analog Output
U2351A, U2353A:

Offset/ Gain Error (V)	Setting	Range (V)		Test Point (V)		Test Limit (V)		Test Result
	Polarity	Min	Max	Location	Value	Lower	Upper	Reading
0.001	BIP	–10	10	0	0.0000	–0.0010	0.0010	Offset = DMM reading – DAQ source voltage
0.004	BIP	–10	10	Positive FS	9.9997	9.9957	10.0037	DMM reading – Offset
0.004	BIP	–10	10	Negative FS	–10.0000	–10.0040	–9.9960	DMM reading – Offset
0.001	UNIP	0	10	0	0.0000	–0.0010	0.0010	Offset = DMM reading – DAQ source voltage
0.002	UNIP	0	10	Positive FS	9.9998	9.9978	10.0018	DMM reading – Offset

Analog Output
U2355A, U2356A:

Offset/ Gain Error (V)	Setting	Range (V)		Test Point (V)		Test Limit (V)		Test Result
	Polarity	Min	Max	Location	Value	Lower	Upper	Reading
0.001	BIP	–10	10	0	0.0000	–0.0010	0.0010	Offset = DMM reading – DAQ source voltage
0.004	BIP	–10	10	Positive FS	9.9951	9.9911	9.9991	DMM reading – Offset
0.004	BIP	–10	10	Negative FS	–10.0000	–10.0040	–9.9960	DMM reading – Offset
0.001	UNIP	0	10	0	0.0000	–0.0010	0.0010	Offset = DMM reading – DAQ source voltage
0.002	UNIP	0	10	Positive FS	9.9976	9.9956	9.9996	DMM – Offset

Analog Output
U2331A:

Offset/ Gain Error (V)	Setting	Range (V)		Test Point (V)		Test Limit (V)		Test Result
	Polarity	Min	Max	Location	Value	Lower	Upper	Reading
0.0015	BIP	–10	10	0	0.0000	–0.0015	0.0015	Offset = DMM reading – DAQ source voltage
0.004	BIP	–10	10	Positive FS	9.9951	9.9911	9.9991	DMM reading – Offset
0.004	BIP	–10	10	Negative FS	–10.0000	–10.0040	–9.9960	DMM reading – Offset
0.0025	UNIP	0	10	0	0.0000	–0.0025	0.0025	Offset = DMM reading – DAQ source voltage
0.004	UNIP	0	10	Positive FS	9.9976	9.9936	10.0016	DMM reading – Offset

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