Agilent 33500 Series 30 MHz Function / Arbitrary Waveform Generator

Service Guide

Agilent Technologies

Notices

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www.agilent.com/find/33522A

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CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Additional Safety Notices

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings or instructions elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability of the customer's failure to comply with the requirements.

General

Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

Before Applying Power

Verify that all safety precautions are taken. Make all connections to the unit before applying power and select the appropriate power line voltage on the fuse module.

Ground the Instrument

This product is provided with protective earth terminals. To minimize shock hazard, the instrument must be connected to the ac power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes.

Do Not Remove the Instrument Cover

Only qualified, service-trained personal who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover.

Do Not Modify the Instrument

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In Case of Damage

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

CAUTION

Unless otherwise noted in the specifications, this instrument or system is intended for indoor use in an installation category II, pollution degree 2 environment per IEC 61010-1 and 664 respectively. It is designed to operate at a maximum relative humidity of 20% to 80% at 40 °C or less (non-condensing). This instrument or system is designed to operate at altitudes up to 2000 meters, and at temperatures between 0 °C and 55 °C.

Technical Support

If you have questions about your shipment, or if you need information about warranty, service, or technical support, contact Agilent Technologies:

In the United States: (800) 829-4444

In Europe: 31 20 547 2111

In Japan: 0120-421-345

Or go to

www.agilent.com/find/assist

for information on contacting Agilent in your country of specific location. You can also contact your Agilent Technologies Representative.

Safety Symbols

	Alternating current
	Frame or chassis terminal
	Standby supply. Unit is not completely disconnected from AC mains when switch is off.
	Caution, risk of electric shock
	Caution, refer to accompanying documents
	Earth ground terminal
	The CE mark is a registered trademark of the European Community.
	The CSA mark is a registered trademark of the CSA-International.
N10149	The C-tick mark is a registered trademark of the Spectrum Management Agency of Australia. This signifies compliance with the Australian EMC Framework regulations under the terms of the Radio Communications Act of 1992.
40	Contains one or more of the 6 hazardous substances above the maximum concentration value (MCV), 40 Year EPUP.
1SM1-A	This text indicates that the instrument is an Industrial Scientific and Medical Group 1 Class A product (CISPER 11, Clause 4).
ICES/ NMB -001	This text indicates product compliance with the Canadian Interference-Causing Equipment Standard (ICES-001).

Service Guide

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Edition 2, September 2010

Agilent 33500 Series 30 MHz Function / Arbitrary Waveform Generator

Agilent 33500 Series at a Glance

The Agilent Technologies 33500 Series is a 30 MHz synthesized waveform generator with built-in arbitrary waveform and pulse capabilities. Its combination of bench-top and system features makes this waveform generator a versatile solution for your testing requirements now and in the future.

Convenient bench-top features

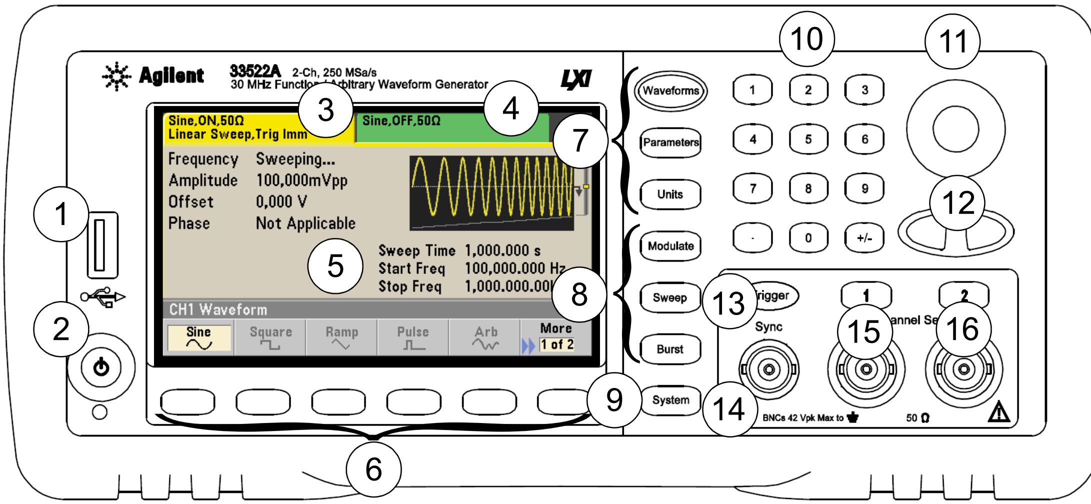
- 16 standard waveforms
- Built-in 16-bit 250 MSa/s arbitrary waveform capability
- Precise pulse waveform capabilities with adjustable edge time
- LCD display provides numeric and graphical views
- Easy-to-use knob and numeric keypad
- Instrument state storage with user-defined names
- Portable, ruggedized case with non-skid feet

Flexible system features

- Downloadable 1M-point or optional 16M-point arbitrary waveform memories
- GPIB (IEEE-488), USB, and LAN remote interfaces are standard
- LXI Class C Compliant
- SCPI (Standard Commands for Programmable Instruments) compatibility

Note: *Unless otherwise indicated, this manual applies to all Serial Numbers.*

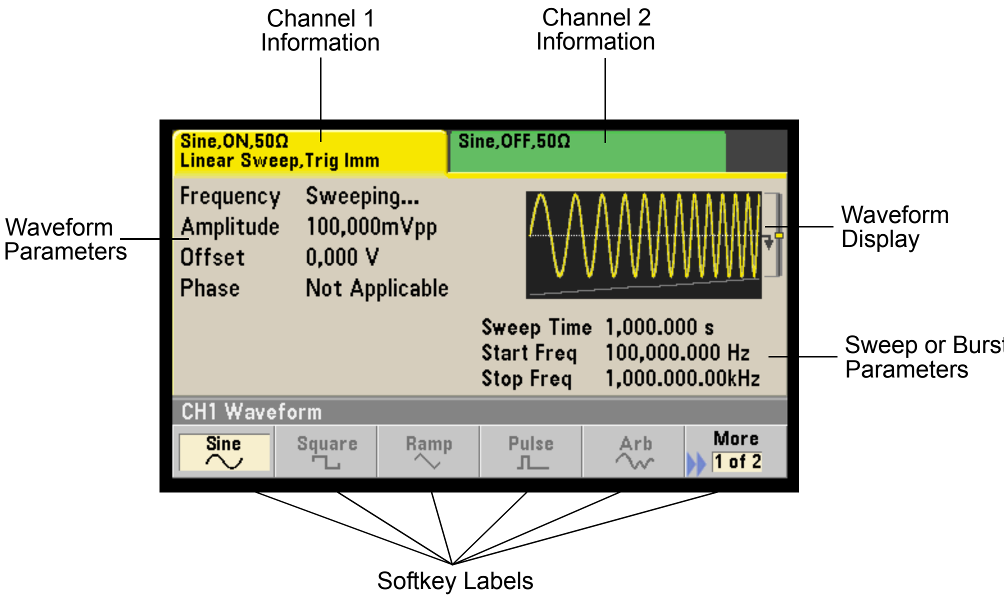
The Front Panel at a Glance



1 USB Port	9 System Key
2 On/Off Switch	10 Numeric Keypad
3 Channel 1 Summary Tab	11 Knob
4 Channel 2 Summary Tab	12 Cursor Keys (Arrows)
5 Waveform and Parameter Display Area	13 Manual Trigger (Sweep and Burst only)
6 Menu Operation Softkeys	14 Sync Connector
7 Waveforms/Parameters/Units Keys	15 Channel 1
8 Modulate/Sweep/Burst Keys	16 Channel 2 (2-channel instrument only)

Note: *To get context-sensitive help on any front-panel key or menu softkey, press and hold down that key.*

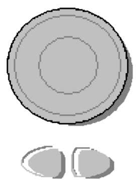
The Front-Panel Display at a Glance



Front-Panel Number Entry

You can enter numbers from the front-panel using one of two methods.

Use the knob and cursor keys to modify the displayed number.



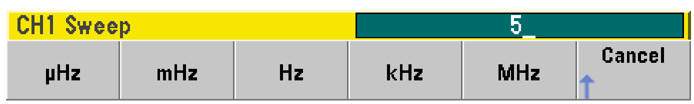
1. Use the keys below the knob to move the cursor left or right.

2. Rotate the knob to change a digit (clockwise to increase).

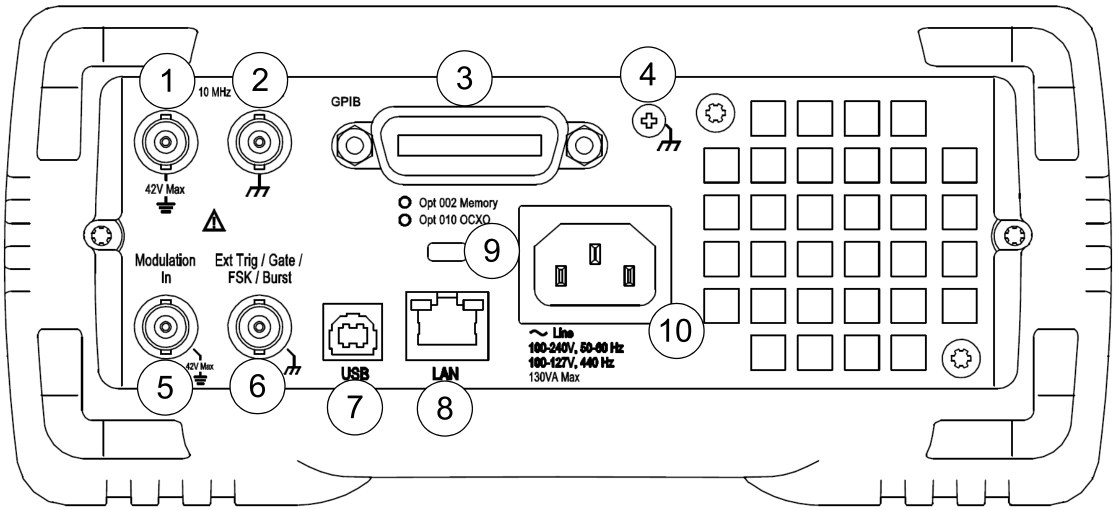
Use the keypad to enter numbers and the softkeys to select units.

1. Key in a value using the keypad.

2. Select a unit to enter the value.



The Rear Panel at a Glance



1 External 10 MHz Reference Input Terminal
2 Internal 10 MHz Reference Output Terminal
3 GPIB Interface Connector (option 400)
4 Chassis Ground
5 External Modulation Input Terminal
6 Input: External Trig/Gate/FSK/Burst
7 USB Interface Connector
8 Local Area Network (LAN) Connector
9 Instrument Cable Lock
10 AC Power

WARNING

For protection from electrical shock, the power cord ground must not be defeated. If only a two-contact electrical outlet is available, connect the instrument's chassis ground screw (see above) to a good earth ground.

In This Book

Specifications Chapter 1 lists the waveform generator's specifications.

Quick Start Chapter 2 prepares the waveform generator for use and helps you get familiar with a few of its front-panel features.

Front-Panel Menu Operation Chapter 3 introduces you to the front-panel menu and describes some of the waveform generator's menu features.

Calibration and Adjustment Chapter 4 provides calibration, verification, and adjustment procedures for the waveform generator.

Block Diagram Chapter 5 describes how the waveform generator works at a block level.

Service and Repair Chapter 6 provides guidelines for returning your waveform generator to Agilent Technologies for servicing, troubleshooting procedures and replaceable parts lists for servicing it yourself, and disassembly procedures.

You can contact Agilent Technologies at one of the following telephone numbers for warranty, service, or technical support information.

In the United States: (800) 829-4444

In Europe: 31 20 547 2111

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Or use our Web link for information on contacting Agilent worldwide.

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Or contact your Agilent Technologies Representative.

Chapter 1 Agilent 33500 Series 30 MHz Function/ Arbitrary Waveform Generator 5

Agilent 33500 Series at a Glance 6
The Front Panel at a Glance 7
The Front-Panel Display at a Glance 8
Front-Panel Number Entry 9
The Rear Panel at a Glance 10
In This Book 11

Chapter 2 Specifications 17

Chapter 3 Quick Start 25

Quick Start 26
To Prepare the Waveform Generator for Use 27
To Adjust the Carrying Handle 29
To Set the Output Frequency 30
To Set the Output Amplitude 32
To Set a DC Offset Voltage 35
To Set the High-Level and Low-Level Values 37
To Output a DC Voltage 39
To Set the Duty Cycle of a Square Wave 40
To Configure a Pulse Waveform 42
To Select a Stored Arbitrary Waveform 44
To Use the Built-In Help System 45
To Rack Mount the Waveform Generator 48

Chapter 4 Front-Panel Menu Operation 51

Front-Panel Menu Operation 52
Front-Panel Menu Reference 53
To Select the Output Termination 57
To Reset the Waveform Generator 58
To Output a Modulated Waveform 59
To Output an FSK Waveform 61
To Output a PWM Waveform 63
To Output a Frequency Sweep 66
To Output a Burst Waveform 69
To Trigger a Sweep or Burst 72
To Store the Instrument State 73
To Configure the Remote Interface 75
To Secure and Unsecure the Instrument for Calibration 83

Contents

Chapter 5 Calibration and Adjustment 85

Calibration and Adjustment 86
Agilent Technologies Calibration Services 87
Calibration Interval 87
Adjustment is Recommended 87
Time Required for Calibration 88
Automating Calibration Procedures 89
Recommended Test Equipment 90
Test Considerations 91
Performance Verification Tests 92
Internal Timebase Verification 96
AC Amplitude (high-impedance) Verification 97
DC Offset Voltage Verification 98
-8 dB Range Flatness Verification 99
-24 dB Range Flatness Verification 101
Calibration Security 103
Calibration Message 106
Calibration Count 106
General Calibration/Adjustment Procedure 107
Aborting a Calibration in Progress 108
Sequence of Adjustments 108
Self-Test 109
Frequency (Internal Timebase) Adjustment 110
Internal ADC Adjustment 111
Self Calibration Adjustment. 112
Output Impedance Adjustment 113
AC Amplitude (high-impedance) Adjustment 114
-24 dB Range Flatness Adjustment 116
-8 dB Range Flatness Adjustment 118
Self Calibration Adjustment (Channel 2) 120
Output Impedance Adjustment (Channel 2) 121
AC Amplitude (high-impedance) Adjustment (Channel 2) 122
-24 dB Range Flatness Adjustment (Channel 2) 124
-8 dB Range Flatness Adjustment (Channel 2) 126
Calibration Errors 128

Chapter 6 Block Diagram 131

Block Diagram 132
Block Diagram 133
Power Supplies 137

Chapter 7 Service and Repair 139

Service and Repair 140
Operating Checklist 140
Types of Service Available 141
Repackaging for Shipment 142
Cleaning 142
Electrostatic Discharge (ESD) Precautions 143
Surface Mount Repair 143
Troubleshooting 144
Self-Test Procedures 150
Replaceable Parts 156
Disassembly 157

Contents

1

Specifications

The characteristics and specifications shown below are a subset of the full specifications for the 33500 Series waveform generators. For the complete set of the latest specifications, see the Web page at

www.agilent.com/find/33521A

www.agilent.com/find/33522A

INSTRUMENT CHARACTERISTICS		
MODELS AND OPTIONS		
33521A	1-Channel	
33522A	2-Channel	
Option 002	Increases Arbitrary Waveform memory from 1 MSa/channel to 16 MSa/channel	
Option 010	High-stability frequency reference	
Option 400	GPIB interface	
WAVEFORMS		
Standard	Sine, Square, Ramp, Pulse, Triangle, Gaussian Noise, PRBS (Pseudorandom Binary Sequence), DC	
Built-In Arbitrary	Cardiac, Exponential Fall, Exponential Rise, Gaussian Pulse, Haversine, Lorentz, Negative Ramp, Sinc	
User-Defined Arbitrary	Up to 1 MSa (16 MSa with Option 002) with multi-segment sequencing	
MODULATION TYPES & OPERATING MODES		
Operating Modes	Continuous, Modulate, Frequency Sweep, Burst, Output Gate	
Modulation Types	AM, FM, PM, FSK, BPSK, PWM, Sum (Carrier + Modulation)	
100 kHz offset:	-125 dBc/Hz	-135 dBc/Hz

WAVEFORM CHARACTERISTICS	
SINE	
Frequency Range	1 μHz to 30 MHz, 1 μHz resolution
SQUARE and PULSE	
Frequency Range	1 μHz to 30 MHz, 1 μHz resolution
Rise and Fall Times (nom)	Square: 8.4 ns, fixed Pulse: 8.4 ns to 1 μs, independently variable, 100 ps or 3-digit resolution
RAMP and TRIANGLE	
Frequency Range	1 μHz to 200 kHz, 1 μHz resolution
Ramp Symmetry	0.0% to 100.0%, 0.1% resolution (0% is negative ramp, 100% is positive ramp, 50% is triangle)
GAUSSIAN NOISE	
Bandwidth (typ)	1 mHz to 30 MHz, variable
Crest Factor (nom)	4.6
Repetition period	> 50 years
PSEUDORANDOM BINARY SEQUENCE (PRBS)	
Bit Rate	1 mbps to 50 Mbps, 1-mbps resolution
Sequence Length	2^{m-1}, m=7, 9, 11, 15, 20, 23
WAVEFORM SEQUENCING	
Operation	Individual arbitrary waveforms (segments) can be combined into user-defined lists (sequences) to form longer, more complex waveforms. Each sequence step specifies whether to repeat the associated segment a certain number of times, to repeat it indefinitely, to repeat it until a Trigger event occurs, or to stop and wait for a Trigger event. Additionally, the behavior of the Sync output can be specified in each step. To improve throughput, up to 32 sequences totaling of up to 1024 segments can be pre-loaded into volatile memory.
Segment Length	8 Sa to 1 MSa (16 MSa with Option 002) in increments of 1
Sequence Length	1 to 512 steps
Segment Repeat Count	1 to 1,000,000 or Infinite

OUTPUT CHARACTERISTICS	
ISOLATION	
Outputs	
Connector shells for Ch 1, Ch2 , Sync, and Mod In are connected together but isolated from the instrument's chassis. Maximum allowable voltage on isolated connector shells is ±42 Vpk.	
SIGNAL OUTPUT	
Output Impedance (nom)	50 Ω
On, Off, Inverted	User-selectable for each channel
Voltage Limit	User-definable V_{MAX} and V_{MIN} safety limits
Overload Protection	Output turns off automatically when an overload is applied. Instrument will tolerate a short circuit to ground indefinitely.

FREQUENCY ACCURACY	
STANDARD (spec)	
1 Year 23°C ± 5 °C	±1 ppm of setting ± 15 pHz
1 Year 0°C to 55°C	±2 ppm of setting ± 15 pHz
OPTION 010 (spec)	
1 Year 0°C to 55°C	±0.1 ppm of setting ± 15 pHz

MODULATION TYPES AND OPERATING MODES									
CARRIER	AM	FM	PM	FSK	BPSK	PWM	Sum	Burst	Sweep
SINE and SQUARE	•	•	•	•	•		•	•	•
PULSE	•	•	•	•	•	•	•	•	•
TRIANGLE and RAMP	•	•	•	•	•		•	•	•
GAUSSIAN NOISE	•						•	•(a)	
PRBS	•	•	•				•	•	
SINGLE ARB	•		•(b)		•(b)		•	•	
SEQUENCED ARB	•						•		

(a) Gated burst only
(b) Applies to sample clock, not whole waveform

MODULATING SIGNAL							
CARRIER	Sine	Square	Triangle/ Ramp	Gaussian Noise	PRBS	ARB	External
SINE	•	•	•	•	•	•	•
SQUARE and PULSE	•	•	•	•	•	•	•
TRIANGLE and RAMP	•	•	•	•	•	•	•
GAUSSIAN NOISE	•	•	•		•	•	•
PRBS	•	•	•	•		•	•
ARB	•	•	•	•	•		•

MODULATION CHARACTERISTICS	
AMPLITUDE MODULATION (AM)	
Source	Internal or External, or either channel with 33522A
Type	Double-Sideband, Suppressed Carrier or Full Carrier
Depth[1]	0% to 120%, 0.01% resolution
FREQUENCY MODULATION (FM)[2]	
Source	Internal or External, or either channel with 33522A
Deviation	DC to 15 MHz, 1-μHz resolution
PHASE MODULATION (PM)	
Source	Internal or External, or either channel with 33522A
Deviation	0° to 360°, 0.1° resolution
FREQUENCY SHIFT KEY MODULATION (FSK)[2]	
Source	Internal Timer or *Ext Trig* connector
Mark & Space	Any frequency within the carrier signal's range
Rate	DC to 1 MHz
BINARY PHASE SHIFT KEY MODULATION (BPSK)	
Source	Internal Timer or *Ext Trig* connector
Phase Shift	0° to 360°, 0.1° resolution
Rate	DC to 1 MHz
PULSE WIDTH MODULATION (PWM)	
Source	Internal or External, or either channel with 33522A
Deviation[3]	0% to 100% of Pulse Width, 0.01% resolution
ADDITIVE MODULATION (Sum)	
Source	Internal or External, or either channel with 33522A
Ratio	0% to 100% of carrier amplitude, 0.01% resolution

BURST[4]	
Type	Counted or Gated
Count	1 to 100,000,000 cycles, or infinite
Gated	Produces complete cycles while *Ext Trig* is asserted
Start/Stop Phase	-360° to 360°, 0.1° resolution
Trigger Source	Internal Timer or *Ext Trig* connector
Marker	Adjustable to any cycle; indicated by the trailing edge of the Sync pulse

SWEEP[2]	
Type	Linear, Logarithmic, List (up to 128 user-defined frequencies)
Operation	Linear and Logarithmic sweeps are characterized by a Sweep time (during which the frequency changes smoothly from Start to Stop), a Hold time (during which the frequency stays at the Stop frequency), and a Return time (during which the frequency changes linearly from Stop to Start).
Direction	Up (Start freq < Stop freq) or Down (Start freq > Stop freq)
Start & Stop Frequencies	Any frequency within the waveform's range.
Sweep Time (except IMM trigger mode)	Linear: 1 ms to 3600 s, 1 ms resolution; 3601 s to 250,000 s, 1 s resolution
Sweep Time for IMM trigger	Linear: 1 ms to 3600 s, 1 ms resolution; 3601 s to 8,000 s, 1 s resolution
Sweep Time	Logarithmic: 1 ms to 500 s
Hold Time	0 s to 3600 s, 1 ms resolution
Return Time	0 s to 3600 s, 1 ms resolution
Trigger Source	Immediate (continuous), External, Single, Bus, or Timer
Marker	Adjustable to any frequency between Start and Stop for Linear and Logarithmic types or any frequency in the list for List type; indicated by the trailing edge of the Sync pulse

INTERNAL TIMER FOR FSK, BPSK, BURST, AND SWEEP	
Range	1 μs to 8,000 s, 6-digit or 4-ns resolution

2-CHANNEL CHARACTERISTICS (33522A ONLY)	
Operating Modes	• Independent • Coupled Parameter(s) • Combined (Ch1+Ch2) • Equal (Ch2 = Ch1) • Differential (Ch2 = -Ch1)
Parameter Coupling	• None • Frequency (Ratio or Difference) • Amplitude & DC Offset
Relative Phase	0 degrees to 360 degrees, 0.1 degrees resolution

[1] Subject to maximum output voltage limits.

[2] All frequency changes are phase-continuous.

[3] Subject to pulse width limits.

[4] The maximum Sine-wave frequency for counted and gated burst is 10 MHz unless Burst Count is set to "Infinite". Counted Burst operation is not allowed for Gaussian Noise.

SYNC / MARKER OUTPUT	
Connector	Front-panel BNC, isolated from chassis
Functions	Sync, Sweep Marker, Burst Marker, or Arbitrary Waveform Marker
Assignment	Channel 1 or Channel 2
Polarity	Normal or Inverted
Voltage Level (nom)	3 Vpp into open circuit, 1.5 Vpp into 50 Ω
Output Impedance (nom)	50 Ω
Min. Pulse Width (nom)	16 ns

MODULATION INPUT	
Connector	Rear-panel BNC, isolated
Assignment	Channel 1, Channel 2, or Both
Voltage Level	±5 V full-scale
Input Impedance (nom)	5 kΩ
Bandwidth (-3 dB typ)	DC to 100 kHz

FREQUENCY REFERENCE INPUT	
Connector	Rear-panel BNC, isolated from chassis and all other connectors
Reference Selection	Internal, External, or Auto
Frequency Range	Standard: 10 MHz ± 20 Hz Option 010: 10 MHz ± 1 Hz
Lock Time (typ)	<2 s
Voltage Level	200 mVpp to 5 Vpp
Input Impedance (nom)	1 kΩ || 20 pF, AC-coupled

FREQUENCY REFERENCE OUTPUT	
Connector	Rear-panel BNC, chassis-referenced
Output Impedance (nom)	50 Ω, AC-coupled
Level (nom)	0 dBm, 632 mVpp

REAL-TIME CLOCK / CALENDAR	
Set and Read	Year, Month, Day, Hour, Minute, Second
Battery	CR-2032 coin-type, replaceable, >5-year life (typ)

MEMORY	
ARBITRARY WAVEFORM MEMORY	
Volatile	1M samples / ch 512 Sequence steps / ch Optional 16M point / ch
Non-Volatile	File system file space is limited to 64 MB (approximately 32 MSa of arbitrary waveform records).
INSTRUMENT STATE	
Store / Recall	User defined instrument states
Power Off	Power Off state automatically saved
Power On	Selectable Reset, Power Off, or User State
USB File System	
Front-panel port	USB 2.0 high-speed mass storage (MSC) class device
Capability	Read or Write instrument configuration settings, instrument states, and User Arbitrary waveform and sequence files.
Speed	10 MB/s (nominal)
GENERAL CHARACTERISTICS	
COMPUTER INTERFACES	
LXI-C (rev 1.3)	10/100Base-T Ethernet (Sockets & VXI-11 protocol) USB 2.0 (USB-TBC488 protocol) GPIB/IEEE-488.1, IEEE-488.2
Web User Interface	Remote operation and monitoring
Programming Language	SCPI-1999, IEEE-488.2 Agilent 33210A / 33220A compatible
Graphical Display	4.3" Color TFT WQVGA (480x272) with LED backlight
MECHANICAL	
Size	261.1mm W x 103.8mm H x 303.2mm D (with bumpers installed) 212.8mm W x 88.3mm H x 272.3mm D (with bumpers removed) 2U x 1/2-width
Weight	33521A: 3.2 kg (7.1 lbs.) 33522A: 3.3 kg (7.2 lbs.)

ENVIRONMENTAL	
Storage Temperature	-40˚ C to 70˚C
Warm-Up Time	1 hour
Operating Environment	EN61010, Pollution Degree 2; Indoor Locations
Operating Temperature	0 ˚C to 55 ˚C
Operating Humidity	5% to 80% RH, non-condensing
Operating Altitude	up to 3000 meters
REGULATORY	
Safety	CAT II (300V), EN61010
EMC	EN55011, EN50082-1, MIL-461C
Vibration & Shock	MIL-T-28800, Type III, Class 5
Acoustic Noise	35 dB(A)
LINE POWER	
Voltage	100 V - 240 V 50/60 Hz -5%, +10% 100 V - 120 V 400 Hz ± 10%
Power Consumption (typ)	< 45 W, < 130 VA
WARRANTY	
	1 year standard, 3 years optional

Note: *Specifications are subject to change without notice. For the latest specifications, go to the Agilent 33521A or Agilent 33522A product page for the latest datasheet.*

www.agilent.com/find/33521A

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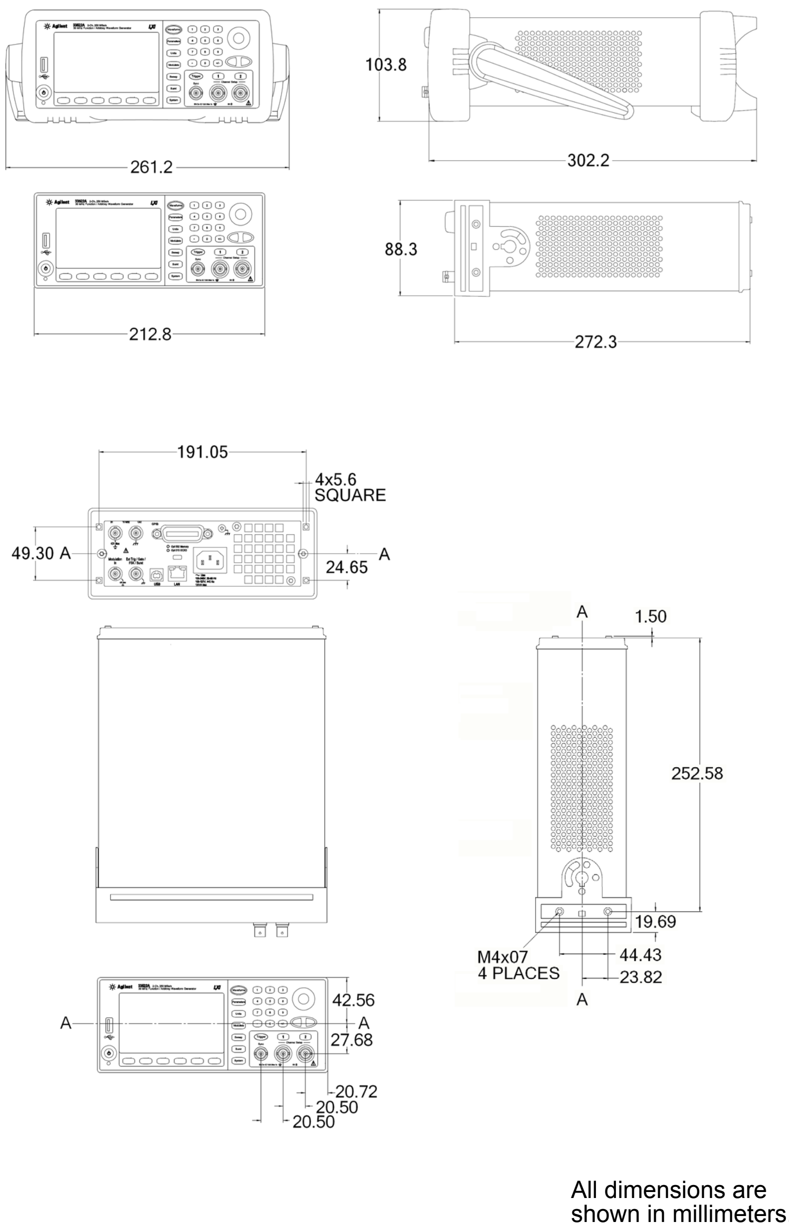
This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme à la norme NMB-001 du Canada.

N10149

Product Dimensions



All dimensions are
shown in millimeters.

Quick Start

Quick Start

One of the first things you will want to do with your waveform generator is to become acquainted with the front panel. We have written the exercises in this chapter to prepare the instrument for use and help you get familiar with some of its front-panel operations. This chapter is divided into the following sections:

- To Prepare the Waveform Generator for Use, *on page 27*
- To Adjust the Carrying Handle, *on page 29*
- To Set the Output Frequency, *on page 30*
- To Set the Output Amplitude, *on page 32*
- To Set a DC Offset Voltage, *on page 35*
- To Set the High-Level and Low-Level Values, *on page 37*
- To Output a DC Voltage, *on page 39*
- To Set the Duty Cycle of a Square Wave, *on page 40*
- To Configure a Pulse Waveform, *on page 42*
- To Select a Stored Arbitrary Waveform, *on page 44*
- To Use the Built-In Help System, *on page 45*
- To Rack Mount the Waveform Generator, *on page 48*

To Prepare the Waveform Generator for Use

1 Check the list of supplied items.

Verify that you have received the following items with your instrument. If anything is missing, please contact your nearest Agilent Sales Office.

- Power cord (for country of destination).
- Certificate of Calibration.
- *Agilent 33500 Series Product Reference CD* (product software, programming examples, and manuals).
- *Agilent Automation-Ready CD* (Agilent IO Libraries Suite).
- USB 2.0 cable.

Note: All of the 33500 Series product documentation is provided on the *Agilent 33500 Series Product Reference CD* that comes with the product, and is also available on the Web at **www.agilent.com/find/33521A** and **www.agilent.com/find/33522A**. Printed (hardcopy) manuals are available as an extra cost option.


Power Switch

2 Connect the power cord and turn on the waveform generator.

The instrument runs a power-on self test. When the instrument is ready for use it displays a message about how to obtain help, along with the current IP address. The instrument also displays the GPIB address if the GPIB option is installed and GPIB is enabled. The waveform generator powers up in the *sine wave* function at 1 kHz with an amplitude of 100 mV peak-to-peak (into a 50Ω termination). At power-on, the channel output connectors are disabled. To enable output on a channel connector, press the Channel (33521A) 1 or 2 (33522A) button and then press the **Output Off / On** softkey.

If the waveform generator *does not* turn on, verify that the power cord is firmly connected to the power receptacle on the rear panel (the power-line voltage is automatically sensed at power-on). You should also make sure that the waveform generator is connected to an energized power source. Then, verify that the waveform generator is turned on.

Also look at the LED below the power switch. If it is off, there is no AC power connected. If it is amber, the instrument is in standby mode with AC power connected, and if it is green, the instrument is on.

To turn off the instrument, you must hold the power switch down for about 500 ms. This prevents you from accidentally turning off the instrument by brushing against the power switch.

If the power-on self test fails, the instrument shows the ERR annunciator in the upper right corner of the display. It also prominently displays the following message:

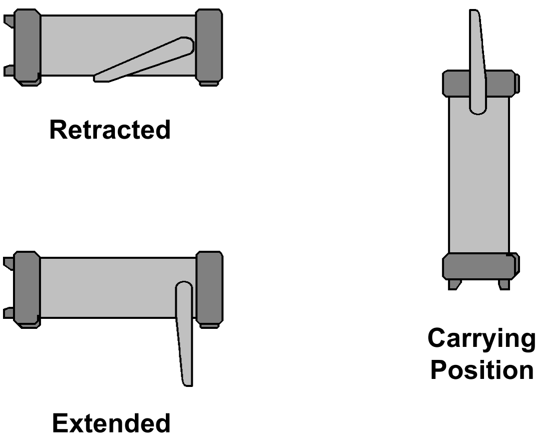
```
Check for error messages in the error queue.
```

See Chapter 6 for information on error codes, and for instructions on returning the waveform generator to Agilent for service.

2

To Adjust the Carrying Handle

To adjust the position, grasp the handle by the sides and *pull outward*. Then, rotate the handle to the desired position.



To Set the Output Frequency

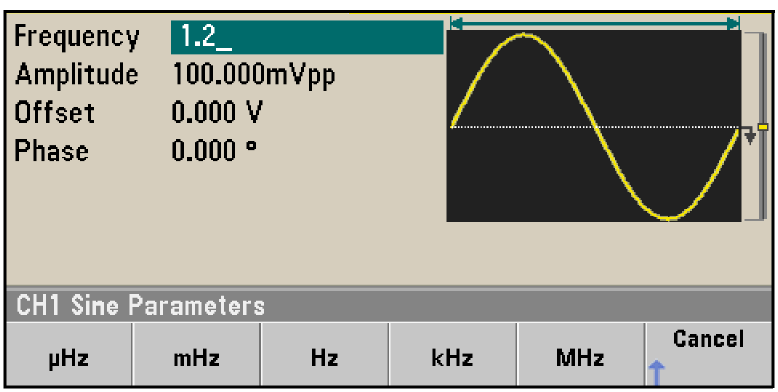
At power-on, the waveform is configured for a sine wave at 1 kHz with an amplitude of 100 mV peak-to-peak (into a 50Ω termination).
The following steps show you how to change the frequency to 1.2 MHz.

1 Press the (Parameters) button, followed by the Frequency softkey.

The displayed frequency is either the power-on value or the frequency previously selected. When you change functions, the same frequency is used if the present value is valid for the new function. To set the waveform *period* instead, press (Units), then press the **Frequency** softkey to toggle to the **Period** softkey (the current **Frequency** selection is highlighted in the image below.).

2 Enter the magnitude of the desired frequency.

Using the numeric keypad, enter the value 1.2.



3 Select the desired units.

Press the softkey that corresponds to the desired units. When you select the units, the waveform generator outputs a waveform with the displayed frequency (if the output is enabled). For this example, press **MHz**.

Note: *You can also enter the desired value using the knob and cursor keys.*

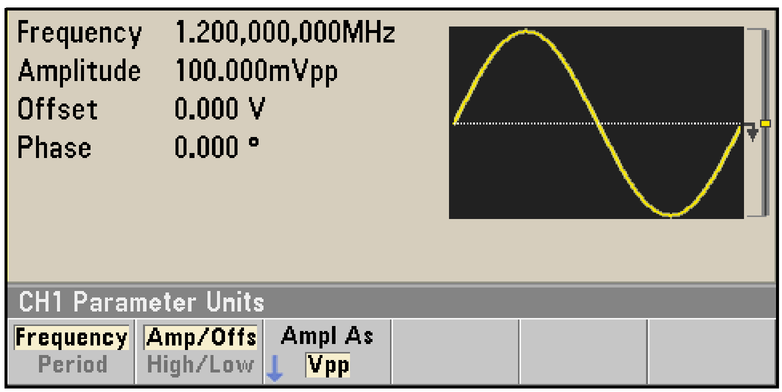
2

To Set the Output Amplitude

At power-on, the waveform generator is configured for a sine wave with an amplitude of 100 mV peak-to-peak (into a 50Ω termination).
The following steps show you how to change the amplitude to 50 mVpp.

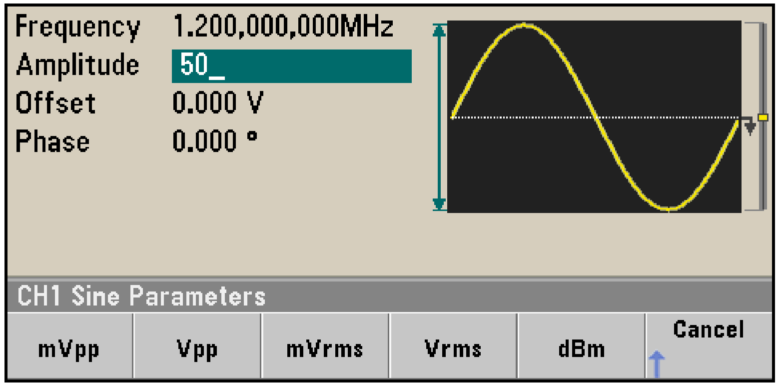
1 Press Units, then the softkey marked Amp/Offs or High/Low to make sure that you are in Amp/Offs.

The displayed amplitude is either the power-on value or the amplitude previously selected. When you change functions, the same amplitude is used if the present value is valid for the new function. To choose whether you want to specify voltage as amplitude and offset or high and low values, press Units and then the second softkey. In this case, we will highlight **Amp/Offs**.



2 Enter the magnitude of the desired amplitude.

Press (Parameters) and then press **Amplitude**. Using the numeric keypad, enter the number 50.

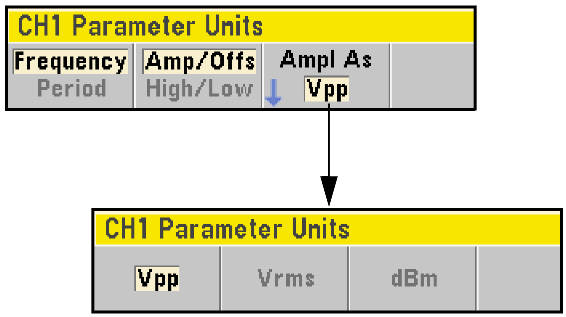


3 Select the desired units.

Press the softkey that corresponds to the desired units. When you select the units, the waveform generator outputs the waveform with the displayed amplitude (if the output is enabled). For this example, press **mVpp**.

Note: *You can also enter the desired value using the knob and cursor keys. If you do so, you do not need to use a units softkey.*

You can easily convert the displayed amplitude from one unit to another. Simply press (Units), and then press the **Ampl As** softkey and select the desired units.



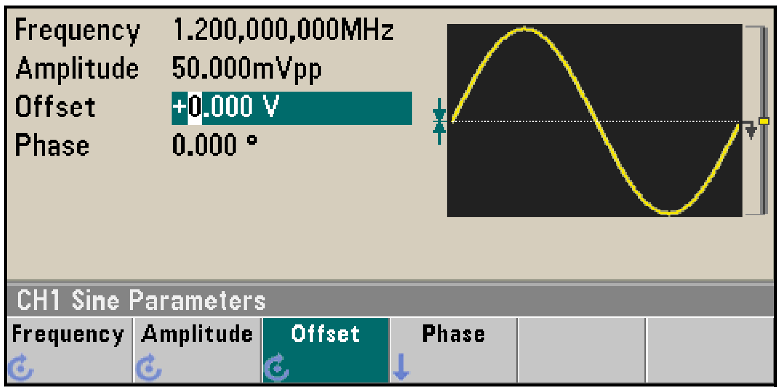
2

To Set a DC Offset Voltage

At power-on, the waveform generator outputs a sine wave with a DC offset of 0 volts (into a 50Ω termination). *The following steps show you how to change the offset to –1.5 VDC.*

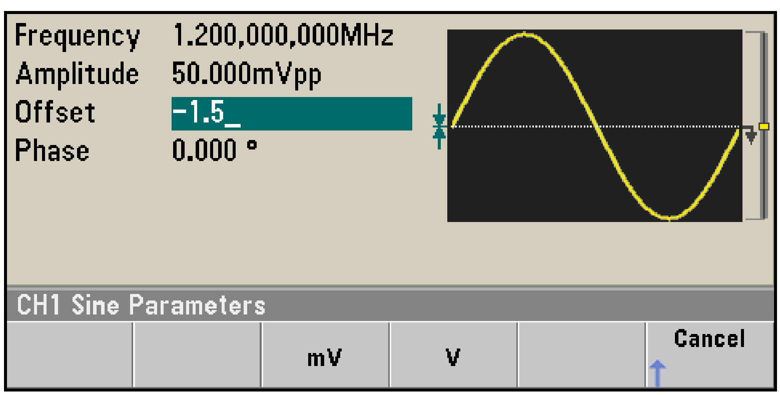
1 Press (Parameters), followed by the "Offset" softkey.

The displayed offset voltage is either the power-on value or the offset previously selected. When you change functions, the same offset is used if the present value is valid for the new function.



2 Enter the magnitude of the desired offset.

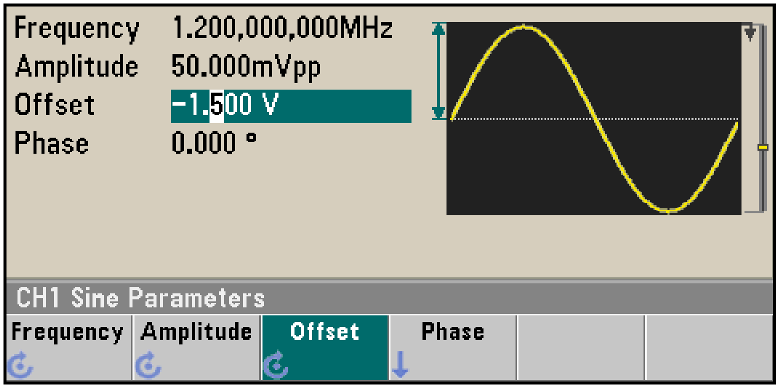
Using the numeric keypad, enter the value "–1.5".



2

3 Select the desired units.

Press the softkey for the desired units. When you select the units, the waveform generator outputs the waveform with the displayed offset (if the output is enabled). For this example, press **V**. The voltage will be set as shown below.



Note: *You can also enter the desired value using the knob and cursor keys.*

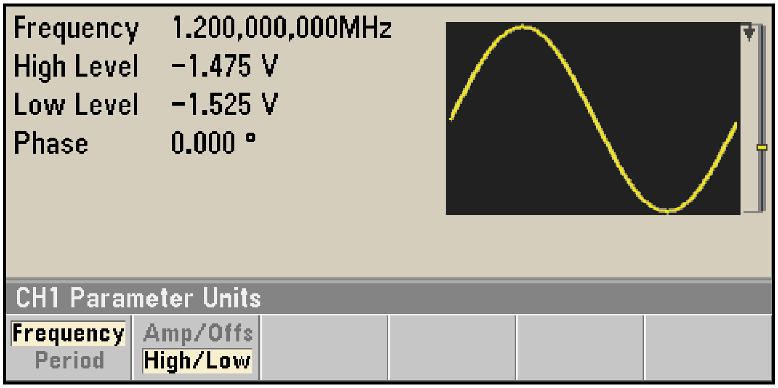
2

To Set the High-Level and Low-Level Values

You can specify a signal by setting its amplitude and DC offset values, as described previously. Another way to set the signal limits is to specify its high (maximum) and low (minimum) values. This is typically convenient for digital applications. In the following example, we will set the high level to 1.0 V and the low level to 0.0 V.

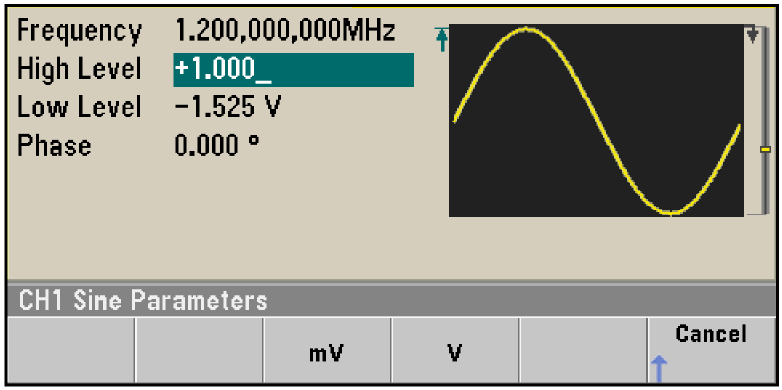
1 Press Units.

2 Press the Amp/Offs softkey to toggle to High/Low as shown below.



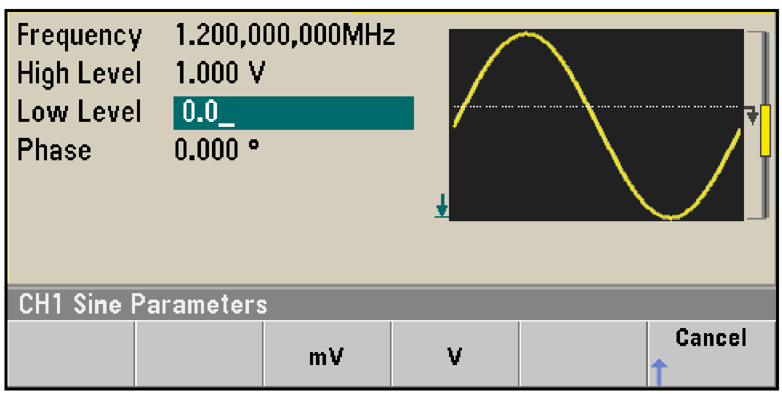
3 Set the "High Level" value.

Press the Parameters key and select **High Level**. Using the numeric keypad or knob and arrows, select a value of 1.0 V. (If you are using the keypad, you will need to select the **V** unit softkey to enter the value.)



4 Press the Low Level softkey and set the value.

Again, use the numeric keypad or the knob to enter a value of 0.0 V.



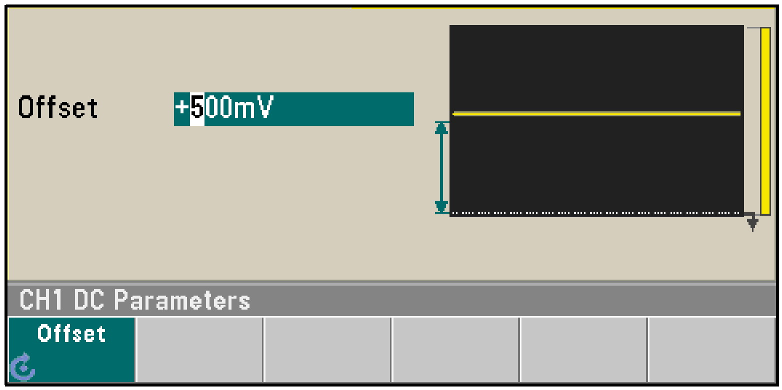
These settings (high-level = 1.0 V and low-level = 0.0 V) are equivalent to setting an amplitude of 1.0 Vpp and an offset of 500 mV.

To Output a DC Voltage

You can specify a constant DC voltage to be output

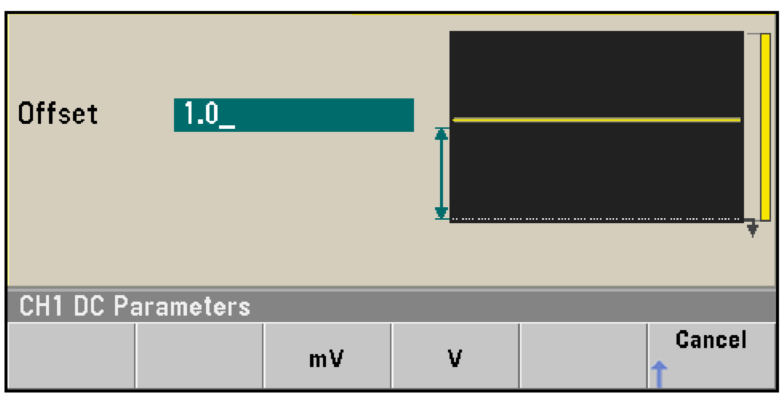
1 **Press** (Waveforms) **and then select More and DC.**

The **Offset** value becomes selected.



2 **Enter the desired voltage level as an Offset.**

Enter 1.0 with the numeric keypad or knob and then press the **V** softkey if you used the keypad.



You can enter any DC voltage from -5 V to +5 V into 50 Ω, or -10 V to +10 V into a high impedance load.

2

To Set the Duty Cycle of a Square Wave

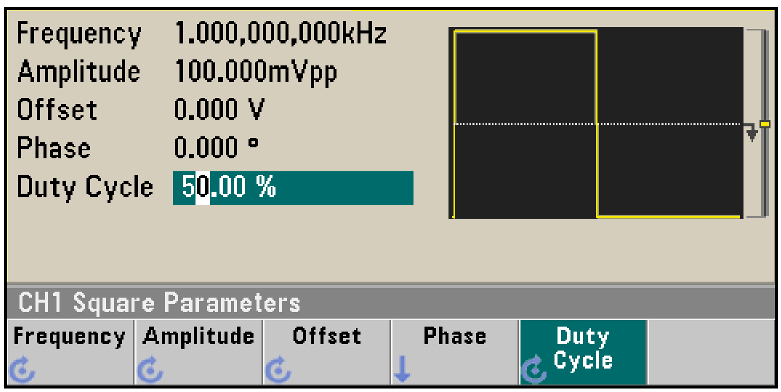
At power-on, the duty cycle for square waves is 50%. The duty cycle is limited by the minimum pulse width specification of 16 ns. *The following steps show you how to change the duty cycle to 75%.*

1 Select the square wave function.

Press the (Waveforms) key and choose **Square**.

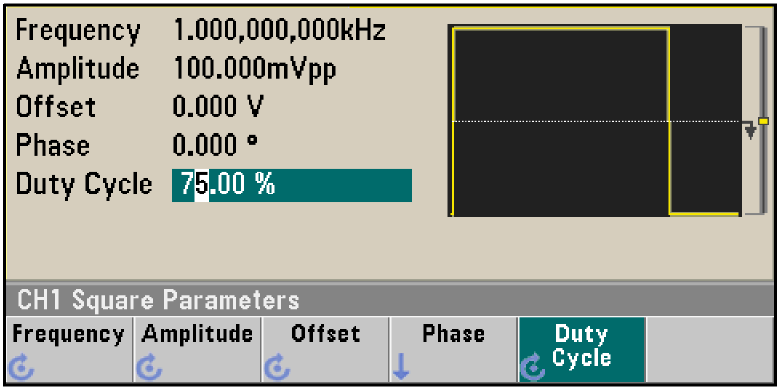
2 Press the Duty Cycle softkey.

The displayed duty cycle is either the power-on value or the percentage previously selected. The duty cycle represents the amount of time per cycle that the square wave is at a *high* level.



3 Enter the desired duty cycle.

Using the numeric keypad or the knob and arrows, select a duty cycle value of “75”. If you are using the numeric keypad, press the **Percent** softkey to finish the entry. The waveform generator adjusts the duty cycle immediately and outputs a square wave with the specified value (if the output is enabled).



2

To Configure a Pulse Waveform

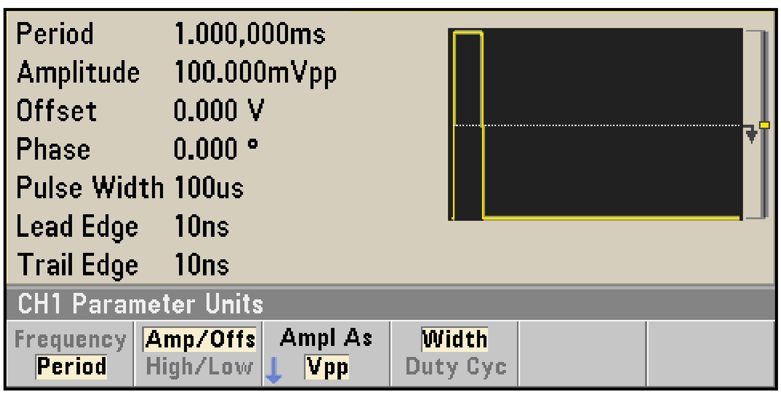
You can configure the waveform generator to output a pulse waveform with variable pulse width and edge time. *The following steps show you how to configure a 500 ms periodic pulse waveform with a pulse width of 10 ms and edge times of 50 ns.*

1 Select the pulse function.

Press the Waveforms key and choose **Pulse** to select the pulse function and output a pulse waveform with the default parameters.

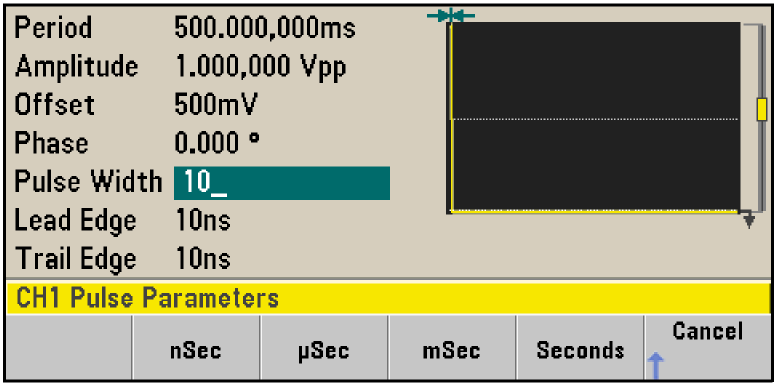
2 Set the pulse period.

Press the Units key and then press the **Frequency/Period** softkey to choose **Period**. Then press Parameters and choose **Period**. Set the period to 500 ms.



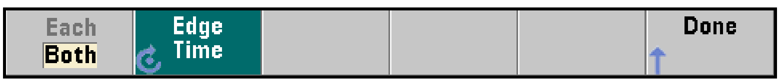
3 Set the pulse width.

Press (Parameters) and the **Pulse Width** softkey, and then set the pulse width to 10 ms. The pulse width represents the time from the 50% threshold of the rising edge to the 50% threshold of the next falling edge.



4 Set the edge time for both edges.

Press the **Edge Time** softkey and then set the edge time for *both* the leading and trailing edges to 50 ns. The edge time represents the time from the 10% threshold to the 90% threshold of each edge.



2

To Select a Stored Arbitrary Waveform

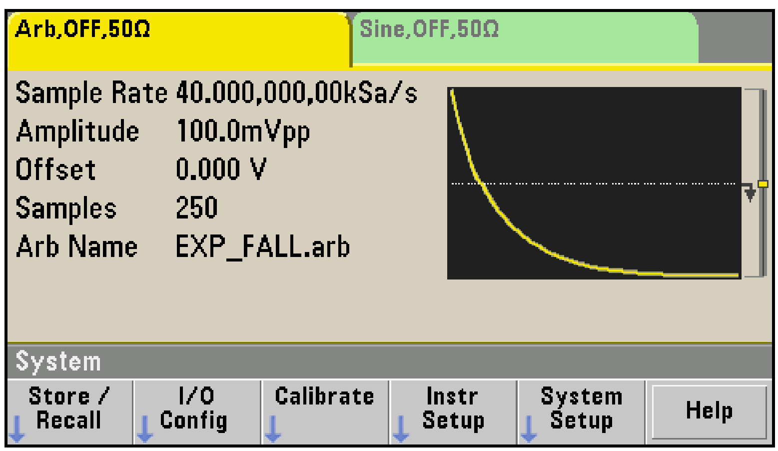
There are nine built-in arbitrary waveforms stored in non-volatile memory. They are Cardiac, D-Lorentz, Exponential Fall, Exponential Rise, Gaussian, Haversine, Lorentz, Negative Ramp, and Sinc.

The following steps show you how to select the built-in "exponential fall" waveform from the front panel.

For information on creating a custom arbitrary waveform, refer to the *Agilent 33500 Series User's Guide*.

1 Select the arbitrary waveform function.

Press the (Waveforms) button and choose the **Arb** and **Arbs** softkeys. Then choose **Select Arb** and use the knob to select **Exp_Fall**. Press **Select**.

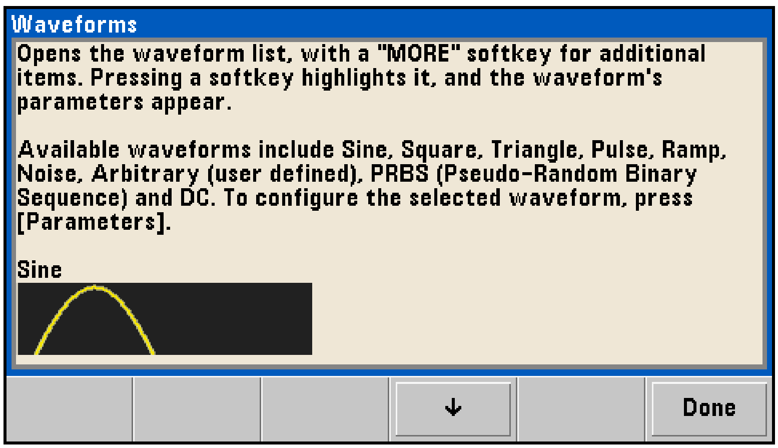


To Use the Built-In Help System

The built-in help system is designed to provide context-sensitive assistance on any front-panel key or menu softkey. A list of help topics is also available to assist you with several front-panel operations.

1 View the help information for a function key.

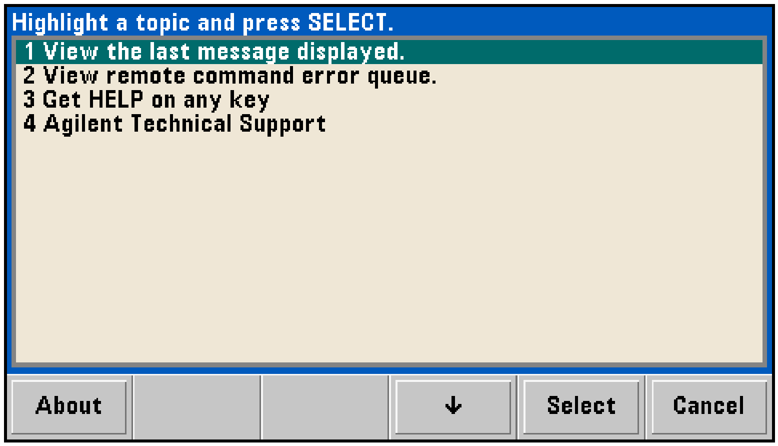
Press and hold down any softkey or button such as Waveforms. If the message contains more information than will fit on the display, press the ↓ softkey to view the remaining information.



Press **Done** to exit Help.

2 View the list of help topics.

Press the (System) button and then press **Help** to view the list of available help topics. To scroll through the list, press the ↑ and ↓ softkeys. Select the topic **Get HELP on any key** and then press **Select**.

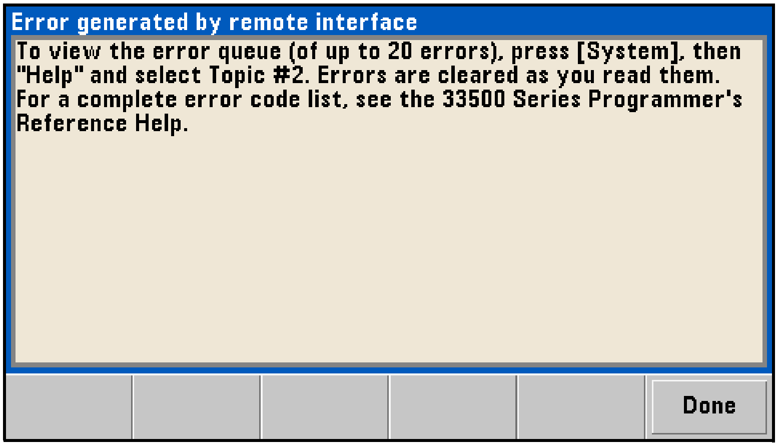


Press **Done** to exit Help.

3 View the help information for displayed messages.

Whenever a limit is exceeded or any other invalid configuration is found, the waveform generator will display a message. The built-in help system provides additional information on the most recent message.

Press the System button and then press **Help**. Then select the topic **View the last message displayed**, and press **Select**.



Press **Done** to exit Help.

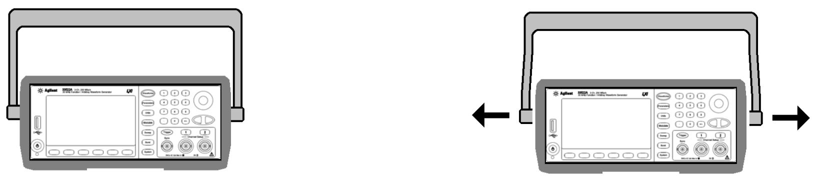
Local Language Help: The built-in help system is available in Chinese, French, German, Japanese, and Korean. All messages, context-sensitive help, and help topics appear in the selected language. The menu softkey labels and status line messages are not translated.

To select the local language, press the System button, then press the **System Setup** softkey, the **User Settings** softkey, and the **Help Lang** softkey. Then select the desired language.

To Rack Mount the Waveform Generator

You can mount the instrument in a standard 19-inch rack cabinet using one of two optional kits available. Instructions and mounting hardware are included with each rack-mounting kit. Any Agilent *System II* instrument of the same size can be rack-mounted beside the Agilent 33500 Series.

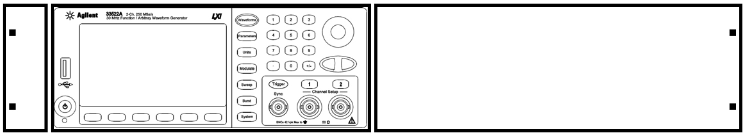
Note: *Remove the carrying handle, and the front and rear rubber bumpers, before rack-mounting the instrument.*



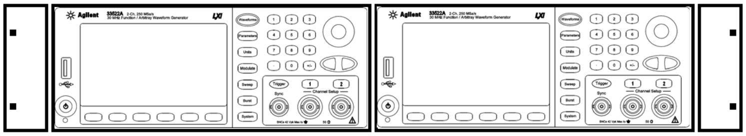
To remove the handle, rotate it to vertical and pull the ends outward.

Front   Rear (bottom view)

To remove the rubber bumper, stretch a corner and then slide it off.



To rack mount a single instrument, order adapter kit 5063-9240.



To rack mount two instruments side-by-side, order lock-link kit 5061- 8769 and flange kit 5063-9212. Be sure to use the support rails in the rack cabinet.

In order to prevent overheating, do not block the flow of air into or out of the instrument. Be sure to allow enough clearance at the rear, sides, and bottom of the instrument to permit adequate internal air flow.

2

Front-Panel Menu Operation

3

Front-Panel Menu Operation

This chapter introduces you to the front-panel keys and menu operation. This chapter does not give a detailed description of every front-panel key or menu operation. It does, however, give you an overview of the front-panel menus and many front-panel operations. Refer to the *Agilent 33500A Series User's Guide* for a complete discussion of the waveform generator's capabilities and operation.

- Front-Panel Menu Reference, *on page 53*
- To Select the Output Termination, *on page 57*
- To Reset the Waveform Generator, *on page 58*
- To Output a Modulated Waveform, *on page 59*
- To Output an FSK Waveform, *on page 61*
- To Output a PWM Waveform, *on page 63*
- To Output a Frequency Sweep, *on page 66*
- To Output a Burst Waveform, *on page 69*
- To Trigger a Sweep or Burst, *on page 72*
- To Store the Instrument State, *on page 73*
- To Configure the Remote Interface, *on page 75*
- To Secure and Unsecure the Instrument for Calibration, *on page 83*

3

Front-Panel Menu Reference

This section gives an overview of the front-panel menus. The remainder of this chapter contains examples of using the front-panel menus.

Waveforms **Select a waveform**
• Select one of nine waveform types, including Sine, Square, Ramp, Pulse, Arbitrary, Triangle, Noise, PRBS, and DC.

Parameters **Configure parameters for the selected waveform**
Depending on the waveform, you can do some of the various tasks: • Configure Period/Frequency • Configure Amplitude • Configure Offset • Configure Phase • Configure Duty Cycle • Configure Symmetry • Configure Pulse Width • Configure Edge Times • Configure Arbitrary Waveforms • Configure Bandwidth • Configure PRBS Data • Configure Bit Rate • Configure Marker Position (if enabled) • Configure Marker Frequency

Units **Specify what units and parameters to use for various waveforms.**
• Specify whether to use Frequency or Period • Specify whether to use Amplitude and Offset or High and Low Voltage • Specify which voltage units to use • Specify whether to use Width or Duty Cycle • Specify whether to configure Frequency sweep as Center/Span or Start/Stop

Modulate **Configure the parameters for modulation.**
• Turn modulation on or off. • Specify the modulation type. • Specify the modulation source. • Specify parameters for AM, FM, PM, PWM, BPSK, FSK and SUM modulation.

Sweep **Configure the parameters for frequency sweep.**
• Turn sweep on or off. • Select linear, logarithmic or frequency list sweeping. • View and edit a list of frequencies to sweep. • Select the start/stop frequencies <u>or</u> center/span frequencies. • Select the time in seconds required to complete a sweep. • Specify dwell, hold, and return times.

Burst **Configure the parameters for burst.**
• Turn burst on or off. • Select the triggered (N Cycle) or externally-gated burst mode. • Select the number of cycles per burst (1 to 100,000,000). • Select the starting phase angle of the burst (-360° to +360°). • Specify the time from the start of one burst to the start of the next burst.

System **Store/Recall - Store and recall instrument states.**
• Store an arbitrary number of instrument states in non-volatile memory. • Assign a custom name to each storage location. • Recall stored instrument states. • Restore all instrument settings to their factory default values. • Select the instrument's power-on configuration (last or factory default).

System **I/O Config - Configure instrument I/O interfaces.**

- Select the GPIB address.
- Specify the LAN configuration (IP address and network configuration).

System **Calibrate - Perform calibration tasks.**

- Lock and unlock the instrument for calibration.
- Set the calibration password.
- Calibrate the instrument (see *Agilent 33500 Series Service Guide)*.

System **Instr Setup - Configure instrument parameters.**

- Perform self-test.
- Configure reference oscillator.
- Clear instrument memory.

System **System Setup - Configure system-related parameters.**

- Set screen layout.
- Select how periods and commas are used in numbers displayed on the front panel.
- Select the local language for front-panel messages and help text.
- Enable/disable the tone heard when an error is generated.
- Enable/disable the display screen saver mode.
- Adjust the brightness setting of the front-panel display.
- Perform an instrument self-test.
- Secure/unsecure the instrument for calibration and perform manual calibrations.
- Query the instrument's firmware revision codes.
- Install licenses for licensed features.
- Set date and time.
- Perform file management.

3

Channel or 1 or 2 Channels - Enable and configure channels.

- Turn channel on and off
- Select the output termination (1Ω to 10 kΩ, or Infinite).
- Enable/disable amplitude autoranging.
- Select the waveform polarity (normal or inverted).
- Specify voltage limits on channel.
- Specify whether the channel is to be in normal or gated mode.
- Configure the channel for dual channel operation (33522A).

System Help - View the list of Help topics.

- View the last message displayed.
- View the remote command error queue.
- Get help on any key.
- Learn how to obtain Agilent Technical Support.
- View “about” data - serial number, IP address, firmware version, and so on.

Trigger Configure Trigger Settings

- Specify an internal or external trigger source for the sweep.
- Specify the slope (rising or falling edge) for an external trigger source.
- Specify the slope (rising or falling edge) of the “Trig Out” signal.
- Enable/disable the Sync signal which is output from the “Sync” connector.

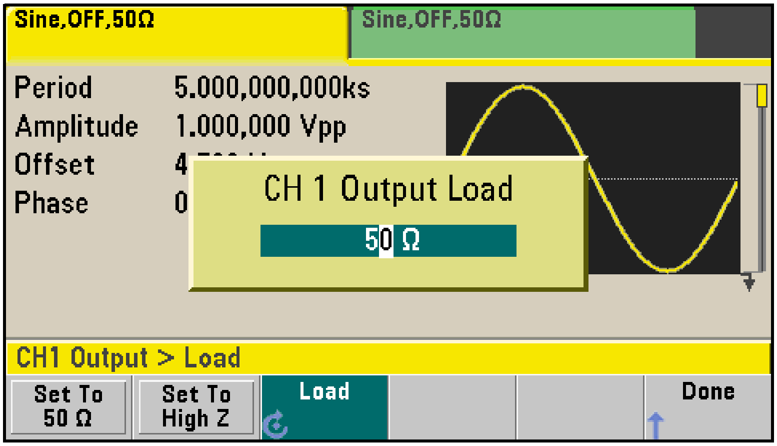
To Select the Output Termination

The Agilent 33500 Series has a fixed series output impedance of 50 ohms to the front-panel channel connectors. If the actual load impedance is different than the value specified, the displayed amplitude and offset levels will be incorrect. The load impedance setting is simply provided as a convenience to ensure that the displayed voltage matches the expected load.

1 Press Channel or 1 or 2 to open the channel configuration screen.

2 Specify the output termination.

Press the **Output Load** softkey.



3 Select the desired output termination.

Use the knob or numeric keypad to select the desired load impedance or press the **Set to 50** Ω softkey or the **Set to High Z** softkey.

To Reset the Waveform Generator

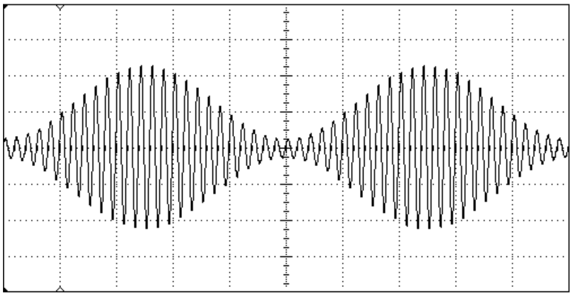
To reset the instrument to its factory default state, press System and then select the **Store/Recall** and **Set to Defaults** softkeys.

For a complete listing of the instrument's power-on and reset conditions, reefer to the Agilent 33500 Series User's Guide.

3

To Output a Modulated Waveform

A modulated waveform consists of a *carrier* and a *modulating waveform*. In AM (amplitude modulation), the amplitude of the carrier is varied by the amplitude of the modulating waveform. For this example, you will output an AM waveform with 80% modulation depth. The carrier will be a 5 kHz sine wave and the modulating waveform will be a 200 Hz sine wave.



1 Select the function, frequency, and amplitude of the carrier.

Press (Waveforms) and then press the **Sine** softkey. Press the **Frequency**, **Amplitude**, and **Offset** softkeys to configure the carrier waveform. *For this example, select a 5 kHz sine wave with an amplitude of 5 Vpp, with 0 offset.*

2 Select AM.

Press (Modulate) and then select “AM” using the **Type** softkey. Then press the **Modulate** softkey to turn modulation On. Notice that the (Modulate) button is illuminated, and the status message “AM Modulated by Sine” appears at the top of the display.

3 Set the modulation depth.

Press the **AM Depth** softkey and then set the value to 80% using the numeric keypad or the knob and cursor keys.

4 Select the modulating waveform shape.

Press the **Shape** softkey to select the shape of the modulating waveform. For this example, select a sine wave.

5 Set the modulating frequency.

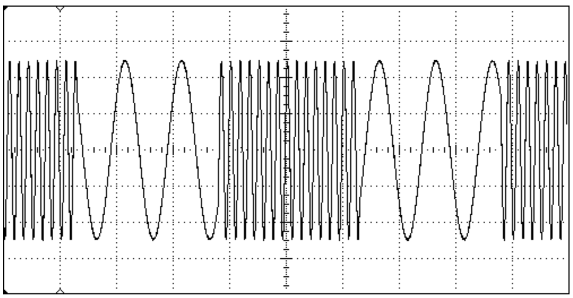
Press **More** and then the **AM Freq** softkey. Set the value to 200 Hz using the numeric keypad or the knob and cursor keys. Press the **Hz** softkey to finish entering the number if you are using the numeric keypad.

At this point, the waveform generator outputs an AM waveform with the specified modulation parameters.

3

To Output an FSK Waveform

You can configure the waveform generator to "shift" its output frequency between two preset values using FSK modulation. The rate at which the output shifts between the two frequencies (called the "carrier frequency" and the "hop frequency") is determined by the internal rate generator or the signal level on the rear-panel *Trig In* connector. *For this example, you will set the "carrier" frequency to 3 kHz and the "hop" frequency to 500 Hz, with an FSK rate of 100 Hz.*



1 Select the function, frequency, and amplitude of the carrier.

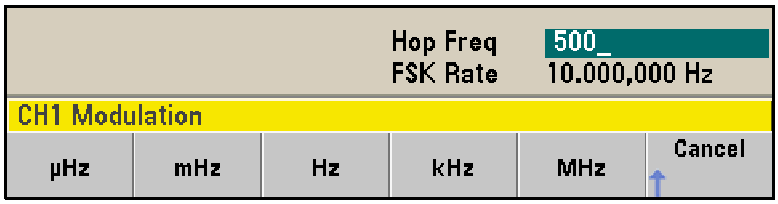
Press (Waveforms) and then press the **Sine** softkey. Press the **Frequency**, **Amplitude**, and **Offset** softkeys to configure the carrier waveform. *For this example, select a 3 kHz sine wave with an amplitude of 5 Vpp, with 0 offset.*

2 Select FSK.

Press (Modulate) and then select **FSK** using the **Type** softkey. Then press the **Modulate** softkey to turn modulation On. Notice the status message "FSK Modulated" at the top of the display.

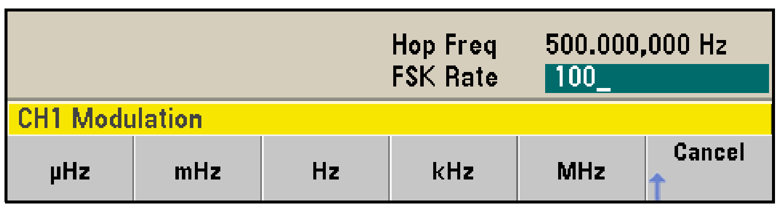
3 Set the “hop” frequency.

Press the **Hop Freq** softkey and then set the value to 500 Hz using the numeric keypad or the knob and cursor keys. If you use the numeric keypad, be sure to finish the entry by pressing the **Hz** softkey.



4 Set the FSK “shift” rate.

Press the **FSK Rate** softkey and then set the value to 100 Hz using the numeric keypad or the knob and cursor keys.



At this point, the waveform generator outputs an FSK waveform.

3

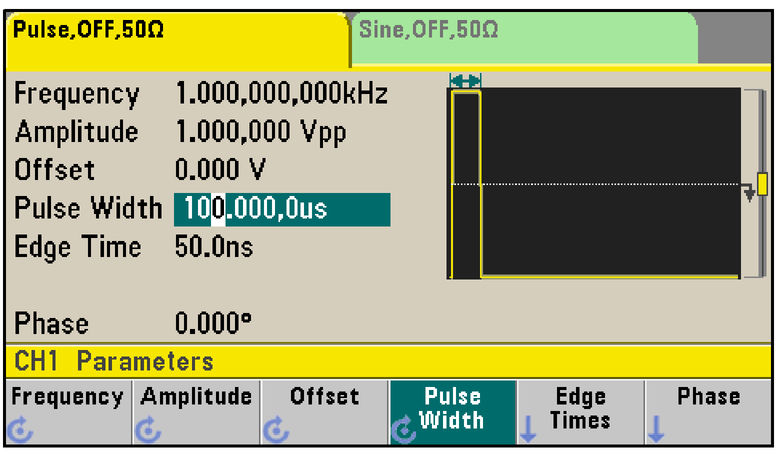
To Output a PWM Waveform

You can configure the waveform generator to output a pulse width modulated (PWM) waveform. The Agilent 33500 Series provides PWM for pulse carrier waveforms. In PWM, the pulse width or duty cycle of the carrier waveform is varied according to the modulating waveform. You can specify either a pulse width and width deviation, or a pulse duty cycle and duty cycle deviation, the deviation to be controlled by the modulating waveform.

For this example, you will specify a pulse width and pulse width deviation for a 1 kHz pulse waveform with a 5Hz sine wave modulating waveform.

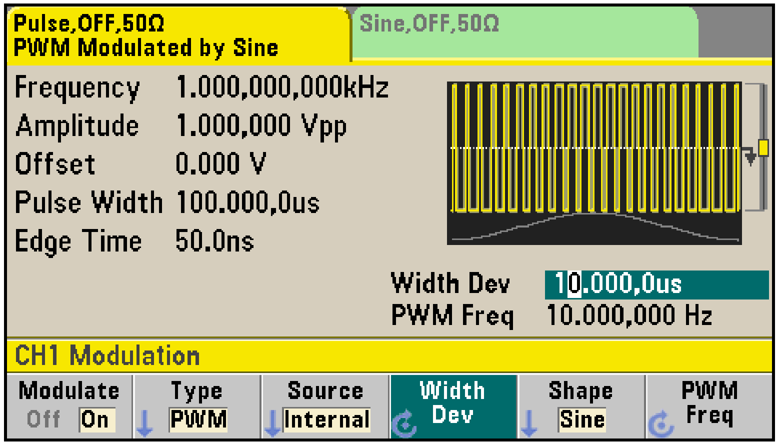
1 **Select the carrier waveform parameters.**

Press (Waveforms) and then press **Pulse**. Use the **Frequency**, **Amplitude**, **Offset**, **Pulse Width** and **Edge Times** softkeys to configure the carrier waveform. For this example, select a 1 kHz pulse waveform with an amplitude of 1 Vpp, zero offset, a pulse width of 100 µs, and an edge time of 50 ns (both leading and trailing).



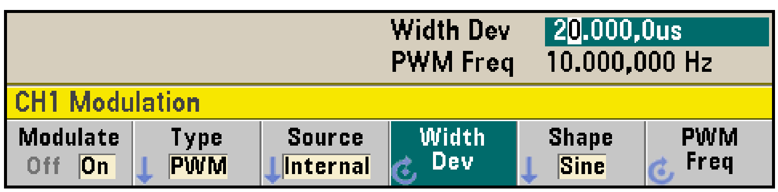
2 Select PWM.

Press (Modulate) and choose **Type,** then **PWM**. Then press the first softkey (**Modulate**) to turn modulation on. Notice the status message “PWM Modulated by Sine” in the upper-left corner of the display.



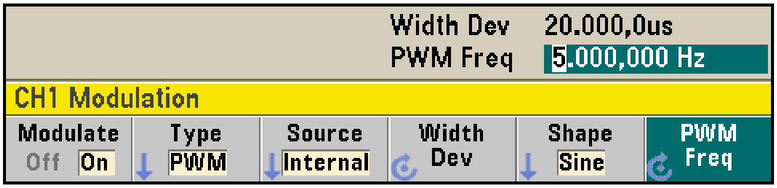
3 Set the width deviation.

Press the **Width Dev** softkey and set the value to 20 μs using the numeric keypad or the knob and cursor keys.



4 Set the modulating frequency.

Press the **PWM Freq** softkey and then set the value to 5 Hz using the numeric keypad or the knob and cursor keys.



5 Select the modulating waveform shape.

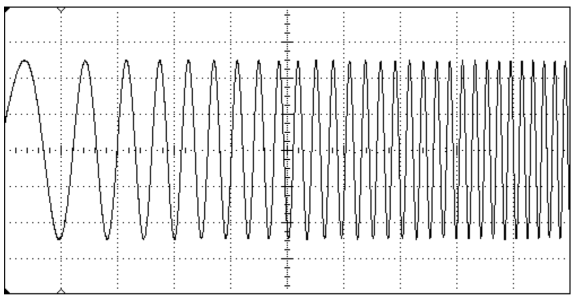
Press the **Shape** softkey to select the shape of the modulating waveform. For this example, select a sine wave.

At this point, the waveform generator outputs a PWM waveform with the specified modulation parameters (if the output is enabled).

Of course, to really view the PWM waveform, you would need to output it to an oscilloscope. If you do this, you will see how the pulse width varies, in this case, from 80 to 120 µs. At a modulation frequency of 5 Hz, the deviation is quite visible.

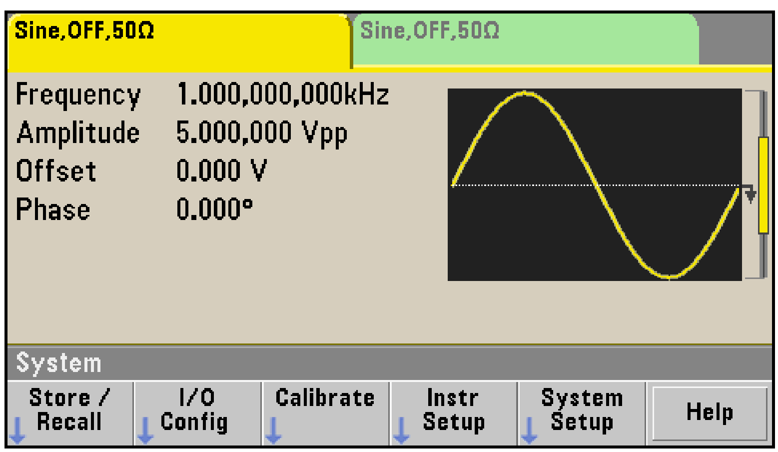
To Output a Frequency Sweep

In the frequency sweep mode, the waveform generator moves from the *start frequency* to the *stop frequency* at a *sweep rate* which you specify. You can sweep up or down in frequency, and with either linear or logarithmic spacing, or using a list of frequencies. *For this example, you will output a swept sine wave from 50 Hz to 5 kHz. You will not change the other parameters from their default settings.*



1 Select the function and amplitude for the sweep.

For sweeps, you can select sine, square, ramp, or arbitrary waveforms (PRBS, noise, and DC are not allowed). *For this example, select a sine wave with an amplitude of 5 Vpp.*

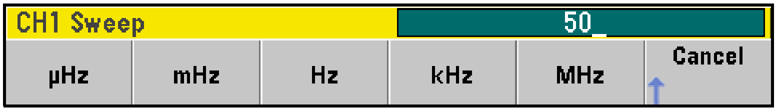


2 Select the sweep mode.

Press Sweep and then verify that the linear sweep mode is currently selected on the second softkey. Press the **Sweep** softkey to turn sweep on. Notice the “Linear Sweep” status message at the top of the tab for the current channel. The Sweep button is also illuminated.

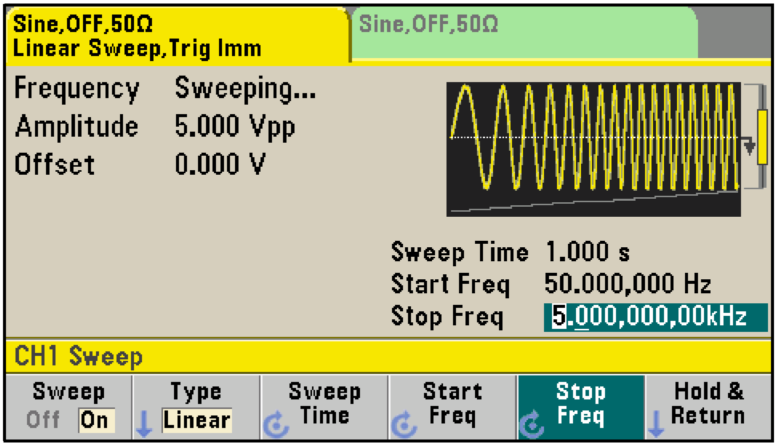
3 Set the start frequency.

Press the **Start Freq** softkey and then set the value to 50 Hz using the numeric keypad or the knob and cursor keys.



4 Set the stop frequency.

Press the **Stop Freq** softkey and then set the value to 5 kHz using the numeric keypad or the knob and cursor keys. *At this point, the waveform generator outputs a continuous sweep from 50 Hz to 5 kHz if output is enabled.*



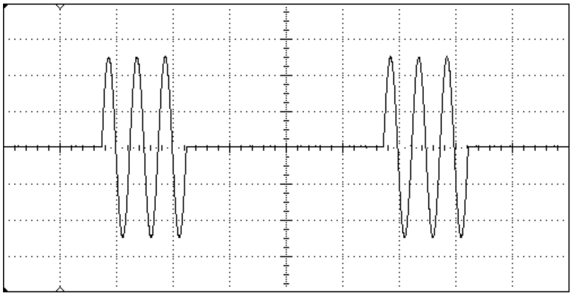
Note: If desired, you can press the Units button and then press the fourth softkey choose to set the frequency boundaries of the sweep using a *center frequency* and *frequency span*. These parameters are similar to the start frequency and stop frequency and are included to give you added flexibility. To achieve the same results, set the center frequency to 2.525 kHz and the frequency span to 4.950 kHz.

To generate a frequency sweep, press Trigger twice. The first press puts the trigger in manual mode, and the second one sends a trigger. For more information, see "To Trigger a Sweep or Burst" on page 72.

3

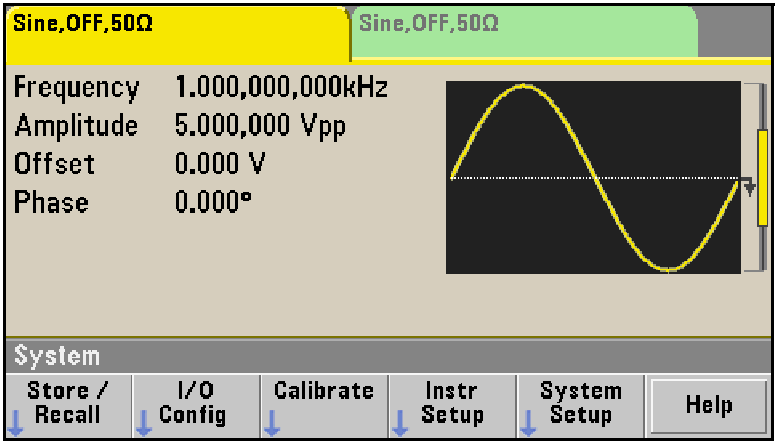
To Output a Burst Waveform

You can use the waveform generator to output a waveform with a specified number of cycles, called a *burst*. You can control the burst rate with the internal rate generator or the signal level on the rear-panel *Trig In* connector. *For this example, you will output a three-cycle sine wave with a 20 ms burst period. You will not change the other parameters from their default settings: trigger source and 0 degree starting phase.*



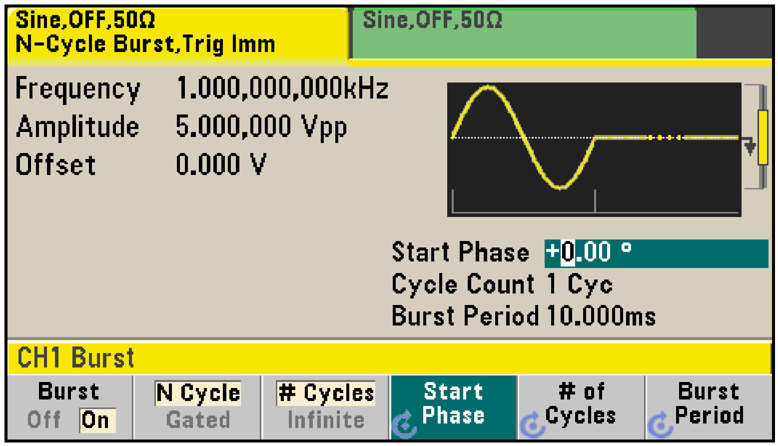
1 Select the function and amplitude for the burst.

For burst waveforms, you can select sine, square, ramp, pulse, arbitrary waveforms, triangle, or PRBS. Noise is allowed only in the “gated” burst mode and DC is not allowed. *For this example, select a sine wave with an amplitude of 5 Vpp.*



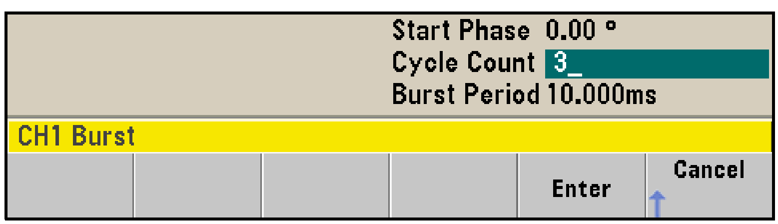
2 Select the burst mode.

Press (Burst) and then press the **Burst Off / On** softkey. Notice that a status message “N Cycle Burst, Trig Imm” is shown in the tab of the current channel.



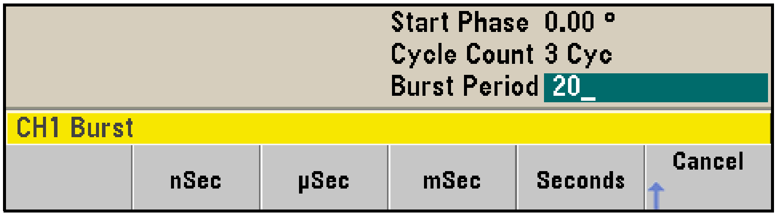
3 Set the burst count.

Press the **# of Cycles** softkey and then set the count to “3” using the numeric keypad or knob. Press the **Enter** softkey to finish data entry if you are using the numeric keypad.



4 Set the burst period.

Press the **Burst Period** softkey and then set the period to 20 ms using the numeric keypad or the knob and cursor keys. The burst period sets the time from the start of one burst to the start of the next burst (note the display icon).



At this point, the waveform generator outputs a continuous three-cycle burst at 20 ms intervals.

> You can generate a single burst (with the specified count) by pressing the Trigger key. For more information, see “To Trigger a Sweep or Burst” on page 72.
>
> You can also use the external gate signal to create gated bursts, where a burst is produced while a gate signal is present on the input.

To Trigger a Sweep or Burst

You can issue triggers from the front panel for sweeps and bursts using one of four different trigger types.

- *Immediate* or “automatic” triggering is the default setting. In this mode, the waveform generator outputs continuously when the sweep or burst mode is selected.
- *Ext* or “external” triggering controls triggering via the Trigger connector on the rear of the instrument.
- *Manual* triggering initiates one sweep or outputs one burst each time you press the (Trigger) button. Continue pressing this key to re-trigger the waveform generator.
- *Timer* issues one or more triggers separated in time by a fixed amount.

If sweep or burst is on, pressing (Trigger) will set the trigger source to manual. Pressing (Trigger) displays the trigger menu. The button is illuminated when a channel is awaiting a manual trigger.

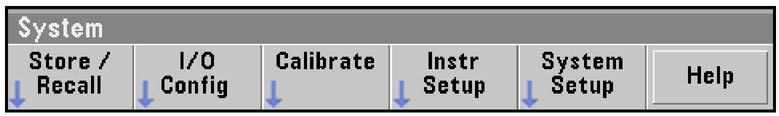
Pressing (Trigger) while you are in the trigger menu will send a manual trigger.

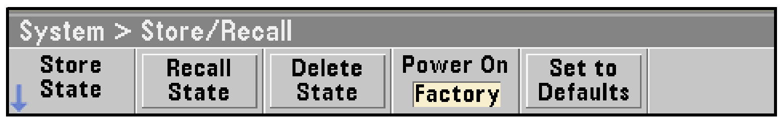
To Store the Instrument State

You can store instrument states in any number of state files, which always have a .STA extension. You can do this for backup purposes, or you can save your state to a USB drive and then reload the state on a different instrument. in order to have instruments with matching configurations.

1 Select the desired storage location.

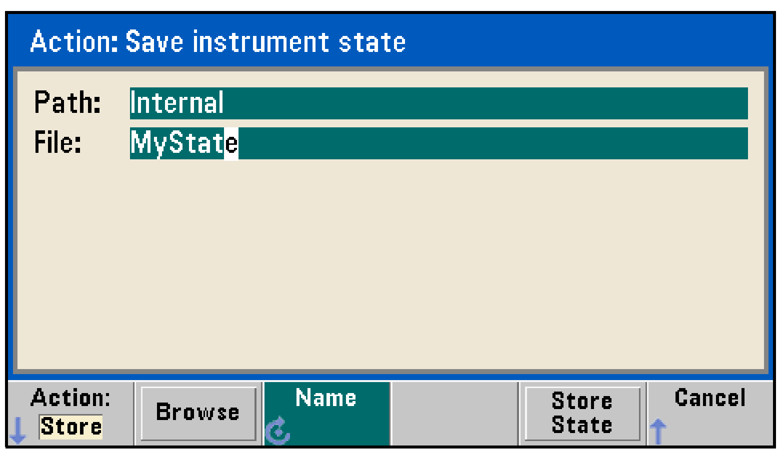
Press System and then press the **Store / Recall** softkey, followed by the **Store State** softkey.





2 Specify the name for the selected location.

Use the knob and arrows to enter the file name. Then press **Store State**.



3

- Standard file naming rules apply to state files.
- To add characters, press the right-cursor key until the cursor is to the right of the existing name and then turn the knob.
- To use numbers in the name, you can enter them directly from the numeric keypad.

3 Store the instrument state.

Press the **STORE STATE** softkey. A stored state contains the selected function, frequency, amplitude, dc offset, duty cycle, symmetry, as well as any modulation parameters in use. The instrument *does not* store volatile waveforms created in the arbitrary waveform function.

4 Recall the instrument state (optional).

To restore (retrieve) a stored state, press (System) and then **Store / Recall**. Then press **Recall State**, select the state to recall and press **Select**.

To Configure the Remote Interface

The Agilent 33500 Series supports remote interface communication using a choice of three interfaces: GPIB, USB, and LAN (LXI Class C compliant). All three interfaces are “live” at power up. The following sections explain how to configure the remote interface from the instrument front panel.

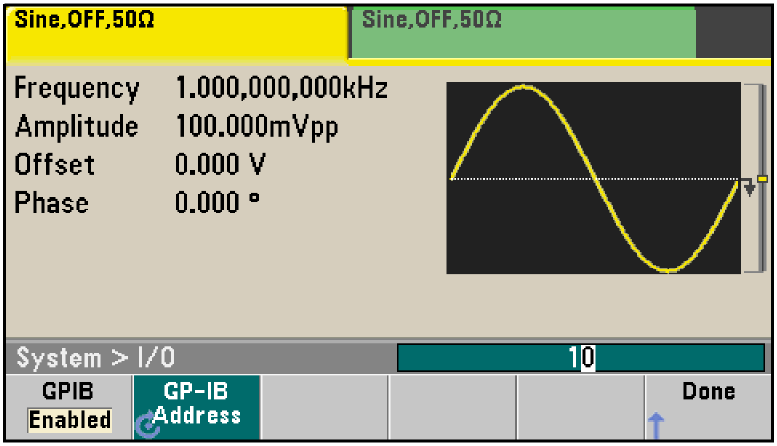
Note: *Two CDs, provided with your instrument, contain connectivity software to enable communications over the remote interfaces. See the Agilent 33500 Series User’s Guide for further information on these CDs and the software they contain.*

GPIB Configuration (Option GPIB)

You need only select a GPIB address.

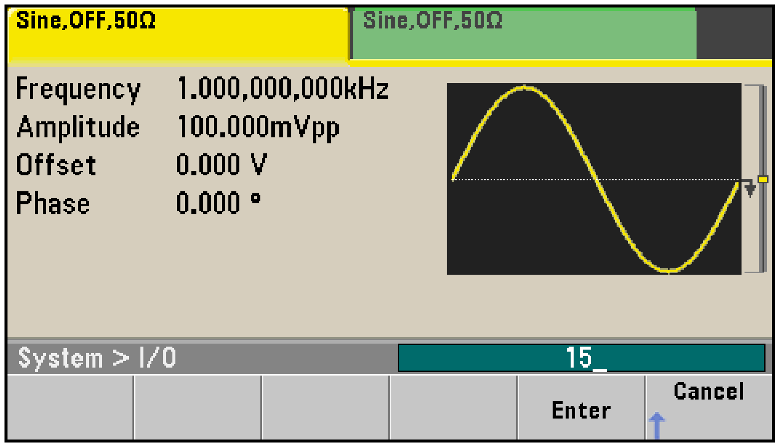
1 Select the “I/O” menu.

Press (System) and then press the **I/O Config** and **GPIB Settings** softkeys. Then press the **GP-IB Address** softkey.



2 **Set the GPIB address.**

Use the knob and cursor keys or the numeric keypad to select a GPIB address in the range 0 through 30 (the factory default is “10”). Press **Enter** when done.



USB Configuration

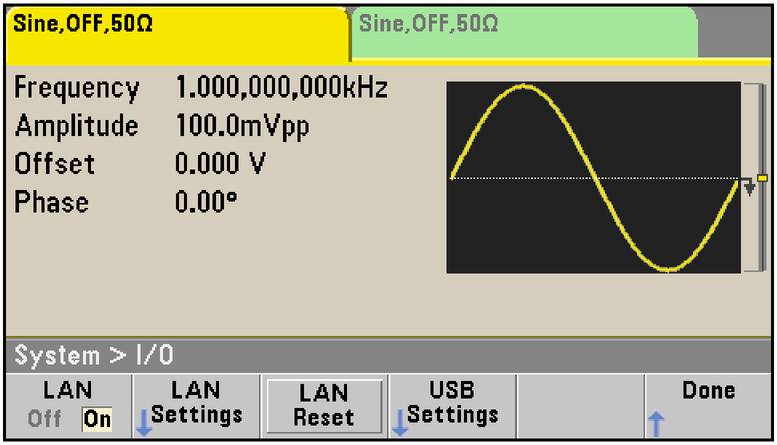
The USB interface requires no front panel configuration parameters. Just connect the Agilent 33500 Series to your PC with the appropriate USB cable. The interface will configure itself. The instrument supports both USB 1.1 and USB 2.0.

LAN Configuration

There are several parameters that you may need to set to establish network communication using the LAN interface. Primarily, you will need to establish an IP address. You may need to contact your network administrator for help in establishing communication with the LAN interface.

1 **Select the "I/O" menu.**

Press (System) and then press the **I/O Config** softkey.



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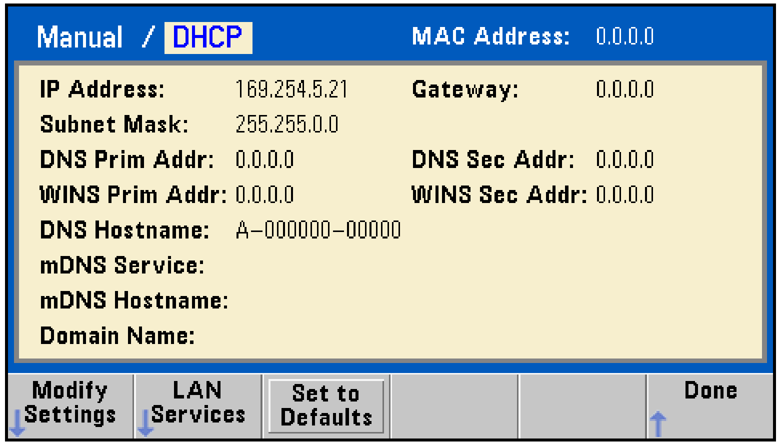
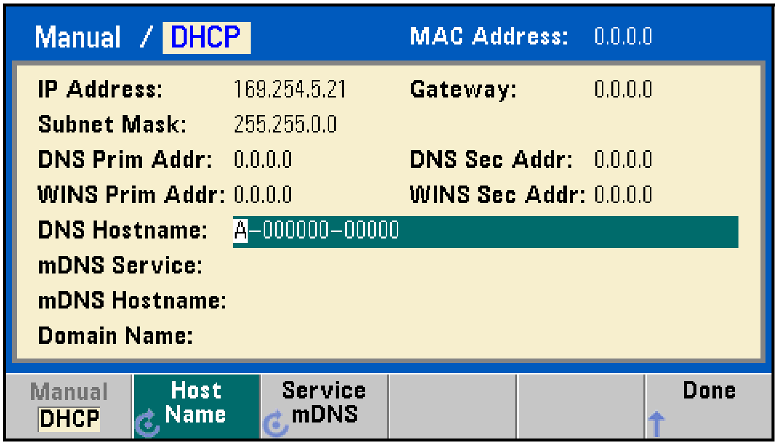
2 Select the LAN Settings menu.

Press the **LAN Settings** softkey.



You can select **Modify Settings** to change the LAN settings, or you can turn LAN Services on and off or restore the LAN settings to default values.

3 Press **Modify Settings.**

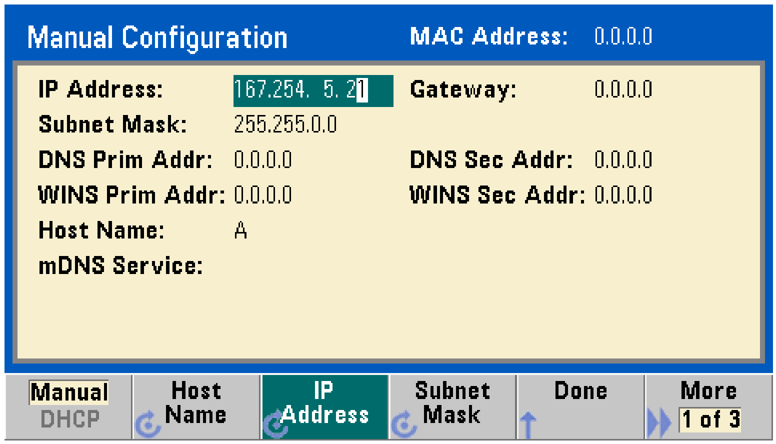


To access most items on this screen, you must use the first softkey to switch from **DHCP** to **Manual**. With **DHCP** on, an IP address will automatically be set by DHCP (Dynamic Host Configuration Protocol) when you connect the instrument to the network, provided the DHCP server is found and is able to do so. DHCP also automatically deals with the subnet mask and gateway address, if required. *This is typically the easiest way to establish LAN communication for your instrument. All you need to do is leave* **DHCP** *on. Contact your LAN administrator for more information.*

3

4 Establish an "IP Setup."

If you are not using DHCP, you must first establish an IP setup, including an IP address, and possibly a subnet mask and gateway address. The **IP Address** and **Subnet Mask** buttons are on the main screen, and you press the **More** softkey button to get to the **Gateway** configuration feature.



With **Auto IP On**, if DHCP fails to assign an IP address, Auto IP will attempt to do so after a time-out period.

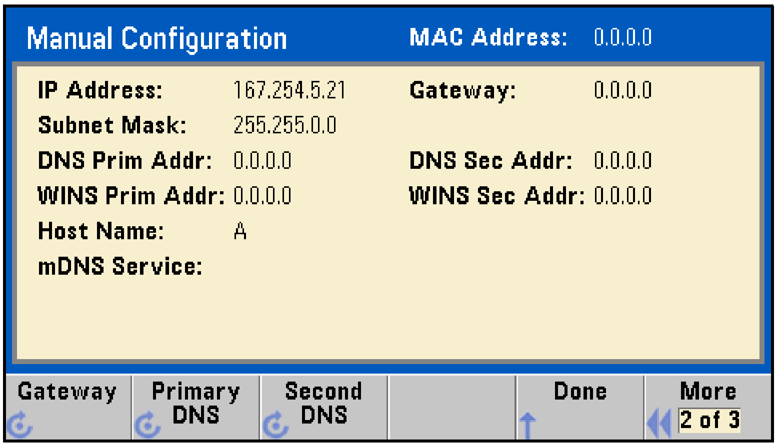
Contact your network administrator for the IP address, subnet mask, and gateway to use. All IP addresses take the *dot-notation* form "nnn.nnn.nnn.nnn" where "nnn" in each case is a byte value in the range 0 through 255. You can enter a new IP address using the numeric keypad (not the knob). Just type in the numbers and the period delimiters using the keypad. Use the left cursor key as a backspace key. *Do not enter leading zeros*. For further information, see "More about IP Addresses and Dot Notation" at the end of this section.

5 Configure the "DNS Setup" (optional).

DNS (Domain Name Service) is an Internet service that translates domain names into IP addresses. Ask your network administrator whether DNS is in use, and if it is, for the host name, domain name, and DNS server address to use.

a. **Set the "Host Name."** Press the **Host Name** softkey and enter the host name. The host name is the host portion of the domain name, which is translated into an IP address. The host name is entered as a string using the knob and cursor keys to select and change characters. The host name may include letters, numbers, and dashes ("-"). You can use the keypad for the numeric characters only.

b. Set the "DNS Server" addresses. From the LAN configuration screen, press **More** to go to the second of the three pages.



Enter the **Primary DNS and Second DNS**. See your network administrator for details.

More about IP Addresses and Dot Notation

Dot-notation addresses (“nnn.nnn.nnn.nnn” where “nnn” is a byte value) such as IP addresses must be expressed with care. This is because most web software on the PC will interpret byte values with leading zeros as octal numbers. Thus, ”255.255.020.011” is actually equivalent to the decimal ”255.255.16.9” rather than ”255.255.20.11” because ”.020” is interpreted as ”16” expressed in octal, and ”.011” as ”9”. To avoid confusion it is best to use only decimal expressions of byte values (0 to 255), with no leading zeros.

The Agilent 33500 Series assumes that all IP addresses and other dot-notation addresses are expressed as decimal byte values, and strips all leading zeros from these byte values. Thus, if you try to enter "255.255.020.011" in the IP address field, it becomes "255.255.20.11" (a purely decimal expression). You should enter exactly the same expression, "255.255.20.11" in your PC web software to address the instrument. Do not use "255.255.020.011"—the PC will interpret that address differently due to the leading zeros.

3

To Secure and Unsecure the Instrument for Calibration

The instrument uses a security code to prevent accidental or unauthorized adjustments of the instrument. When you first receive your instrument, it is secured. Before you can adjust the instrument, you must unsecure it by entering the correct security code.

Use the CAL:SEC:STAT ON *command to enter the security code using the remote interface.*

- The security code is set to **AT33520A** when the instrument is shipped from the factory. The security code is stored in non-volatile memory, and does not change when power has been off, after a Factory Reset (*RST command), or after an Instrument Preset (SYSTem:PRESet command).
- The security code may contain up to 12 alphanumeric characters. The first character must be a letter, but the remaining characters can be letters, numbers, or an underscore (_). You do not have to use all 12 characters but the first character must always be a letter.

Note *If you forget your security code, you can disable the security feature by applying a temporary short inside the instrument as described See "To Unsecure the Instrument Without the Security Code" on page 104.*

1 Select the "I/O" menu.

Press System and then press the **Calibrate** softkey.

Use the knob and numeric keys to enter the security code.

Once unsecured the **Calibrate** softkey is available.

Calibration and Adjustment

Calibration and Adjustment

This chapter contains procedures for verification of the instrument's performance and adjustment (calibration). The chapter is divided into the following sections:

- Agilent Technologies Calibration Services, *on page 87*
- Calibration Interval, *on page 87*
- Adjustment is Recommended, *on page 87*
- Time Required for Calibration, *on page 88*
- Automating Calibration Procedures, *on page 89*
- Recommended Test Equipment, *on page 90*
- Test Considerations, *on page 91*
- Performance Verification Tests, *on page 92*
- Internal Timebase Verification, *on page 96*
- AC Amplitude (high-impedance) Verification, *on page 97*
- DC Offset Voltage Verification, *on page 98*
- -8 dB Range Flatness Verification, *on page 99*
- -24 dB Range Flatness Verification, *on page 101*
- Calibration Security, *on page 103*
- Calibration Message, *on page 106*
- Calibration Count, *on page 106*
- General Calibration/Adjustment Procedure, *on page 107*
- Aborting a Calibration in Progress, *on page 108*
- Sequence of Adjustments, *on page 108*
- Self-Test, *on page 109*
- Frequency (Internal Timebase) Adjustment, *on page 110*
- Internal ADC Adjustment, *on page 111*
- Self Calibration Adjustment., *on page 112*
- Output Impedance Adjustment, *on page 113*
- AC Amplitude (high-impedance) Adjustment, *on page 114*
- -24 dB Range Flatness Adjustment, *on page 116*
- -8 dB Range Flatness Adjustment, *on page 118*
- Self Calibration Adjustment (Channel 2), *on page 120*
- Output Impedance Adjustment (Channel 2), *on page 121*
- AC Amplitude (high-impedance) Adjustment (Channel 2), *on page 122*
- -24 dB Range Flatness Adjustment (Channel 2), *on page 124*
- -8 dB Range Flatness Adjustment (Channel 2), *on page 126*
- Calibration Errors, *on page 128*

Closed-Case Electronic Calibration The instrument features closed-case electronic calibration. No internal mechanical adjustments are required. The instrument calculates correction factors based upon the input reference value you set. The new correction factors are stored in non-volatile memory until the next calibration adjustment is performed. Non-volatile EEPROM calibration memory does not change when power has been off or after a remote interface reset.

Agilent Technologies Calibration Services

When your instrument is due for calibration, contact your local Agilent Technologies Service Center for a low-cost recalibration. The waveform generator is supported on automated calibration systems which allow Agilent to provide this service at competitive prices.

Calibration Interval

The instrument should be calibrated on a regular interval determined by the measurement accuracy requirements of your application. A 1-year interval is adequate for most applications. Accuracy specifications are warranted only if adjustment is made at regular calibration intervals. Accuracy specifications are not warranted beyond the 1-year calibration interval. Agilent Technologies does not recommend extending calibration intervals beyond 2 years for any application.

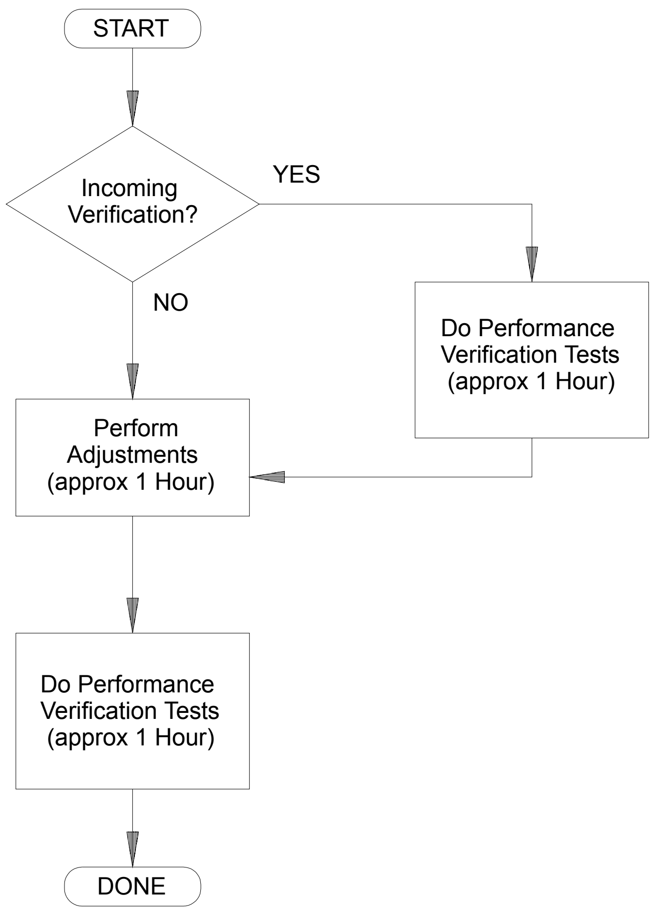
Adjustment is Recommended

Whatever calibration interval you select, Agilent Technologies recommends that complete re-adjustment should always be performed at the calibration interval. This will assure that the instrument will remain within specification for the next calibration interval. This criteria for re-adjustment provides the best long-term stability. Performance data measured using this method can be used to extend future calibration intervals.

Use the Calibration Count (see page 106) to verify that all adjustments have been performed.

Time Required for Calibration

The waveform generator can be automatically calibrated under computer control. With computer control you can perform the complete calibration procedure and performance verification tests in approximately 30 minutes (33521A) or 60 minutes (33522A) once the instrument is warmed-up (see “Test Considerations” on page 91). Manual adjustments and verifications, using the recommended test equipment, will take approximately 1 hour (33521A) or 2 hours (33522A).



Automating Calibration Procedures

You can automate the complete verification and adjustment procedures outlined in this chapter if you have access to programmable test equipment. You can program the instrument configurations specified for each test over the remote interface. You can then enter read-back verification data into a test program and compare the results to the appropriate test limit values.

You can also adjust the instrument from the remote interface. Remote adjustment is similar to the local front-panel procedure. You can use a computer to perform the adjustment by first selecting the required function and range on the measurement equipment. The calibration value is sent to the instrument and then the calibration is initiated over the remote interface. The instrument must be unsecured prior to initiating the calibration procedure.

A typical programming sequence for a single calibration setup is as follows:

1. CAL:SETup 2 //puts the instrument into calibration setup 2
2. //measure the output frequency with the external frequency counter
3. CAL:VALue 9.99994321E6 //send the measured value to the instrument
4. CAL? // initiates the calibration adjustment for setup 2
5. //query returns 0 or 1 (failure or success of adjustment)
6. CAL:SETup 3 // puts the instrument in calibration setup 3

For further information on programming the instrument, see chapters 2, 3, and 4 in the *Agilent 33500 waveform generator User's Guide* and the *Agilent 33500 Series Programmer's Reference CD.*

Recommended Test Equipment

The test equipment recommended for the performance verification and adjustment procedures is listed below. If the exact instrument is not available, substitute calibration standards of equivalent accuracy.

Instrument	Requirements	Recommended Model	Use*
Digital Multimeter (DMM)	ac volts, true rms, ac coupled accuracy: ±0.02% to 1 MHz dc volts accuracy: 50 ppm resolution: 100 μV Resistance Offset-compensated accuracy: ±0.1Ω	Agilent 3458A	Q, P, T
Precision ac Voltmeter	1000 Hz to 30 MHz 0.1 Vrms to 2 Vrms (–7 dBm to +20 dBm) accuracy: 0.02 dB resolution: 0.01 dB	Fluke 5790A	Q, P, T
Frequency Meter	accuracy: 0.1 ppm	Agilent 53132A Opt 012 (high stability)	Q, P, T
Oscilloscope	1 GHz 4 Gs/second 50Ω input termination	Agilent MSO6104A	T
Adapter	BNC (m) to dual-banana (f)	Agilent 11001-60001	Q, P, T
Adapter	N type (m) to BNC (m)	Agilent E9623A	Q, P, T
Cable (2 required)	Dual banana (m) to dual banana (m)	Agilent 11000-60000	Q, P, T
Cable	RG58, BNC (m) to dual banana	Agilent 11001-60001	Q, P, T
Cable	RG58, BNC (m) to BNC (m)	Agilent 11170C	Q, P, T

* Q = Quick Verification P = Performance Verification T = Troubleshooting

Test Considerations

For optimum performance, all procedures should comply with the following recommendations:

- Assure that the calibration ambient temperature is stable and between 18 °C and 28 °C. Ideally, the calibration should be performed at 23 °C ±1 °C.
- Assure ambient relative humidity is less than 80%.
- Allow a 1-hour warm-up period before verification or adjustment.
- Keep the measurement cables as short as possible, consistent with the impedance requirements.
- Use only RG-58 or equivalent 50Ω cable.

Performance Verification Tests

Use the Performance Verification Tests to verify the measurement performance of the instrument. The performance verification tests use the instrument's specifications listed in the "Specifications" chapter beginning on page 17.

You can perform three different levels of performance verification tests:

- **Self-Test** A series of internal verification tests that give high confidence that the instrument is operational.
- **Quick Verification** A combination of the internal self-tests and selected verification tests.
- **Performance Verification Tests** An extensive set of tests that are recommended as an acceptance test when you first receive the instrument or after performing adjustments.

Self-Test

A brief power-on self-test occurs automatically whenever you turn on the instrument. This limited test assures that the instrument is operational.

To perform a complete self-test:

1 Press System Key on the front panel.

2 Select the **Self Test** softkey from the “Utility > Test/Cal” menu.

A complete description of the self-tests can be found in chapter 6. The instrument will automatically perform the complete self-test procedure when you release the key. The self-test will complete in approximately 15 seconds.

- If the self-test is successful, “Self Test Passed” is displayed on the front panel.
- If the self-test fails, “Self Test Failed” and the number of errors are displayed. The errors are viewable under the “Help” softkey.
- If repair is required, see chapter 6, “Service,” for further details.

Quick Performance Check

The quick performance check is a combination of internal self-test and an abbreviated performance test (specified by the letter **Q** in the performance verification tests). This test provides a simple method to achieve high confidence in the instrument's ability to functionally operate and meet specifications. These tests represent the absolute minimum set of performance checks recommended following any service activity. Auditing the instrument's performance for the quick check points (designated by a **Q**) verifies performance for normal accuracy drift mechanisms. This test does not check for abnormal component failures.

To perform the quick performance check, do the following:

4

1. Perform a complete self-test. A procedure is given on page 93.
2. Perform only the performance verification tests indicated with the letter **Q**.
3. If the instrument fails the quick performance check, adjustment or repair is required.

Performance Verification Tests

The performance verification tests are recommended as acceptance tests when you first receive the instrument. The acceptance test results should be compared against the specifications given in chapter 1. After acceptance, you should repeat the performance verification tests at every calibration interval.

If the instrument fails performance verification, adjustment or repair is required.

Adjustment is recommended at every calibration interval. If adjustment is not made, you must guard band, using no more than 80% of the specifications listed in chapter 1, as the verification limits.

Amplitude and Flatness Verification Procedures

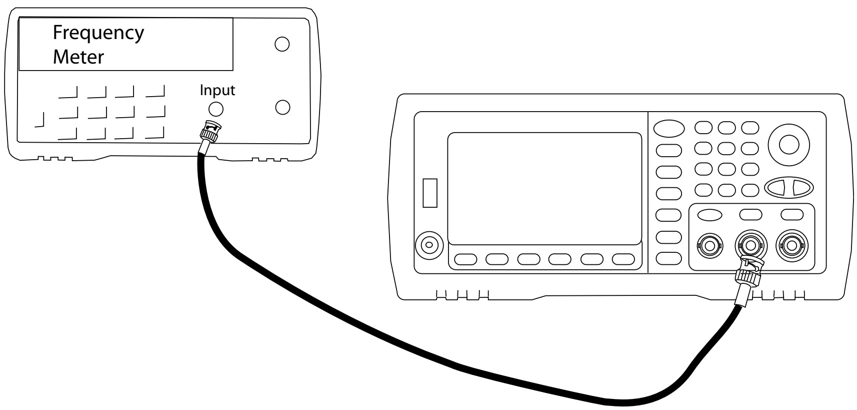
The flatness verification procedures use a precision AC Voltmeter. You may substitute Thermal Voltage Converters (TVCs) to make measurements using appropriate operating procedures and test equipment.

Flatness measurements for the -24 dB and -8 dB attenuator ranges are measured during the verification procedure. Other attenuator ranges are verified as a part of -24 dB and -8 dB attenuation range verification procedures. No separate verification procedure is given for these ranges.

Internal Timebase Verification

This test verifies the output frequency accuracy of the instrument. All output frequencies are derived from a single generated frequency.

1 Connect a frequency counter to the channel 1 output as shown below (the frequency counter input should be terminated at 50 Ω).



2 Set the instrument to the output described in the table below and measure the output frequency. *Be sure the instrument output is enabled.*

	Waveform Generator			Measurement	
	Function	Amplitude	Frequency	Nominal	Error*
Q	Sine Wave	1.00 Vpp	10.000,000,0 MHz	10.000 MHz	**± 10 Hz**

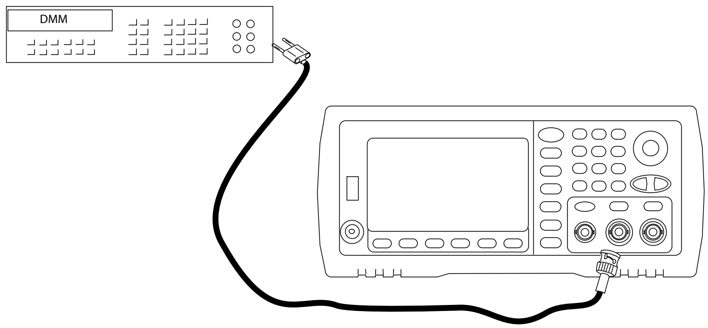
* With Option 010 OCXO the measurement error is **± 1 Hz**

3 Compare the measured frequency to the test limits shown in the table.

AC Amplitude (high-impedance) Verification

This procedure checks the ac amplitude output accuracy at a frequency of 1 kHz using each attenuator.

1 Set the DMM to measure Vrms. Connect the DMM to the channel 1 output as shown below.



2 Set the instrument to each output described in the table below and measure the output voltage with the DMM. Be sure the output impedance is set to High–Z and the output is enabled.

	Waveform Generator				Measurement	
	Output Setup	Function	Frequency	Amplitude	Nominal	Error*
Q	High Z**	Sine Wave	1.000 kHz	400.0 mVrms	0.400 Vrms	**± 0.004707 Vrms**
Q	High Z	Sine Wave	1.000 kHz	400.0 mVrms	0.400 Vrms	**± 0.004707 Vrms**
Q	High Z	Sine Wave	1.000 kHz	1.00 Vrms	1.00 Vrms	**± 0.010707 Vrms**
Q	High Z	Sine Wave	1.000 kHz	2.500 Vrms	2.5 Vrms	**± 0.025707 Vrms**
Q	High Z	Sine Wave	1.000 kHz	7.000 Vrms	7.0000 Vrms	**± 0.070707 Vrms**

* Based upon 1% of setting ±1 mVpp (50 Ω); converted to Vrms for High–Z.
** Use the following sequence to set this output:
- **a** Set the amplitude to 400.0 mVrms
- **b** Set the DC Offset to 1.0 Vdc
- **c** Set Auto-Range to OFF
- **d** Set DC Offset Voltage to 0.0 Vdc
- **e** After the measurement, set Auto-Range to ON for the rest of the measurements.

3 Compare the measured voltage to the test limits shown in the table.

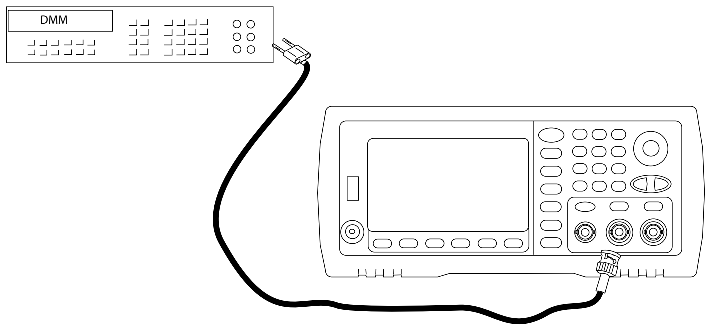
4 **33522A Only.** Connect the DMM to the channel 2 output and repeat steps 2 and 3.

4

DC Offset Voltage Verification

This procedure checks the DC Offset Voltage on two attenuator ranges,

1 Set the DMM to measure DC Volts. Connect the DMM to the Channel 1 Output as shown below.



2 Set the instrument to each output described in the table below and measure the output voltage with the DMM.

	Waveform Generator			Measurement	
	Output Setup	Function	Voltage	Nominal	Error*
Q	High Z	DC	0.0 V	0.0 Vdc	**± 0.002 Vdc**
Q	High Z	DC	500 mV	0.500 Vdc	**± 0.007 Vdc**
Q	High Z	DC	10.0 V	10.0 Vdc	**± 0.102 Vdc**

* Based upon 1% of setting ±2 mVdc for High-Z.

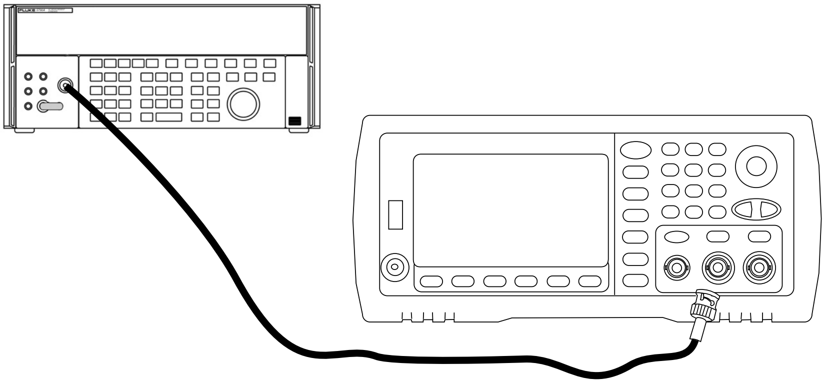
3 Compare the measured voltage to the test limits shown in the table.

4 **33522A Only.** Connect the DMM to the channel 2 output and repeat steps 2 and 3.

-8 dB Range Flatness Verification

This procedure checks the high frequency ac amplitude flatness on the -8dB attenuator range. This also checks flatness for all other ranges excluding the -24 dB and 0 dB attenuator ranges.

1 Connect a precision AC Voltmeter to measure the output amplitude of channel 1 as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



Note

If you are using substitute test equipment, be sure the input impedance is 50 Ω. Measurement quality will be directly related to the accuracy of the 50 Ω load used.

2 Set the precision AC Voltmeter to “Medium, Medium” Digital Filter and Filter Restart configuration.

3 Set the instrument to each output described in the table below and measure the output amplitude with the AC Voltmeter. This will become the reference measurement. Set the output impedance to 50 Ω. Be sure the output is enabled.

	FunctionWaveform Generator				Measurement	
	Output Setup	Function	Amplitude	Frequency	Nominal	Error
Q	50 Ω	Sine Wave	1.200 Vrms	1.000 kHz	1.2 Vrms	**± 0.0127 Vrms**

4 Set the measured value in Step 3 to be the reference value on the AC Voltmeter.

5 Set the instrument to each output described in the table below and measure the output amplitude relative to the source as a percent with the AC Voltmeter. Note that the table also lists the output in dB if you are using a power meter to perform this test.

	Waveform Generator				Measurement			
	Output Setup	Function	Amplitude	Frequency	Nominal	Error	Nominal	Error
	50 Ω	Sine Wave	1.200 Vrms	100.000 kHz	100%	**± 1.15%**	0 dB	**± 0.10 dB**
	50 Ω	Sine Wave	1.200 Vrms	500.000 kHz	100%	**± 1.74%**	0 dB	**± 0.15 dB**
	50 Ω	Sine Wave	1.200 Vrms	1.000 MHz	100%	**± 1.74%**	0 dB	**± 0.15 dB**
Q	50 Ω	Sine Wave	1.200 Vrms	2.000 MHz	100%	**± 1.74%**	0 dB	**± 0.15 dB**
	50 Ω	Sine Wave	1.200 Vrms	5.000 MHz	100%	**± 1.74%**	0 dB	**± 0.15 dB**
	50 Ω	Sine Wave	1.200 Vrms	10.00 MHz	100%	**± 3.51%**	0 dB	**± 0.30 dB**
	50 Ω	Sine Wave	1.200 Vrms	15.00 MHz	100%	**± 3.51%**	0 dB	**± 0.30 dB**
	50 Ω	Sine Wave	1.200 Vrms	20.00 MHz	100%	**± 3.51%**	0 dB	**± 0.30 dB**
	50 Ω	Sine Wave	1.200 Vrms	22.00 MHz	100%	**± 4.71%**	0 dB	**± 0.40 dB**
	50 Ω	Sine Wave	1.200 Vrms	27.00 MHz	100%	**± 4.71%**	0 dB	**± 0.40 dB**
	50 Ω	Sine Wave	1.200 Vrms	30.00 MHz	100%	**± 4.71%**	0 dB	**± 0.40 dB**

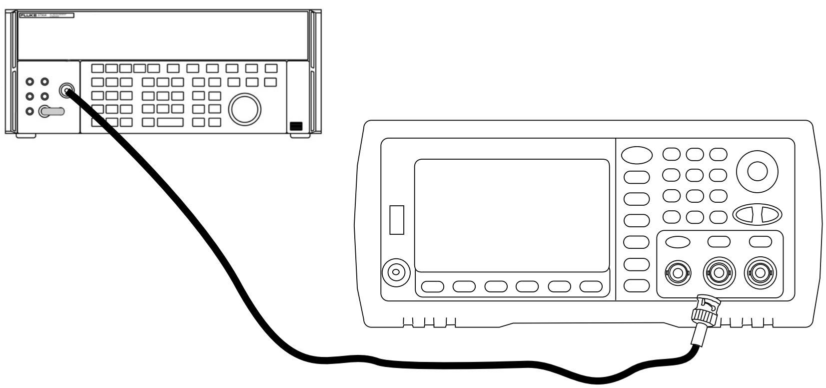
6 Compare the measured output to the test limits shown in the table.

7 **33522A Only.** Connect the AC Voltmeter to the channel 2 output and repeat steps 2 through 6.

-24 dB Range Flatness Verification

This procedure checks the high frequency ac amplitude flatness on the - 24 dB attenuator range. This also checks flatness for the 0 dB attenuator range.

1 Connect a precision AC Voltmeter to measure the output amplitude of channel 1 as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



Note

If you are using substitute test equipment, be sure the input impedance is 50 Ω. Measurement quality will be directly related to the accuracy of the 50 Ω load used.

2 Set the precision AC Voltmeter to “Medium, Medium” Digital Filter and Filter Restart configuration.

3 Set the instrument to each output described in the table below and measure the output amplitude with the AC Voltmeter. This will become the reference measurement. Set the output impedance to 50 Ω. Be sure the output is enabled.

	Waveform Generator				Measurement	
	Output Setup	Function	Amplitude	Frequency	Nominal	Error
Q	50 Ω	Sine Wave	0.190 Vrms	1.000 kHz	0.190 Vrms	**± 0.0026 Vrms**

4 Set the measured value in Step 3 to be the reference value on the AC Voltmeter.

5 Set the instrument to each output described in the table below and measure the output amplitude relative to the source as a percent with the AC Voltmeter. Note that the table also lists the output in dB if you are using a power meter to perform this test.

	Waveform Generator				Measurement			
	Output Setup	Function	Amplitude	Frequency	Nominal	Error	Nominal	Error
	50 Ω	Sine Wave	0.190 Vrms	100.000 kHz	100%	**± 1.15%**	0 dB	**± 0.10 dB**
	50 Ω	Sine Wave	0.190 Vrms	500.000 kHz	100%	**± 1.74%**	0 dB	**± 0.15 dB**
	50 Ω	Sine Wave	0.190 Vrms	1.000 MHz	100%	**± 1.74%**	0 dB	**± 0.15 dB**
Q	50 Ω	Sine Wave	0.190 Vrms	2.000 MHz	100%	**± 1.74%**	0 dB	**± 0.15 dB**
	50 Ω	Sine Wave	0.190 Vrms	5.000 MHz	100%	**± 1.74%**	0 dB	**± 0.15 dB**
	50 Ω	Sine Wave	0.190 Vrms	10.00 MHz	100%	**± 3.51%**	0 dB	**± 0.30 dB**
	50 Ω	Sine Wave	0.190 Vrms	15.00 MHz	100%	**± 3.51%**	0 dB	**± 0.30 dB**
	50 Ω	Sine Wave	0.190 Vrms	20.00 MHz	100%	**± 3.51%**	0 dB	**± 0.30 dB**
	50 Ω	Sine Wave	0.190 Vrms	22.00 MHz	100%	**± 4.71%**	0 dB	**± 0.40 dB**
	50 Ω	Sine Wave	0.190 Vrms	27.00 MHz	100%	**± 4.71%**	0 dB	**± 0.40 dB**
	50 Ω	Sine Wave	0.190 Vrms	30.00 MHz	100%	**± 4.71%**	0 dB	**± 0.40 dB**

6 Compare the measured output to the test limits shown in the table.

7 **33522A Only.** Connect the AC Voltmeter to the channel 2 output and repeat steps 2 through 6.

Calibration Security

This feature allows you to enter a security code to prevent accidental or unauthorized adjustments of the instrument. When you first receive your instrument, it is secured. Before you can adjust the instrument, you must unsecure it by entering the correct security code.

See "To Secure and Unsecure the Instrument for Calibration", on page 83 for a procedure to enter the security code from the front panel. *Use the* CAL:SEC:STAT ON *command to enter the security code using the remote interface.*

- The security code is set to **AT33520A** when the instrument is shipped from the factory. The security code is stored in non-volatile memory, and does not change when power has been off, after a Factory Reset (*RST command), or after an Instrument Preset (SYSTem:PRESet command).
- The security code may contain up to 12 alphanumeric characters. The first character must be a letter, but the remaining characters can be letters, numbers, or an underscore (_). You do not have to use all 12 characters but the first character must always be a letter.

Note *If you forget your security code, you can disable the security feature by applying a temporary short inside the instrument as described on the following page.*

To Unsecure the Instrument Without the Security Code

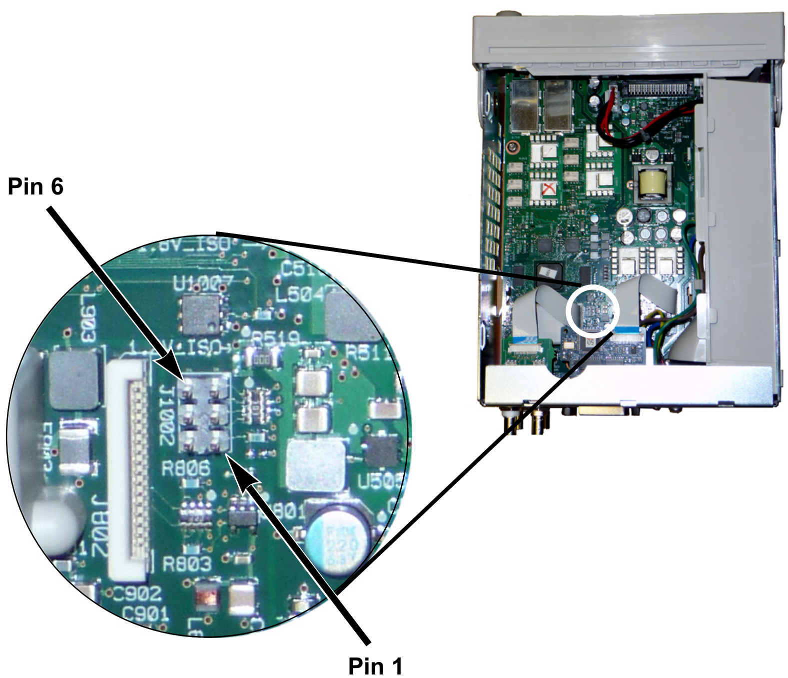
To unsecure the instrument without the correct security code, follow the steps below.

See "Electrostatic Discharge (ESD) Precautions" on page 143 before beginning this procedure.

1 Disconnect the power cord and all input connections.

2 Disassemble the instrument using the "General Disassembly Procedure" on page 158.

3 Apply a temporary short between pin 1 and pin 6 of the header on the main board. The general location is shown in the figure below.



4 Apply power and turn on the instrument.

WARNING *Be careful not to touch the power line connections or high voltages on the power supply module. Power is present even if the instrument is turned off.*

5 The display will show the message “Calibration security has been disabled”. The instrument is now unsecured.

As a result of this procedure:

- Calibration security will be unlocked
- Calibration Password will be reset to "AT33520A"
- Calibration Count will be incremented when jumper is present during power-up or connected during operation.
- The error message

  +701,"Calibration error; security defeated by hardware jumper"

  will be sent to the I/O devices
- The Front Panel will display a message
- Nonvolatile calibration storage will be updated to reflect these operations

6 Turn off the instrument and remove the power cord.

7 Reassemble the instrument.

Now you can enter a new security code, see “To Secure and Unsecure the Instrument for Calibration”, on page 83. Be sure you record the new security code.

Calibration Message

The instrument allows you to store one message in calibration memory. For example, you can store the date when the last calibration was performed, the date when the next calibration is due, the instrument's serial number, or even the name and phone number of the person to contact for a new calibration.

You can **record** a calibration message only from the remote interface and only when the instrument is unsecured. Use the CAL:STRING <*message*> command.

You can **read** the message from either the front-panel or over the remote interface. You can read the calibration message whether the instrument is secured or unsecured. Reading the calibration message from the front panel is described on. Use the CAL:STRING? query to read the message over the remote interface.

Calibration Count

You can query the instrument to determine how many calibrations have been performed. Note that your instrument was calibrated before it left the factory. When you receive your instrument, read the count to determine its initial value. The count value increments by one for each calibration point for each calibration point which stores a new calibration value, and a complete calibration will increase the value by many counts. Use the CAL:COUNT? query to read the count over the remote interface.

General Calibration/Adjustment Procedure

The following procedure is the recommended method to complete an instrument calibration. This procedure is an overview of the steps required for a complete calibration. Additional details for each step in this procedure are given in the appropriate sections of this chapter.

1. Read "Test Considerations" on page 91.
2. Perform the verification tests, beginning on page page 92, to characterize the instrument (incoming data).
3. Press (System) and then press the **Calibrate** softkey. If the instrument is secured from calibration, unsecure the instrument for calibration (see page 103)
4. Enter the **Setup Number** for the procedure being performed. The default setup number is "1" and, from the front panel, the number will increment as the procedures are performed.
5. Select **BEGIN**.
6. For setups that require an input, adjust the value shown in the display to the measured value and select **ENTER VALUE**.
7. The setup will automatically advance to the next required value.

Note To cancel the adjustment procedure, select **CANCEL STEP**. The display will return to the setup number entry.

8. When finished, select **END CAL**.

Note You may wish to set a new calibration message using the remote interface. The message (up to 40 characters) is stored with the calibration coefficients.

9. Secure the instrument against calibration.
10. Note the new security code and calibration count in the instrument's maintenance records.

Aborting a Calibration in Progress

Sometimes it may be necessary to abort a calibration after the procedure has already been initiated. You can abort a calibration at any time by turning off the power. When performing a calibration from the remote interface, you can abort a calibration by issuing a remote interface device clear message followed by a *RST.

The instrument stores calibration constants at the end of each adjustment procedure. If you lose power, or otherwise abort an adjustment in progress, you will only need to perform the interrupted adjustment procedure again.

4

Caution *If power is lost when the instrument is attempting to write new calibration constants to EEPROM, you may lose all calibration constants for the function. Typically, upon re-applying power, the instrument will report error "-313, Calibration Memory Lost".*

Sequence of Adjustments

The adjustment sequence shown in the following sections of this chapter is recommended to minimize the number of test equipment set-up and connection changes.

You may perform individual adjustments as necessary. Setups 1 through 7 **must** be performed in order and **must** be performed **before** any other setup procedure.

Self-Test

Self-Test is performed as the first step to ensure the instrument is in working order before beginning any additional adjustments.

Note Be sure to follow the requirements listed in “Test Considerations” on page 91 before beginning any adjustments.

1 Press (System) and then press the **Calibrate** softkey. Enter setup number “1” and select **BEGIN**.

Setup	
1	Performs the Self-test. The Main Output is disabled during test.

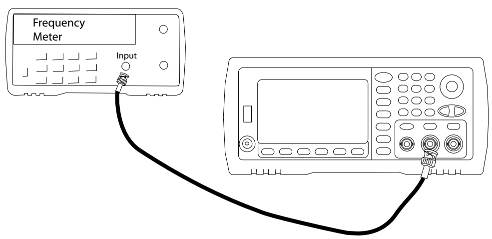
2 If the instrument fails any self-test, you must repair the instrument before continuing the adjustment procedures.

Note The self-test procedure takes approximately 15 seconds to complete.

Frequency (Internal Timebase) Adjustment

The waveform generator stores a calibration constant that sets the TCXO (or OCXO with option 0101) to put out exactly 10 MHz. The instrument should have been running continuously for 30 minutes prior to this calibration adjustment to ensure timebase stability.

1 Set the frequency counter resolution to better than 0.01 ppm and the input termination to 50 Ω (if your frequency counter does not have a 50 Ω input termination, you must provide an external termination). Make the connections shown below.



2 Use the frequency counter to measure the output frequency for each setup in the following table.

	Nominal Signal		
Setup	Frequency	Amplitude	
2	<10 MHz	~1 Vpp	Output frequency is slightly less than 10MHz
3	>10 MHz	~1 Vpp	Output frequency is slightly more than 10MHz
4	~10 MHz	~1 Vpp	Output frequency should be near 10MHz
5*	10 MHz	~1 Vpp	Output frequency should be 10MHz ±1ppm

* Constants are stored after completing this setup.

3 Using the numerical keypad or knob, adjust the displayed frequency at each setup to match the measured frequency. Select **ENTER VALUE**.

4 After performing setup 5:

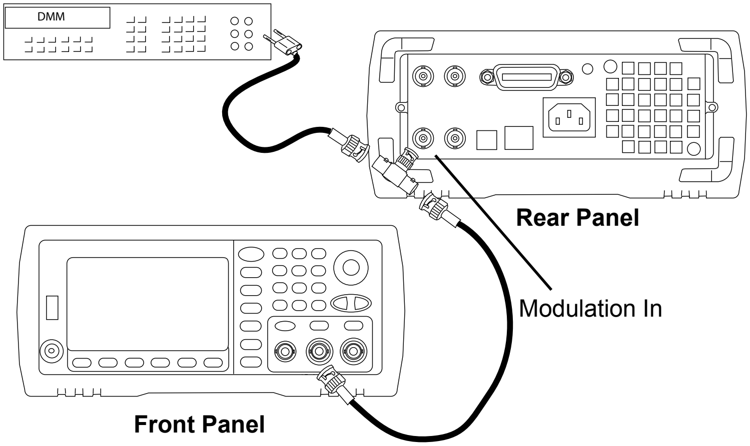
a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform "Internal Timebase Verification", on page 96.

b. If you are making all the adjustments and then verifying the instrument's performance, continue with the next procedure in this chapter.

Internal ADC Adjustment

The waveform generator stores calibration constants related to the gain and offset of the internal ADC. Setup 6 **must** always be performed **before** any other amplitude adjustments are attempted. The internal ADC is then used as a source for the calibration constants generated in self calibration (setup 7).

1 Connect the waveform generator Channel 1 Output to the waveform generator rear panel Modulation Input and DMM as shown below.



2 Set the DMM to display 5 1/2 digits and function to dcV.

3 Enter the following setup.

	Nominal Signal	
Setup	DC level	
6*	~1.0 Vdc **±10%**	Calibrates the internal ADC.

* Constants are stored after completing this setup.

4 Use the numeric keypad or knob to enter the value measured on the DMM.

Note This setup requires approximately 15 seconds to complete.

5 Disconnect all cables from the instrument

Self Calibration Adjustment.

1 Enter and begin the following setup.

Setup	
7*	Self-calibration. The output is disabled.

* Constants are stored after completing this setup.

2 After performing setup 6 and 7:

a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform “DC Offset Voltage Verification”, on page 98.

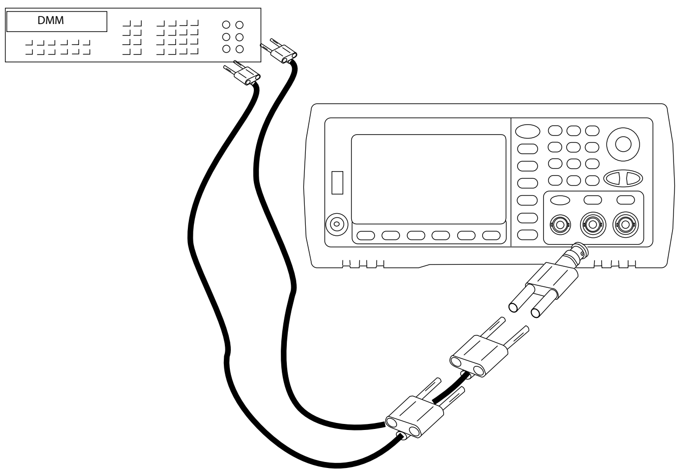
b. If you are making all the adjustments and then verifying the instrument’s performance, continue with the next procedure in this chapter.

Note This setup requires approximately 15 seconds to complete.

Output Impedance Adjustment

The waveform generator stores calibration constants for the output Impedance of the instrument. The output impedance constants are generated with and without the post-amplifier attenuator.

1 Set the DMM to measure offset-compensated, four-wire Ohms. Set the DMM to use 100 NPLC integration. Connect the Ohms Source and Ohms Sense DMM inputs to the Channel 1 output as shown below.



2 Use the DMM to make a 4-wire resistance measurement at the front panel Output connector for each setup in the following table. The expected measured value is approximately 50 Ω.

Setup	
8*	-24 dB post-attenuator range
9*	0 dB range

* Constants are stored after completing this setup.

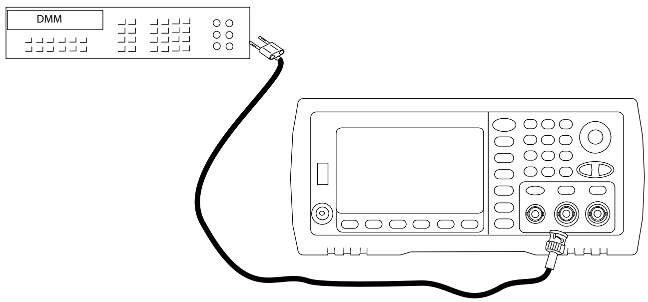
3 Using the numeric keypad or knob, adjust the displayed impedance at each setup to match the measured impedance. Select **ENTER VALUE**.

4 There are no specific operational verification tests for Output Impedance. Continue with the next adjustment procedure in this chapter.

AC Amplitude (high-impedance) Adjustment

The waveform generator stores a calibration constant for each high-impedance attenuator path. The gain coefficient of each path is calculated using two measurements; one with the waveform DAC at + output and one with waveform DAC at – output. The setups, therefore, must be performed in pairs.

1 Connect the DMM to the Channel 1 Output as shown below.



2 Use the DMM to measure the dc voltage at the front-panel Output connector for each setup in the following table.

	Nominal Signal	
Setup	DC level	
10	+0.0028 V	Output of -72 dB range
11*	-0.0028 V	Output of -72 dB range
12	+0.007 V	Output of -64 dB range
13*	-0.007 V	Output of -64 dB range
14	+0.017 V	Output of -56 dB range
15*	-0.017 V	Output of -56 dB range
16	+0.044 V	Output of -48 dB range
17*	-0.04 V	Output of -48 dB range
18	+0.11 V	Output of -40 dB range
19*	-0.11 V	Output of -40 dB range

	Nominal Signal	
Setup	DC level	
20	+0.28 V	Output of -32 dB range
21*	-0.28 V	Output of -32 dB range
22	+0.68 V	Output of -24 dB range
23*	-0.68 V	Output of -24 dB range
24	+1.7 V	Output of -16 dB range
25*	-1.7 V	Output of -16 dB range
26	+4.3 V	Output of -8 dB range
27*	-4.3 V	Output of -8 dB range
28	+10.8 V	Output of 0 dB range
29*	-10.8 V	Output of 0 dB range
30	+0.044 V	Output of -48 dB High dc range
31*	-0.044 V	Output of -48 dB High dc range
32	+0.11 V	Output of -40 dB High dc range
33*	-0.11 V	Output of -40 dB High dc range
34	+0.28 V	Output of -32 dB High dc range
35*	-0.28 V	Output of -32 dB High dc range
36	+0.68 V	Output of -24 dB High dc range
37*	-0.68 V	Output of -24 dB High dc range

* Constants are stored after completing this setup.

3 Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.

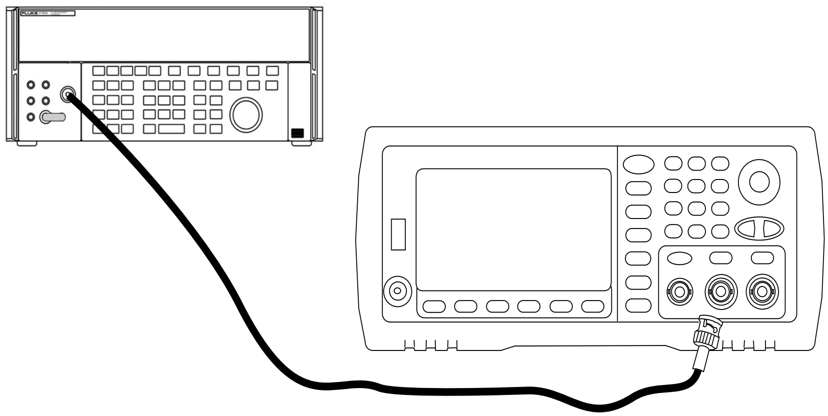
4 After performing setup 37:

a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform “AC Amplitude (high-impedance) Verification”, on page 97.

b. If you are making all the adjustments and then verifying the instrument’s performance, continue with the next procedure in this chapter.

-24 dB Range Flatness Adjustment

1 Connect a precision AC Voltmeter to measure the output amplitude of channel 1 as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



2 Use the precision AC Voltmeter to measure the output amplitude for each of the setups in the table below.

	Nominal Signal		
Setup	Frequency	Amplitude	
38*	1 kHz	0.192 Vrms	Flatness for -24 dB range
39*	100 kHz	0.192 Vrms	Flatness for -24 dB range
40*	1 MHz	0.192 Vrms	Flatness for -24 dB range
41*	5 MHz	0.192 Vrms	Flatness for -24 dB range
42*	10 MHz	0.192 Vrms	Flatness for -24 dB range
43*	20 MHz	0.192 Vrms	Flatness for -24 dB range
44*	25 MHz	0.192 Vrms	Flatness for -24 dB range
45*	30 MHz	0.192 Vrms	Flatness for -24 dB range

* Constants are stored after completing this setup.

3 Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.

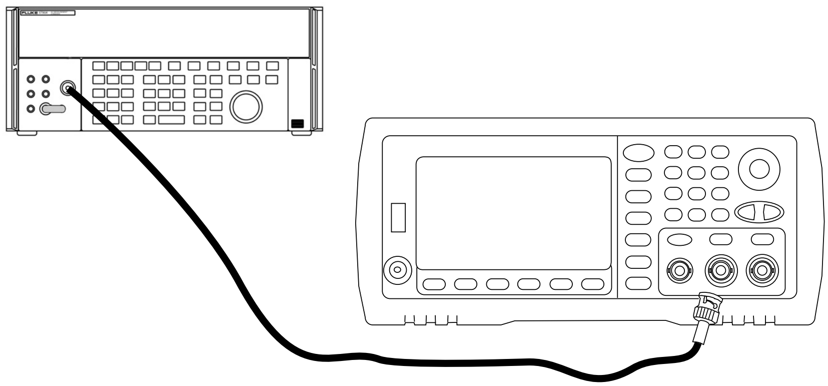
4 After performing setup 45:

a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform “-24 dB Range Flatness Verification”, on page 101.

b. If you are making all the adjustments and then verifying the instrument’s performance, continue with the next procedure in this chapter.

-8 dB Range Flatness Adjustment

1 Connect a precision AC Voltmeter to measure the output amplitude of channel 1 as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



2 Use the precision AC Voltmeter to measure the output amplitude for each of the setups in the table below.

	Nominal Signal		
Setup	Frequency	Amplitude	
46*	1 kHz	1.22 Vrms	Flatness for -8 dB range
47*	100 kHz	1.22 Vrms	Flatness for -8 dB range
48*	1 MHz	1.22 Vrms	Flatness for -8 dB range
49*	5 MHz	1.22 Vrms	Flatness for -8 dB range
50*	10 MHz	1.22 Vrms	Flatness for -8 dB range
51*	20 MHz	1.22 Vrms	Flatness for -8 dB range
52*	25 MHz	1.22 Vrms	Flatness for -8 dB range
53*	30 MHz	1.22 Vrms	Flatness for -8 dB range

* Constants are stored after completing this setup.

3 Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.

4 After performing setup 53:

   a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform "-8 dB Range Flatness Verification", on page 99.

   b. If you are making all the adjustments and then verifying the instrument's performance, verify the output specifications of the instrument using the "Performance Verification Tests", on page 92.

This completes the adjustment procedures for the 35521A 1-Channel Function/Arb Generator. Verification of the output specifications is recommended.

If you are making adjustments to a 35522A 2-Channel Function/Arb Generator, continue with the next procedure in this chapter.

Self Calibration Adjustment (Channel 2)

1 Enter and begin the following setup.

Setup	
54*	Self-calibration. The output is disabled.

* Constants are stored after completing this setup.

2 After performing setup 54:

a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform “DC Offset Voltage Verification”, on page 98.

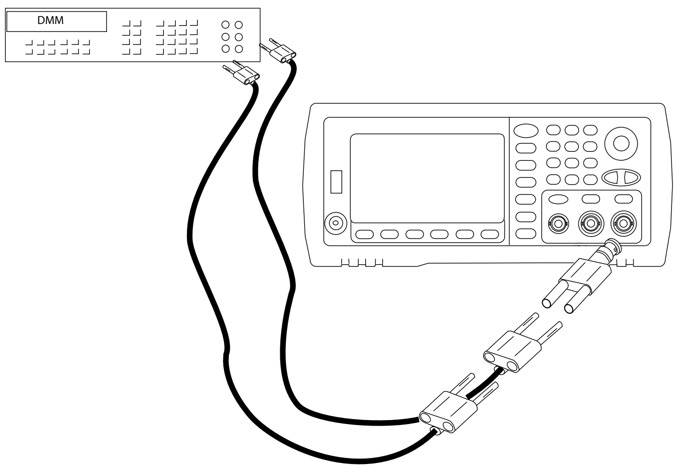
b. If you are making all the adjustments and then verifying the instrument’s performance, continue with the next procedure in this chapter.

Note This setup requires approximately 15 seconds to complete.

Output Impedance Adjustment (Channel 2)

The waveform generator stores calibration constants for the output Impedance of the instrument. The output impedance constants are generated with and without the post-amplifier attenuator.

1 Set the DMM to measure offset-compensated, four-wire Ohms. Set the DMM to use 100 NPLC integration. Connect the Ohms Source and Ohms Sense DMM inputs to the Channel 2 output as shown below.



2 Use the DMM to make a 4-wire resistance measurement at the front panel Output connector for each setup in the following table. The expected measured value is approximately 50 Ω.

Setup	
55*	-24 dB post-attenuator range
56*	0 dB range

* Constants are stored after completing this setup.

3 Using the numeric keypad or knob, adjust the displayed impedance at each setup to match the measured impedance. Select **ENTER VALUE**.

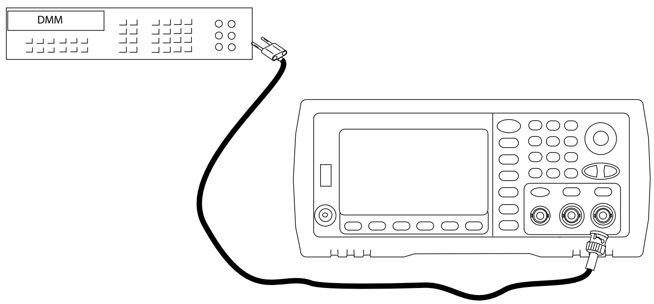
4 There are no specific operational verification tests for Output Impedance. Continue with the next adjustment procedure in this chapter.

4

AC Amplitude (high-impedance) Adjustment (Channel 2)

The waveform generator stores a calibration constant for each high-impedance attenuator path. The gain coefficient of each path is calculated using two measurements; one with the waveform DAC at + output and one with waveform DAC at – output. The setups, therefore, must be performed in pairs.

1 Connect the DMM to the Channel 2 Output as shown below.



2 Use the DMM to measure the dc voltage at the front-panel Output connector for each setup in the following table.

	Nominal Signal	
Setup	DC level	
57	+0.0028 V	Output of -72 dB range
58*	-0.0028 V	Output of -72 dB range
59	+0.007 V	Output of -64 dB range
60*	-0.007 V	Output of -64 dB range
61	+0.017 V	Output of -56 dB range
62*	-0.017 V	Output of -56 dB range
63	+0.044 V	Output of -48 dB range
64*	-0.04 V	Output of -48 dB range
65	+0.11 V	Output of -40 dB range
66*	-0.11 V	Output of -40 dB range

	Nominal Signal	
Setup	DC level	
67	+0.28 V	Output of -32 dB range
68*	-0.28 V	Output of -32 dB range
69	+0.68 V	Output of -24 dB range
70*	-0.68 V	Output of -24 dB range
71	+1.7 V	Output of -16 dB range
72*	-1.7 V	Output of -16 dB range
73	+4.3 V	Output of -8 dB range
74*	-4.3 V	Output of -8 dB range
75	+10.8 V	Output of 0 dB range
76*	-10.8 V	Output of 0 dB range
77	+0.044 V	Output of -48 dB High dc range
78*	-0.044 V	Output of -48 dB High dc range
79	+0.11 V	Output of -40 dB High dc range
80*	-0.11 V	Output of -40 dB High dc range
81	+0.28 V	Output of -32 dB High dc range
82*	-0.28 V	Output of -32 dB High dc range
83	+0.68 V	Output of -24 dB High dc range
84*	-0.68 V	Output of -24 dB High dc range

* Constants are stored after completing this setup.

3 Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.

4 After performing setup 84:

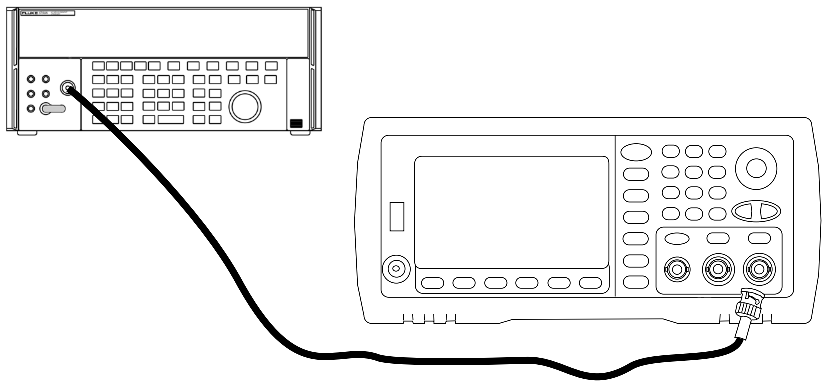
a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform “AC Amplitude (high-impedance) Verification”, on page 97 for Channel 2.

b. If you are making all the adjustments and then verifying the instrument’s performance, continue with the next procedure in this chapter.

4

-24 dB Range Flatness Adjustment (Channel 2)

1 Connect a precision AC Voltmeter to measure the output amplitude of channel 2 as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



2 Use the precision AC Voltmeter to measure the output amplitude for each of the setups in the table below.

	Nominal Signal		
Setup	Frequency	Amplitude	
85*	1 kHz	0.192 Vrms	Flatness for -24 dB range
86*	100 kHz	0.192 Vrms	Flatness for -24 dB range
87*	1 MHz	0.192 Vrms	Flatness for -24 dB range
88*	5 MHz	0.192 Vrms	Flatness for -24 dB range
89*	10 MHz	0.192 Vrms	Flatness for -24 dB range
90*	20 MHz	0.192 Vrms	Flatness for -24 dB range
91*	25 MHz	0.192 Vrms	Flatness for -24 dB range
92*	30 MHz	0.192 Vrms	Flatness for -24 dB range

* Constants are stored after completing this setup.

3 Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.

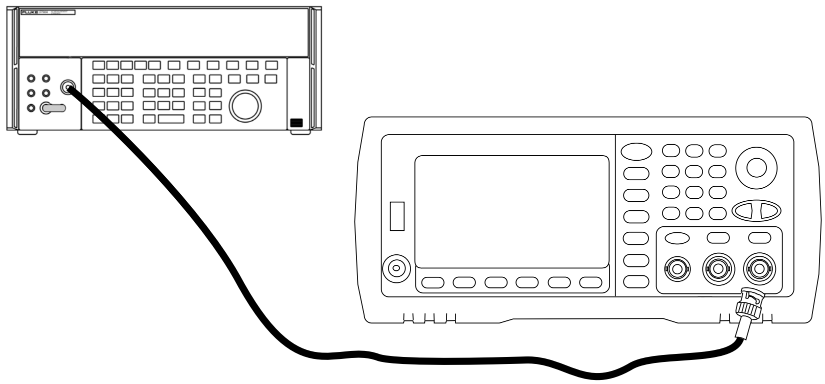
4 After performing setup 92:

a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform "-24 dB Range Flatness Verification", on page 101 for Channel 2.

b. If you are making all the adjustments and then verifying the instrument's performance, continue with the next procedure in this chapter.

-8 dB Range Flatness Adjustment (Channel 2)

1 Connect a precision AC Voltmeter to measure the output amplitude of channel 1 as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



2 Use the precision AC Voltmeter to measure the output amplitude for each of the setups in the table below.

	Nominal Signal		
Setup	Frequency	Amplitude	
93*	1 kHz	1.22 Vrms	Flatness for -8 dB range
94*	100 kHz	1.22 Vrms	Flatness for -8 dB range
95*	1 MHz	1.22 Vrms	Flatness for -8 dB range
96*	5 MHz	1.22 Vrms	Flatness for -8 dB range
97*	10 MHz	1.22 Vrms	Flatness for -8 dB range
98*	20 MHz	1.22 Vrms	Flatness for -8 dB range
99*	25 MHz	1.22 Vrms	Flatness for -8 dB range
100*	30 MHz	1.22 Vrms	Flatness for -8 dB range

* Constants are stored after completing this setup.

3 Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.

4 After performing setup 100, you have now completed the recommended adjustment procedures. Verification of the output specifications is recommended.

   a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform "-8 dB Range Flatness Verification", on page 99.

Calibration Errors

The following errors are failures that may occur during a calibration. System error messages are described in the SCPI Help File on the *Agilent 33500 Series Product Reference CD* provided with your instrument. Self-test error messages are described beginning on page 150.

Note Some error messages include a channel number. The channel number, *n*, in the failures listed below will be replace by a 1 or 2 depending upon which channel failed.

4

701 **Calibration error; security defeated by hardware jumper**
If you short the calibration secure jumper (CAL ENABLE) while turning ON the instrument, this error will occur indicating the security password has been overwritten. See "To Unsecure the Instrument Without the Security Code" on page 104 for details.

702 **Calibration error; calibration memory is secured**
A calibration cannot be performed when calibration memory is secured. See "To Secure and Unsecure the Instrument for Calibration", on page 83 for a procedure to enter the security code from the front panel. Use the CAL:SEC:STAT ON command to enter the security code using the remote interface.

703 **Calibration error; secure code provided was invalid**
The security code specified was invalid.

706 **Calibration error; value out of range**
You have entered a value that was unexpected by the calibration firmware. For example, if a number is expected such a 50.XX ohms, and you enter 10 ohms, that number is outside the expected range of valid inputs.

707 **Calibration error; signal input is out of range**
Occurs during the ADC Adjustment, setup 6, if the 1 Volt input voltage is too high. May also occur during self-calibration (setup 7), run self-test to diagnose cause of problem.

710 **Self-calibration failed; Chan *n*, null DAC cal, invalid self cal**
Self-calibration failed; Chan *n*, offset DAC cal with attenuator, invalid self cal
Self-calibration failed; Chan *n*, offset DAC cal no attenuator, invalid self cal
An error occurred while trying to do an internal cal of the specified DAC. Self-cal has exited without changing the self-cal constants. Run self-test to diagnose the cause of the problem.

711 **Self-calibration failed; Chan *n*, null DAC cal gain too low, meas *value***
Self-calibration failed; Chan *n*, null DAC cal gain too high, meas *value*
Self-calibration failed; Chan *n*, offset DAC cal with attenuator gain too low, meas *value*
Self-calibration failed; Chan *n*, offset DAC cal with attenuator gain too high, meas *value*
Self-calibration failed; Chan *n*, offset DAC cal no attenuator gain too low, meas *value*
Self-calibration failed; Chan *n*, offset DAC cal no attenuator gain too high, meas *value*
The computed gain cal factor for the specified DAC was out of limits. Self-cal has exited without changing the self-cal constants. Run self-test to diagnose the cause of the problem.

712 **Self-calibration failed; Chan *n*, null DAC cal zero too low, meas *value***
Self-calibration failed; Chan *n*, null DAC cal zero too high, meas *value*
Self-calibration failed; Chan *n*, offset DAC cal with attenuator zero too low, meas *value*
Self-calibration failed; Chan *n*, offset DAC cal with attenuator zero too high, meas *value*
Self-calibration failed; Chan *n*, offset DAC cal no attenuator zero too low, meas *value*
Self-calibration failed; Chan *n*, offset DAC cal no attenuator zero too high, meas *value*
Self-calibration failed; Chan *n*, GND measurement out of limits, meas *value*
The computed zero cal factor for the specified DAC was out of limits. Self-cal has exited without changing the self-cal constants. Run self-test to diagnose the cause of the problem.

715 **Self-calibration failed; Chan *n*, null DAC cal, convergence error sub attenuator *value* dB**
The internal null DAC calibration failed to converge on a value during the internal cal. Self-cal has exited without changing the self-cal constants. Run self-test to diagnose the cause of the problem.

720 **Self-calibration failed; Chan *n*, offset DAC cal with attenuator, convergence error**
Self-calibration failed; Chan *n*, offset DAC cal no attenuator, convergence error
The internal offset DAC calibration failed to converge on a value during the internal cal. Self-cal has exited without changing the self-cal constants. Run self-test to diagnose the cause of the problem.

850 **Calibration error; set up is invalid**
You have selected an invalid calibration setup number.

850 **Calibration error; set up is out of order**
Certain calibration steps require a specific beginning and ending sequence. You may not enter into the middle of a sequence of calibration steps.

Block Diagram

Block Diagram

This chapter provides an overview of the various assemblies in the 33500 Series.

- Block Diagram, *on page 133*
- Power Supplies, *on page 137*

5

Block Diagram

The waveform generator can be divided into four main assemblies: the processor, the main board, front panel, and the main power supply. A simplified block diagram is shown on page 136.

The processor is a single board computer and, in addition to the CPU, contains the RAM, ROM, and circuits used to drive the GPIB, LAN, and USB ports. The built in web interface is contained in the ROM. The processor circuitry is earth referenced.

When the power switch is pressed, the processor communicates with and loads the FPGA. This communication uses three asynchronous serial data lines and one serial clock line. These four lines are isolated.

The FPGA stores all waveforms except arbitrary waveforms. Arbitrary waveforms are loaded into SDRAM on the main board. All control of waveforms, triggers, sync signals, output path, attenuation, and offset is provided by the FPGA.

The main waveform for each channel is (only a single channel is shown in the block diagram on page 136) is loaded into the waveform DAC and clocked by the timebase. The DAC output passes through an elliptical filter before the main attenuators. There are three attenuators available in the path, -7.96 dB, -15.91 dB, and -23.87 dB.

The signal is applied to the output amplifier. The DC offset is summed at the output amplifier. A post amplifier -23.87 dB attenuator is available for low level signals. The table below show the attenuators used to create the desired output signal amplitude.

Output Range DC Offset < 320 mV	-7.96 dB	-15.91 dB	-23.87 dB	-23.87 dB (post)
10 V_{PP} - 3.6 V_{PP}	Out	Out	Out	Out
4 V_{PP} - 1.44 V_{PP}	In	Out	Out	Out
1.6 V_{PP} - 576 mV_{PP}	Out	In	Out	Out
640 mV_{PP} - 230 mV_{PP}	Out	Out	Out	In
256 mV_{PP} - 92 mV_{PP}	In	Out	Out	In
102.4 mV_{PP} - 36.86 mV_{PP}	Out	In	Out	In
40.96 mV_{PP} - 14.75 mV_{PP}	Out	Out	In	In
16.38 mV_{PP} - 5.90 mV_{PP}	In	Out	In	In
6.55 mV_{PP} - 2.36 mV_{PP}	Out	In	In	In
2.62 mV_{PP} - 1.00 mV_{PP}	In	In	In	In
Output Range (DC Offset ≥ 320 mV)	**-7.96 dB**	**-15.91 dB**	**-23.87 dB**	**-23.87 dB (post)**
9.36 V_{PP} - 3.6 V_{PP}	Out	Out	Out	Out
4 V_{PP} - 1.44 V_{PP}	In	Out	Out	Out
1.6 V_{PP} - 576 mV_{PP}	Out	In	Out	Out
640 mV_{PP} - 230 mV_{PP}	Out	Out	In	Out
256 mV_{PP} - 92 mV_{PP}	In	Out	In	Out
102.4 mV_{PP} - 36.86 mV_{PP}	Out	In	In	Out
40.96 mV_{PP} - 1.00 mV_{PP}	In	In	In	Out

The output relay when enabled provides the waveform to the front panel BNC connector. Additionally, this relay, when disabled, routes the signal to the Modulation ADC for internal self-test and calibration routines.

The output relay is controlled by the FPGA. Two circuits provide overvoltage and over current protection. The protection circuits primarily provide protection against injected voltages or currents from an external circuit. The waveform generator is capable of sourcing very low output impedances.

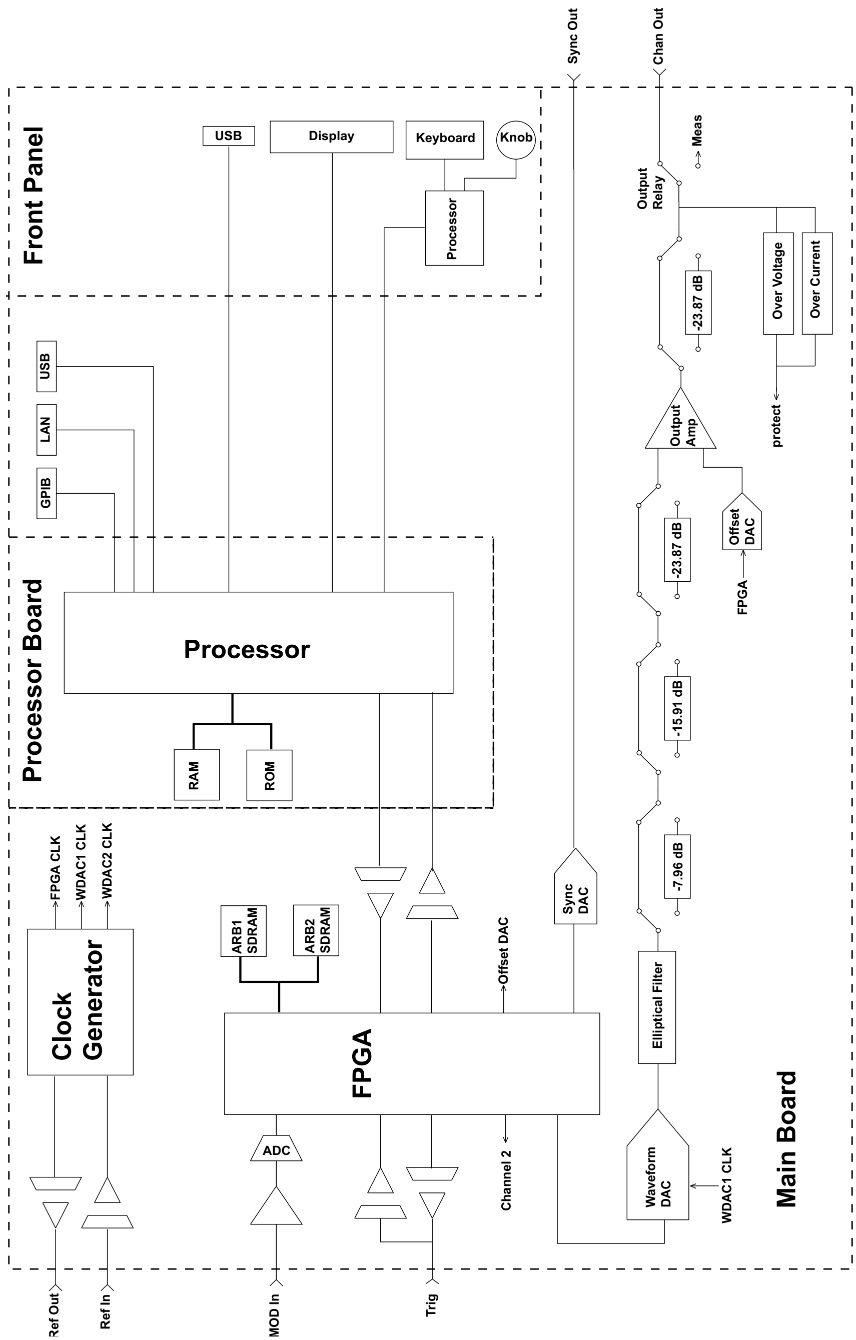
The Sync output signal is generated as a waveform from the FPGA to the Sync DAC.

External trigger in and out is chassis referenced at the BNC connector but is isolated before the FPGA.

Modulation in is an isolated input applied to the A/D converter. The FPGA applies the modulation in signal to the output waveform.

The clock generator for the waveform generator employs a 10-MHz TCXO (OCXO for Option 010) and a phase-locked loop to generate the 250-MHz clocks used by the FPGA and Waveform DACs. When an external 10-MHz frequency reference is used, a digital phase-locked loop in the FPGA keeps the TCXO (or OCXO) in sync.

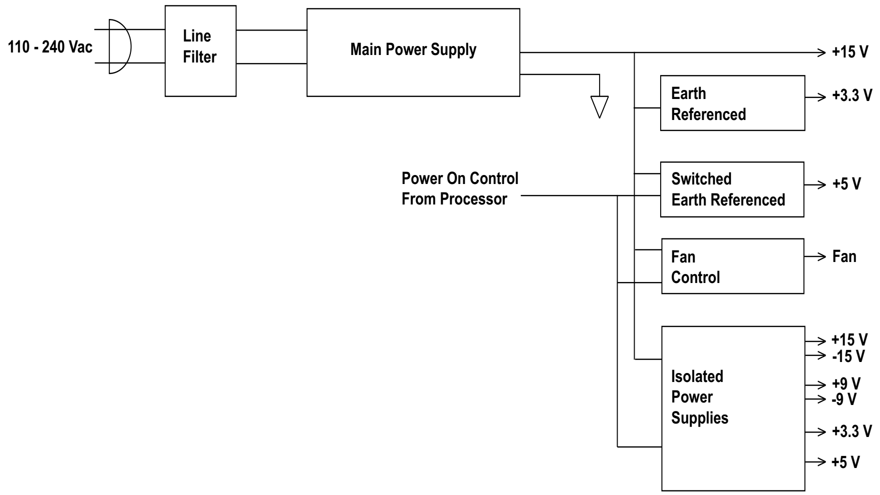
Block Diagram



Power Supplies

The line voltage is filtered and applied to the main power supply. This 15 volt supply is always on when line power is applied to the waveform generator. A regulator creates an earth referenced +3.3 Volt supply from the main supply. This supply is always active when line power is applied.

A small microprocessor on the main board senses the power switch and enables all other supplies. the main supplies are shown in the diagram below.



Service and Repair

Service and Repair

This chapter discusses the procedures involved for returning a failed instrument to Agilent Technologies for service or repair. Subjects covered include the following:

- Operating Checklist, on page 140
- Types of Service Available, on page 141
- Repackaging for Shipment, on page 142
- Cleaning, on page 142
- Electrostatic Discharge (ESD) Precautions, on page 143
- Surface Mount Repair, on page 143
- Troubleshooting, on page 144
- Self-Test Procedures, on page 150
- Replaceable Parts, on page 156
- Disassembly, on page 157

Operating Checklist

Before returning your instrument to Agilent Technologies for service or repair, check the following items:

Is the instrument inoperative?

- Verify that the ac power cord is connected to the instrument.
- Verify that the front-panel On/Standby switch has been pushed.

Does the instrument fail self-test?

Remove all external connections to the instrument. Errors may be induced by signals present on the external wiring during a self-test. Long test leads, even leads that are otherwise unconnected, can act as an antenna causing pick-up of ac signals.

Types of Service Available

If your instrument fails during the warranty period, Agilent Technologies will repair or replace it under the terms of your warranty. After your warranty expires, Agilent offers repair services at competitive prices.

Extended Service Contracts

Many Agilent products are available with optional service contracts that extend the *covered period* after the standard warranty expires. If you have such a service contract and your instrument fails during the covered period, Agilent Technologies will repair or replace it in accordance with the contract.

Obtaining Repair Service (Worldwide)

To obtain service for your instrument (in–warranty, under service contract, or post–warranty), contact your nearest Agilent Technologies Service Center. They will arrange to have your unit repaired or replaced, and can provide warranty or repair–cost information where applicable.

To obtain warranty, service, or technical support information you can contact Agilent Technologies at one of the following telephone numbers:

In the United States: (800) 829–4444
In Europe: 31 20 547 2111
In Japan: 0120–421–345

Or use our Web link for information on contacting Agilent worldwide:

www.agilent.com/find/assist

Or contact your Agilent Technologies Representative.

Before shipping your instrument, ask the Agilent Technologies Service Center to provide shipping instructions, including what components to ship. Agilent recommends that you retain the original shipping carton for use in such shipments.

Repackaging for Shipment

If the unit is to be shipped to Agilent for service or repair, be sure to:

- Attach a tag to the unit identifying the owner and indicating the required service or repair. Include the model number and full serial number.
- Place the unit in its original container with appropriate packaging material for shipping.
- Secure the container with strong tape or metal bands.

If the original shipping container is not available, place your unit in a container which will ensure at least 4 inches of compressible packaging material around all sides for the instrument. Use static-free packaging materials to avoid additional damage to your unit.

Agilent suggests that you always insure shipments.

Cleaning

Clean the outside of the instrument with a soft, lint-free, slightly dampened cloth. Do not use detergent. Disassembly is not required or recommended for cleaning.

Electrostatic Discharge (ESD) Precautions

Almost all electrical components can be damaged by electrostatic discharge (ESD) during handling. Component damage can occur at electrostatic discharge voltages as low as 50 volts.

The following guidelines will help prevent ESD damage when servicing the instrument or any electronic device.

- Disassemble instruments *only* in a static-free work area.
- Use a conductive work area to reduce static charges.
- Use a conductive wrist strap to reduce static charge accumulation.
- Minimize handling.
- Keep replacement parts in original static-free packaging.
- Remove all plastic, foam, vinyl, paper, and other static-generating materials from the immediate work area.
- Use *only* anti-static solder suckers.

Surface Mount Repair

Surface mount components should only be removed using soldering irons or desoldering stations expressly designed for surface mount components. Use of conventional solder removal equipment will almost always result in permanent damage to the printed circuit board and will void your Agilent Technologies factory warranty.

Troubleshooting

This section provides a brief check list of common failures. Before troubleshooting or repairing the instrument, make sure the failure is in the instrument rather than any external connections. Also make sure that the instrument is accurately calibrated within the last year (*see "Calibration Interval", on page 87*). The instrument's circuits allow troubleshooting and repair with basic test equipment.

Unit is Inoperative

- Verify that the ac power cord is connected to the instrument.
- Verify that the front-panel On/Standby switch has been pushed.

Unit Fails Self-Test

Ensure that all terminal connections (both front panel and rear terminals) are removed while the self-test is performed.

Caution

DO NOT swap the motherboard, the processor board, or the front panel board from one instrument to another. These boards contain model number and serial number information that uniquely identifies a specific unit, and boards that are mismatched to the instrument may result in problems with its performance, licensing, serviceability, importability/exportability or warranty.

Power Supplies

Verify the main power supply.

WARNING *Shock Hazard. To check the power supplies, remove the instrument cover as described in "Disassembly", on page 157.*

The main power supply provides a +15 Vdc supply to the main circuit board. All other supplies are derived from this supply. This supply is energized at all times while the line power cord is connected.

Power Supply	Minimum	Maximum
+15 V	14.7 V	15.3 V

Test the supply at the connector to the main board. Note that the supply is not referenced to the chassis when disconnected from the main board.

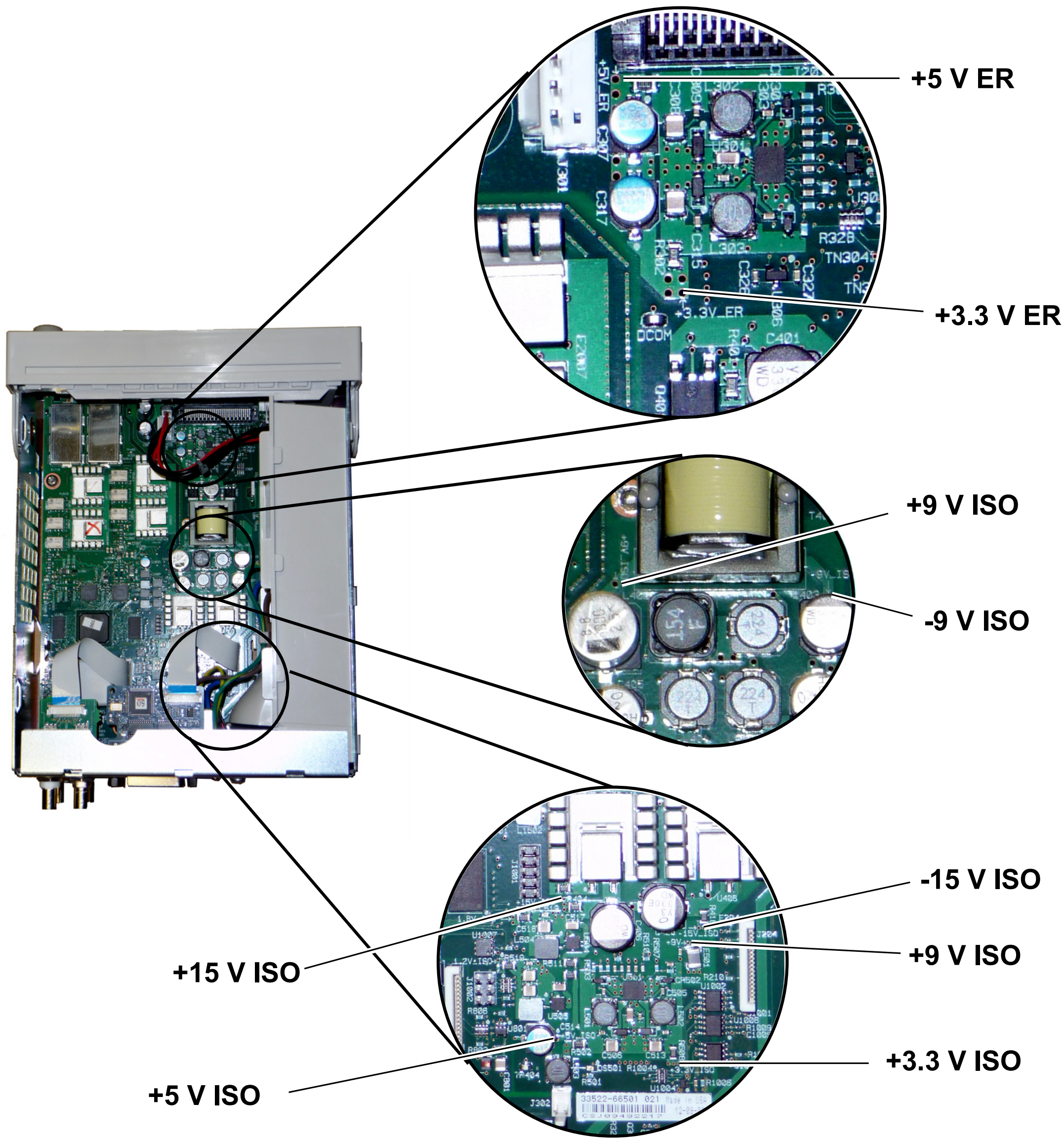
- Circuit failure can cause heavy supply loads which may pull down the supply output voltage. Disconnect the main supply from the main board to test.
- Always check the supply is free of oscillations using an oscilloscope.
- The main power supply contains a fuse. Replacing this fuse is not recommended. Replace the entire main power supply assembly. Note that power supply failures are often caused by other instrument failures.

Caution The heat sinks on the main board are at different potentials. Damage may occur if any of the heat sinks are shorted together. Use care when probing the main board.

Verify the power supplies listed in the table below and shown in the figure on page 146. Earth referenced supplies may be tested using the chassis as ground. Isolated supplied may be tested by using one of the heat sinks shown in the figure.

Supply			
+3.3 V ER*	+15 V Isolated	+9 V Isolated	+3.3 V Isolated
+5 ER	-15 V Isolated	-9 V Isolated	+5 V Isolated

* This supply is active whenever ac power is applied to the waveform generator.


+5 V ER
+3.3 V ER
+9 V ISO
-9 V ISO
-15 V ISO
+15 V ISO
+9 V ISO
+3.3 V ISO
+5 V ISO

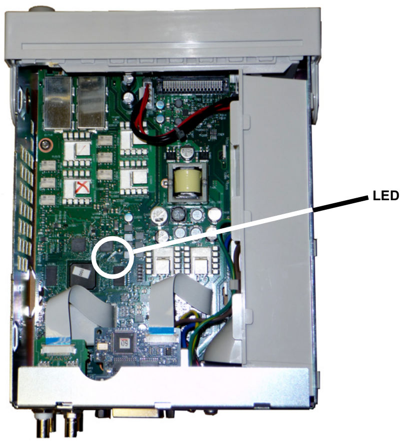
Self-Test Errors 605 - 609

If the instrument reports self-test errors 605-609, this means the processor board is unable to correctly program or communicate with the waveform FPGA (U1005) on the main board. In this case further, troubleshooting is required to determine where the fault lies. The problem could be due to out of date firmware, unseated processor board or main board, main board failure or processor board failure. Before starting proceeding with troubleshooting these errors, ensure that the instrument firmware is up to date. If the errors are still being reported then continue with the following procedure.

Reseat the Boards Power off the unit, remove the cover. Reseat the processor board, and the main board. Power up the unit and see if the errors 605-609 are still being reported at power-on.

Check Power Supplies Probe the system power supplies and verify they are operating within limits. If any of the power supplies are out of limit, diagnose the power supply. Otherwise, continue on to the SPI communications.

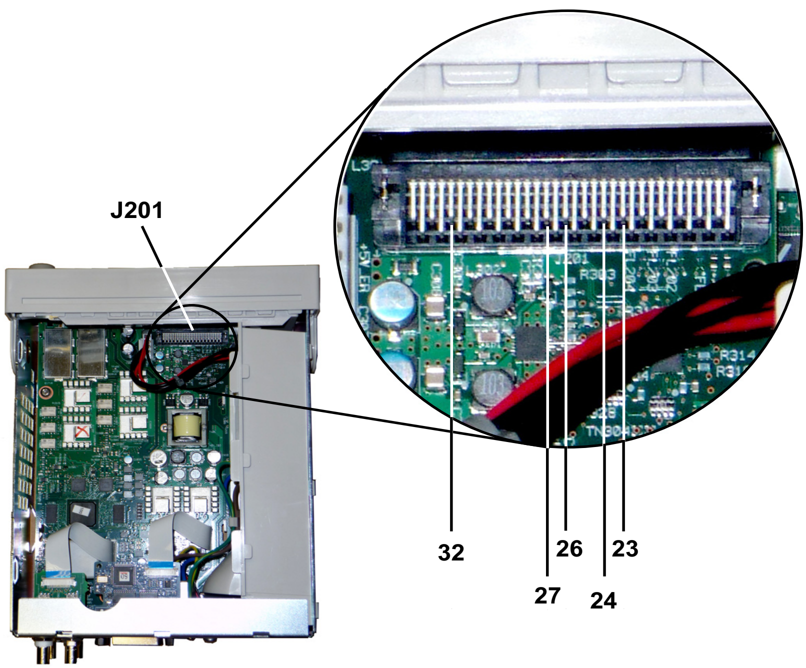
Probe the SPI communications lines If you still see errors after reseating the boards, then the next step is to probe the SPI communications lines between the processor board and the main board. First, locate LED DS1001 on the main board as shown below. Cycle power on the unit, wait until it fully boots, and see if the main board LED lights up. The main board LED indicates whether the FPGA was successfully programmed. The following sections indicate which signal lines to probe on the main board connector (J201).



Main Board LED Lights up after Boot

This indicates that the FPGA is programmed and running. Most likely there is a communications failure from the main board to the processor board. Probe the J201, pin 27 line with an oscilloscope, and cycle power on the unit (wait for full boot) to see if there is activity on the line. Activity should be +3.3 V pulses (isolated). Note that activity ceases once the waveform generator is booted.

- If there is no activity on the line even after the LED lights up, then most likely the main board is the cause of the failure.
- If there is activity on the line, then the processor board is the most likely cause of the failure



Main Board LED Does not Light up after Boot

This indicates that the processor was unable to program the FPGA. Most likely there is a communications failure from the processor board to the main board. Probe the following serial data lines at power up with an oscilloscope:

J201, pin 23
J201, pin 24
J201, pin 26
J201, pin 32

- If all of the above SPI lines show activity during FPGA programming, then the main board is the most likely cause of the failure.
- If any of the SPI lines fail to show activity, then processor board is the most likely cause of the failure.

10 MHz Out

If the power supplies are functional and self-test passes. Check the 10 MHz out at the rear panel. This output is present whenever the instrument has powered on and the processor and main board are operational. If the 10 MHz is present, but the display is not working, suspect the front panel board or display assembly.

Self-Test Procedures

Power-On Self-Test

Each time the instrument is powered on, a subset of self-tests are performed. These tests check that the minimum set of logic and subsystems are functioning properly.

Full Self-Test

The successful execution of the self-test procedure provides a high degree of confidence that the waveform generator is operating normally. The self-test procedure is an automated procedure that systematically exercises the internal oscillator, digital infrastructure, waveform memory, and the analog attenuator paths. The test procedure attempts to isolate any failing conditions found to a particular assembly to facilitate troubleshooting and repair. The test typically takes approximately 15 seconds to complete.

During the test the waveform generator main output(s) are disconnected internally from the BNC connectors and are connected to the internal ADC. The ADC is used to check for expected signal levels through-out the instrument. As the different signal paths are configured for testing, the activation of the relays used to switch the signal paths is audible. After the test procedure completes, the instrument is restored to the state it was in before the full self-test was executed.

Self-test should be executed before beginning any of the verification or adjustment procedures.

Remote I/O Execution

1 While not required, it is recommended that all input connections to the instrument be removed before running self-test. Cycle power to reboot the instrument and run the power-on self test.

2 Make a connection the instrument using the remote interface see (“To Configure the Remote Interface”, on page 75).

3 Send the `*TST?` query and read the result. Be sure to set the time-out longer than 15 seconds.

4 If the self-test successfully passed, the `*TST?` query returns “+0”. If self-test errors occur, the `*TST?` query returns a “+1”. Use the `SYStem:ERRor?` query to read any errors.

Front Panel Execution

1 While not required, it is recommended that all input connections to the instrument be removed before running self-test. Cycle power to reboot the instrument and run the power-on self test.

2 Press [System] and then press the **Utility**, **Test/Cal**, and **Self Test** soft keys

3 A progress bar will be displayed as self-test executes. After completion any failures can be viewed by pressing [System] and then pressing the **Help** and **View Errors** softkeys.

The full self test will take approximately 15 seconds to complete and you may hear the instrument's internal relays switching during the procedure. If the self-test is successful “Self-test Passed” is reported on the front panel. If the self-test is not successful “Self-test Failed” is reported. The self-test error messages and their meaning are shown beginning on the next page.

6

Self-Tests Error Numbers and Messages

A failure can generated multiple error messages. The earliest message generated should be considered the primary cause of failure.

Note Some self test messages include a channel number. The channel number, *n*, will be replaced with the number 1 or 2 depending upon which channel failed.

Error	Message and Meaning	Probable Cause
601	**Self-test failed; real time clock settings lost** This error indicates real time clock's date-time settings were lost. This is most likely due a disconnected or discharged RTC battery (coin cell found on the front panel board). This error can also occur if the processor board is removed and reinserted into the front-panel assembly. Note this error condition is captured at power-on, and will be reported by self-test until the problem is corrected and power is cycled.	RTC Battery
602	**Self-test failed; main CPU power supply out of range** This error indicates the processor board detected that one of its supplies was +/-10% out range of the nominal voltage.	Processor Board
603	**Self-test failed; main CPU error accessing boot env** This error indicates the processor wasn't able to access its boot parameters from flash. This could be due to out of date firmware, or a problem on the processor board.	Processor Board
604	**Self-test failed; front panel processor ping failed** This error indicates the processor board tried to read the front panel revision code and received a 0. This could be due to an un-programmed front panel processor, an unseated processor board, or a defective front panel processor.	Front Panel Board
605	**Self-test failed; waveform FPGA not programmed** This error indicates the processor was unable to program the waveform FPGA (U1005) at boot-up. If this error is reported, the hardware will not work properly.	Processor Board or Main Board*

* Refer to Self-Test Errors 605 - 609, on page 147 for additional information about troubleshooting these errors.

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Error	Message and Meaning	Probable Cause
606	**Self-test failed; waveform FPGA revision check failed** This error indicates the processor tried to read the revision register from the waveform FPGA (U1005) and received an invalid value. This could be due to an un-programmed FPGA or an internal SPI communications failure.	Processor Board or Main Board*
607	**Self-test failed; waveform FPGA read back error** This error indicates the processor was unable to write and read back from a test location in the waveform FPGA (U1005). This could be due to an un-programmed FPGA or an internal SPI communications failure.	Processor Board or Main Board*
608	**Self-test failed; waveform FPGA security check failed** This error indicates that the waveform FPGA (U1005) failed the internal security check. This error can be caused by FPGA failures (tests 605-608), an invalid FPGA image, or a malfunctioning security device (U1007). Self-test will exit on this failure.	Processor Board or Main Board*
609	**Self-test failed; waveform FPGA security check failed** This error indicates that the waveform FPGA (U1005) failed the internal security check. This error can be caused by FPGA failures (tests 605-608), an invalid FPGA image, or a malfunctioning security device (U1007). Self-test will exit on this failure.	Processor Board or Main Board*
610	**Self-test failed; main PLL not locked** This error indicates the waveform FPGA (U1005) was unable to lock to the internal 10MHz oscillator (U903 or U905).	Main Board
611	**Self-test failed; FPGA PLL not locked** This error indicates the waveform FPGA (U1005) was unable to lock to the internal sample clock generator IC (U906).	Main Board
612	**Self-test failed; Chan *n*, waveform memory PLL not locked** Waveform RAM for the indicated channel (U1101 or U1102) wasn't able to lock to its clock.	Main Board

* Refer to Self-Test Errors 605 - 609, on page 147 for additional information about troubleshooting these errors.

6

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Error	Message and Meaning	Probable Cause
613	**Self-test failed; Chan *n*, waveform memory not initialized** Waveform RAM for the indicated channel (U1101 or U1102) failed to initialize.	Main Board
615	**Self-test failed; modulation ADC offset too low** **Self-test failed; modulation ADC offset too high** This error indicates the internal ADC's measurement of ACOM was out of limits.	Main Board
616	**Self-test failed; modulation ADC reference too low** **Self-test failed; modulation ADC reference too high** This error indicates the internal ADC's measurement of its voltage reference (VRef) was out of limits.	Main Board
620	**Self-test failed; Chan *n*, waveform memory test failed on idle** This error indicates the waveform memory test was not started properly. Most likely an error in the waveform FPGA (U1005)	Main Board
621	**Self-test failed; Chan *n*, waveform memory test failed** Waveform RAM memory test for the indicated channel (U1101 or U1102) failed. The memory test consists of writing and reading back the entire waveform RAM with a predetermined pattern.	Main Board
625	**Self-test failed; Chan *n*, waveform DAC gain[*idx*] too low** **Self-test failed; Chan *n*, waveform DAC gain[*idx*] too high** This error indicates that the waveform DAC (U1801 or U1501) output is not providing the correct output. The gain *idx* of 1 is the POS voltage test, gain *idx* of 2 refers to the NEG voltage test.	Main Board
630	**Self-test failed; Chan *n*, sub attenuator failure 0dB** This error indicates the trim DAC inside the waveform DAC (U1801 or U1501) is not providing the correct output at the 0dB setting. If this test fails, the test 631 will not be executed.	Main Board

6

Error	Message and Meaning	Probable Cause
631	**Self-test failed; Chan *n*, sub attenuator <-7.00 to 0.00>dB too low** **Self-test failed; Chan *n*, sub attenuator <-7.00 to 0.00>dB too high** This error indicates the trim DAC inside the waveform DAC (U1801 or U1501) is producing output outside of the expected range.	Main Board
635	**Self-test failed; Chan *n*, null DAC gain[*idx*] too low** **Self-test failed; Chan *n*, null DAC gain[*idx*] too high** This error indicates the aux DAC output of the waveform DAC (U1801 or U1501) or its associated analog circuitry is producing output outside of the expected range. The gain *idx* of 1 refers to the POS voltage test, gain *idx* of 2 refers to the NEG voltage test.	Main Board
640	**Self-test failed; Chan *n*, offset DAC gain[*idx*] too low** **Self-test failed; Chan *n*, offset DAC gain[*idx*] too high** This error indicates that the offset DAC (U1702 or U2002) the associated circuitry is producing output outside of the expected range. In the case of the offset DAC, the *idx* polarities are inverted. The gain *idx* of 1 refers to the NEG voltage test, gain *idx* of 2 refers to the POS voltage test.	Main Board
650	**Self-test failed; Chan *n*, 0dB path failure expected 0dB, measured value dB** This error indicates the straight-through (no attenuators) path from the waveform DAC to the ADC input is producing output outside of the expected range. If this test fails, then the extended attenuator test 655 will be not be executed.	Main Board
655	**Self-test failed; Chan *n*, -8 dB pre attenuator path too low** **Self-test failed; Chan *n*, -8 dB pre attenuator path too high** **Self-test failed; Chan *n*, -16 dB pre attenuator path too low** **Self-test failed; Chan *n*, -16 dB pre attenuator path too high** **Self-test failed; Chan *n*, -24 dB pre attenuator path too low** **Self-test failed; Chan *n*, -24 dB pre attenuator path too high** **Self-test failed; Chan *n*, -24 dB post attenuator path too low** **Self-test failed; Chan *n*, -24 dB post attenuator path too high** This error indicates the specified attenuator relay is malfunctioning, or the attenuator circuitry isn't providing the expected amount of attenuation.	Main Board

Replaceable Parts

Caution Always use anti-static techniques when assemblies are handled or serviced.

The following table lists the replacement assemblies for the 33500 Series Function/Arb Generators:

Part Number	Description
34401-86020	Bumper Kit
34401-45021	Handle
33220-84101	Cover
1990-3263	Encoder
35220-87401	Knob
33521-80001	Keypad for 33521A
33522-80001	Keypad for 33522A
2090-0977	Display
1250-3569	Front Panel BNCs
33521-80002	Front Panel for 33521A
33522-80002	Front Panel for 33522A
33522-66502	Front Panel Board
1252-8483	USB Connector
1253-4669	LAN Connector
53200-61608	Line Filter
33250-68501	Fan
1420-0356	Battery (in Front Panel) CR2032
53200-80002	Power Supply and Cover*

* The power supply contains a 15A 250V radial lead fuse. Fuse replacement is not recommended.

Disassembly

For procedures in this manual, the following tools are required for disassembly:

- T15 Torx driver (most disassembly)
- T8 Torx driver (front panel disassembly)
- Posidriv and flat bladed screw drivers
- 14 mm nut driver, hollow shaft (rear-panel BNC connectors)
- 7 mm nut driver (rear-panel GPIB connector)

WARNING *SHOCK HAZARD. Only service-trained personnel who are aware of the hazards involved should remove the instrument covers. To avoid electrical shock and personal injury, make sure to disconnect the power cord from the instrument before removing the covers. Some circuits are active and have power applied even when the power switch is turned off.*

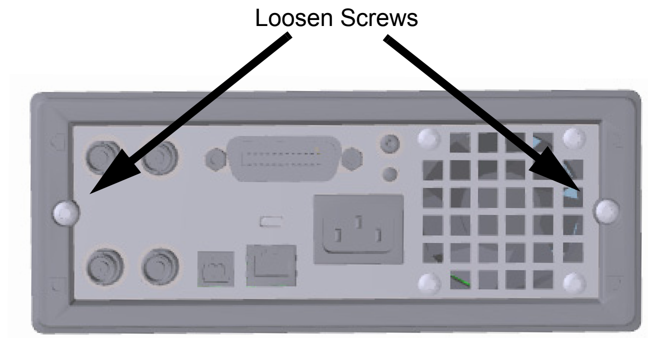
General Disassembly Procedure

1 Turn off the power. Remove all cables from the instrument.

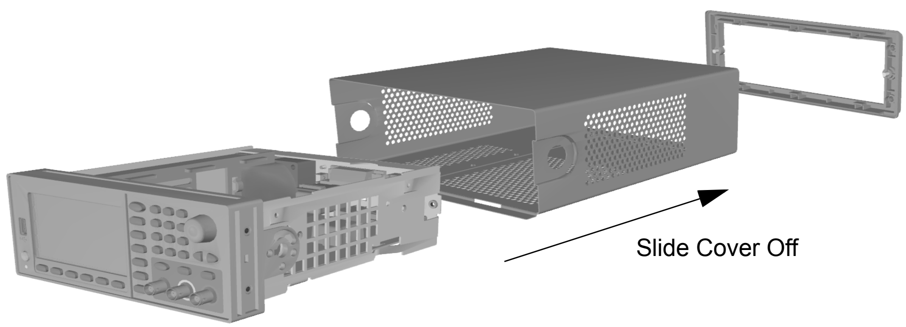
2 Rotate the handle upright and pull off.

3 Pull off the instrument bumpers.

4 Loosen the two captive screws in the rear bezel and remove the rear bezel.



5 Slide off the instrument cover.

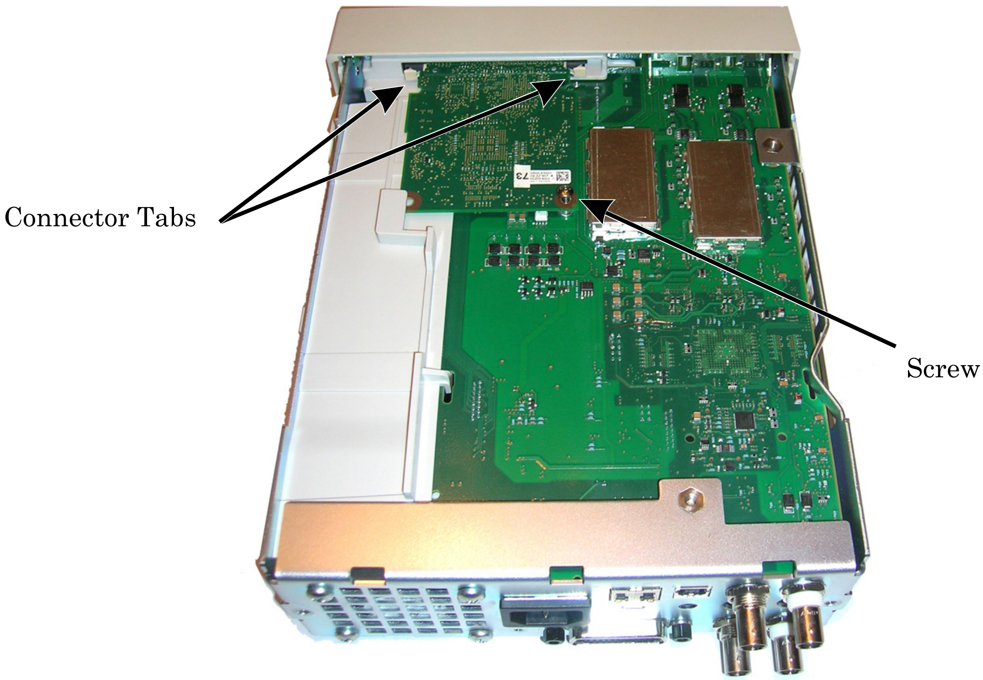


Many of the service procedures can now be performed without further disassembly. Troubleshooting and service procedures that require power be applied can be performed with the instrument in this state of disassembly.

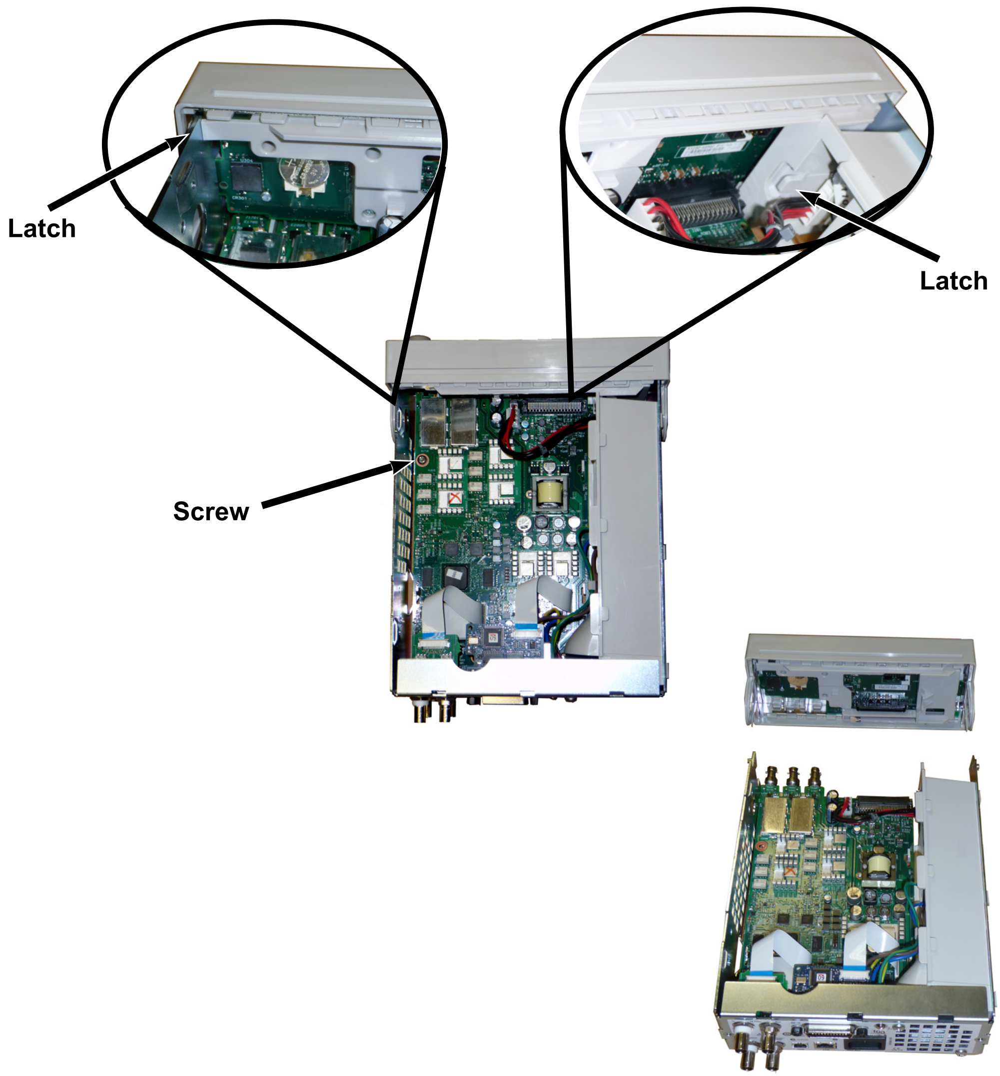
WARNING *SHOCK HAZARD. Only service-trained personnel who are aware of the hazards involved should remove the instrument covers. Dangerous voltages may be encountered with the instrument covers removed.*

Main Component Disassembly

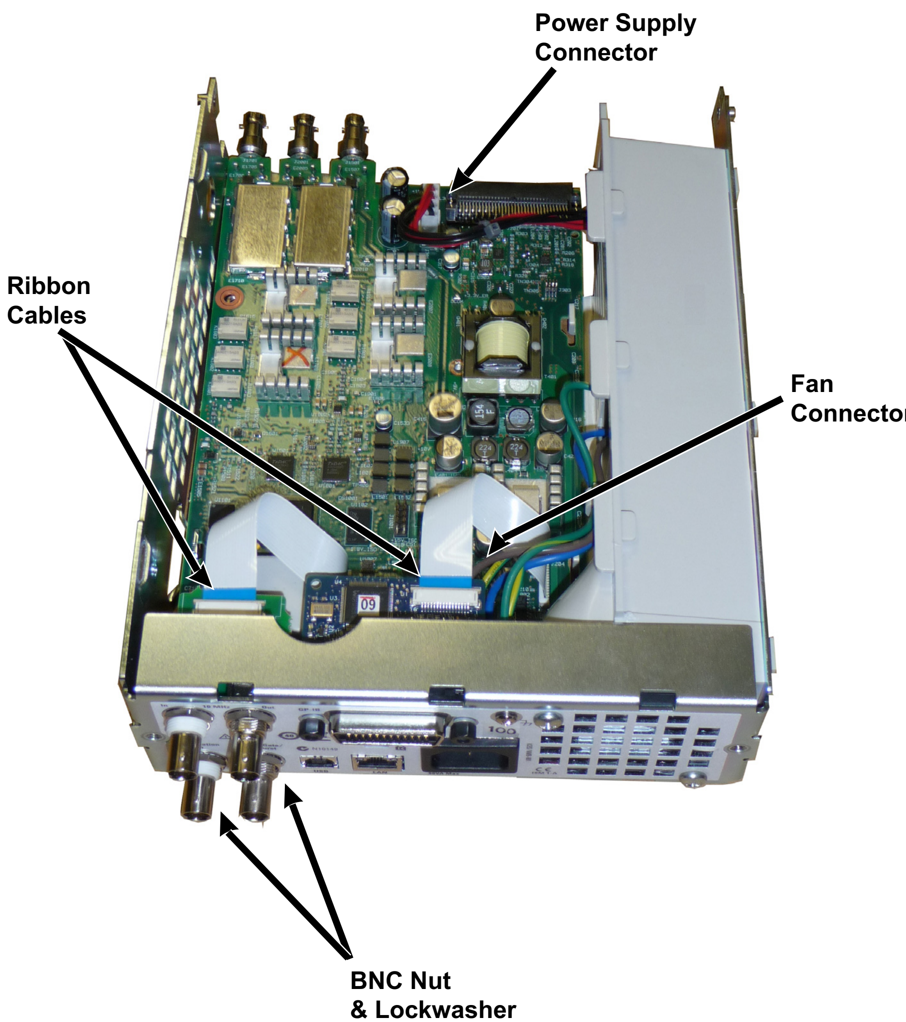
1 Remove the processor board. Turn the instrument over. Remove the T-8 screw securing the processor board. Press the tabs on the processor board connector and slide the processor board toward the back of the instrument to disengage the connector. Lift the processor board out..



2 Remove the front panel assembly. Remove the T15 screw holding the main board. Press the latch on the left side of the front panel and the latch in the power supply cover on the right side of the front panel. Push the sides of the metal chassis toward the center to disengage the studs on either side of the front panel assembly. Gently pull the front panel assembly straight off the chassis. Note that the front panel assembly has an electrical connector to the main board. Be careful not to damaged the connector.



3 Removing the Main Board. Disconnect the power supply connector from the main board. Disconnect the GPIB and Oscillator In ribbon cables. Disconnect the fan power cable from the main board. Loosen and remove the nuts securing the Modulation In and Ext Trigger BNC connector to the rear panel. Remove the screw below the GPIB board securing the main board to the chassis. Slide the main board toward the front of the instrument to disengage the tabs on the power supply cover. Lift the main board out.



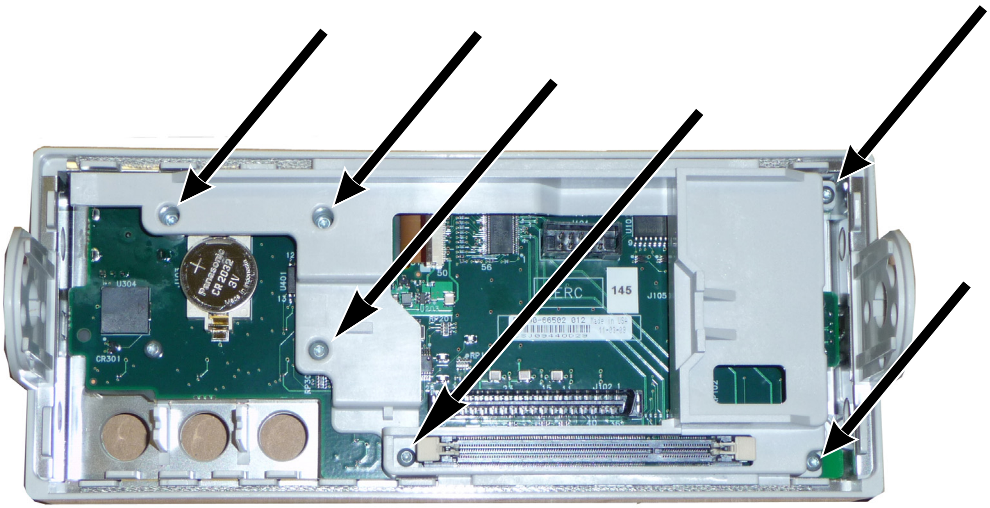
4 Removed the Power Supply. Disconnect the input power to the power supply board (blue and brown wires). Disconnect the green ground connector on the power supply board. Remove the screw securing the power supply cover to the chassis. Slide the power supply assembly toward the front of the instrument and remove.

WARNING *Always be sure to re-attach the green ground wire to the power supply before operating the instrument.*

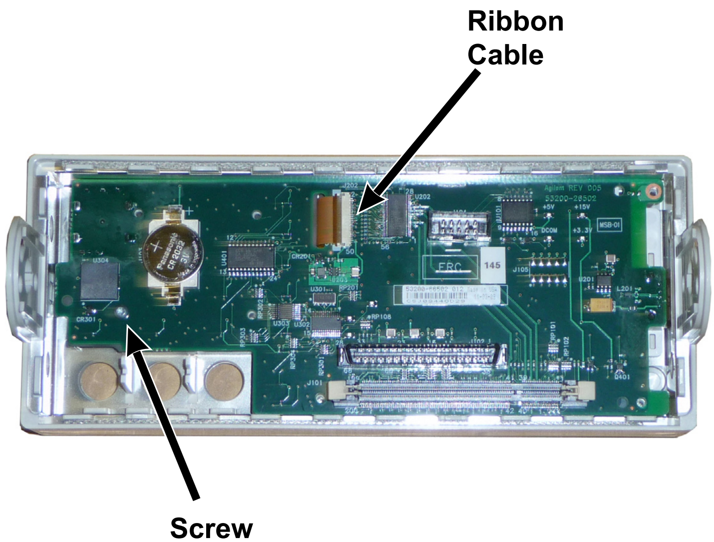
5 The remaining assemblies can be removed from the chassis if needed.

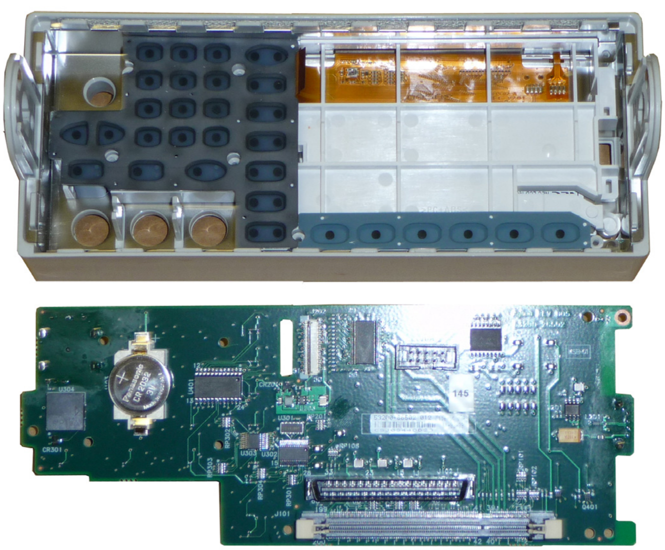
Front Panel Disassembly

1 Remove the knob by pulling straight off. Remove the six T8 screws securing the front panel bracket to the front panel assembly. Lift out the bracket.



2 Disconnect the display ribbon cable from the front panel board. Remove the T8 screws securing the front panel board to the front panel assembly. Lift out the printed circuit board.





3 All additional front panel assemblies can now be lifted out of the front panel housing.