Trueform Arbitrary Waveform Generator

EDU33210 Series

KEYSIGHT

SERVICE GUIDE

Notices

Copyright Notice

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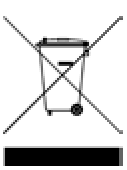

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CAUTION

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.

1 Service and Maintenance

This chapter provides the specifications and service information on cleaning, troubleshooting, repair, and replaceable parts of the EDU33210 Series waveform generator. This chapter also explains how to assemble and disassemble the instrument.

Specifications and Characteristics

NOTE For the characteristics and specifications of the EDU33210 Series waveform generator, refer to the datasheet at https://www.keysight.com/us/en/assets/3121-1004/data-sheets/EDU33210-Series-20-MHz-Function-Arbitrary-Waveform-Generators.pdf.

General Information

Types of service available

If your instrument fails during the warranty period, Keysight Technologies will repair or replace it under the terms of your warranty. After your warranty expires, Keysight offers repair services at competitive prices. You also have the option to purchase a service contract that extends the coverage after the standard warranty expires.

Obtaining repair service (worldwide)

To obtain service for your instrument, contact your nearest Keysight Technologies Service Center. They will arrange to have your unit repaired or replaced, and can provide warranty or repair–cost information where applicable. Ask the Keysight Technologies Service Center for shipping instructions, including what components to ship. Keysight recommends that you retain the original shipping carton for return shipments.

Repackaging for shipment

Ensure the following to ship the unit to Keysight for service or repair:

- 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.
- Secure the container with strong tape or metal bands.
- If the original shipping container is unavailable, use a container that will ensure at least 10 cm (4 in.) of compressible packaging material around the entire instrument. Use static-free packaging materials.

Keysight suggests that you always insure your shipments.

Cleaning and handling

Cleaning

To prevent electrical shock, disconnect the instrument from AC mains power and disconnect all test leads before cleaning. Clean the outside of the instrument using a soft, lint-free, cloth slightly dampened with water.

- Do not use detergent or solvents.
- Do not attempt to clean internally.

If required, contact a Keysight Technologies Sales and Service office to arrange for proper cleaning to ensure that safety features and performance are maintained.

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 V.

The following guidelines will help prevent ESD damage during service operations:

- 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.

Troubleshooting

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 was accurately calibrated within the last year (see Calibration Adjustment Procedures > Calibration Interval for details).

Perform the following verifications if the unit is inoperative:

- Verify that the ac power cord is connected to the waveform generator.
- Verify that the front-panel power switch is depressed.
- Verify the power-line voltage setting.

Self-Test Procedures

A power-on self-test occurs automatically when you turn on the waveform generator. This limited test assures you that the waveform generator is operational.

Press **[System]** > **Instr. Setup** > **Self Test** to perform the complete self-test of the waveform generator. It takes approximately 12 seconds for the self-test to complete.

You can also perform a complete self-test from the remote interface, see Programming Guide for details.

- If the self-test is successful, "Self test passed" is displayed on the front panel.
- If the self-test fails, "" is displayed on the front panel. Press **[System]** > **Help** > **Error View** to record the error code and message and contact Keysight support if necessary.
- If the self-test is successful, this indicates a high chance that the waveform generator is operational.

Self-Test Error

The self test (see the *TST? command) performs a series of tests on the instrument hardware.

A failure can generate multiple error messages; the first one should be considered the primary cause of failure. Some error messages include a failing channel number (1 or 2), shown as n in the messages below.

Error Code	Error Messages
601	Self-test failed; real time clock settings lost
602	Self-test failed; main CPU power supply out of range
603	Self-test failed; main CPU error accessing boot env
604	Self-test failed; front panel processor ping failed
605	Self-test failed; waveform FPGA not programmed
606	Self-test failed; waveform FPGA revision check failed
607	Self-test failed; waveform FPGA read back error
608	Self-test failed; waveform FPGA security check failed
609	Self-test failed; waveform FPGA security check failed
610	Self-test failed; main PLL not locked
611	Self-test failed; FPGA PLL not locked
612	Self-test failed; Chan n, waveform memory PLL not locked
613	Self-test failed; Chan n, waveform memory not initialized
615	Self-test failed; modulation ADC offset too low (too high)
616	Self-test failed; modulation ADC reference too low (too high)
620	Self-test failed; Chan n, waveform memory test failed on idle
621	Self-test failed; Chan n, waveform memory test failed
625	Self-test failed; Chan n, waveform DAC gain[idx] too low (too high)
630	Self-test failed; Chan n, sub attenuator failure 0dB

Error Code	Error Messages
631	Self-test failed; Chan n, sub attenuator <-7.00 to 0.00>dB too low (too high)
635	Self-test failed; Chan n, null DAC gain[idx] too low (too high)
640	Self-test failed; Chan n, offset DAC gain[idx] too low (too high)
650	Self-test failed; Chan n, 0dB path failure expected 0dB, measured value dB
655	Self-test failed; Chan n, -8 dB pre attenuator path too low (too high) Self-test failed; Chan n, -16 dB pre attenuator path too low (too high) Self-test failed; Chan n, -24 dB pre attenuator path too low (too high) Self-test failed; Chan n, -24 dB post attenuator path too low (too high)

User Replaceable Parts

You can find the instrument support part list at Keysight's Test & Measurement Parts Catalog http://www.keysight.com/find/parts.

Battery Replacement

WARNING SHOCK HAZARD
Only qualified, service-trained personnel 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. Some circuits are active and have power for a short time even when the power switch is turned off.

The internal battery powers the real-time clock. The primary function of the clock it to provide a time stamp for the internal file system. If the battery fails, the clock and time stamp function will not be available. No other instrument functions are affected.

Under normal use at room temperature, the lithium battery has a life expectancy between seven and ten years. Note that battery life will be reduced if the instrument is stored for a prolonged period at temperatures above 40 degrees Celsius.

The battery type is CR 2032.

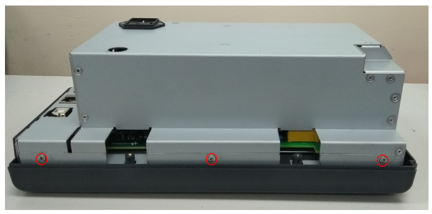
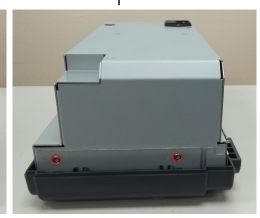
Replacing the Battery

Tools required

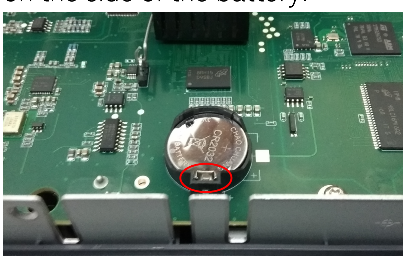
Items	Torque value
T10 Torx screwdriver	0.56 Nm
Flat plastic screwdriver	-

1. Remove four screws as shown below.

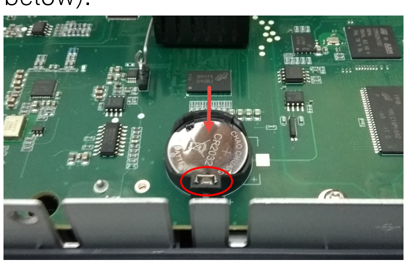
2. Remove the rear panel.
3. Remove nine screws from the chassis. Then, remove the chassis from the front panel.

4. The battery is located at the main board.
5. Press out the small spring clips (see red circle below). Use a flat-bladed plastic screwdriver and carefully pry up on the side of the battery.




6. Install the new battery. Make sure that the positive side (+) is facing up. Place the battery under the small spring clips (see red circle below), then push down on the opposite end of the battery to seat the battery (see red arrow below).



7. Assemble the rear panel when finished.
8. Reset the date and time.

NOTE Properly dispose of the old battery in accordance with local laws and regulations.

Removing/Installing the Knob

Steps	Instructions	Visual
1.	Pull out the knob to remove the knob from the front panel.	
2.	To install back the knob, push the knob back in the shaft. NOTE: Make sure to follow the shaft orientation before pushing the knob.	 

2 Performance Verification

This chapter contains the performance verification procedures which verify that the EDU33210 Series waveform generator is operating within its published specifications.

Performance Verification

Performance verification ensures that the instrument performs within the specifications stated in the data sheet (https://www.keysight.com/us/en/assets/3121-1004/data-sheets/EDU33210-Series-20-MHz-Function-Arbitrary-Waveform-Generators.pdf).

You can perform two different levels of performance verification tests:

- **Self test** A series of internal verification tests that give a high confidence that the instrument is operational.
- **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.
  - Performance verification tests
    - Internal timebase verification
    - AC amplitude (high-impedance) verification
    - DC offset voltage verification
    - -8 dB flatness verification
    - - 24 dB flatness verification

Recommended Test Equipment

The test equipments recommended for the performance verification and adjustment procedures are listed below.

Type	Requirements	Recommended model
Digital multimeter	ACV, true rms, AC coupled accuracy: ±0.02% to 1 MHz DCV accuracy: 50 ppm resolution: 100 µV Resistance Offset-compensated accuracy: ±0.1 Ω	Keysight 3458A
Power meter	Specific model	Keysight N1914A
Power sensor	Specific model	Keysight E9304A
Frequency counter	Accuracy: 0.1 ppm	Keysight 53132A Option 012 (high stability)
Adapter	Type-N (f) to BNC (m), 50 Ω	
Adapter	BNC male to dual banana	
Adapter	BNC feedthrough 50 Ω termination	Keysight part number: 0960-0301
Adapter	Coaxial BNC T-connector	
Cable	Dual banana (m) to dual banana (m)	
Cable	RG58 coaxial cable with BNC (m) to dual banana adapter	
Cable	RG58 coaxial cable with BNC (m) to BNC (m)	

[a] Q= Quick Verification, P= Performance Verification

Test Considerations

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

- Ensure 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.
- Ensure ambient relative humidity is less than 80%.
- Allow an hour warm-up period before verification or calibration.
- Measurement cables as short as possible, consistent with the impedance requirements.
- 50 Ω cable (RG-58 or equivalent)

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 one year test limits the specifications on the instrument datasheet. After acceptance, you should repeat the performance verification tests at every calibration interval.

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

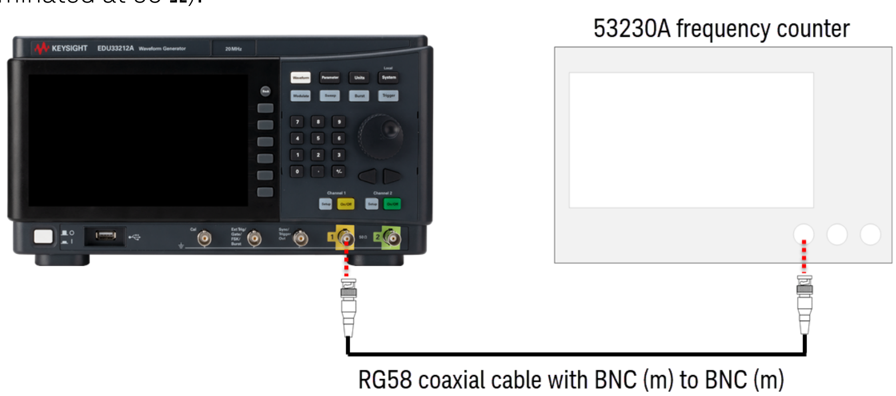
Adjustment is recommended at every calibration interval. If adjustment is not made, you must establish a 'guard band', using no more than 80% of the specifications, as the verification limits.

NOTE Ensure that you have read Test Considerations before running the performance verification tests.

Internal timebase verification

These tests verify output frequency accuracy. All output frequencies are derived from a single generated frequency.

1. Connect the 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.

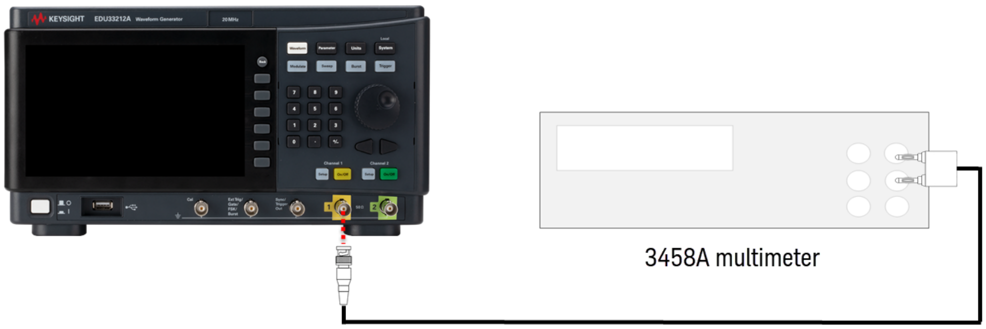
Waveform Generator			Measurement	
Function	Amplitude	Frequency	Nominal	Error
Sine	1.00 Vpp	10.000000 MHz	10.000 MHz	±10 Hz

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

AC amplitude (high impedance) verification

This test checks AC amplitude output accuracy at 1 kHz frequency using each attenuator.

1. Set the multimeter to measure Vrms. Connect the multimeter to the channel output as shown above.



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

Waveform Generator				Measurement	
Output Setup	Function	Amplitude	Frequency	Nominal	Error[a]
High Z[b]	Sine	400 mVrms	1 kHz	400 mVrms	±0.008354 Vrms
High Z	Sine	400 mVrms	1 kHz	400 mVrms	±0.008354 Vrms
High Z	Sine	1 Vrms	1 kHz	1 Vrms	±0.020354 Vrms
High Z	Sine	2.5 Vrms	1 kHz	2.5 Vrms	±0.050354 Vrms
High Z	Sine	7 Vrms	1 kHz	7 Vrms	±0.140354 Vrms

[a] Based upon 2% of setting ±1 mVpp; converted to Vrms for High–Z.

[b] Use the following sequence to set this output:

1. Set amplitude to 400.0 mVrms
2. Set DC Offset to 1.0 VDC
3. Set Auto-Range to OFF
4. Set DC Offset Voltage to 0.0 VDC
5. After the measurement, set autorange ON for remaining measurements.

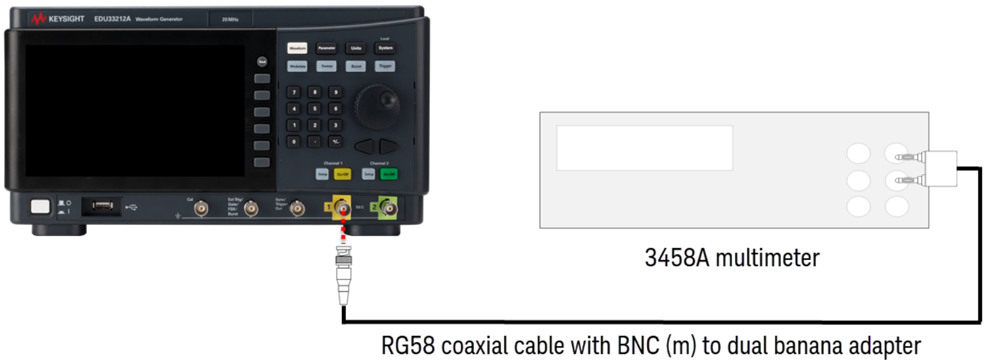
3. Compare the measured value to the test limits shown in the table.

4. For EDU33212A only. Connect multimeter to channel 2 output and repeat steps 2 and 3.

DC offset voltage verification

This test checks the DC Offset Voltage on two attenuator ranges:

1. Set the multimeter to measure DCV. Connect the multimeter to the channel output as shown below.



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

Waveform Generator			Measurement	
Output Setup	**Function**	**Voltage**	**Nominal**	**Error[a]**
High Z	DC	0.0 V	0.0 VDC	±0.005 VDC
High Z	DC	500 mV	0.500 VDC	±0.010 VDC
High Z	DC	10.0 V	10.0 VDC	±0.105 VDC

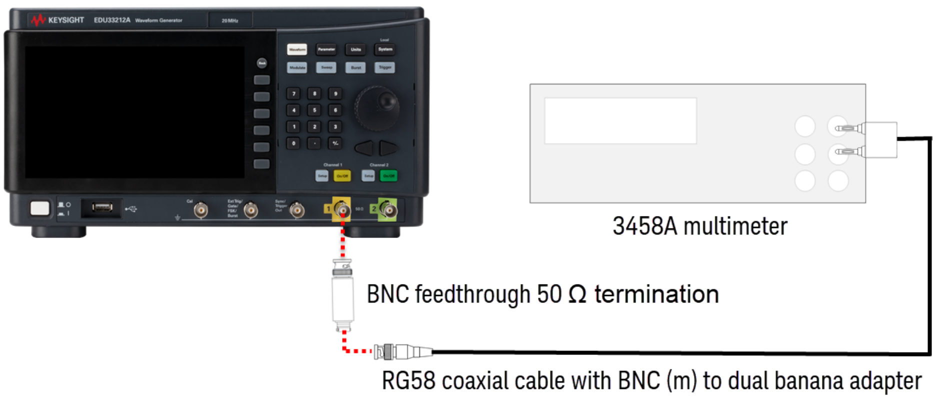
[a] Based upon 1% of setting ±5 mVDC for High-Z.

3. Compare the measured value to the test limits shown in the table.
4. For EDU33212A only. Connect multimeter to channel 2 output and repeat steps 2 and 3.

- 8 dB flatness verification

This test checks high frequency AC amplitude flatness on the -8 dB attenuator range.

1. Connect the multimeter with a 50 Ω feedthrough to the channel output as shown below.

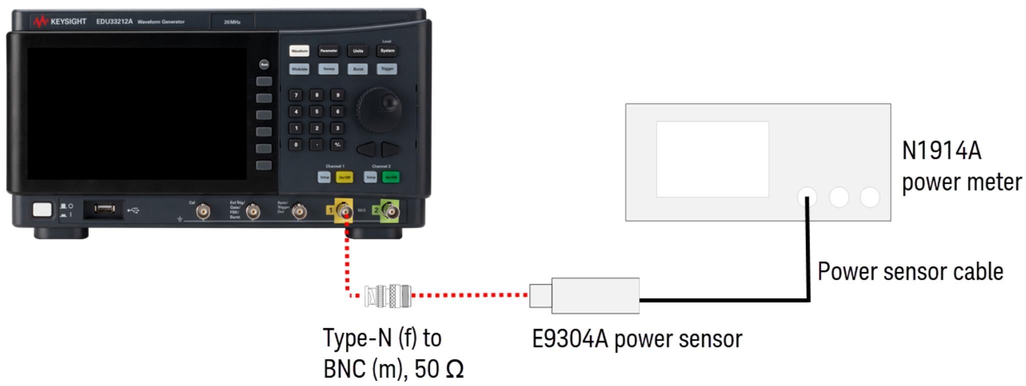


2. Set the instrument to each output in the table below and configure the multimeter to AC mode. Measure the output voltage with the multimeter. This will become the reference measurement. Set the output impedance to 50 Ω. Be sure the output is enabled.

Waveform Generator				Measurement	
Output Load	Function	Amplitude	Frequency	Nominal	Error
50 Ω	Sine	1.200 Vrms	1.00 kHz	1.200 Vrms	±0.024354 Vrms

3. The measured value in Step 2 is the flatness reference point at 1 kHz.
4. Record the multimeter measured value and convert the multimeter measurement in Vrms to dBm by using the equation below.
   Reference point @1 kHz (dBm) = $10 \times \log_{10}(20 \times Vrms^2)$
5. Convert multimeter error to ratio using equation below.
   Reference point accuracy @1 kHz (dB) = 20 x log(multimeter measurement in Vrms / amplitude setting)
6. Set the instrument to the output described in the table below and measure the amplitude by using multimeter. Without resetting and setting the instrument, remove the multimeter and connect power meter and power sensor to the channel output as shown below. Then, measure the amplitude by using power meter and power sensor. Crossover error between both instruments are required to be find out in the following step.

Waveform Generator				Measurement	
Output Load	Function	Amplitude	Frequency	Nominal	Error
50 Ω	Sine	1.200 Vrms	100.000 kHz	0 dB	±0.10 dB



7. Record down both multimeter and power meter measured value.
8. Convert the multimeter measurement in Vrms to dBm using equation below:
   $dBm = 10 \times \log_{10} (20 \times Vrms^2)$
9. Calculate the crossover measurement error across both measurement instrument.
   Crossover @100 kHz (dB) = Power meter measured value in dBm – Multimeter converted value in dBm
10. Compare the measured value to the test limits shown in the table by using formula below:
    Flatness error @100 kHz (dB) = Multimeter converted value in dBm (Step 8) – 1 kHz reference point in dBm (Step 4)
11. Set the instrument to each of the output described in the table below and measure the amplitude by using power meter and power sensor.

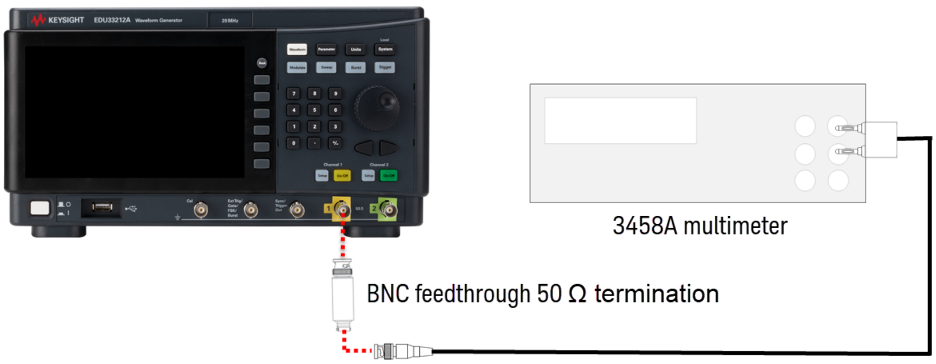
Waveform Generator				Measurement	
Output Load	**Function**	**Amplitude**	**Frequency**	**Nominal**	**Error**
50 Ω	Sine	1.200 Vrms	500.0 kHz	0 dB	±0.15 dB
			1.000 MHz		
			2.000 MHz		
			5.000 MHz		
50 Ω	Sine	1.200 Vrms	10.00 MHz	0 dB	±0.30 dB
			15.00 MHz		
			20.00 MHz		

12. Record down the power meter measured value.
13. Each result measured under Step 11 are required to be corrected by crossover error and 1 kHz reference point error. Use equation below.
    Flatness error above 100 kHz (dB) = Power meter measured value in dBm (Step 12) – Crossover @100 kHz (Step 9) - 1 kHz reference point in dBm (Step 4)
14. Compare the measured value to the test limits shown in the table.
15. For EDU33212A only. Connect multimeter to channel 2 output and repeat steps 2 through 14.

– 24 dB flatness verification

This test checks high frequency AC amplitude flatness on the -24 dB attenuator range.

1. Connect the multimeter with a 50 Ω feedthrough to the channel output as shown below.



2. Set the instrument to each output in the table below and configure the multimeter to AC mode. Measure the output voltage with the multimeter. This will become the reference measurement. Set the output impedance to 50 Ω. Be sure the output is enabled.

	Waveform Generator			Measurement	
Output Load	**Function**	**Amplitude**	**Frequency**	**Nominal**	**Error**
50 Ω	Sine	0.190 Vrms	1.00 kHz	0.190 Vrms	±0.004154 Vrms

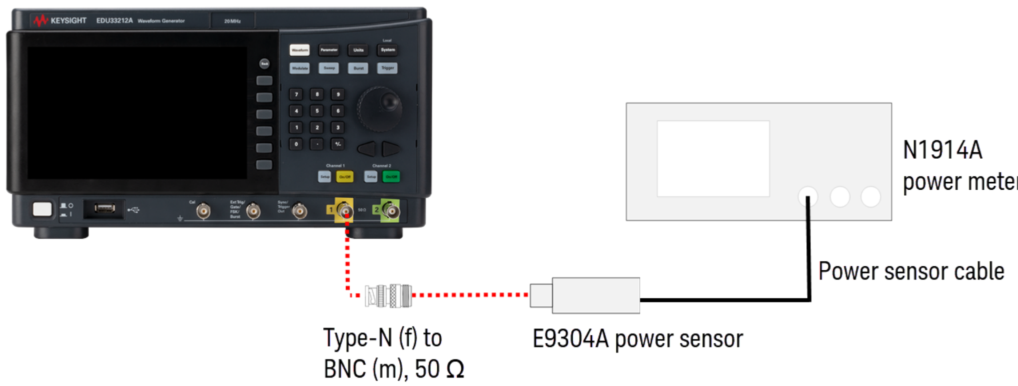
3. The measured value in Step 2 is the flatness reference point at 1 kHz.

4. Record the multimeter measured value and convert the multimeter measurement in Vrms to dBm by using the equation below.
   Reference point @1 kHz (dBm) $= 10 \times \log_{10} (20 \times Vrms^2)$

5. Convert multimeter error to ratio using equation below.
   Reference point accuracy @1 kHz (dB) = 20 x log(multimeter measurement in Vrms / amplitude setting)

6. Set the instrument to the output described in the table below and measure the amplitude by using multimeter. Without resetting and setting the instrument, remove the multimeter and connect power meter and power sensor to the channel output as shown below. Then, measure the amplitude by using power meter and power sensor. Crossover error between both instruments are required to be find out in the following step.

	Waveform Generator			Measurement	
Output Load	**Function**	**Amplitude**	**Frequency**	**Nominal**	**Error**
50 Ω	Sine	0.190 Vrms	100.000 kHz	0 dB	±0.1 dB



7. Record down both multimeter and power meter measured value.
8. Convert the multimeter measurement in Vrms to dBm using equation below:
   $dBm = 10 \times \log_{10}(20 \times Vrms^2)$
9. Calculate the crossover measurement error across both measurement instrument.
   Crossover @100 kHz (dB) = Power meter measured value in dBm – Multimeter converted value in dBm
10. Compare the measured value to the test limits shown in the table by using formula below:
    Flatness error above 100 kHz (dB) = Multimeter converted value in dBm (Step 8) – 1 kHz reference point in dBm (Step 4)
11. Set the instrument to each of the output described in the table below and measure the amplitude by using power meter and power sensor.

Waveform Generator				Measurement	
Output Load	Function	Amplitude	Frequency	Nominal	Error
50 Ω	Sine	0.190 Vrms	500.0 kHz	0 dB	±0.15 dB
			1.000 MHz		
			2.000 MHz		
			5.000 MHz		
50 Ω	Sine	0.190 Vrms	10.00 MHz	0 dB	±0.30 dB
			15.00 MHz		
			20.00 MHz		

12. Record down the power meter measured value.
13. Each result measured under Step 11 are required to be corrected by crossover error and 1 kHz reference point error. Use equation below.
    Flatness error above 100 kHz (dB) = Power meter measured value in dBm (Step 12) – Crossover @100 kHz (Step 9) - 1 kHz reference point in dBm (Step 4)
14. Compare the measured value to the test limits shown in the table.
15. For EDU33212A only. Connect multimeter to channel 2 output and repeat steps 2 through 14.

3 Calibration Adjustments

This chapter contains information on adjustments performed after a performance verification fails.

Calibration Adjustment

This chapter includes calibration adjustment procedures for Keysight EDU33210 Series waveform generator. Instructions are applicable for performing the procedures from a controller over the LAN or USB.

NOTE **Perform the verification tests before calibrating your instrument. If the instrument passes the verification tests, the unit is operating within its calibration limits and does not need to be re-calibrated.**

Closed–case electronic calibration

The instrument uses closed-case electronic calibration; no internal mechanical adjustments are required. The instrument calculates correction factors based on reference signals that you apply and stores the correction factors in non-volatile memory. This data is not changed by cycling power, *RST, or SYSTem:PRESet.

Keysight Technologies calibration services

When your instrument is due for calibration, contact your local Keysight Service Center for a low-cost re-calibration. The EDU33210 Series waveform generator is supported on automated calibration systems, which allow Keysight to provide this service at competitive prices.

Calibration interval

The recommended calibration interval for Keysight EDU33210 Series waveform generator is one year.

Time required for calibration

For incoming instrument verification, do performance verification tests first. Then perform adjustments and re-run the performance verification tests. Each of these steps, if done manually, takes approximately 30 minutes per channel to perform. The instrument can also be automatically calibrated under computer control. With computer control, you can perform the complete calibration procedure and performance verification tests in approximately 30 minutes (one channel) or 60 minutes (two channels) once the instrument is warmed-up (see Test Considerations). Refer to the *EDU33210 Series Programming Guide* for more information.

Automating calibration procedures

You can automate the complete verification and adjustment procedures outlined in this manual. 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. The instrument calibration must be unsecured to perform a calibration.

Calibration Adjustment Process

The following general procedure is recommended to complete a full calibration adjustment.

1. Adhere to the test considerations. See Performance Verification > Test considerations for details.
2. Perform the performance verification tests to characterize the instrument. See Performance Verification for details.
3. Perform the calibration procedures. See Calibration procedure for details.
4. (Optional) Set a new calibration message using the remote interface. The message (up to 40 characters) is stored with the calibration coefficients.
5. Secure the instrument against the calibration. See Calibration security for details.
6. Take note of the security code and calibration count in the instrument's maintenance records.
7. Perform the performance verification tests to verify the calibration.

Calibration Security

The instrument has a calibration passcode to prevent accidental or unauthorized calibration. When you receive your waveform generator, it is secured by a default passcode.

The default security passcode is EDU3321XA. The security code cannot be changed by a power cycle or *RST.

You can enter a passcode of up to 12 characters. The first character must be a letter (A-Z), remaining may contains letters, numbers (0-9), or underscore "_". Blank spaces are not allowed.

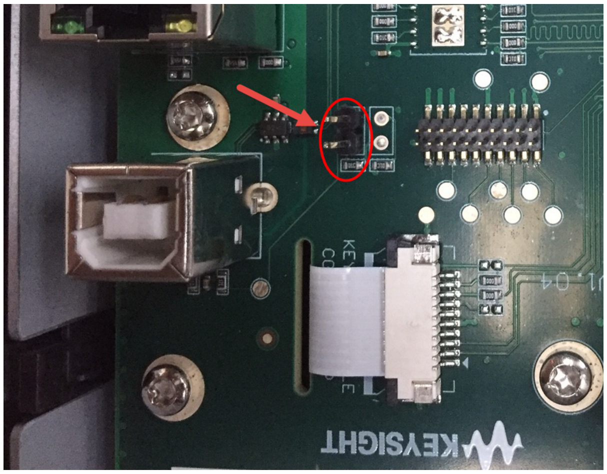
You can only unsecure and change the passcode from remote interface.

From the remote interface:

To unsecure the instrument:
CAL:SEC:STAT 0, EDU3321XA

To change a new passcode to K_EDU33211A:
CAL:SEC:CODE K_EDU33211A

NOTE To change a forgotten passcode to a new passcode, you can turn on the instrument after shorting CAL SECURE jumper J1 on the front panel board as shown below and send CAL:SEC:CODE <code> to change the passcode.



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, and a complete calibration will increase the value by many counts. The calibration count increments up to a maximum of 2^{32}-1 after which it rolls over to 0. The calibration count can only be read remotely.

From the remote interface:

CAL:COUN?

Calibration Message

You can use the CALibration:STRing command to store a message of up to 40 characters in calibration memory. For example, you could store the last calibration date, the calibration due date, or contact information for the person responsible for calibration. The calibration message is not affected by a power cycle or *RST.

You can only store the calibration message when the instrument is unsecured, but you can execute the CALibration:STRing? query regardless of whether the instrument is secured. A new calibration message overwrites the previous message, and messages over 40 characters are truncated.

Calibration Error

The following errors indicate failures that may occur during a calibration.

Error Code	Error Messages	Descriptions
701	Calibration error; security defeated by hardware jumper	If you short the calibration secure jumper (CAL ENABLE) while turning the instrument on, this error indicates the security password has been overwritten. See Calibration Security for details.
702	Calibration error; calibration memory is secured	To perform calibration, unsecure the instrument. See Calibration Security for details.
703	Calibration error; secure code provided was invalid	Specified security code was invalid.
706	Calibration error; value out of range	Value entered was outside valid range.
707	Calibration error; signal input is out of range	Occurs during the ADC Adjustment, setup 6, if the 1 V input voltage is too high. May also occur during self-calibration (setup 7). Run self-test to diagnose 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	Error occurred while performing internal calibration of specified DAC. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.
711	Self-calibration failed; Chan n, null DAC cal gain too low (too high), <meas_value> Self-calibration failed; Chan n, offset DAC cal with attenuator gain too low (too high), <meas_value> Self-calibration failed; Chan n, offset DAC cal no attenuator gain too low (too high), <meas_value>	Computed gain calibration factor for specified DAC was out of limits. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.
712	Self-calibration failed; Chan n, null DAC cal zero too low (too high), <meas_value> Self-calibration failed; Chan n, offset DAC cal with attenuator zero too low (too high), <meas_value> Self-calibration failed; Chan n, offset DAC cal no attenuator zero too low (too high), <meas_value> Self-calibration failed; Chan n, GND measurement out of limits, <meas_value>	Computed zero calibration factor for specified DAC was out of limits. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.
715	Self-calibration failed; Chan n, null DAC cal, convergence error sub attenuator value dB	Internal null DAC calibration failed to converge during internal calibration. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose 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	Internal offset DAC calibration failed to converge internal calibration. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.
850	Calibration error; set up is invalid	Invalid calibration setup number selected.

Error Code	Error Messages	Descriptions
850	Calibration error; set up is out of order	Certain calibration steps require a specific beginning and ending. Do not enter into the middle of a calibration sequence.

Calibration Procedure

The only way to calibrate the instrument is by remote interface. Use a computer to perform the adjustment by first selecting the required function and range on the measurement equipment. Send the calibration value to the instrument and then initiate calibration.

You must unsecure the instrument before calibration.

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

1. CAL:SETup 2 (configures instrument for calibration step 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. Read CAL? query value to determine the failure (+1) or success (+0) of adjustment
6. CAL:SETup 3 (configures instrument for calibration step 3)
7. Perform the performance verification tests to verify the calibration.

For further information on instrument programming, refer to the *EDU33210 Series Programming Guide*.

CAUTION If you abort a calibration in progress, all calibration constants for the selected function range are lost. If power is turned off when the instrument is attempting to write new calibration constants to EEPROM, all calibration constants for the selected function range may also lost. Typically, upon re-applying power, the instrument will report Calibration Corrupt in the Questionable Data Register. Refer to the STAT:QUES:COND? command in the *EDU333210 Series Programming Guide* for more details. If this occurs, you should not use the instrument until a complete re-adjustment has been performed.

Aborting a calibration in progress

Sometimes it may be necessary to abort a calibration in progress. You can abort a calibration at any time by turning off the power or by issuing a remote interface device clear message followed by *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.

Sequence of adjustments

The adjustment sequence in the numbered steps minimizes the number of test equipment setups and connection changes. You may perform individual adjustments as necessary, but setups 1 through 7 must be performed in order, before any other setup procedure

Channel 1 Adjustments

Self-test

Run self-test to ensure that the instrument is in working order before beginning any additional adjustments. Be sure to unlock the instrument and follow the requirements listed in Test Considerations before beginning any adjustments.

1. Enter command CALibration:SeTup 1 to begin.

Setup		SCPI command
1	Performs the self-test. The main output is disabled during test.	CAL:SET 1

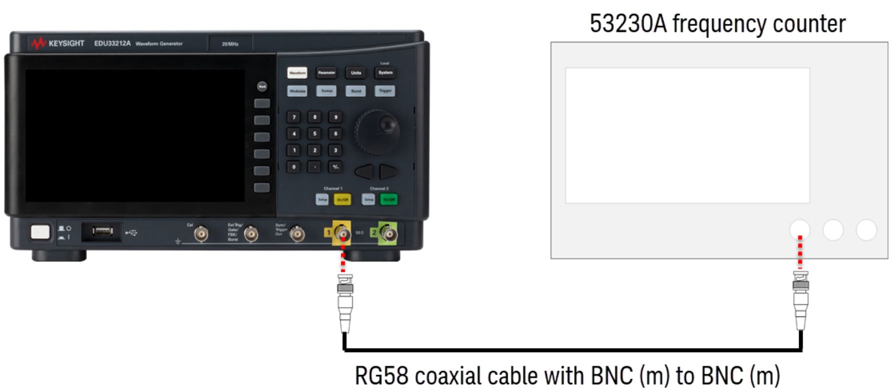
2. If the instrument fails any self-test, press **[System]** > **Help** > **Error View** to record the error code and message, and contact Keysight support if necessary.

A complete self-test (*TST?) takes approximately 12 seconds.

Frequency (internal timebase) adjustment

The instrument stores a calibration constant that sets the crystal oscillator to put out exactly 10 MHz. The instrument should have been running continuously for one hour 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).



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

Setup	Frequency	Amplitude		SCPI command
2	< 10 MHz	~ 1 Vpp	Output frequency is slightly less than 10 MHz	CAL:SET 2
3	> 10 MHz		Output frequency is slightly more than 10 MHz	CAL:SET 3
4	~ 10 MHz		Output frequency should be near 10 MHz	CAL:SET 4
5[a]	10 MHz		Output frequency should be 10 MHz ± 1 ppm	CAL:SET 5

[a] Constants are stored after completing this setup.

3. Enter the measured frequency by using SCPI command.

4. To proceed:

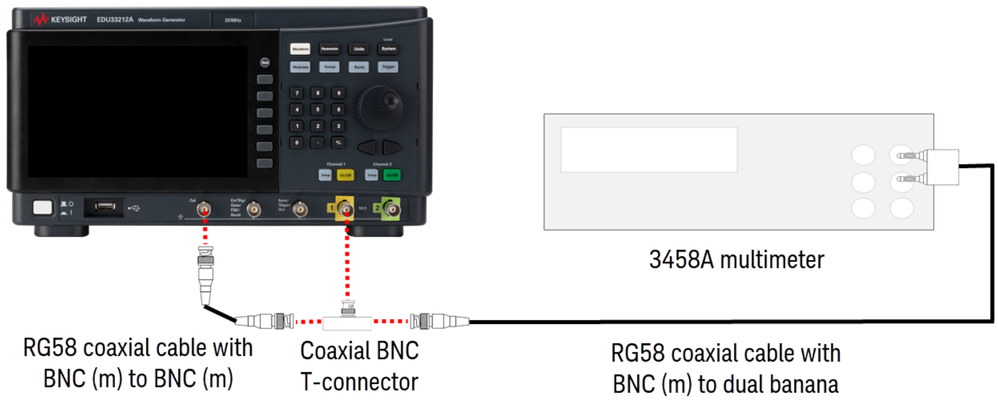
   a. If CAL? check return (+1), exit the calibration menu and perform Internal Timebase Verification.

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

Internal ADC adjustment

The instrument 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 channel 1 output to the instrument's front panel CAL connector and multimeter as shown below.



2. Set the multimeter to display 5½ digits and set the function to DCV.
3. Enter the following setup.

	Nominal Setup		
Setup	**DC level**		**SCPI command**
6[a]	~1.0 VDC ± 10%	Calibrates the internal ADC.	CAL:SET 6

[a] Constants are stored after completing this setup.

4. Enter the measured frequency by using SCPI command.
5. To proceed:
   a. If CAL? check return (+1), exit the calibration menu and perform Internal Timebase Verification.
   b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

Self calibration adjustment

1. Enter and begin the following setup.

Setup		SCPI command
7[a]	Self-calibration. The output is disabled.	CAL:SET 7

[a] Constants are stored after completing this setup.

2. To proceed:

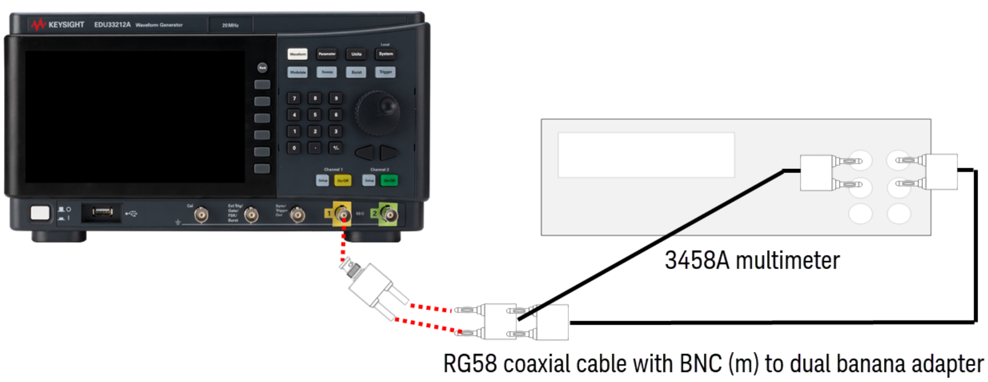
   a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform DC Offset Voltage Verification.

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

Output impedance adjustment

The instrument stores calibration constants for the channels' output impedance. These constants are generated with and without the post-amplifier attenuator.

1. Set the multimeter to measure offset-compensated, 4-wire Ohms. Set the multimeter to use 100 NPLC integration. Connect the Ohms Source and Ohms Sense of the multimeter inputs to the channel output as shown below.



2. Use the multimeter 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		SCPI command
8[a]	24 dB post-attenuator range	CAL:SET 8
9[a]	0 dB	CAL:SET 9

[a] Constants are stored after completing this setup.

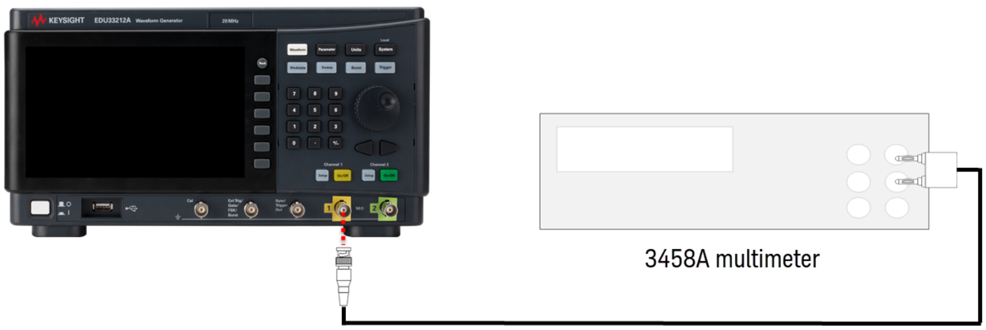
3. Enter the value measured using SCPI command.

4. There are no specific operational verification tests for output impedance. Continue with the next adjustment procedure in this section.

AC amplitude (high-impedance) adjustment

The instrument stores a calibration constant for each high-impedance attenuator path. Each path's gain coefficient 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 multimeter to the channel output as shown below.



2. Use the multimeter to measure the DC voltage at the front panel connector for each setup in the following table.

	Nominal Setup		
Setup	DC level		SCPI command
10	+0.0028 V	Output of -72 dB range	CAL:SET 10
11[a]	-0.0028 V	Output of -72 dB range	CAL:SET 11
12	+0.007 V	Output of -64 dB range	CAL:SET 12
13[a]	-0.007 V	Output of -64 dB range	CAL:SET 13
14	+0.017 V	Output of -56 dB range	CAL:SET 14
15[a]	-0.017 V	Output of -56 dB range	CAL:SET 15
16	+0.044 V	Output of -48 dB range	CAL:SET 16
17[a]	-0.044 V	Output of -48 dB range	CAL:SET 17
18	+0.11 V	Output of -40 dB range	CAL:SET 18
19[a]	-0.11 V	Output of -40 dB range	CAL:SET 19
20	+0.28 V	Output of -32 dB range	CAL:SET 20
21[a]	-0.28 V	Output of -32 dB range	CAL:SET 21
22	+0.68 V	Output of -24 dB range	CAL:SET 22
23[a]	-0.68 V	Output of -24 dB range	CAL:SET 23
24	+1.7 V	Output of -16 dB range	CAL:SET 24
25[a]	-1.7 V	Output of -16 dB range	CAL:SET 25
26	+4.3 V	Output of -8 dB range	CAL:SET 26
27[a]	-4.3 V	Output of -8 dB range	CAL:SET 27
28	+10.8	Output of 0 dB range	CAL:SET 28

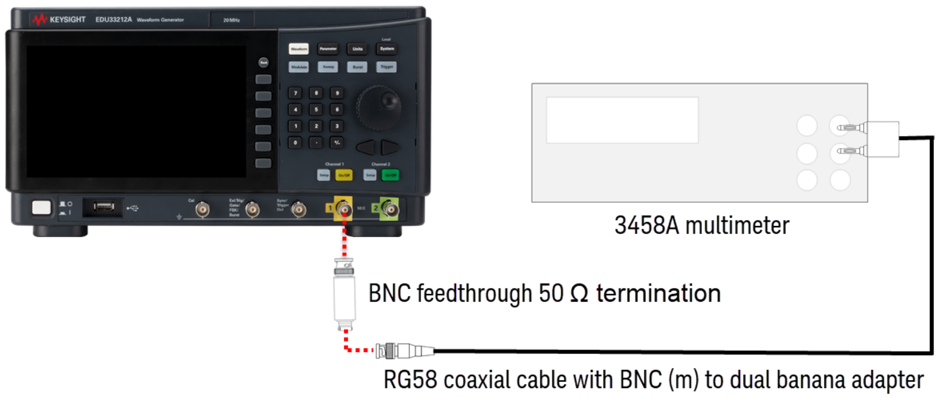
	Nominal Setup		
Setup	DC level		SCPI command
29[a]	-10.8	Output of 0 dB range	CAL:SET 29
30	+0.044 V	Output of -48 dB range	CAL:SET 30
31[a]	-0.044 V	Output of -48 dB range	CAL:SET 31
32	+0.1 V	Output of -40 dB range	CAL:SET 32
33[a]	-0.11 V	Output of -40 dB range	CAL:SET 33
34	+0.28 V	Output of -32 dB range	CAL:SET 34
35[a]	-0.28 V	Output of -32 dB range	CAL:SET 35
36	+0.68 V	Output of -24 dB range	CAL:SET 36
37[a]	-0.68 V	Output of -24 dB range	CAL:SET 37

[a] Constants are stored after completing this setup.

3. Enter the value measured using SCPI command.
4. To proceed:
   a. If your calibration procedures require you to verify this adjustment, exit the calibration menu and perform AC Amplitude (high-impedance) Verification.
   b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

- 8 dB range flatness adjustment

1. Connect the multimeter with a 50 Ω feedthrough to the channel output as shown below.

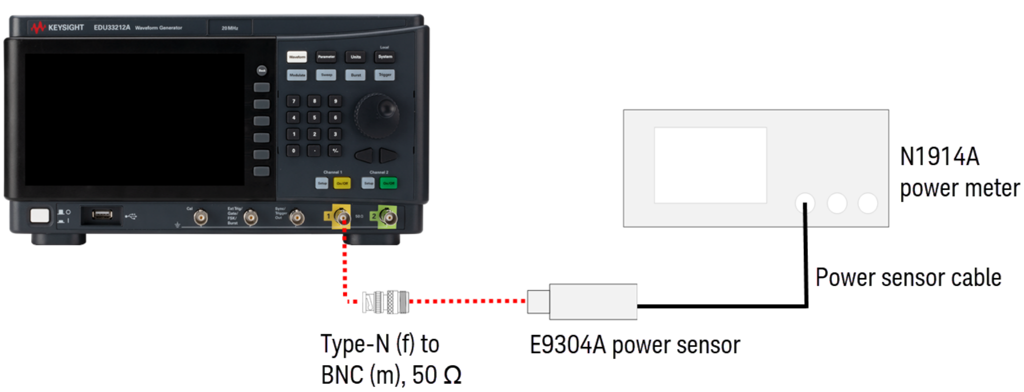


2. Configure 3458A multimeter to ACV mode and measure the output for each setup in the following table.

Setup	Frequency	Amplitude	SCPI command
46[a]	1 kHz	1.22 Vrms	CAL:SET 46
47[a]	100 kHz	1.22 Vrms	CAL:SET 47

[a] Constants are stored after completing this setup.

3. Enter the value measured using SCPI command.
4. For Setup 47, record down the multimeter measurement value during 100 kHz frequency output.
   Multimeter measurement @100 kHz = _____________Vrms
5. Without resetting and setting the instrument, remove the multimeter and connect power meter and power sensor to the instrument output as shown below.



6. Configure the power meter and power sensor to measure the instrument output amplitude as shown in Setup 47.
7. Record down the power meter measurement value. Convert to Vrms if necessary.
   Power meter measurement @100 kHz = _____________Vrms

8. Enter the value measured by multimeter (Step 4) using SCPI command.
9. Calculate the crossover point at 100 kHz by using below formula.
   Crossover @100 kHz = Power meter converted value in Vrms (Step 7) – Multimeter measured value in Vrms (Step 4)
10. Using the existing connection, configure the instrument and measure the output for each setup in the following table.

Setup	Frequency	Amplitude	SCPI command
48	1 MHz	1.22 Vrms	CAL:SET 48
49	5 MHz		CAL:SET 49
50	10 MHz		CAL:SET 50
51	20 MHz		CAL:SET 51
52	25 MHz		CAL:SET 52
53	30 MHz		CAL:SET 53

[a] Constants are stored after completing this setup.

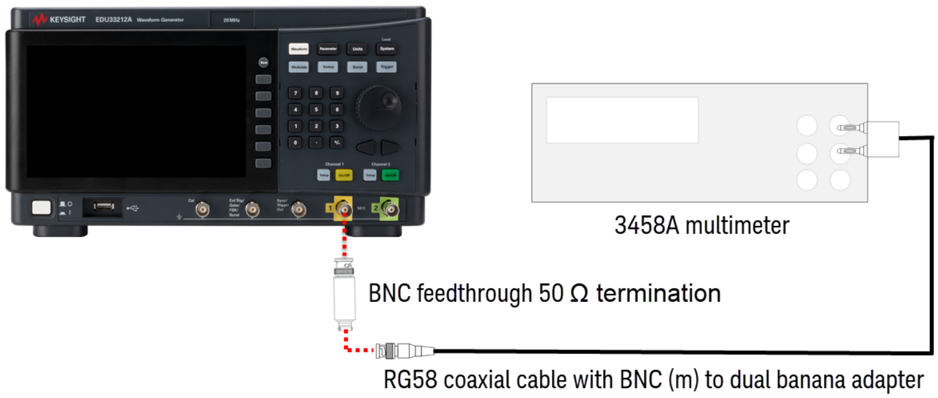
11. Convert the measured power level from dBm to Vrms.
12. Enter the value measured (calibration value) using SCPI command.
    Calibration Value = Power meter converted value in Vrms – Crossover @100 kHz in Vrms (Step 9)
13. To proceed:
    a. If your calibration procedures require you to verify this adjustment, exit the calibration menu and perform -8 dB range flatness verification.
    b. If you are making all of the adjustments and then verifying the instrument’s performance, verify the output specifications of the instrument with the Performance Verification Test.

This completes the adjustment procedures for the one-channel instrument. Verification of the output specifications is recommended.

If you are making adjustment to a two-channel instrument, continue with the next procedure in this section

- 24 dB range flatness adjustment

1. Connect the multimeter with a 50 Ω feedthrough to the channel output as shown below.

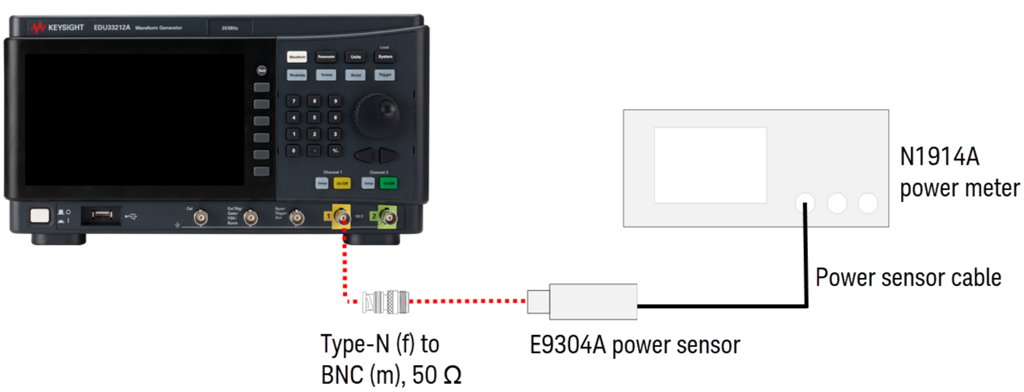


2. Configure 3458A multimeter to ACV mode and measure the output for each setup in the following table.

Setup	Frequency	Amplitude	SCPI command
38[a]	1 kHz	0.192 Vrms	CAL:SET 38
39[a]	1 kHz	1.22 Vrms	CAL:SET 39

[a] Constants are stored after completing this setup.

3. Enter the value measured using SCPI command.
4. For Setup 39, record down the multimeter measurement value during 100 kHz frequency output.
   Multimeter measurement @100 kHz = ______________Vrms
5. Without resetting and setting the instrument, remove the multimeter and connect power meter and power sensor to the instrument output as shown below.



6. Configure the power meter and power sensor to measure the instrument output amplitude as shown in Setup 39.
7. Record down the power meter measurement value. Convert to Vrms if necessary.
   Power meter measurement @100 kHz = ______________Vrms

8. Enter the value measured by multimeter (Step 4) using SCPI command.

9. Calculate the crossover point at 100 kHz by using below formula:
   Crossover @100 kHz = Power meter converted value in Vrms (Step 7) – Multimeter measured value in Vrms (Step 4)

10. Using the existing connection, configure the instrument and measure the output for each setup in the following table.

Setup	Frequency	Amplitude	SCPI command
40[a]	1 MHz	0.192 Vrms	CAL:SET 40
41[a]	5 MHz		CAL:SET 41
42[a]	10 MHz		CAL:SET 42
43[a]	20 MHz		CAL:SET 43
44[a]	25 MHz		CAL:SET 44
45[a]	30 MHz		CAL:SET 45

[a] Constants are stored after completing this setup.

11. Convert the measured power level from dBm to Vrms.

12. Enter the value measured (calibration value) using SCPI command.
    Calibration Value = Power meter converted value in Vrms – crossover @100 kHz in Vrms (Step 9)

13. To proceed:

    a. If your calibration procedures require you to verify this adjustment, exit the calibration menu and perform -24 dB Range Flatness Verification.

    b. If you are making all of the adjustments and then verifying the instrument's performance, verify the output specifications of the instrument with the Performance Verification Test.

Channel 2 Adjustments (EDU33212A only)

Self calibration adjustment (channel 2)

1. Enter and begin the following setup.

Setup		SCPI command
54[a]	Self-calibration. The output is disabled.	CAL:SET 54

[a] Constants are stored after completing this setup.

2. To proceed:

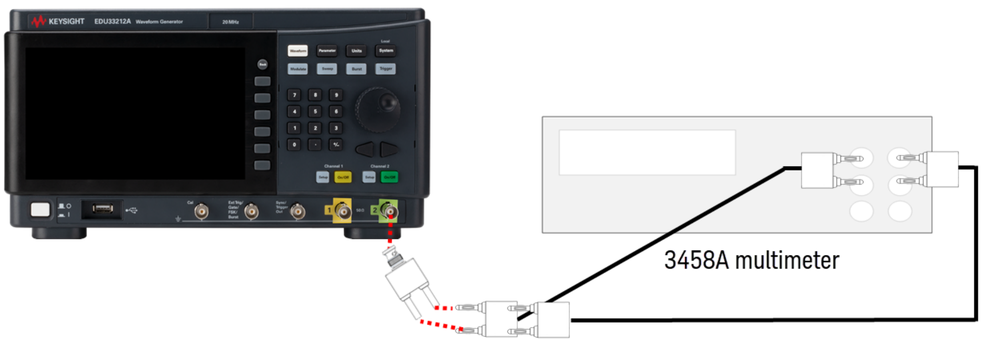
   a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform DC Offset Voltage Verification. Be sure to do this for channel 2.

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

Output impedance adjustment (channel 2)

The instrument stores calibration constants for the channels' output impedance. These constants are generated with and without the post-amplifier attenuator.

1. Set the multimeter to measure offset-compensated, 4-wire Ohms. Set the multimeter to use 100 NPLC integration. Connect the Ohms Source and Ohms Sense of the multimeter inputs to the channel output as shown below.



2. Use the multimeter 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		SCPI command
55[a]	24 dB post-attenuator range	CAL:SET 55
56[a]	0 dB	CAL:SET 56

[a] Constants are stored after completing this setup.

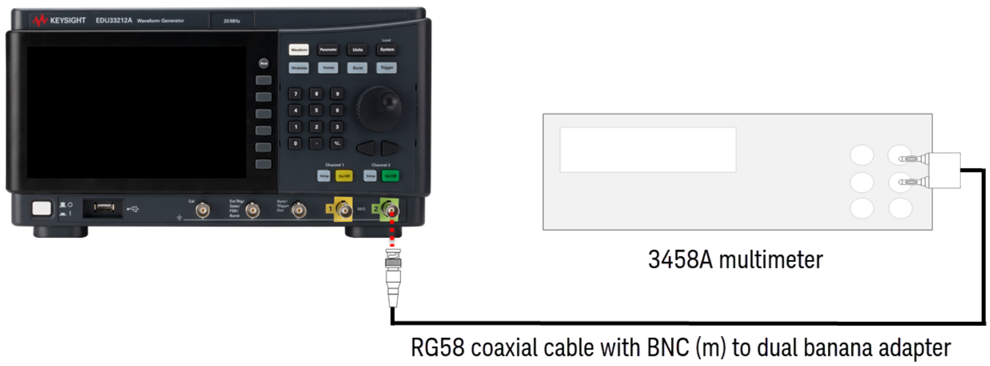
3. Enter the value measured using SCPI command.

4. There are no specific operational verification tests for output impedance. Continue with the next adjustment procedure in this section.

AC amplitude (high-impedance) adjustment (channel 2)

The instrument stores a calibration constant for each high-impedance attenuator path. Each path's gain coefficient 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 multimeter to the channel output as shown below.



2. Use the multimeter to measure the DC voltage at the front panel connector for each setup in the following table.

	Nominal Setup		
Setup	**DC level**		**SCPI command**
57	+0.0028 V	Output of -72 dB range	CAL:SET 57
58[a]	-0.0028 V	Output of -72 dB range	CAL:SET 58
59	+0.007 V	Output of -64 dB range	CAL:SET 59
60[a]	-0.007 V	Output of -64 dB range	CAL:SET 60
61	+0.017 V	Output of -56 dB range	CAL:SET 61
62[a]	-0.017 V	Output of -56 dB range	CAL:SET 62
63	+0.044 V	Output of -48 dB range	CAL:SET 63
64[a]	-0.044 V	Output of -48 dB range	CAL:SET 64
65	+0.11 V	Output of -40 dB range	CAL:SET 65
66[a]	-0.11 V	Output of -40 dB range	CAL:SET 66
67	+0.28 V	Output of -32 dB range	CAL:SET 67
68[a]	-0.28 V	Output of -32 dB range	CAL:SET 68
69	+0.68 V	Output of -24 dB range	CAL:SET 69
70[a]	-0.68 V	Output of -24 dB range	CAL:SET 70
71	+1.7 V	Output of -16 dB range	CAL:SET 71
72[a]	-1.7 V	Output of -16 dB range	CAL:SET 72
73	+4.3 V	Output of -8 dB range	CAL:SET 73
74[a]	-4.3 V	Output of -8 dB range	CAL:SET 74
75	+10.8	Output of 0 dB range	CAL:SET 75

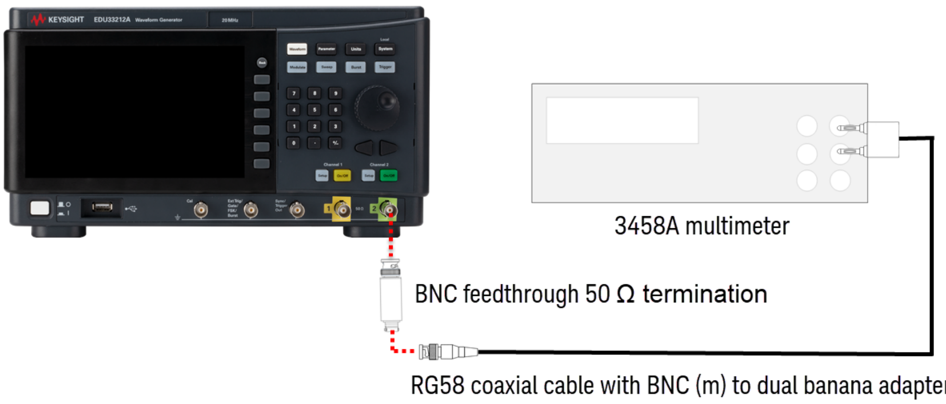
	Nominal Setup		
Setup	DC level		SCPI command
76[a]	-10.8	Output of 0 dB range	CAL:SET 76
77	+0.044 V	Output of -48 dB range (High DC range)	CAL:SET 77
78[a]	-0.044 V	Output of -48 dB range (High DC range)	CAL:SET 78
79	+0.1 V	Output of -40 dB range (High DC range)	CAL:SET 79
80[a]	-0.11 V	Output of -40 dB range (High DC range)	CAL:SET 80
81	+0.28 V	Output of -32 dB range (High DC range)	CAL:SET 81
82[a]	-0.28 V	Output of -32 dB range (High DC range)	CAL:SET 82
83	+0.68 V	Output of -24 dB range (High DC range)	CAL:SET 83
84[a]	-0.68 V	Output of -24 dB range (High DC range)	CAL:SET 84

[a] Constants are stored after completing this setup.

3. Enter the value measured using SCPI command.
4. To proceed:
   a. If your calibration procedures require you to verify this adjustment, exit the calibration menu and perform AC Amplitude (high-impedance) Verification.
   b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

- 8 dB range flatness adjustment (channel 2)

1. Connect the multimeter with a 50 Ω feedthrough to the channel output as shown below.

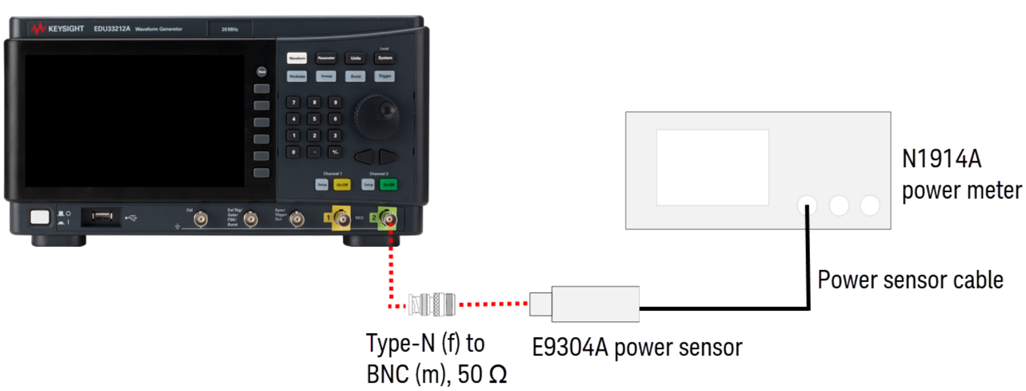


2. Configure 3458A multimeter to ACV mode and measure the output for each setup in the following table.

Setup	Frequency	Amplitude	SCPI command
93[a]	1 kHz	1.22 Vrms	CAL:SET 93
94[a]	100 kHz	1.22 Vrms	CAL:SET 94

[a] Constants are stored after completing this setup.

3. Enter the value measured using SCPI command.
4. For Setup 94, record down the multimeter measurement value during 100 kHz frequency output.
   Multimeter measurement @100 kHz = ____________Vrms
5. Without resetting and setting the instrument, remove the multimeter and connect power meter and power sensor to the instrument output as shown below.



6. Configure the power meter and power sensor to measure the instrument output amplitude as shown in Setup 94.
7. Record down the power meter measurement value. Convert to Vrms if necessary.
   Power meter measurement @100 kHz = ____________Vrms

8. Enter the value measured by multimeter (Step 4) using SCPI command.
9. Calculate the crossover point at 100 kHz by using below formula:
   Crossover @100 kHz = Power meter converted value in Vrms (Step 7) – Multimeter measured value in Vrms (Step 4)
10. Using the existing connection, configure the instrument and measure the output for each setup in the following table.

Setup	Frequency	Amplitude	SCPI command
95[a]	1 MHz	1.22 Vrms	CAL:SET 95
96[a]	5 MHz		CAL:SET 96
97[a]	10 MHz		CAL:SET 97
98[a]	20 MHz		CAL:SET 98
99[a]	25 MHz		CAL:SET 99
100[a]	30 MHz		CAL:SET 100

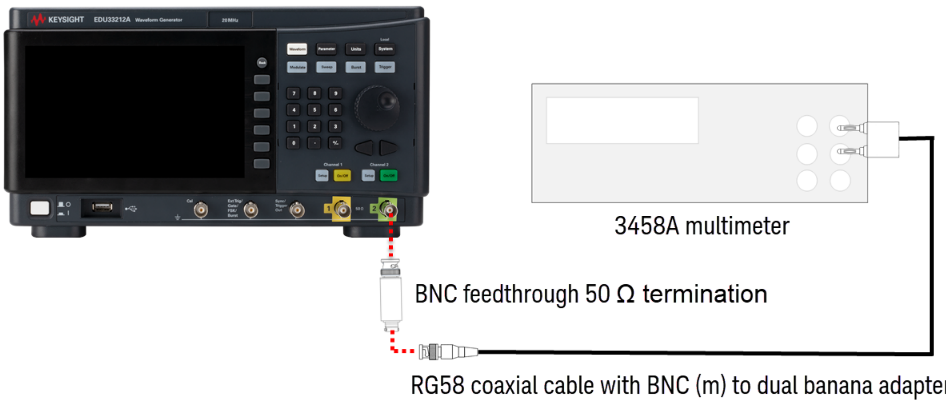
[a] Constants are stored after completing this setup.

11. Convert the measured power level from dBm to Vrms.
12. Enter the value measured (calibration value) using SCPI command.
    Calibration Value = Power meter converted value in Vrms – Crossover @100 kHz in Vrms (step 9)
13. To proceed:
    a. If your calibration procedures require you to verify this adjustment, exit the calibration menu and perform -8 dB range flatness verification.
    b. If you are making all of the adjustments and then verifying the instrument's performance, verify the output specifications of the instrument with the Performance Verification Test.

This completes the adjustment procedures for EDU33212A. Verification of the output specifications is recommended.

- 24 dB range flatness adjustment (channel 2)

1. Connect the multimeter with a 50 Ω feedthrough to the channel output as shown below.

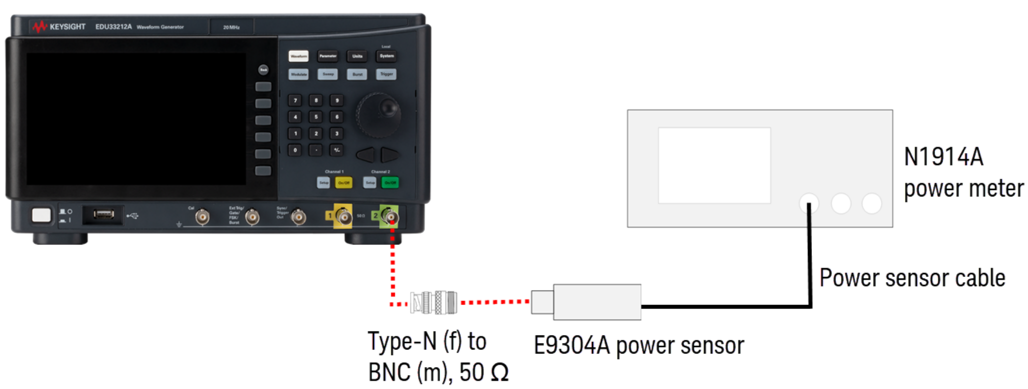


2. Configure 3458A multimeter to ACV mode and measure the output for each setup in the following table.

Setup	Frequency	Amplitude	SCPI command
85[a]	1 kHz	0.192 Vrms	CAL:SET 85
86[a]	100 kHz	0.192 Vrms	CAL:SET 86

[a] Constants are stored after completing this setup.

3. Enter the value measured using SCPI command.
4. For Setup 86, record down the multimeter measurement value during 100 kHz frequency output.
   Multimeter measurement @100 kHz = _____________Vrms
5. Without resetting and setting the instrument, remove the multimeter and connect power meter and power sensor to the instrument output as shown below.



6. Configure the power meter and power sensor to measure the instrument output amplitude as shown in Setup 86.
7. Record down the power meter measurement value. Convert to Vrms if necessary.
   Power meter measurement @100 kHz = _____________Vrms

8. Enter the value measured by multimeter (Step 4) using SCPI command.

9. Calculate the crossover point at 100 kHz by using below formula:
   Crossover @100 kHz = Power meter converted value in Vrms (Step 7) – Multimeter measured value in Vrms (Step 4)

10. Using the existing connection, configure the instrument and measure the output for each setup in the following table.

Setup	Frequency	Amplitude	SCPI command
87[a]	1 MHz	0.192 Vrms	CAL:SET 87
88[a]	5 MHz		CAL:SET 88
89[a]	10 MHz		CAL:SET 89
90[a]	20 MHz		CAL:SET 90
91[a]	25 MHz		CAL:SET 91
92[a]	30 MHz		CAL:SET 92

[a] Constants are stored after completing this setup.

11. Convert the measured power level from dBm to Vrms.

12. Enter the value measured (calibration value) using SCPI command.
    Calibration Value = Power meter converted value in Vrms – Crossover @100 kHz in Vrms (Step 9)

13. To proceed:

    a. If your calibration procedures require you to verify this adjustment, exit the calibration menu and perform -24 dB range flatness verification.

    b. If you are making all of the adjustments and then verifying the instrument's performance, verify the output specifications of the instrument with the Performance Verification Test.

This information is subject to change without notice.

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