Keysight 2050/60 X-Series Wide Dynamic Range Power Sensors

Wide dynamic range power sensors
for any modulated signals

KEYSIGHT TECHNOLOGIES

Service Guide

Notices

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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.

Environmental Conditions

The 2050/60 X-Series is designed for indoor use and in an area with low condensation. The table below shows the general environmental requirements for this instrument.

Environmental condition	Requirement
Temperature	Operating condition – 0 °C to 55 °C Storage condition – –40 °C to 70 °C
Humidity	Operating condition – Up to 95% RH at 40 °C (non-condensing) Storage condition – Up to 90% RH at 65 °C (non-condensing)
Altitude	Operating condition – Up to 3000 m (9840 ft) Storage condition – Up to 15420 m (50000 ft)

Regulatory Information

The 2050/60 X-Series complies with the following Electromagnetic Compatibility (EMC) compliances:

– IEC 61326-1/EN 61326-1

– Canada: ICES/NMB-001

– Australia/New Zealand: AS/NZS CISPR11

Regulatory Markings

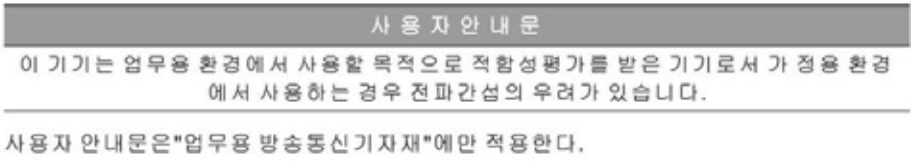
	The RCM mark is a registered trademark of the Spectrum Management Agency of Australia. This signifies compliance with the Australia EMC Framework regulations under the terms of the Radio Communication Act of 1992.		The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives. ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB-001 du Canada. ISM GRP.1 Class A indicates that this is an Industrial Scientific and Medical Group 1 Class A product.
	This symbol indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.		The UKCA (UK Conformity Assessed) marking is a UK product marking that is used for goods being placed on the market in Great Britain (England, Wales, and Scotland)
	This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.		
 **MSIP-REM-Kst-XXXXXXXXX**	This symbol is a South Korean Class A EMC Declaration. This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home. 이 기기는 업무용(A 급) 전자파적합기기로서 판 매자 또는 사용자는 이 점을 주 의하시기 바라 며, 가정외의 지역에서 사용하는 것을 목적으 로 합니다.		

South Korean Class A EMC Declaration

Information to the user:

This instrument has been conformity assessed for use in business environments. In a residential environment, this equipment may cause radio interference.

This EMC statement applies to the equipment only for use in business environment.



Waste Electrical and Electronic Equipment (WEEE) Directive

This instrument complies with the WEEE Directive marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.

Product category:

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

The affixed product label is as shown below.

Do not dispose in domestic household waste.

To return this unwanted instrument, contact your nearest Keysight Service Center, or visit http://about.keysight.com/en/companyinfo/environment/takeback.shtml for more information.

Sales and Technical Support

To contact Keysight for sales and technical support, refer to the support links on the following Keysight websites:

– www.keysight.com/find/widedynamicsensor
(product-specific information and support, software and documentation updates)

– www.keysight.com/find/assist
(worldwide contact information for repair and service)

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1 General Information

This chapter provides the specifications and maintenance information of the 2050/60 X-Series wide dynamic range power sensors.

Specifications and Characteristics

For the characteristics and specifications of the 2050/60 X-Series, refer to the data sheet at http://literature.cdn.keysight.com/litweb/pdf/5992-0040EN.pdf.

Cleaning

Use a clean, water-dampened cloth to clean the body of the 2050/60 X-Series.

Connector care

A solution of pure isopropyl or ethyl alchohol can be used to clean the connector but make sure to keep in mind on its flammable nature.

CAUTION

- The RF connector beads deteriorate when contacted by hydrocarbon compounds such as acetone, trichloroethylene, carbon tetrachloride, and benzene.
- Do not attempt to clean the connector with anything metallic such as pins or paper clips.
- Clean the connector only at a static-free workstation. Electrostatic discharge to the center pin of the connector will render the 2050/60 X-Series inoperative.

Clean the connector face by first using a blast of compressed air. If the compressed air fails to remove contaminants, use a foam swab dipped in isopropyl or ethyl alcohol. If the swab is too big, use a round wooden toothpick wrapped in a lint-free cloth dipped in isopropyl or ethyl alcohol.

2 Performance Verification

This chapter contains the performance verification procedures which verify that the 2050/60 X-Series is operating within its published specifications.

Equipment List

The following equipment are required for performance verification:

Table 2-1 Equipment list for performance verification

Equipment	Critical specification	Recommended Keysight model
PNA microwave network analyzer	Frequency range: 10 MHz to 53 GHz or above Option 217 (only for the high power S11 verification for N5224A and N5225A only)	N5224A or N5225A or N5227A opt 219
Calibration kit	N-Type calibration kits	85054D
	3.5 mm-Type calibration kits Calibrated up to 33 GHz 2.92 mm-Type calibration kits Calibrated up to 40 GHz 2.4 mm-Type calibration kits Calibrated up to 50 GHz 1.85 mm-Type calibration kits Calibrated up to 67 GHz	85052B 85056KE01 85056A 85058B
Amplifier	Frequency range: 10 MHz to 2 GHz (to provide +26 dBm output power at the test port)	
	Frequency range: >2 to 33 GHz (to provide +26 dBm output power at the test port)	
	Frequency range: >33 to 53 GHz (to provide +20 dBm output power at the test port)	
	Frequency range: >50 to 67 GHz (to provide +15 dBm output power at the test port)	
Coupler	Frequency range: 10 MHz to 67 GHz	
Fixed attenuators	Frequency range: 10 MHz to 67 GHz (10 dB or 20 dB depending on the amplifier)	
Power meter	Dual-channel power meter, compatible with the N8480 Series power sensors	N1914A or N1912A

Equipment	Critical specification	Recommended Keysight model
Power sensor	Frequency range: 10 MHz to 18 GHz Power range: –35 to +20 dBm	N8481A
	Frequency range: 10 MHz to 18 GHz Power range: –15 to +35 dBm	N8481H
	Frequency range: 10 MHz to 33 GHz (Option 033) Power range: –35 to +20 dBm Frequency range: 50 MHz to 50 GHz Power range: –35 to +20 dBm Frequency range: 10 MHz to 67 GHz Power range: –35 to +20 dBm	N8485A N8487A N8488A
Signal generator	Power range: –50 dBm to +22 dBm at 1 GHz Output resistance: 50 Ω Option 1EU (high output power)	E8257D
	—	N5172B
Power splitter	2-resistor-type power splitter, N-Type (f) Maximum frequency: 18 GHz DC - 67 GHz Power splitter, 50 ohm, 1.85 (f) Max frequency: 67 GHz	11667A 11667CH67
Directional RF coupler	Frequency range: 10 MHz to 2 GHz Impedance: 50 Ω	5086-7488 R-channel coupler or 86205A directional bridge
Function generator	>10 MHz pulse signal frequency Adjustable edge time of 20 ns to 100 ns	33250A

Voltage Standing Wave Ratio (VSWR) Performance Verification

VSWR is a measure of how efficiently an RF power is transmitted from an RF power source. In real systems, mismatched impedances between the RF source and load can cause some of the power to be reflected back towards the source and vary the VSWR.

This performance verification requires the following equipment.

- For low power S11 verification (refer to datasheet for the power range of different models, http://literature.cdn.keysight.com/litweb/pdf/5992-0040EN.pdf):
  - PNA microwave network analyzer (N5227A)
  - N-Type calibration kit
  - 3.5-mm calibration kit
  - 2.4 -mm calibration kit
  - 2.92-mm calibration kit
  - 1.85-mm calibration kit
  - N-Type female adapter
  - 3.5-mm female adapter
  - 2.4-mm female adapter
  - 2.92-mm female adapter
  - 1.85-mm female adapter
- For high power S11 verification (refer to datasheet for the power range of different models, http://literature.cdn.keysight.com/litweb/pdf/5992-0040EN.pdf):
  - PNA microwave network analyzer (N5227A with Option 219)
  - N-Type calibration kit
  - 3.5-mm calibration kit
  - 2.4 -mm calibration kit
  - 2.92-mm calibration kit
  - 1.85-mm calibration kit
  - N-Type female adapter

- 3.5-mm female adapter
- 2.4-mm female adapter
- 2.92-mm female adapter
- 1.85-mm female adapter
- Power amplifier
- Coupler
- Fixed attenuators (8490D)
- Power meter (N1913A/N1914A)
- Power sensor (N8481H/N8485A with Option 033 or N8487A/N8488A)

Procedure

Low power S11 verification (without amplifier)

1 Set up the equipment as shown below. The network analyzer is used to perform the final return loss test.

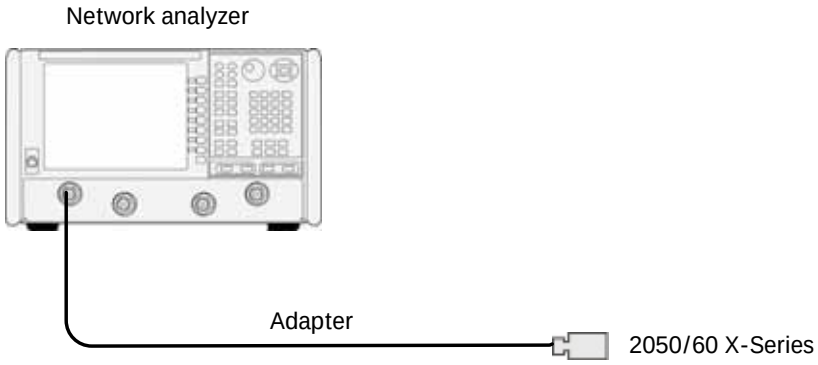

Figure 2-1 Equipment setup for low power S11 verification

2 Set the start frequency of the network analyzer to 10 MHz and the stop frequency to 6 GHz (for the U2051/61XA, L2051/61XA), 18 GHz (for the U2052/62XA, L2052/62XA), and 33 GHz (for the U2053/63XA, L2053/63XA), 40GHz (for the U2054/64XA, L2054/64XA), 50GHz (for the U2055/65XA, L2055/65XA), 53 GHz (for the L2065XT), 54 GHz (for the U2056/66XA, L2056/66XA and L2066XT) and 67 GHz (for the U2057/67XA, L2057/67XA and L2067XT).

3 Set additional configuration on the network analyzer as follows:

- IF bandwidth: 1 kHz
- Power level: 0 dBm

4 Perform calibration for the 1-port return loss measurement using the appropriate calibration kit for the device type. Perform the calibration using the open, short, and load circuits/sliding load of the network analyzer.

5 After calibration, connect the 2050/60 X-Series to the test port of the network analyzer. Turn on **Correction** on the network analyzer to perform the VSWR measurement.

6 Connect the 2050/60 X-Series (device-under-test) to the 1-Port of the network analyzer and start the measurement for S11, SWR, and phase across frequencies.

7 Compare the measured results to the specifications in the data sheet. If the verification fails, return the 2050/60 X-Series to Keysight.

NOTE Refer to the data sheet (http://literature.cdn.keysight.com/litweb/pdf/5992-0040EN.pdf) for the maximum SWR specifications.

High power S11 verification (with amplifier)

1 Set up the equipment as shown below.

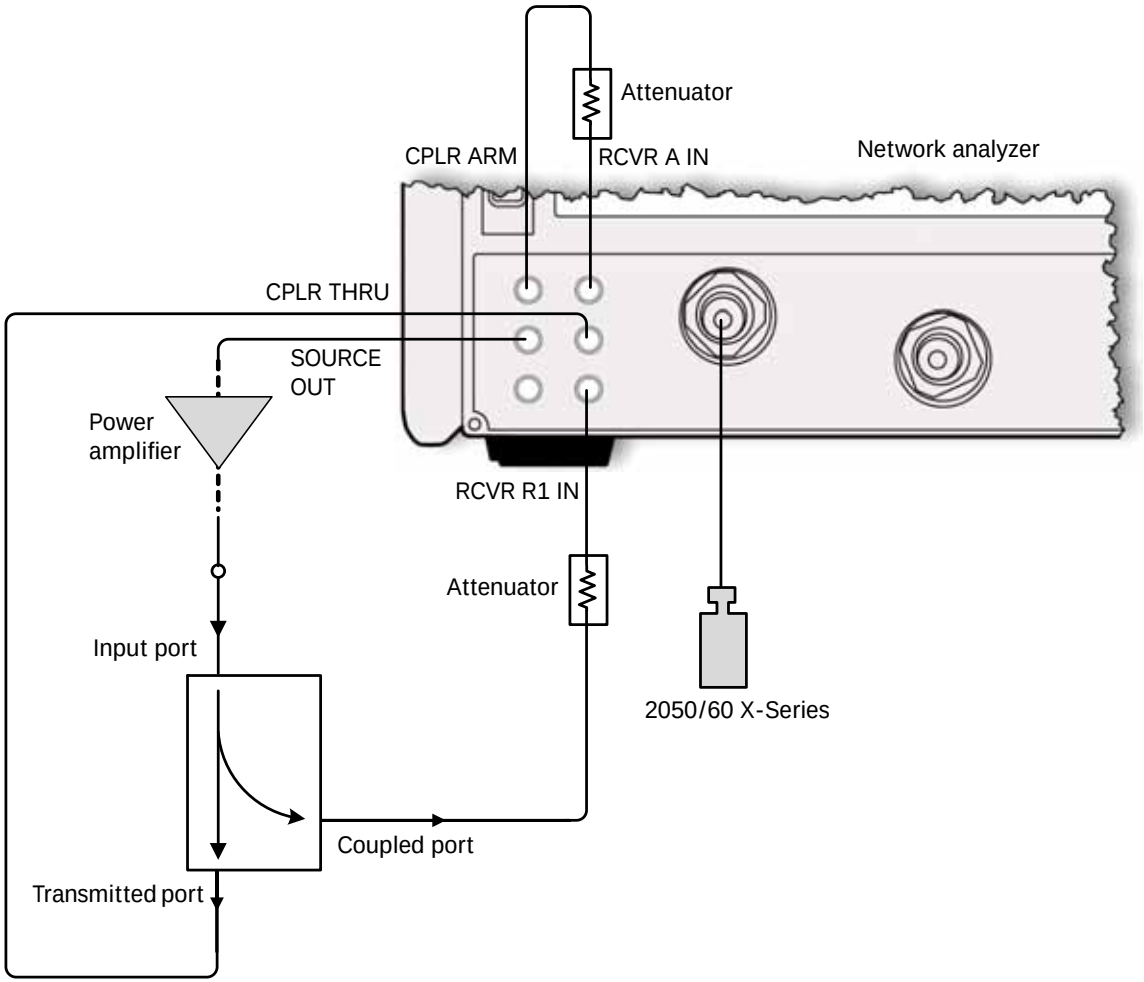

Figure 2-2 Equipment setup for high power S11 verification

2 Turn off the amplifier.

3 Preset the network analyzer.

4 Configure the frequency range for the sensor model to be tested.

5 Set the **R1 Input Path** to **External : flow through R1 loop.**.

6 Set the power level to –30 dBm or lower depending on the gain and output power of the amplifier.

7 Turn on the amplifier.

8 Set the **IF Bandwidth** of the network analyzer to 1 kHz.

9 Perform a **Source Power Calibration** on the network analyzer:

   a Connect the power meter with the 2050/60 X-Series to the network analyzer via a GPIB controller.

   b Set the **Power Offset** to achieve the desired **Cal Power**.

   c Select **Take Cal Sweep**.

   d Follow the instructions on the display screen.

10 Perform calibration for the 1-port return loss measurement using the appropriate calibration kit for the device type. Perform the calibration using the open, short, and load circuits / sliding load of the network analyzer.

11 Ensure that the **"C 1-Port"** and **"SrcPwrCal"** status indicators are displayed on the network analyzer.

12 Connect the 2050/60 X-Series (device-under-test) to the test port of the network analyzer.

13 Compare the measured results to the specifications in the data sheet at http://literature.cdn.keysight.com/litweb/pdf/5992-0040EN.pdf. If the verification fails, return the 2050/60 X-Series to Keysight.

NOTE Refer to the data sheet (http://literature.cdn.keysight.com/litweb/pdf/5992-0040EN.pdf) for the maximum SWR specifications.

NOTE

- To protect the network analyzer receivers from being overloaded, configure the network analyzer to turn off power if its receiver is overloaded.
- Depending on the amplifier being used, the test port power might not be sufficient. In this case, a banded setup with different amplifiers covering different frequency ranges might be required.
- The high power setup can be verified by performing the calibration and measurement at low power level, and comparing the results to the data from the low power setup without the amplifier.
- Use the fixed attenuators to lower the power seen by the network analyzer receivers so that they are not in the compression region. The receiver A attenuator can also be used to protect receiver A.
- For further information, refer to the Keysight's application note: *Recommendations for Testing High-Power Amplifiers Using the PNA Microwave Network Analyzers, 5989-1349EN*.

Power Accuracy Verification

The purpose of this test is to verify the compliance of calibration of 2050/60 X-Series (DUT) after a period of usage to ensure that the 2050/60 X-Series still works within its published calibration uncertainty specifications.

Power Accuracy Verification performance test is to compare sensor measurement against a calibrated test port signal where the system uncertainty should not be greater than the values stated in Table 2-2. The specifications of the sensor are defined as the sum of Calibration Uncertainty and Maximum Test System Uncertainty for each frequency band, contributed by both 2050/60 X-Series Power Sensor and test system used to conduct verification test. Since the test system used for Power Accuracy Verification is different from the characterization, therefore the uncertainty of test system should not be ignored.

Verification error (%) from Power Accuracy Verification during periodical calibration should meet the specifications stated in Table 2-3 to confirm its compliance. Relative expanded uncertainty available in the data sheet (http://literature.cdn.keysight.com/litweb/pdf/5992-0040EN.pdf) should be taken as sensor's calibration uncertainty if compliance is confirmed.

Table 2-2 Maximum Test System Uncertainty

Frequency band	L/U2051/61XA	L/U2052/62XA	L/U2053/63XA
10 MHz to 30 MHz	1.9%	1.9%	2.8%
>30 MHz to 500 MHz	1.9%	1.9%	2.8%
>500 MHz to 1 GHz	1.9%	1.9%	2.4%
>1 GHz to 6 GHz	1.9%	1.9%	2.5%
>6 GHz to 10 GHz	—	2.1%	2.8%
>10 GHz to 18 GHz	—	2.3%	3.1%
>18 GHz to 26.5 GHz	—	—	3.2%
>26.5 GHz to 33 GHz	—	—	3.4%

Frequency band	L/U2054/64XA	L/U2055/65XA	L/U2055/65XA (Option 053) and L2065XT
10 MHz to 30 MHz	2.2%	2.3%	2.3%
>30 MHz to 500 MHz	1.6%	1.7%	1.9%
>500 MHz to 6 GHz	1.7%	2.1%	2.1%
>6 GHz to 8 GHz	1.8%	2.2%	2.2%
>8 GHz to 12 GHz	1.9%	2.5%	2.2%
>12 GHz to 16 GHz	2.0%	2.6%	2.5%
>16 GHz to 26.5 GHz	2.2%	2.7%	2.7%
>26.5 GHz to 33 GHz	2.4%	2.9%	3.6%
>33 GHz to 40 GHz	3.1%	3.3%	3.6%
>40 GHz to 50 GHz	—	3.3%	4%
>50 GHz to 53 GHz	—	—	4%

Frequency band	L/U2056/66XA and L2066XT	L/U2057/67XA and L2067XT
10 MHz to 30 MHz	2.6%	2.6%
>30 MHz to 500 MHz	2.2%	2.2%
>500 MHz to 6 GHz	2.6%	2.6%
>6 GHz to 12 GHz	2.6%	2.6%
>12 GHz to 16 GHz	2.9%	2.9%
>16 GHz to 26.5 GHz	3.0%	3.0%
>26.5 GHz to 33 GHz	3.5%	3.5%
>33 GHz to 40 GHz	3.4%	3.5%
>40 GHz to 48 GHz	3.7%	3.7%
>48 GHz to 54 GHz	4.2%	4.2%

Frequency band	L/U2056/66XA and L2066XT	L/U2057/67XA and L2067XT
>54 GHz to 60 GHz	—	4.3%
>60 GHz to 67 GHz	—	4.3%

Table 2-3 Power Accuracy Verification Specification (Sensor Calibration Uncertainty + Maximum Test System Uncertainty)

Frequency band	Average mode		
	L/U2051/61XA	L/U2052/62XA	L/U2053/63XA
10 MHz to 30 MHz	5.1%	5.1%	7.2%
>30 MHz to 500 MHz	4.2%	4.2%	6.7%
>500 MHz to 1 GHz	4.2%	4.2%	6.3%
>1 GHz to 6 GHz	4.2%	4.2%	6.4%
>6 GHz to 10 GHz	—	4.9%	6.8%
>10 GHz to 18 GHz	—	5.3%	7.3%
>18 GHz to 26.5 GHz	—	—	7.7%
>26.5 GHz to 33 GHz	—	—	8.5%

Frequency band	Average mode		
	L/U2054/64XA	L/U2055/65XA	L/U2055/65XA (Option 053) and L2065XT
10 MHz to 30 MHz	6.8%	6.9%	7.0%
>30 MHz to 500 MHz	5.2%	5.3%	5.7%
>500 MHz to 6 GHz	5.3%	5.7%	6.0%
>6 GHz to 8 GHz	5.5%	5.9%	6.1%
>8 GHz to 12 GHz	5.6%	6.2%	6.1%
>12 GHz to 16 GHz	5.9%	6.5%	6.4%
>16 GHz to 26.5 GHz	6.4%	6.9%	7.0%

Frequency band	Average mode		
	L/U2054/64XA	L/U2055/65XA	L/U2055/65XA (Option 053) and L2065XT
>26.5 GHz to 33 GHz	6.7%	7.2%	8.5%
>33 GHz to 40 GHz	7.9%	8.1%	8.6%
>40 GHz to 50 GHz	—	8.3%	9.6%
>50 GHz to 53 GHz	—	—	9.8%

Frequency band	Average mode	
	L/U2056/66XA and L2066XT	L/U2057/67XA and L2067XT
10 MHz to 30 MHz	7.4%	7.4%
>30 MHz to 500 MHz	5.4%	5.4%
>500 MHz to 6 GHz	6.2%	6.2%
>6 GHz to 12 GHz	6.2%	6.2%
>12 GHz to 16 GHz	6.7%	6.7%
>16 GHz to 26.5 GHz	7.0%	7.0%
>26.5 GHz to 33 GHz	8.0%	8.0%
>33 GHz to 40 GHz	8.1%	8.2%
>40 GHz to 48 GHz	8.8%	8.8%
>48 GHz to 54 GHz	9.3%	9.3%
>54 GHz to 60 GHz	—	9.7%
>60 GHz to 67 GHz	—	9.7%

Frequency band	Normal mode					
	Video bandwidth OFF/HIGH			Video bandwidth MED/LOW		
	L/U2051/61XA	L/U2052/62XA	L/U2053/63XA	L/U2051/61XA	L/U2052/62XA	L/U2053/63XA
10 MHz to 30 MHz	5.6%	5.6%	7.2%	5.7%	5.7%	7.1%
>30 MHz to 500 MHz	4.7%	4.7%	6.9%	4.7%	4.7%	6.8%
>500 MHz to 6 GHz	4.7%	4.7%	6.5%	4.7%	4.7%	6.4%

Frequency band	Normal mode					
	Video bandwidth OFF/HIGH			Video bandwidth MED/LOW		
	L/U2051/61XA	L/U2052/62XA	L/U2053/63XA	L/U2051/61XA	L/U2052/62XA	L/U2053/63XA
>6 GHz to 12 GHz	4.7%	4.7%	6.6%	4.8%	4.8%	6.5%
>12 GHz to 16 GHz	—	5.4%	6.9%	—	5.4%	6.9%
>16 GHz to 26.5 GHz	—	5.7%	7.4%	—	5.8%	7.4%
>26.5 GHz to 33 GHz	—	—	7.8%	—	—	7.7%
>33 GHz to 40 GHz	—	—	8.6%	—	—	8.6%

Frequency band	Normal mode					
	Video bandwidth OFF/HIGH			Video bandwidth MED/LOW		
	L/U2054/64XA	L/U2055/65XA	L/U2055/65XA (Option 053) and L2065XT	L/U2054/64XA	L/U2055/65XA	L/U2055/65XA (Option 053) and L2065XT
10 MHz to 30 MHz	6.9%	7.0%	6.9%	6.6%	6.7%	7.0%
>30 MHz to 500 MHz	5.6%	5.7%	5.9%	5.1%	5.2%	5.8%
>500 MHz to 6 GHz	5.7%	6.1%	6.1%	5.2%	5.6%	6.1%
>6 GHz to 8 GHz	5.9%	6.3%	6.4%	5.5%	5.9%	6.2%
>8 GHz to 12 GHz	6.0%	6.6%	6.4%	5.6%	6.2%	6.2%
>12 GHz to 16 GHz	6.2%	6.8%	6.7%	5.8%	6.4%	6.9%
>16 GHz to 26.5 GHz	6.8%	7.3%	7.2%	6.2%	6.7%	7.7%
>26.5 GHz to 33 GHz	7.1%	7.6%	8.7%	6.6%	7.1%	8.6%
>33 GHz to 40 GHz	8.4%	8.6%	8.7%	7.8%	8.0%	8.6%
>40 GHz to 50 GHz	—	9.0%	9.8%	—	8.2%	9.6%
>50 GHz to 53 GHz	—	—	9.9%	—	—	9.8%

Frequency band	Normal mode			
	Video bandwidth OFF/HIGH		Video bandwidth MED/LOW	
	L/U2056/66XA and L2066XT	L/U2057/67XA and L2067XT	L/U2056/66XA and L2066XT	L/U2057/67XA and L2067XT
10 MHz to 30 MHz	7.6%	7.6%	7.1%	7.1%
>30 MHz to 500 MHz	6.4%	6.4%	5.9%	5.9%
>500 MHz to 6 GHz	6.8%	6.8%	6.5%	6.5%
>6 GHz to 12 GHz	6.9%	6.9%	6.6%	6.6%
>12 GHz to 16 GHz	7.5%	7.5%	7.3%	7.3%
>16 GHz to 26.5 GHz	7.8%	7.8%	7.7%	7.7%
>26.5 GHz to 33 GHz	8.6%	8.6%	8.3%	8.3%
>33 GHz to 40 GHz	8.5%	8.6%	8.2%	8.3%
>40 GHz to 48 GHz	9.5%	9.5%	8.9%	8.9%
>48 GHz to 54 GHz	10.1%	10.1%	9.4%	9.4%
>54 GHz to 60 GHz	–	10.3%	–	9.6%
>60 GHz to 67 GHz	–	10.3%	–	9.6%

The self-verification to verify the performance of 2050/60 X-Series can be performed using the below methods. This performance verification requires the following equipment:

- For low power verification (refer to datasheet for the power range of different models, http://literature.cdn.keysight.com/litweb/pdf/5992-0040EN.pdf):
  - PSG analog signal generator (E8257D, with Option 1EU)
  - Power sensor (N8481A/N8485A with Option 033 or N8487A/N8488A) × 2
  - Power meter (N1912A/N1914A/E4417A)
  - Power splitter
- For high power verification (refer to datasheet for the power range of different models, http://literature.cdn.keysight.com/litweb/pdf/5992-0040EN.pdf):
  - PSG analog signal generator (E8257D)

- Power sensor (N8481A/N8485A with Option 033 or N8487A/N8488A) × 2
- Power meter (N1912A/N1914A/E4417A)
- Power amplifier
- Directional RF coupler
- Low-pass filter (for reducing the high harmonic content of the test signal to approximately –30 dBc for the 2nd harmonics)

Procedure

Low power verification

NOTE

- The accuracy error measured in this verification includes a combination of errors for linearity, calibration factor, and temperature compensation.
- The maximum input power to the 11667A splitter is 0.5 W or +27 dBm.
- To set the sensor mode (Average/Normal mode), send the `SENS:DET:FUNC AVER|NORM` command.
- To set the sensor video bandwidth, send the `SENS:BAND:VID OFF|HIGH|MED|LOW` command.
- The hardware paths for the `OFF` and `HIGH` video bandwidth are identical, while the paths for the `MED` and `LOW` video bandwidths are identical. Verification for the sensor's Normal mode can be performed in the `OFF` and `MED` video bandwidth settings.

1. Connect the standard sensor (N8481A/N8485A/N8487A/N8488A) to the power meter's channel A and the incident sensor (N8481A/N8485A/N8487A/N8488A) to the power meter's channel B.
2. The equipment setup is as shown below.

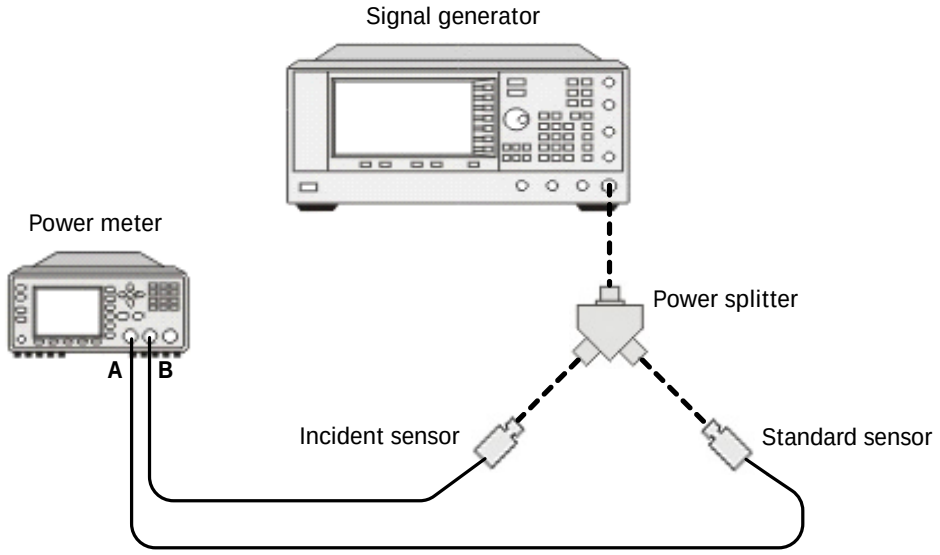

Figure 2-3 Equipment setup for low power verification

3 Zero and calibrate the standard and incident sensors on channels A and B respectively.

4 Set the frequency of the signal generator to 50 MHz and the power level to 0 dBm. Turn on the RF output.

5 Set the frequency of the power meter's channels A and B to the same frequency as the signal generator.

6 Measure the standard power (P_{STD}) of channel A and the incident power (P_{INC1}) of channel B. Compute and record the power ratio (P_{ratio}) of these channels for the current frequency and power level, based on the following equation:

$$P_{ratio}(dB) = P_{STD} - P_{INC1}$$

7 Repeat steps 4 to 6 for other frequencies with the same power level.

8 Turn off the RF output of the signal generator.

9 Remove the standard sensor from the test port.

10 Replace it with the 2050/60 X-Series, which is the device-under-test (DUT).

11 Zero and calibrate the DUT.

12 Measure and record the power readings for the current frequency and power level, as P_{DUT} (from the PC) and P_{INC2} (from the power meter's channel B).

13 Turn off the RF output of the signal generator.

14 Compute the accuracy error of the DUT for each frequency being measured at the same power level, using the following equations:

$$\text{Accuracy error (\%)} <= \pm\sqrt{(MU_{INC})^2 + (MU_{DUT})^2}$$

MU_{INC} and MU_{DUT} are the incident sensor combined uncertainty and DUT combined uncertainty values respectively.

NOTE The measurement uncertainty values for incident sensor, standard sensor and DUT can be calculated using the Measurement Uncertainty Calculator tool available for each sensor under Resources tab on Keysight website.

15 Repeat steps 12 to 14 for other frequencies with the same power level.

16 Compare the computed accuracy errors to the calibration uncertainty values in Table 2-3. If the verification fails, return the 2050/60 X-Series to Keysight.

17 Repeat steps 4 to 16 by sweeping through the power levels from –20 dBm to +10 dBm. Level the power manually if necessary with reference to the incident sensor, using the following equation:

$$\text{Test port power} = P_{INC2} + (P_{STD} - P_{INC1})\text{High power verification}$$

NOTE

– The accuracy error measured in this verification includes a combination of errors for linearity, calibration factor, and temperature compensation.

– The maximum power is +20 dBm.

– The frequency range of the DUT may be wider than the coupler selected in the test. More than one coupler may be required to cover the frequency range of the DUT.

– The procedure below is only applicable for limited verification. For full verification, you need to return the 2050/60 X-Series to Keysight.

1 Connect the standard sensor (N8481A/N8485A/N8487A/N8488A) to the power meter's channel A and the incident sensor (N8481A/N8485A/N8487A/N8488A) to the power meter's channel B.

2 The equipment setup is as shown below:

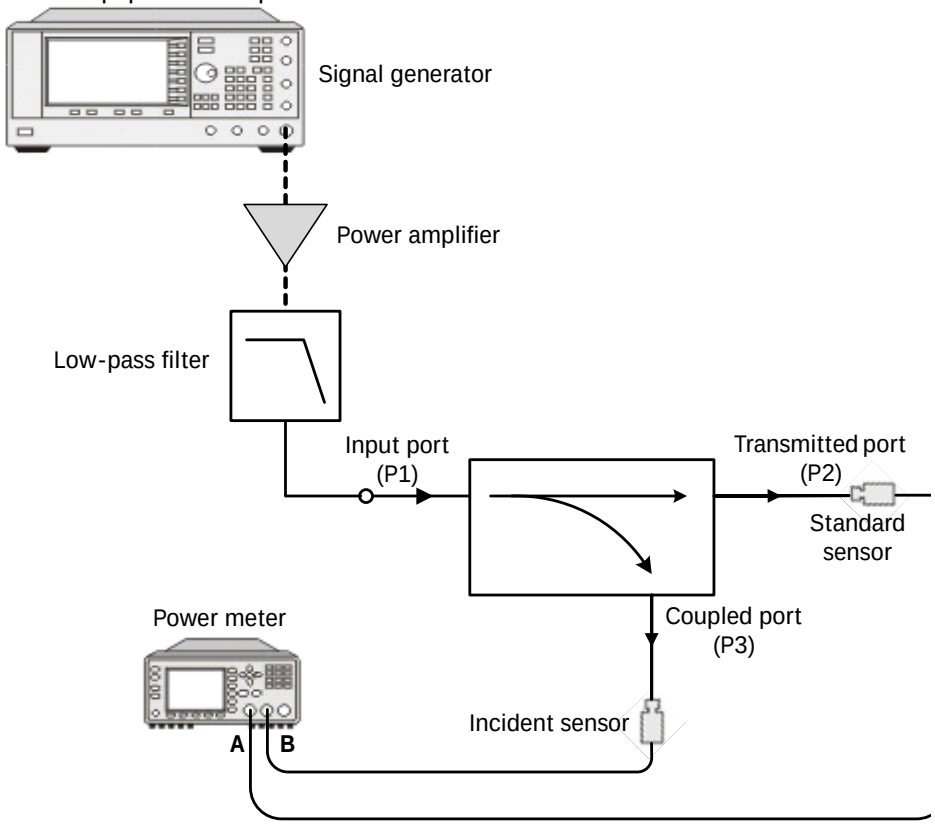

Figure 2-4 Equipment setup for high power verification

3 Offset the signal generator's power by the gain of the power amplifier. On the signal generator, press **Amplitude > More (1 of 2) > Ampl Offset**. Gain is entered as a positive number while loss is entered as negative number.

For example, if the amplifier gain is 28 dB, enter **+28** as the amplitude offset.

4 Zero and calibrate the standard and incident sensors on channels A and B respectively.

5 Set the frequency of the signal generator to 50 MHz and the power level to +10 dBm. Turn on the RF output.

6 Set the frequency of the power meter's channels A and B to the same frequency as the signal source.

7 Measure the standard power (P_{STD}) of channel A and the incident power (P_{INC1}) of channel B. Compute and record the coupling factor (P_{cpl}) of these channels for the current frequency, based on the following equation:

$$P_{cpl}(dB) = P_{STD} - P_{INC1}$$

8 Repeat steps 4 to 6 for other frequencies with the same power level.

9 Turn off the RF output of the signal generator.

10 Remove the standard sensor from the test port.

11 Replace it with the 2050/60 X-Series, which is the device-under-test (DUT).

12 Zero and calibrate the DUT.

13 Measure and record the power readings of channels A and B for the current frequency and power level, as P_{DUT} (from the PC) and P_{INC2} (from the N1912A's channel B).

14 Turn off the RF output of the signal generator.

15 Compute the accuracy error of the DUT for each frequency being measured at the same power level, using the following equations:

$$\text{Accuracy error (\%)} <= \pm\sqrt{(MU_{INC})^2 + (MU_{DUT})^2}$$

MU_{INC} and MU_{DUT} are the incident sensor combined uncertainty and DUT combined uncertainty values respectively.

NOTE The measurement uncertainty values for incident sensor, standard sensor and DUT can be calculated using the Measurement Uncertainty Calculator tool available for each sensor under Resources tab on Keysight website.

16 Repeat steps 13 to 15 for other frequencies with the same power level.

17 Compare the computed accuracy errors to the calibration uncertainty values in Table 2-3. If the verification fails, return the 2050/60 X-Series to Keysight.

18 Repeat steps 13 to 17 by sweeping through the power levels from +10 dBm to +26 dBm. Level the power manually if necessary with reference to the incident sensor, using the following equation:

$$Test\ port\ power = P_{INC2} + P_{cpl}$$

Zero Set Performance Verification

The zero set verification is required to verify the zero level of the 2050/60 X-Series (DUT) after performing zeroing. This verification uses the 20 x 20 method, where the DUT is zeroed for 20 times and for each zero 20 free-run measurements are made, and the mean is obtained. The estimate of the zero level is the mean of the 20 set of mean measurements. The uncertainty of the measurement is stated as the 2x standard deviation of the mean values. The 2x standard deviation can be considered a guard band against the product specification.

NOTE Refer to the data sheet (http://literature.cdn.keysight.com/litweb/pdf/5992-0040EN.pdf) for the zero set specifications.

Equipment setup diagram

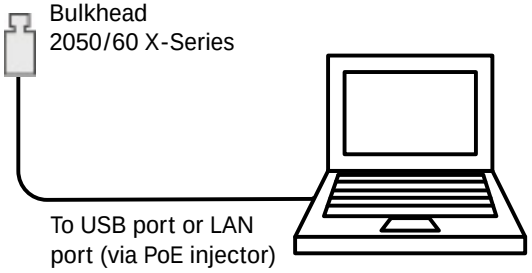

Figure 2-5 Equipment setup for zero set verification

Test equipment settings

Equipment	Key setting
2050/60 X-Series	Free-run mode
	Auto-averaging enabled

SCPI commands

[Repeat for all frequency test points:]

2050/60 X-Series commands

```
SENS:FREQ 50E6/1E9
INIT:CONT ON
UNIT:POW W
```

For external or internal zeroing:

```
CAL:ZERO:TYPE EXT/INT
```

Set the sensor mode (Average/Normal):

```
SENS:DET:FUNC AVER|NORM
```

Set the video bandwidth:

```
BAND:VID OFF|HIGH|MED|LOW
```

[Repeat for 20 times:]

```
CAL:ZERO:AUTO ONCE
```

[Repeat for 20 times:]

```
INIT
FETC?
```

For each 20 FETC? measurements, calculate the mean. Then calculate the standard deviation of the 20 means. Zero set is calculated as the mean of the 20 means. The uncertainty is reported as the 2x standard deviation of the 20 means.

Procedure

1. Send the commands as provided on page 37.
2. Calculate the zero set for the different modes and conditions.
3. Compare the calculated values to the system specifications. If the verification fails, return the 2050/60 X-Series to Keysight.

Rise/Fall Time Performance Verification

NOTE This verification is only applicable for the U2061/2/3/4/5/6/7XA, L2061/2/3/4/5/6/7XA and L2065/6/7XT models.

Rise time verification is required to verify the system rise time of the analog measurement path, from the bulkhead to the inputs of the analog-to-digital converter (ADC). A pulse generator is used to modulate an RF signal generator with fast rise time, and this is captured by the ADC. An equivalent time sampling method is used to calculate the rise time of the captured trace.

This performance verification requires the following equipment:

– Function generator (33250A/33220A)

– Signal generator (N5172B)

System specifications:

Rise/fall time: ≤100 nsecs (with the video bandwidth turned off, the measured signal frequency is ≥300 MHz)

Equipment setup diagram

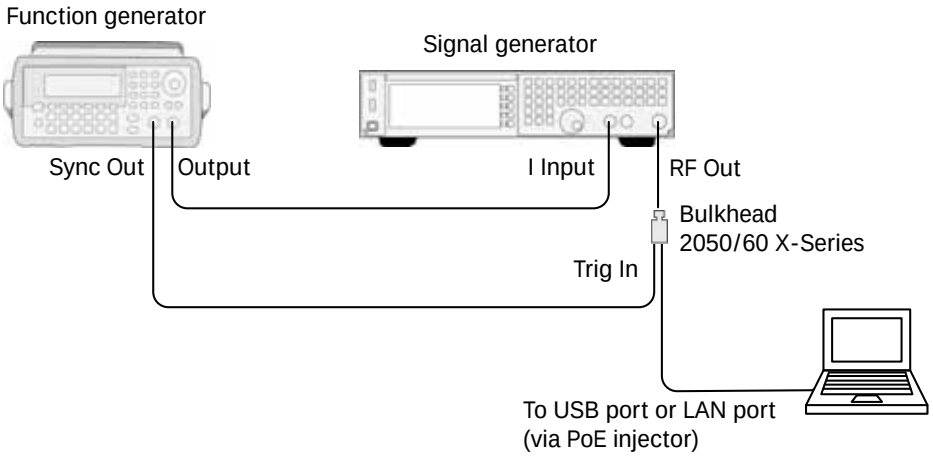

Figure 2-6 Equipment setup for rise time verification

Test equipment settings

Equipment	Key setting
N5172B signal generator	IQ modulation: ON
	RF: ON,
	Mod: ON
33250A/33220A function generator	Pulse waveform
U2061/2/3/4/56/7XA, L2061/2/3/4/5/6/7XA and L2065/6/7XT (DUT)	Trace mode, undecimated
	Trace length: <1.2 ms

U2061/2/3/4/5/66/67XA, L2061/2/3/4/5/6/7XA, L2065/6/7XT SCPI commands

To configure measurement settings:

```
SYST:PRES
SENS:DET:FUNC NORM
INIT:CONT OFF
SENS:AVER OFF
SENS:AVER2 OFF
CAL:ZERO:AUTO OFF
CAL:AUTO OFF
SERV:BIST:TBAS:STAT ON
SENS:FREQ 1e9
TRIG:SOUR EXT
TRAC:STAT ON
TRAC:UNIT W
SENS:TRAC:TIME 500e-6
SENS:BAND:VID LOW|MED|HIGH|OFF
```

To trigger measurement readings:

```
INIT
FETC?
TRAC:DATA? HRES
```

33250A/33220A function generator settings

- Pulse waveform
- Period: 99.99 µs
- HiLevel: 500 mV
- LoLevel: 0 mV
- Pulse width: 50 µs
- Edge time: 20 ns

N5172B signal generator settings

- Frequency: 1 GHz
- Power: +10 dBm
- IQ modulation: ON
- RF: ON
- Mod: ON

MATLAB code *(calculate the rise time of the captured trace using the equivalent time sampling method)*

```
L=2000;
D=5;


aves=1;

data=A;
eff_data_hi=zeros(L*D,1);


    for i=0:aves-1 % averaging loop
        n=0;
        for j=1:L %
            for k=1:D
                    n=n+1;
```

```
                    m=j + (k-1)*L
                    eff_data_hi(n)=eff_data_hi(n)+data(m);
                end
            end
        end
      %disp('finished')
eff_data_hi=eff_data_hi/aves;
X=eff_data_hi
```

The pulse top and pulse bottom are determined by constructing a histogram on the captured trace.

The rise time is measured as the time from 10% above the pulse bottom and 90% above the pulse bottom.

Procedure

1. Send the commands as provided on page 41.
2. Process the trace capture using the MATLAB code as provided on page 41.
3. Locate the pulse top and pulse bottom. Calculate the rise time from 10% to 90%.

   $$Rise\ time_{measured} = \sqrt{Rise\ time_{DUT}^2 + Rise\ time_{system}^2}$$

   Thus,

   $$Rise\ time_{DUT} = \sqrt{Rise\ time_{measured}^2 - Rise\ time_{system}^2}$$

4. Compare the calculated values to the system specifications. If the verification fails, return the 2050/60 X-Series to Keysight.

NOTE For the characteristics and specifications of the 2050/60 X-Series, refer to the data sheet at http://literature.cdn.keysight.com/litweb/pdf/5992-0040EN.pdf.

3 Repair Guide

This chapter contains information on troubleshooting and repair of the 2050/60 X-Series.

Troubleshooting

The 2050/60 X-Series represents a combination of a power meter and a power sensor in one unit. If the LED is red and blinking, it indicates that there is a hardware error or operating system (OS) error in the 2050/60 X-Series. The LED will only blink red if the 2050/60 X-Series encounters any system error. The `SYSTem:ERRor?` query is used to read the exact error messages of the errors that occur on the 2050/60 X-Series. You should send the 2050/60 X-Series to the nearest Keysight Service Center for repair. Refer to the *User's Guide* for more information on the LED indicators.

CAUTION Electrostatic discharge will render the 2050/60 X-Series inoperative. Do not, under any circumstances, open up the 2050/60 X-Series.

Repair

There are no serviceable parts inside the 2050/60 X-Series. If the 2050/60 X-Series is defective, send it back to the nearest Keysight Service Center for repair.

4 Contacting Keysight

This chapter explains the appropriate actions to take if you have a problem with your 2050/60 X-Series.

Introduction

This section provides the information on what to do if you encounter problems with your 2050/60 X-Series.

If you wish to contact Keysight to enquire about the 2050/60 X-Series, from service problems to ordering information, refer to “Sales and Technical Support” on page 6.

If you wish to return the 2050/60 X-Series to Keysight, refer to “Returning the 2050/60 X-Series for Service” on page 48.

Instrument serial number

Keysight makes frequent improvements to its products to enhance their performance, usability, and reliability. Keysight service personnel have access to complete records of design changes for each instrument. The information is based on the serial number and option designation of each 2050/60 X-Series.

Whenever you contact Keysight about your 2050/60 X-Series, have a complete serial number available. This ensures you obtain the most complete and accurate service information. The serial number can be obtained from the serial number label.

The serial number label is attached to the side panel of the 2050/60 X-Series. This label has two instrument identification entries. The first provides the instrument serial number and the second provides the identification number for each option built into the instrument.

The serial number is divided into two parts: the prefix (two letters and the first four numbers), and the suffix (the last four numbers).

– The prefix letters indicate the country of manufacture. This code is based on the ISO international country code standard, and is used to designate the specific country of manufacture for the individual product. The same product number could be manufactured in two different countries. In this case, the individual product serial numbers would reflect different country of manufacture codes. The prefix also consists of four numbers. This is a code identifying the year of manufacture.

– The suffix indicates an alphanumeric code which is used to ensure unique identification of each product throughout Keysight.

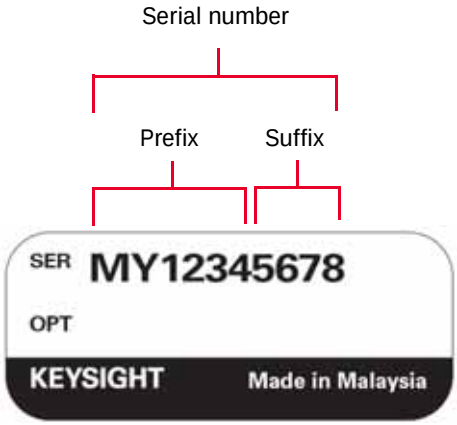

Figure 4-1 Serial number

Recommended calibration interval

Keysight recommends a 1-year calibration cycle for the 2050/60 X-Series.

Returning the 2050/60 X-Series for Service

Use the information in this section if you need to return your 2050/60 X-Series to Keysight.

Packaging the 2050/60 X-Series for shipment

Use the following procedure to package the 2050/60 X-Series for shipment to Keysight for servicing:

– Be as specific as possible about the nature of the problem. Send a copy of any information on the performance of the 2050/60 X-Series.

CAUTION Damage to the instrument can result from using packaging material other than those specified. Never use styrene pellets in any shape as packaging material. They do not adequately cushion the instrument nor prevent it from shifting in the carton. Styrene pellets cause instrument damage by generating static electricity and by getting lodged in the instrument panels.

– Use the original packaging material or a strong shipping container made of double-walled, corrugated cardboard with 91 kg (200 lb.) bursting strength. The carton must be large and strong enough to accommodate the 2050/60 X-Series and allow at least 3 to 4 inches on all sides of the 2050/60 X-Series for packing material.

– Surround the 2050/60 X-Series with at least 3 to 4 inches of packing material, or enough to prevent the 2050/60 X-Series from moving in the carton. If packing foam is not available, the best alternative is SD-240 Air Cap from Sealed Air Corporation (Commerce, CA 90001). Air Cap looks like a plastic sheet covered with 1-1/4-inch air-filled bubbles. Use the pink Air Cap to reduce static electricity. Wrap the 2050/60 X-Series several times in the material as protection and to prevent it from moving in the carton.

– Seal the shipping container securely with strong nylon adhesive tape.

– Mark the shipping container as “FRAGILE, HANDLE WITH CARE” to ensure careful handling.

– Retain copies of all shipping papers.

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