

# Keysight U2020 X-Series USB Peak and Average Power Sensors

# Notices

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## Safety Considerations

Read the information below before using this instrument.

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

### **WARNING**

Before connecting the sensor to other instruments, ensure that all instruments are connected to the protective (earth) ground. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

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### **CAUTION**

Repair or service that is not covered in this manual should only be performed by qualified personnel.

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## Environmental Conditions

The U2020 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 3,000 m (9,840 ft.)
	Storage condition – Up to 15,420 m (50,000 ft.)





## Regulatory Information

The U2020 X-Series complies with the following Electromagnetic Compatibility (EMC) compliances:

### EMC compliance

- IEC 61326-1:2005/EN 61326-1:2006
- Canada: ICES/NMB-001:Issue 4, June 2006
- Australia/New Zealand: AS/NZS CISPR11:2004

## Regulatory Markings

 <p>The RCM mark is a registered trademark of the Australian Communications and Media Authority.</p>	 <p>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.</p>
 <p>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.</p>	 <p>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.</p> <p>ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001.</p> <p>Cet appareil ISM est conforme a la norme NMB-001 du Canada.</p> <p>ISM GRP.1 Class A indicates that this is an Industrial Scientific and Medical Group 1 Class A product.</p>

## 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/usbsensor](http://www.keysight.com/find/usbsensor)  
(product-specific information and support, software and documentation updates)
- [www.keysight.com/find/assist](http://www.keysight.com/find/assist)  
(worldwide contact information for repair and service)

## In This Guide...

### **Chapter 1, "General Information"**

Chapter 1 provides the specifications and maintenance information of the U2020 X-Series.

### **Chapter 2, "Performance Verification and Adjustments"**

Chapter 2 contains the performance verification procedures which verify that the U2020 X-Series is operating within its published specifications. This chapter also provides information on adjustments performed after a performance verification fails.

### **Chapter 3, "Theory of Operation"**

Chapter 3 describes the operation and functions of the U2020 X-Series assembly.

### **Chapter 4, "Repair Guide"**

Chapter 4 contains information on troubleshooting, repair, and replaceable parts of the U2020 X-Series. This chapter also explains how to assemble and disassemble the U2020 X-Series.

### **Chapter 5, "Contacting Keysight"**

Chapter 5 explains the appropriate actions to take if you have a problem with your U2020 X-Series.

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# 1 General Information

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This chapter provides the specifications and maintenance information of the U2020 X-Series USB peak and average power sensors.

## Specifications and Characteristics

For the U2020 X-Series specifications and characteristics, refer to the *U2020 X-Series Data Sheet* at <http://literature.cdn.keysight.com/litweb/pdf/5991-0310EN.pdf>.

## Cleaning

Use a clean, water-dampened cloth to clean the body of the U2020 X-Series.

### Connector care

A solution of pure isopropyl or ethyl alcohol 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 U2020 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.

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## 2 Performance Verification and Adjustments

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This chapter contains the performance verification procedures which verify that the U2020 X-Series is operating within its published specifications. This chapter also provides information on adjustments performed after a performance verification fails.

## Equipment List

The following equipment are required for performance verification:

Equipment	Critical specification	Recommended Keysight model number/part number
Network analyzer	Frequency range: 10 MHz to 40 GHz or above Dynamic range: 94 dB Trace noise: <0.006 dB	E8361A/E8361C/E8363B/E8363C
Calibration kit	Frequency range: DC to 18 GHz or above	85054A/85054D/85056A/85056D
Signal generator	Power range: -50 dBm to +22 dBm at 1 GHz Output resistance: 50 W	E8257D/N5182A/E4438C
Power meter	Dual-channel peak power meter, compatible with P-Series and N8480 Series power sensors Absolute accuracy: $\pm 0.8\%$	N1912A
Power sensor	Frequency: 50 MHz or above Power range: -30 dBm to +20 dBm Standing wave ratio (SWR): $\leq 1.15$ at 50 MHz	N8481A/N8487A
Wideband power sensor	Power range: -30 dBm to +20 dBm SWR: $\leq 1.20$ at 1 GHz	N1921A/N1922A
Cable adapter	11730A sensor cable adapter	N1911A-200
Power splitter	Two-resistor type power splitter, N-type (f) Maximum frequency: 18 GHz	11667A
Pulse pattern generator	Pulse pattern generator that can generate <12 ns pulse period	81130A
Frequency counter	Frequency counter that can count up to 20 MHz frequency	53132A

## 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:

- network analyzer (E8361A/C or E8363B/C)
- calibration kit (85054A/D or 85056A/D)

### Procedure

- 1 Turn on the network analyzer and allow it to warm up for approximately an hour.
- 2 Set the start frequency of the network analyzer to 50 MHz and stop frequency to 18 GHz (for the U2021XA) and 40 GHz (for the U2022XA).
- 3 Calibrate the network analyzer using the appropriate calibration kit (85054A/D for the U2021XA and 85056A/D for the U2022XA). Perform calibration for the open, short, and load circuits of the network analyzer.
- 4 After calibration, connect the U2020 X-Series to the test port of the network analyzer. Turn on **Correction** on the network analyzer to perform the VSWR measurement.
- 5 Compare the measured results to the specifications in the table below. If the verification fails, refer to "**Adjustments**" on page 38.

Frequency band	Maximum SWR	
	U2021XA	U2022XA
50 MHz to 10 GHz	1.2	1.2
>10 GHz to 18 GHz	1.26	1.26
>18 GHz to 26.5 GHz	–	1.3
>26.5 GHz to 40 GHz	–	1.5
>40 GHz to 50 GHz		1.7

## Power Accuracy Verification

The purpose of this test is to verify the compliance of calibration of U2020 X-Series (DUT) after a period of usage to ensure that the U2020 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 2-1](#). 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 U2020 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 2-2](#) to confirm its compliance. Relative expanded uncertainty available in the data sheet (<https://www.keysight.com/my/en/assets/7018-03449/data-sheets/5991-0310.pdf>) should be taken as sensor's calibration uncertainty if compliance is confirmed.

**Table 2-1** Maximum Test System Uncertainty

Frequency band	U2021XA	U2022XA
50 MHz to 500 MHz	3.5%	3.4%
>500 MHz to 1 GHz	2.7%	3.1%
>1 GHz to 10 GHz	2.9%	3.4%
>10 GHz to 18 GHz	3.3%	3.6%
>18 GHz to 26.5 GHz	—	3.8%
>26.5 GHz to 40 GHz	—	4.3%
>40 GHz to 47 GHz	—	4.4%
>47 GHz to 50 GHz	—	5.2%

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

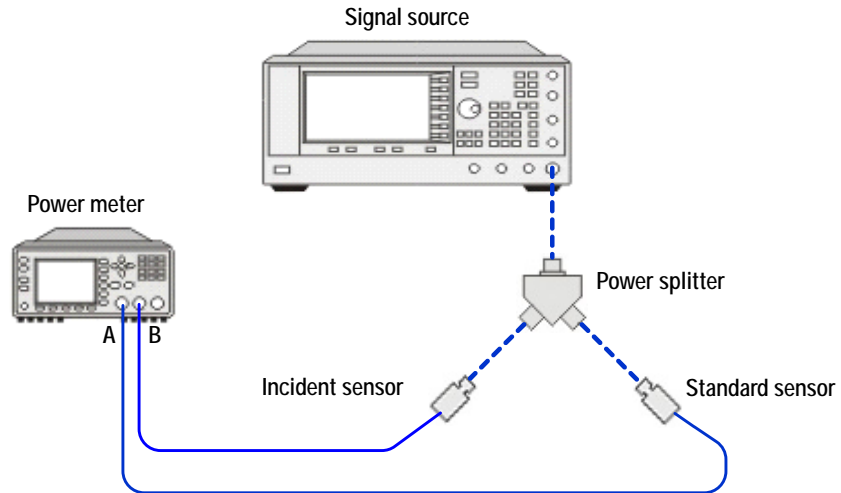
Frequency band	U2021XA	U2022XA
50 MHz to 500 MHz	7.7%	7.7%
>500 MHz to 1 GHz	6.7%	7.3%
>1 GHz to 10 GHz	6.9%	7.9%
>10 GHz to 18 GHz	7.8%	8.1%
>18 GHz to 26.5 GHz	–	9.1%
>26.5 GHz to 40 GHz	–	10.1%
>40 GHz to 47 GHz	–	11.4%
>47 GHz to 50 GHz	–	13.2%

The self-verification to verify the performance of U2020 X-Series can be performed using the below methods. This performance verification requires the following equipment:

- PSG analog signal generator (E8257D)
- power sensor (N1921/2A, N8481/7A)
- power meter (N1912A or N1911A-200)
- power splitter (11667A)

### Procedure

- 1 Turn on the E8257D and N1912A. Allow them to warm up for approximately an hour.
- 2 Connect the standard sensor (N8481/7A) to the N1912A channel A and the incident sensor (N1921/2A) to the N1912A channel B.
- 3 The equipment setup is as shown below:



- 4 Zero and calibrate the standard and incident sensors on channels A and B respectively.
- 5 Set the frequency of the signal source to 50 MHz and power level to 0 dBm. Turn on the RF output.
- 6 Set the frequency of the N1912A channels A and B to the same frequency as the signal source.
- 7 Measure the standard power ( $P_{STD}$ ) of channel A and 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:  

$$P_{ratio}(dB) = P_{STD} - P_{INC1}$$
- 8 Repeat steps 5 to 7 for other frequencies with the same power level.
- 9 Turn off the RF output of the signal source.
- 10 Remove the standard sensor from the N1912A channel A.
- 11 Replace it with the U2020 X-Series, which is the device-under-test (DUT).
- 12 Zero and calibrate the DUT.
- 13 Repeat steps 5 and 6.
- 14 Measure and record the power readings of channels A and B for the current frequency and power level, as  $P_{DUT}$  (for channel A) and  $P_{INC2}$  (for channel B).

- 15 Repeat steps 13 and 14 for other frequencies with the same power level.
- 16 Turn off the RF output of the signal source.
- 17 Compute the accuracy error of the DUT for each frequency being measured at the same power level, using the following equations:

$$\text{Accuracy error (\%)} \leq \pm \sqrt{(\text{MU}_{INC})^2 + (\text{MU}_{DUT})^2}$$

*MU<sub>INC</sub> and MU<sub>DUT</sub> 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.

---

- 18 Compare the computed accuracy errors to the calibration uncertainty values in the table on the following page. If the verification fails, refer to **"Adjustments"** on page 38.
- 19 Repeat steps 5 to 18 by sweeping through the power levels from –25 dBm to 10 dBm with a frequency of 50 MHz.

## Rise Time and Overshoot Performance Verification

**NOTE**

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

---

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.

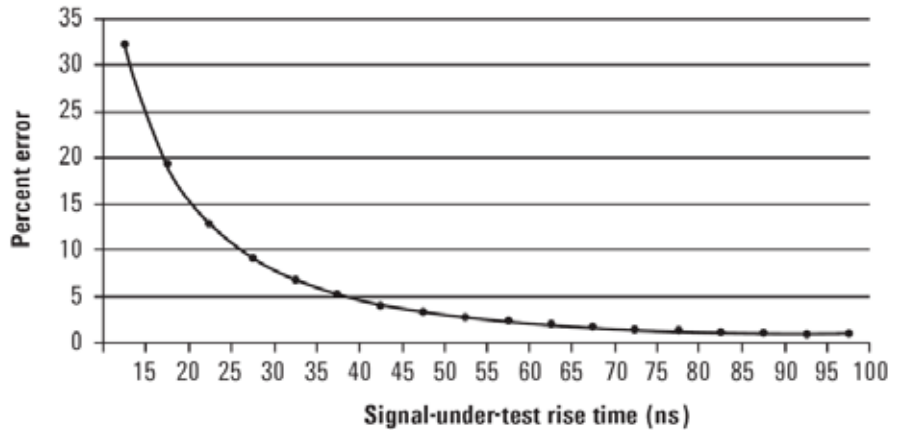
This performance verification requires the following equipment:

- PSG analog signal generator (E8257D)
- Pulse pattern generator (81130A)

System specifications:

- Rise/fall time:  $\leq 13 \text{ nsecs} \pm \% \text{ error}$  (Refer to [Figure](#)) [With the video bandwidth turned off, the measured signal frequency is  $\geq 500 \text{ MHz}$ .]
- Overshoot:  $< 0.5\%$  [With the video bandwidth turned off.]

Measured rise time percentage error versus signal-under-test rise time



**Figure 2-1** Measured rise time percentage error versus signal-under-test rise time

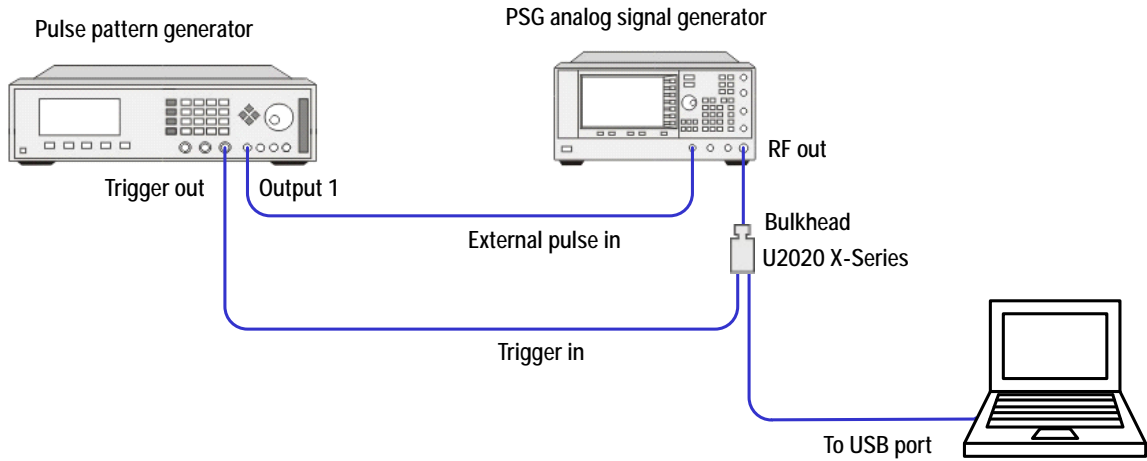
Although the rise time specification is  $\leq 13$  ns, this does not mean that the U2020 X-Series can accurately measure a signal with a known rise time of 13 ns. The measured rise time is the root sum of the squares (RSS) of the signal-under-test (SUT) rise time and the system rise time (13 ns):

$$\text{Measured rise time} = \sqrt{(\text{SUT rise time})^2 + (\text{system rise time})^2}$$

and the % error is:

$$\% \text{ Error} = ((\text{measured rise time} - \text{SUT rise time}) / \text{SUT rise time}) \times 100$$

### Connection diagram



### Test equipment settings

Equipment	Key setting
81130A pulse pattern generator	Pulse period: 12.49 ns
	No. of ON bit: 26
	No. of OFF bit: 24
E8257D PSG analog signal generator	Total bit: 50
	Frequency: 1 GHz
U2020 X-Series	Pulse modulation source: External
	Trace mode, undecimated
	Trace length: <1.2 ms

### 81130A SCPI commands

```
*RST
*CLS
VOLT1 1.5V
VOLT1:OFFS 750mV
DIG:PATT:SEGM1:LENG 26
DIG:PATT:SEGM1:PRES1 1,26
DIG:PATT:SEGM1:PRES2 1,26
DIG:PATT:SEGM2:LENG 24
DIG:PATT:SEGM2:PRES 0,24
DIG:PATT:SEGM2:PRES 0,24
DIG:PATT:LOOP:INF ON
DIG:PATT:LOOP:INF:STAR SEGM1
TRIG:SOUR INT
DIG:PATT ON
DIG:SIGN1:FORM NRZ
DIG:SIGN2:FORM NRZ
OUTP1 ON
PULS:PER 12.49ns
```

### E8257D SCPI commands

```
*RST
*CLS
"POW -110"
"OUTP OFF"
```

### U2020 X-Series SCPI commands

```
SENS:FREQ 50E6/100E6/499E6/500E6/1E9 (Repeat for all frequency test points.)
INIT:CONT OFF
CAL:ALL
TRIG:SOUR EXT
INIT:CONT OFF
TRAC:STAT ON
```

## 2 Performance Verification and Adjustments

```
SENS: TRAC: TIME 200E-6
SENS: TRAC: OFFS: TIME 0
TRAC: UNIT W
TRIG: DEL 0
SENS: AVER OFF
```

### E8257D SCPI commands

```
"FREQ 1E9"
"POW 0"
"OUTP: MOD ON"
"PULM: SOUR EXT"
"PULM: STAT OFF"
"OUTP ON"
"PULM: STAT ON"
```

### U2020 X-Series SCPI commands

```
SENS: BAND: VID LOW/MED/HIGH/OFF (Repeat for all video bandwidth settings.)
INIT
FETC?
```

TRAC? HRES (*Transfer the data in array to the following MATLAB® code.*)

The trace capture is processed using Keysight VEE and MATLAB.

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

```

:
data=A;
eff_data_hi=zeros(1250,1);
    n=0;
    for j=1:50
        for k=1:25
            n=n+1;
            m=j+(k-1)*50;
            eff_data_hi(n)=eff_data_hi(n)+data(m);
        end
    end
X=eff_data_hi

```

The pulse top and pulse bottom are determined by histogramming the captured trace.

The rise time is measured as the time from 10% above the pulse bottom and 90% above the pulse bottom. Overshoot is measured as the maximum of the trace capture relative to the pulse top.

### Procedure

- 1 Ensure that the DUT has been allowed to warm up for approximately an hour before attempting to measure rise time.
- 2 Send the commands as provided in [page 29](#) to [page 30](#).
- 3 Process the trace capture using the above MATLAB code.
- 4 Locate the pulse top and pulse bottom. Then, calculate the rise time from 10% to 90%. Locate the trace maximum and calculate overshoot relative to the pulse top.
- 5 Compare the calculated values to the system specifications. If the verification fails, refer to ["Adjustments"](#) on page 38.

## Zero Set Performance Verification

The zero set verification is required to verify that a minimal amount of residual offset error is present after zeroing has been performed. The offset error is caused by contamination from several sources including the noise of the DUT itself. Zero set is the difference between the power levels indicated by the DUT, after executing zeroing and the true zero power. Ideally, this difference should be zero.

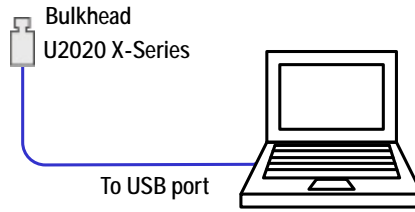
This performance verification requires an ESG vector signal generator (E4438C or PSG E8257D).

System specifications:

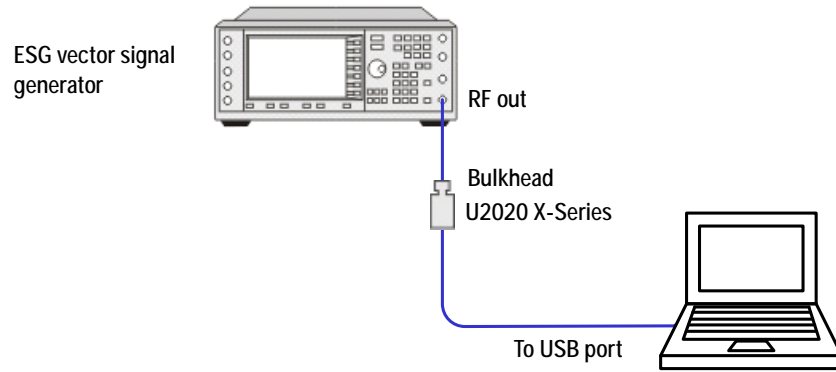
- No RF present during zeroing:  $<200$  nW
- RF present during zeroing ( $\geq 500$  MHz):  $<200$  nW

### Connection diagram

No RF present during zeroing



RF present during zeroing



### Test equipment settings

Equipment	Key setting
U2020 X-Series	Free-run mode
	Auto-averaging enabled

## Procedure

### For zero set with no RF present during zeroing:

- 1 Ensure that the DUT has been allowed to warm up for approximately an hour before attempting to measure zero set.
- 2 Set the channel frequency of the DUT by sending "FREQ 50MHz/100MHz/500MHz/1GHz/etc".
- 3 Enable auto-averaging for the DUT by sending "AVER: COUN: AUTO ON".
- 4 Change the power measurement unit of the DUT to watt by sending "UNIT: POW W".
- 5 Set the DUT to the single trigger mode by sending "INIT: CONT OFF".
- 6 Perform zeroing for the DUT by sending "CAL: ZERO: AUTO ONCE".
- 7 Read the noise level of the DUT by sending "READ?" and record the reading.
- 8 Repeat step 7 for 10 times and then calculate the mean value of the readings.
- 9 Compare the calculated mean value to the system specifications. If the verification fails, refer to "Adjustments" on page 38.

### For zero set with RF present ( $\geq 500$ MHz) during zeroing:

- 1 Ensure that the DUT has been allowed to warm up for approximately an hour before attempting to measure zero set.
- 2 Connect the DUT to the signal generator.
- 3 Set the channel frequency of the DUT by sending "FREQ 50MHz/100MHz/500MHz/1GHz/etc".
- 4 Enable auto-averaging for the DUT by sending "AVER: COUN: AUTO ON".
- 5 Change the power measurement unit of the DUT to watt by sending "UNIT: POW W".
- 6 Set the DUT to the single trigger mode by sending "INIT: CONT OFF".
- 7 Set the signal generator to generate a continuous wave (CW) signal with a frequency of  $\geq 500$  MHz and an amplitude of +20 dBm.
- 8 Perform zeroing for the DUT by sending "CAL: ZERO: AUTO ONCE".
- 9 Change the signal amplitude of the signal generator to  $-110$  dBm and then turn off the signal generator output.

- 10 Read the noise level of the DUT by sending "READ?" and record the reading.
- 11 Repeat steps 7 to 10 for 10 times and then calculate the mean value of the readings.
- 12 Compare the calculated mean value to the system specifications. If the verification fails, refer to "Adjustments" on page 38.

## 10 MHz Timebase Accuracy Performance Verification

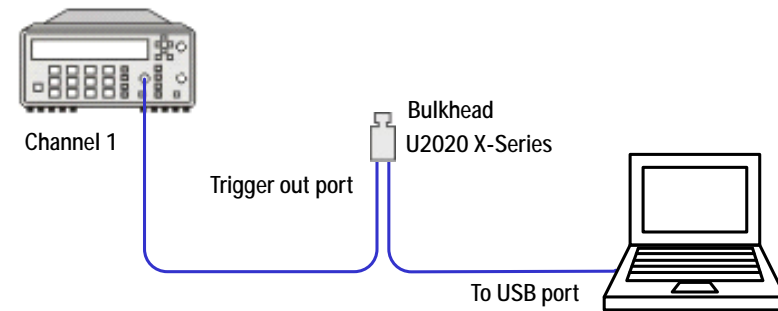
The 10 MHz timebase accuracy verification is required to verify the accuracy of time-based measurements made with the U2020 X-Series.

This performance verification requires a frequency counter (53132A).

System specifications: Timebase accuracy =  $\pm 25$  ppm

### Connection diagram

Frequency counter



### Test equipment settings

Equipment	Key setting
U2020 X-Series	Auto-zeroing disabled
	Auto-calibration disabled
53132A frequency counter	50 W input impedance

### U2020 X-Series SCPI commands

SERV: BI ST: TBAS: STAT ON

CAL: ZERO: AUTO OFF

CAL: AUTO OFF

### 53132A SCPI commands

\*RST

\*CLS

INP1:IMP 50

INIT

FETC?

### Procedure

- 1 Ensure that the DUT has been allowed to warm up for approximately an hour before attempting to measure timebase accuracy.
- 2 Send the commands as provided above. The frequency from the 53132A must be within  $10 \text{ MHz} \pm 250 \text{ Hz}$ .
- 3 If the verification fails, refer to ["Adjustments"](#) on page 38.

## Adjustments

Adjustments are usually required on a yearly basis. They are normally performed only after a performance verification has indicated that some parameters are out of specification. Performance verification must be completed after any repairs that may have altered the characteristics of the U2020 X-Series.

The U2020 X-Series is required to be returned to Keysight for adjustments. To arrange this, contact the Keysight Service Center. Refer to [Chapter 5, "Contacting Keysight"](#) for more information.

# 3 Theory of Operation

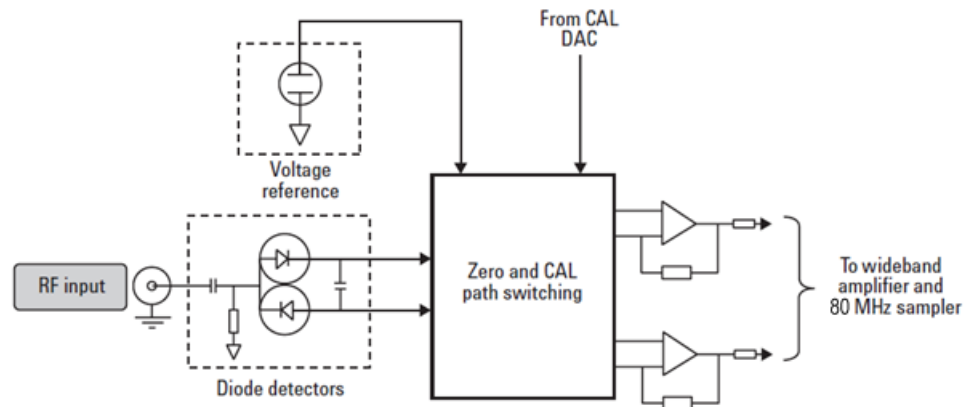
Theory of Operation 40

This chapter describes the operation and functions of the U2020 X-Series assembly.

## Theory of Operation

The U2020 X-Series internal zeroing and calibration process is used to combine the power sensor and power meter to make accurate power measurements.

Figure 3-1 below shows the internal zeroing and calibration process, and explains how three objectives in this process are achieved.



**Figure 3-1** Internal zeroing and calibration block diagram

- To account for the environment that the system is working in – the temperature and the presence of electromagnetic signals.

This is achieved during the internal zeroing process, where the diode detectors are isolated from the active amplifier circuitry. The process allows the zero measurement to be made, regardless of the RF input signal, thus allowing the U2020 X-Series to remain connected to the DUT. The isolation is achieved by a network of transistor switches in the zero and calibration path switching.

- To account for the combination of the sensor and meter, as these may never have been used together as a system.

This is achieved during the internal calibration, where the amplifier circuitry is isolated from the diode detectors by a network of transistor switches and the U2020 X-Series voltage reference is routed to the amplifier circuitry.

- To verify traceability to National Standards, hence, verifying your measurements are going to perform to specification.

To achieve traceable and accurate RF power measurements, each U2020 X-Series is individually characterized during its production procedure.

To achieve optimal accuracy, a 3-dimensional correction is generated across power, frequency, and temperature. This uses advanced modeling techniques, and is superior in accuracy and speed of evaluation to the overlaying of linearity, temperature corrections, and calibration factors.

As a confidence check of the connector integrity, the U2020 X-Series can be connected to any known good signal source (for example, the 50 MHz, 0 dBm reference) and a comparison made.

The calibration factors are stored in the EEPROM during the manufacturing process. All the compensation data is downloaded to the U2020 X-Series at power on or when the U2020 X-Series is connected.

**NOTE**

Between 50 MHz and 500 MHz, the U2020 X-Series is sensitive to the RF signal propagating through onto the detector amplifier circuitry and resulting in distorted power measurements. To reduce this effect, additional filtering is switched into the measurement path, which results in a 15 MHz video bandwidth limitation for signals below 500 MHz.

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# 4 Repair Guide

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This chapter contains information on troubleshooting, repair, and replaceable parts of the U2020 X-Series. This chapter also explains how to assemble and disassemble the U2020 X-Series.

## Troubleshooting

The U2020 X-Series represents a combination of a power meter and 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 U2020 X-Series. The LED will only blink red if the U2020 X-Series fails the self-test. The `SYSTem:ERRor` command is used to read the exact error messages of the errors that occur on the U2020 X-Series. You should send the U2020 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 U2020 X-Series inoperative. Do not, under any circumstances, open up the U2020 X-Series unless you and the U2020 X-Series are in a static-free environment.

---

## Repair

There are no serviceable parts inside the U2020 X-Series. If the U2020 X-Series is defective, send it back to the nearest Keysight Service Center for repair. The entire "module" of the defective U2020 X-Series will be replaced with an appropriate replacement module listed in [Table 4-1](#).

## Replaceable Parts

**NOTE**

Replaceable parts are only available for the use of Keysight Service Center personnel and are not available for trade sales.

**Table 4-1** Replaceable parts list for the U2020 X-Series

Reference designation	Part number	Quantity	Description
A1			
U2021XA	U2021-60002	1	U2021XA replacement sensor module
U2022XA	U2022-60002	1	U2022XA replacement sensor module
Chassis part v			
MP1	U2021-44401	1	Top plastic housing/shield
MP2	U2021-64402	1	Bottom plastic housing/shield
MP3	U2021-84301	1	Top label (U2021XA)
MP3	U2022-84301	1	Top label (U2022XA)
MP4	U2021-84302	2	Side label
MP5	5190-0060	1	Bottom label
MP6	0515-5012	4	Screw-socket 90-deg-flat-HD torx M2.5X0.45 6 mm-LG SST A2

## Disassembly/Reassembly Procedure

**CAUTION**

Disassemble the U2020 X-Series only in a static-free workstation. Electrostatic discharge renders the U2020 X-Series inoperative.

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### Disassembly procedure

Use the following steps to disassemble the U2020 X-Series.

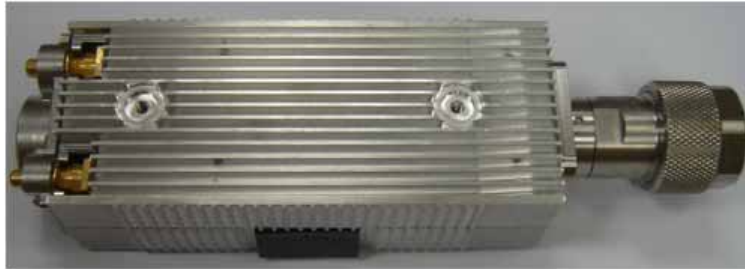
- 1 Remove the top label and bottom label as shown below.



- 2 Loosen two 0515-5012 screws on both the top and bottom housing by using the T8 torque bit (4 in. lbs.). Then, remove the housing.



- 3 Replace the defective module with a new module.



### Reassembly procedure

The reassembly procedure is simply the reversal of the disassembly procedure. Lock the 0515-5012 screws using the T8 torque bit at 4 in. lbs.

# 5 Contacting Keysight

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This chapter explains the appropriate actions to take if you have a problem with your U2020 X-Series.

## Introduction

This section provides the information on what to do if you encounter problems with your U2020 X-Series.

If you wish to contact Keysight to enquire about the U2020 X-Series, from service problems to ordering information, refer to [“Sales and Technical Support”](#) on page 7.

If you wish to return the U2020 X-Series to Keysight, refer to [“Returning the U2020 X-Series for Service”](#) on page 52.

## 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 U2020 X-Series.

Whenever you contact Keysight about your U2020 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 U2020 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 date of the last major design change.

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

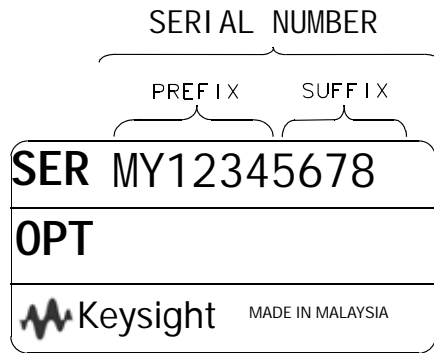


Figure 5-1 Serial number

## Recommended calibration interval

Keysight recommends a one-year calibration cycle for the U2020 X-Series.

## Returning the U2020 X-Series for Service

Use the information in this section if you need to return your U2020 X-Series to Keysight.

### Packaging the U2020 X-Series for shipment

Use the following procedure to package the U2020 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 U2020 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.

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- 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 U2020 X-Series and allow at least 3 to 4 inches on all sides of the U2020 X-Series for packing material.
- Surround the U2020 X-Series with at least 3 to 4 inches of packing material, or enough to prevent the U2020 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 U2020 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.



This information is subject to change without notice. Always refer to the Keysight website for the latest revision.

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