Keysight U7227A/C/F USB Pre-Amplifier

Operating and Service Manual

KEYSIGHT TECHNOLOGIES

Notices

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This product conforms with the protection requirements of EMC Directive 2004/108/EC for Electromagnetic Compatibility.

This product complies to the EMC Directive by assessment according to the IEC/EN61326-1 EMC standard.

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A copy of the Manufacturer's European Declaration of Conformity for this USB Switch can be obtained by contacting your local Keysight Technologies sales representative, or copies can be downloaded from the Keysight Technologies Web site at:

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Contacting Keysight

For more information, please contact your nearest Keysight office.

Americas	
Canada	(877) 894-4414
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Asia Pacific	
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China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
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Netherlands	31 (0) 20 547 2111
Spain	34 (91) 631 3300
Sweden	0200-88 22 55
Switzerland(French)	41 (21) 8113811 (Opt 2)
Switzerland(German)	0800 80 53 53 (Opt 1)
United Kingdom	44 (0) 118 9276201
Other European Countries:	www.keysight.com/find/contactus

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1
Introduction

This chapter provides an overview of the Keysight U7227A/C/F USB Pre-Amplifier.

Product Overview

The Keysight U7227A/C/F USB Pre-Amplifier which operates up to 50 GHz is a general purpose Low Noise Amplifier that offers reliable gain and low noise figure. With the ability to be powered directly using USB connectivity, it eliminates the need for a separate power supply which presents an invaluable alternative for you to optimize the efficiency of your test system. Compact, with a rugged and portable design, this USB Pre-Amplifier is suitable for benchtop measurements or remote front-end field applications.

The U7227A/C/F pre-amplifier provides a simple means to achieve accurate and repeatable noise figure measurements on low-noise low-gain devices, using Keysight N9000/10/20/30A X-series analyzers. The total solution will provide performance and ease-of-use exceeding competitive signal analyzer based solutions.

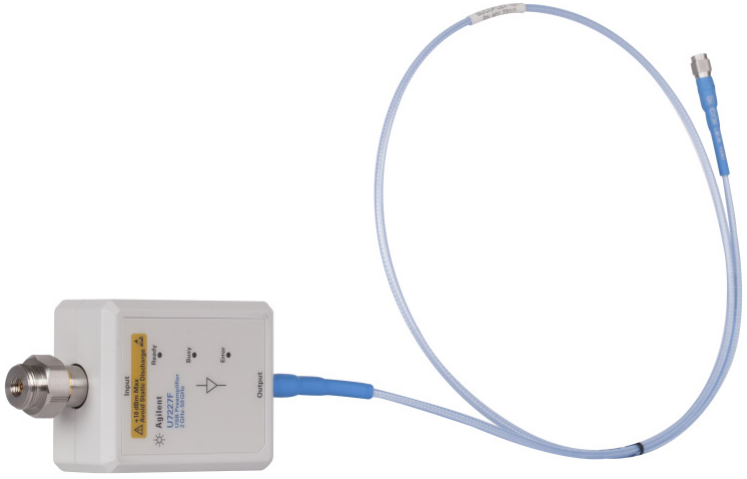

Figure 1-1 U7227A/C/F USB Pre-Amplifier

Key Features of the Keysight U7227A/C/F USB Pre-Amplifier

- Automatic gain correction value with temperature compensation and transfer of calibration data (noise figure and S-parameters) through USB plug-and-play features for improved noise figure measurements with Keysight N9000/10/20/30A X-series analyzers
- Excellent noise figure and optimized gain with the X-series signal analyzers improve measurement accuracy and minimize uncertainty
- Provides ultra-broadband operating frequency from 10 MHz up to 50 GHz for various application needs
- Rugged and portable design for benchtop measurements or remote front-end field applications

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2
Installation

This chapter provides you important information on how to check and prepare your instrument for operation.

Initial Inspection

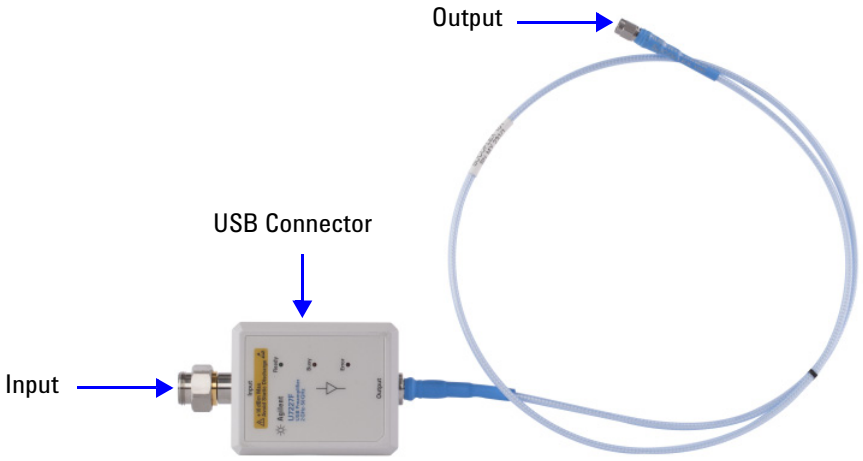
1. Unpack and inspect the shipping container and its contents throughly to ensure that nothing was damaged during shipment. If the shipping container or cushioning material is damaged, the contents should be checked both mechanically and electrically.
   - Check for mechanical damage such as scratches or dents
   - Procedures for checking electrical performance are given under "Operator's Check" on page 36.
2. If the contents are damaged or defective, contact your nearest Keysight Technologies Service and Support Office. Refer to the Service and Support information in the front matter of this manual. Keysight Technologies will arrange for repair or replacement of the damaged or defective equipment. Keep the shipping materials for the carrier's inspection.
3. If you are returning the instrument under warranty or for service, repackaging the instrument requires original shipping containers and material or their equivalents. Keysight Technologies can provide packaging materials identical to the original materials. Refer to Service and Support information in the front matter of this manual for the Keysight Technologies nearest to you. Attach a tag indicating the type of service required, return address, model number, and serial number. Mark the container ***FRAGILE*** to insure careful handling. In any correspondence, refer to the instrument by model number and serial number.

USB Pre-Amplifiers Covered by this Guide

- U7227A: 10 MHz to 4 GHz USB Pre-Amplifier
- U7227C: 100 MHz to 26.5 GHz USB Pre-Amplifier
- U7227F: 2 GHz to 50 GHz USB Pre-Amplifier

Serial numbers

A serial number label is attached to your pre-amplifier that shows the serial number and country of manufacture.



Indication light description

Ready	When the USB Pre-Amplifier is connected with the X-series analyzer
Busy	When communication between the USB Pre-Amplifier and the X-series analyzer is in progress
Error	• When there is a connection error or a data download error. The X-series analyzer is unable to communicate with the USB Pre-Amplifier • When there is an input power overload at the X-series analyzer.

Signal Analyzer Retrofit Requirements

N9010A, N9020A, or N9030A signal analyzer

There is no required Option in the signal analyzer in order to connect the U7227A/C/F to the signal analyzer.

NOTE The N9010A, N9020A, or N9030A instrument software version must be A.14.00 or higher for use with the U7227A/C/F.

Verify the U7227A/C/F Shipment Contents

The following table lists the items that are shipped with the U7227A/C/F.

Table 2-1 U7227A/C Contents

QUANTITY	DESCRIPTION	PART NUMBER
1	U7227A/C/F Operating and Service Manual	U7227-90001
1	Certificate of Calibration	5962-0476
1	3.5 mm (f) to Type-N (m) adapter	1250-1744

Table 2-2 U7227F Contents

QUANTITY	DESCRIPTION	PART NUMBER
1	U7227A/C/F Operating and Service Manual	U7227-90001
1	Certificate of Calibration	5962-0476
1	2.4 mm (f) to 2.4 mm (f) adapter	85056-60006

Service and Recalibration

If your U7227A/C/F requires service or repair, contact the nearest Keysight office for information on where to send it. Refer to "Contacting Keysight" in the front matter of this manual. The performance of the U7227A/C/F can only be verified by specially-manufactured equipment and calibration standard from Keysight. The recommended interval for recalibration is 12 months.

Related Documentation

This Operating and Service Manual is shipped with the product. They are also available at http://www.keysight.com/find/amplifiers.

Operating and Safety Precautions

Observe the following guidelines before connecting or operating the U7227A/C/F USB Pre-Amplifier.

ESD Damage

Protection against electrostatic discharge (ESD) is important while handling and operating the U7227A/C/F.

Static electricity can build up on your body and can easily damage sensitive components when discharged.

Static discharges too small to be felt can cause permanent damage to the unit.

To prevent damage from ESD:

- ***Use*** a grounded antistatic mat in front of your test equipment and wear a grounded wrist strap attached to it when handling or operating the U7227A/C/F.
- ***Wear*** a heel strap when working in an area with a conductive floor.
- ***Ground*** yourself before you clean, inspect, or make a connection to the U7227A/C/F. You can, for example, grasp the grounded outer shell of the analyzer test port or cable connector briefly.
- ***Avoid*** touching the exposed connector pins.

Connector Care

Because connectors can become defective due to wear during normal use, all connectors should be inspected and maintained to maximize their service life.

- Inspect the mating surface each time a connection is made. Metal particles from connector threads often find their way onto the mating surface when a connection is made or disconnected.
- Clean dirt and contamination from the connector mating surface and threads. This simple step can extend the service life of the connector and improve the quality of your calibration and measurements.
- Gage connectors periodically. This not only provides assurance of proper mechanical tolerances and thus connector performance, but can also indicate situations where the potential for damage to another connector may exist.

CAUTION

The U7227A/C/F can be damaged if excessive torque is applied to the connectors.

The recommended torque value is 8 lb-in for 2.4 mm and 3.5 mm type connectors.

For the input port, the recommended torque wrench is 20 mm with part number 8710-1764.

For the output port, the recommended torque wrench is 5/16" with part number 8710-1765.

Cable Handling

Because excessive bending of the cable may damage the cable over time and will affect the performance of the pre-amplifier, the minimum bend radius of the cable is 100 mm. Excessive bending could result in internal damage caused by compression. This preventive measure during handling could significantly extend the life of the cable.

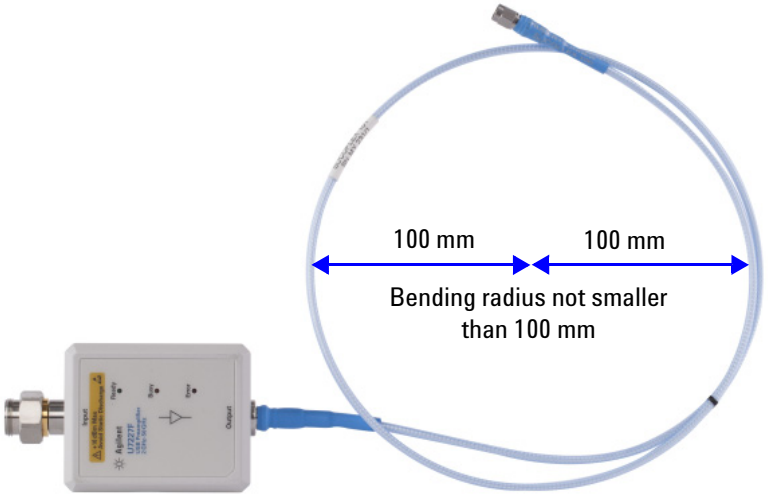


Figure 2-1 Cable Handling

3
Specification

This chapter provides the specifications of the U7227A/C/F USB Pre-Amplifier.

General Specifications

Specifications

Specifications refer to the performance standards or limits against which the U7227A/C/F is tested.

Typical characteristics are included for additional information only and they are not specifications. These are denoted as "typical", "nominal", or "approximate", and are printed in italic.

Table 3-1 U7227A/C/F Specifications[1]

Specification	U7227A	U7227C	U7227F
Frequency	10 MHz to 4 GHz	100 MHz to 26.5 GHz	2 to 50 GHz
Gain (dB)[2]	>16 (10 to 100 MHz) >0.5F + 17 (100 MHz to 4 GHz)	>0.26F + 16.1 (100 MHz to 26.5 GHz)	>0.23F + 16.5 (2 to 50 GHz)
Input Return Loss (Input SWR)	>5 dB (3.57) (10 to 100 MHz) >13.5 dB (1.54) (100 MHz to 2 GHz) >11.5 dB (1.73) (2 to 3 GHz) >10 dB (1.93) (3 to 4 GHz)	>15 dB (1.43) (100 MHz to 4 GHz) >8 dB (2.32) (4 to 26.5 GHz)	>8 dB (2.32) (2 to 40 GHz) >6 dB (3.00) (40 to 44 GHz) >5 dB (3.57) (44 to 50 GHz)
Output Return Loss (Output SWR)	>18 dB (1.29) (10 MHz to 4 GHz)	>18 dB (1.29) (100 MHz to 4 GHz) >11 dB (1.78) (4 to 26.5 GHz)	>18 dB (1.29) (2 to 4 GHz) >11 dB (1.78) (4 to 40 GHz) >8 dB (2.32) (40 to 50 GHz)

Table 3-1 U7227A/C/F Specifications[1] (continued)

Specification	U7227A	U7227C	U7227F
Noise Figure	<5.5 dB (10 to 100 MHz) <5 dB (10 MHz to 4 GHz)	<6 dB (100 MHz to 4 GHz) <5 dB (4 to 6 GHz) <4 dB (6 to 18 GHz) <5 dB (18 to 26.5 GHz)	<10 dB (2 to 4 GHz) <8 dB (4 to 40 GHz) <9 dB (40 to 44 GHz) <10 dB (44 to 50 GHz)

[1] Specifications are tested and measured on an operating temperature of 23 °C.

[2] "F" signifies frequency in GHz.

Table 3-2 U7227A/C/F General Specifications

Specification	U7227A	U7227C	U7227F
Bias Voltage and Current (Nominal)	USB 5 Vdc at 360 mA	USB 5 Vdc at 400 mA	USB 5 Vdc at 460 mA
Survival Input Power	+17 dBm	+17 dBm	+10 dBm
Power Dissipation (Typical)	1.8 W	2 W	2.3 W
RF Connector	3.5 mm (male)	3.5 mm (male)	2.4 mm (male)
Pin Depth	0 to –0.05 mm (0 to –0.002 in)	0 to –0.05 mm (0 to –0.002 in)	0 to –0.05 mm (0 to –0.002 in)
Temperature Co-efficient (Typical)	–0.009 dB/C	–0.03 dB/C	–0.18 dB/C
Plug-and-Play USB Connection	Yes	Yes	Yes
Optimized Gain Slope for Better Spectrum Analysis	Yes	Yes	Yes
Automatic Gain Compensation	Yes	Yes	Yes
Automatic Temperature Compensation	Yes	Yes	Yes

Graphical Performance Data

Table 3-3 U7227A Pre-Amplifier Graphical Performance Data

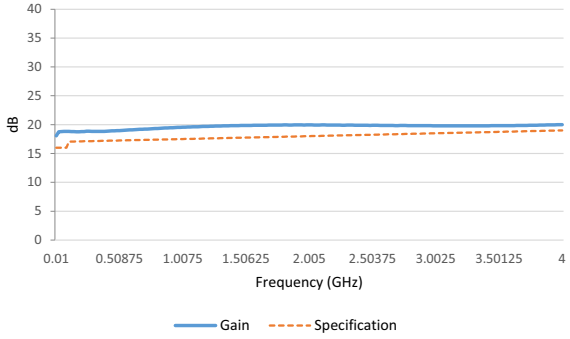


Figure 3-1 Keysight U7227A Gain vs Frequency (Typical)

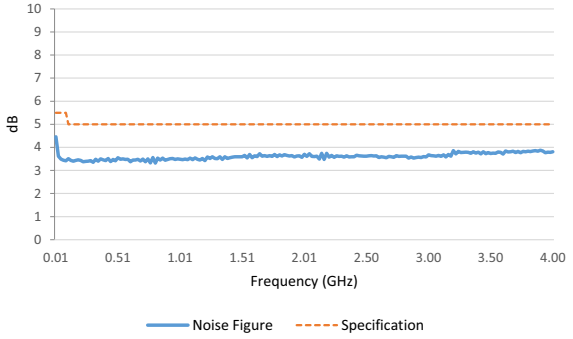


Figure 3-2 Keysight U7227A Noise Figure vs Frequency (Typical)

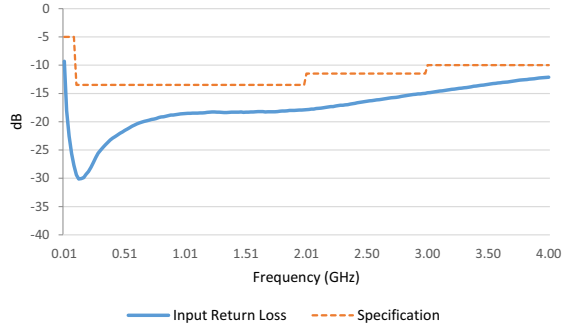


Figure 3-3 Keysight U7227A Input Return Loss vs Frequency (Typical)

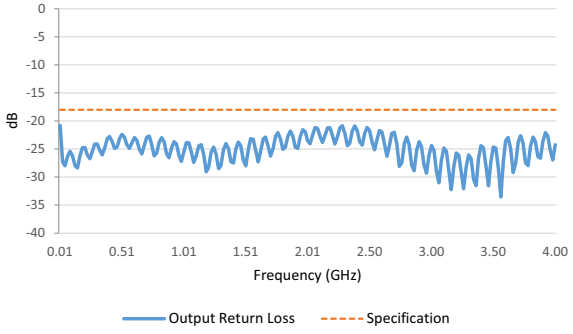


Figure 3-4 Keysight U7227A Output Return Loss vs Frequency (Typical)

Table 3-3 U7227A Pre-Amplifier Graphical Performance Data (continued)

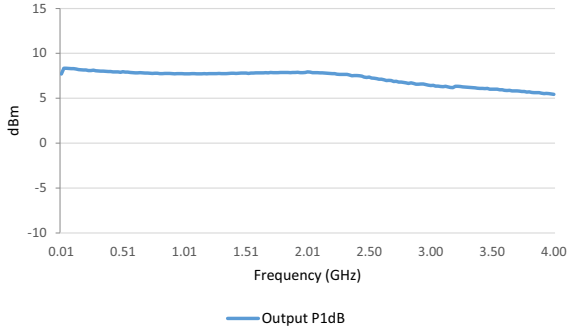


Figure 3-5 Keysight U7227A Output P1dB vs Frequency (Typical)

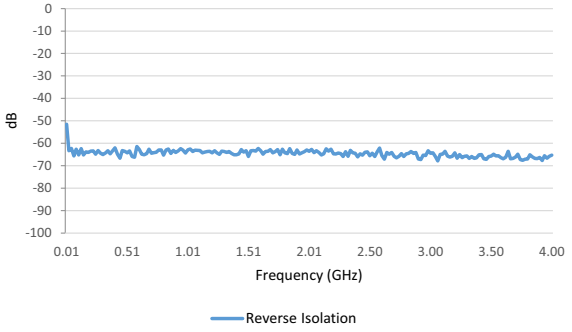


Figure 3-6 Keysight U7227A Reverse Isolation vs Frequency (Typical)

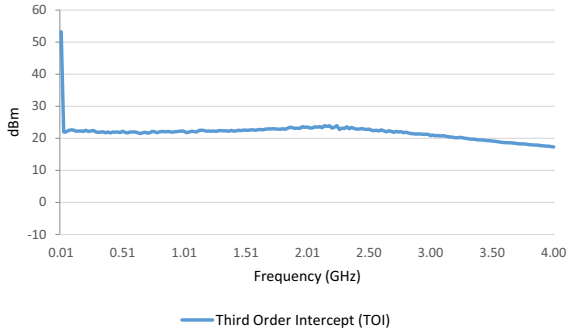


Figure 3-7 Keysight U7227A Third Order Intercept (TOI) vs Frequency (Typical)

Table 3-4 U7227C Pre-Amplifier Graphical Performance Data

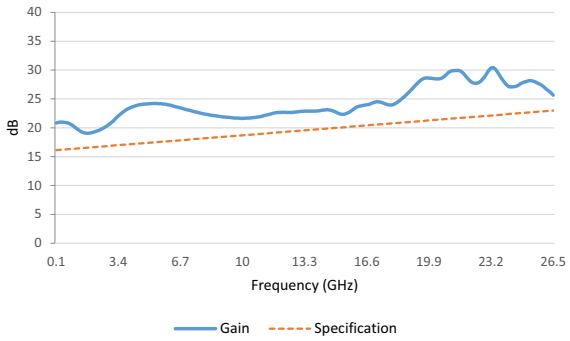


Figure 3-8 Keysight U7227C Gain vs Frequency (Typical)

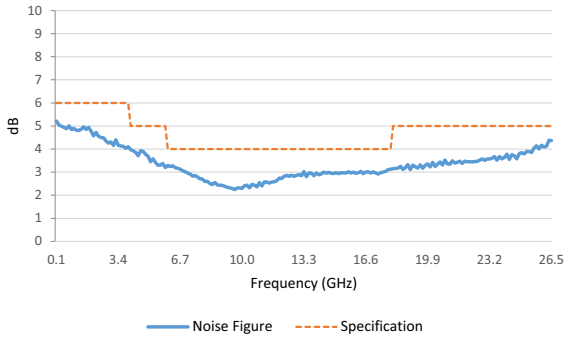


Figure 3-9 Keysight U7227C Noise Figure vs Frequency (Typical)

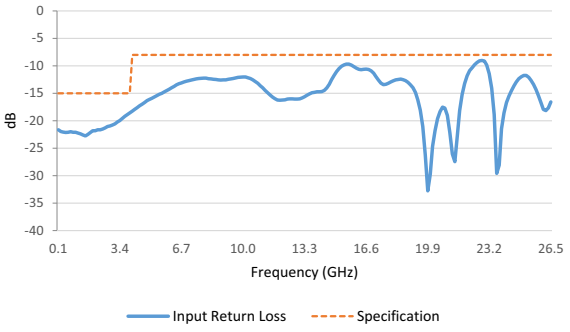


Figure 3-10 Keysight U7227C Input Return Loss vs Frequency (Typical)

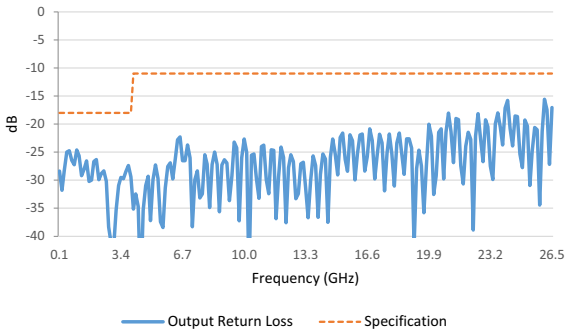


Figure 3-11 Keysight U7227C Output Return Loss vs Frequency (Typical)

Table 3-4 U7227C Pre-Amplifier Graphical Performance Data (continued)

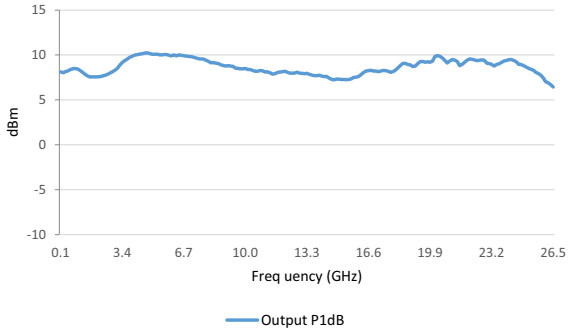


Figure 3-12 Keysight U7227C Output P1dB vs Frequency (Typical)

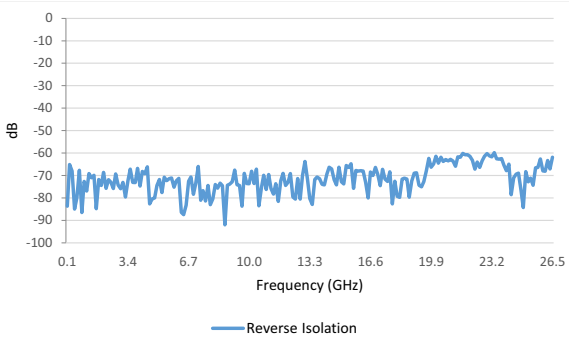


Figure 3-13 Keysight U7227C Reverse Isolation vs Frequency (Typical)

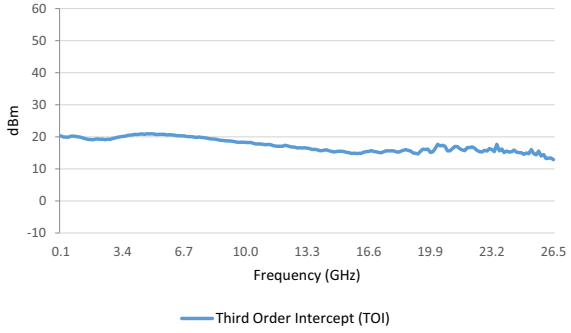


Figure 3-14 Keysight U7227C Third Order Intercept (TOI) vs Frequency (Typical)

Table 3-5 U7227F Pre-Amplifier Graphical Performance Data

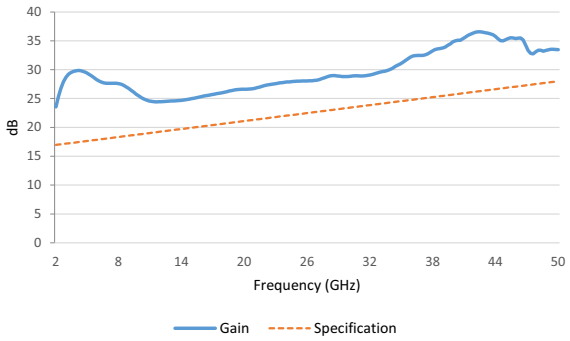


Figure 3-15 Keysight U7227F Gain vs Frequency (Typical)

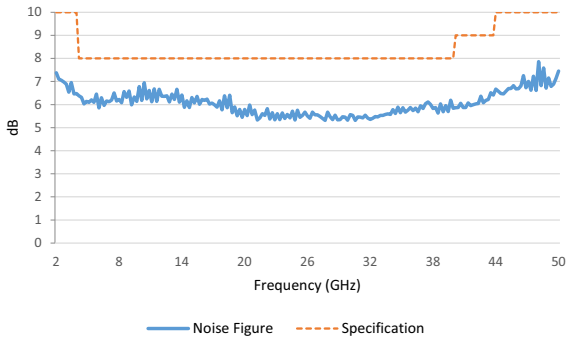


Figure 3-16 Keysight U7227F Noise Figure vs Frequency (Typical)

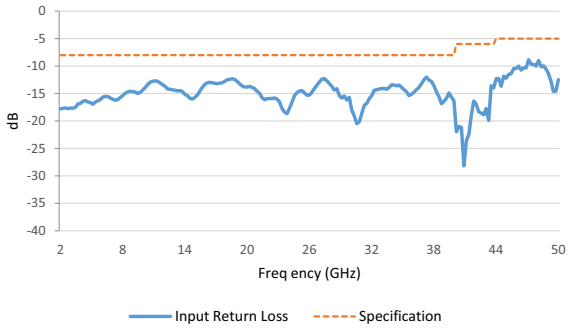


Figure 3-17 Keysight U7227F Input Return Loss vs Frequency (Typical)

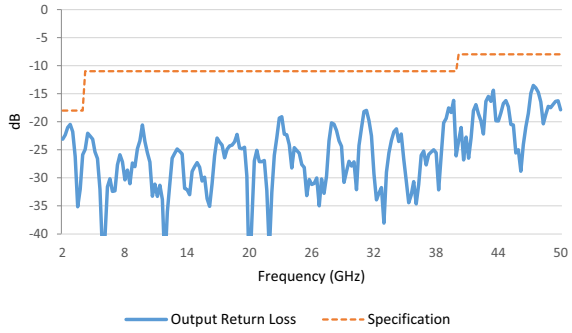


Figure 3-18 Keysight U7227F Output Return Loss vs Frequency (Typical)

Table 3-5 U7227F Pre-Amplifier Graphical Performance Data (continued)

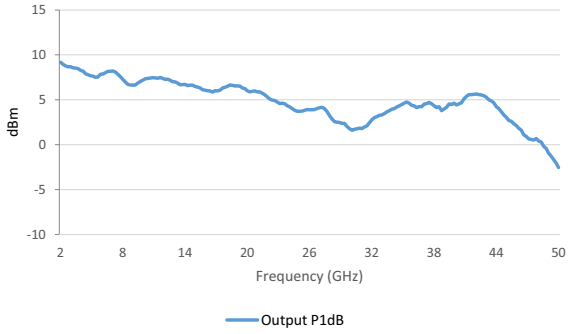


Figure 3-19 Keysight U7227F Output P1dB vs Frequency (Typical)

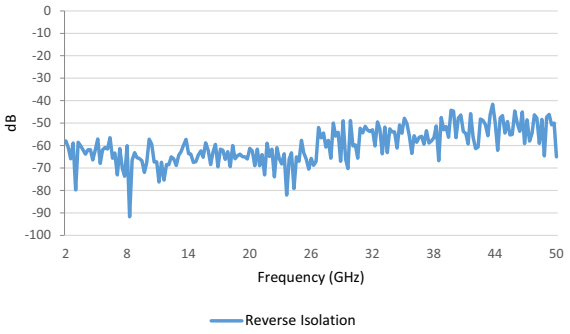


Figure 3-20 Keysight U7227F Reverse Isolation vs Frequency (Typical)

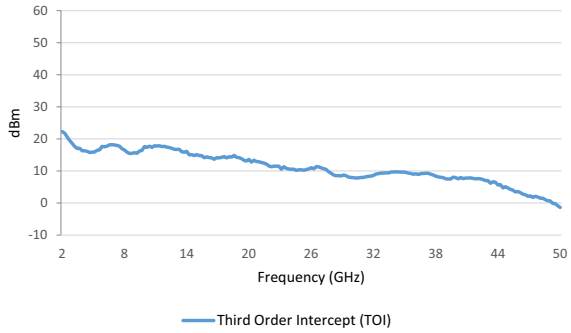


Figure 3-21 Keysight U7227F Third Order Intercept (TOI) vs Frequency (Typical)

Physical Specifications

Physical specification	
Net weight	0.38 kg (0.84 lbs)
Shipping weight	1.35 kg
Shipping dimensions:	
Length	430 mm (16.93 in)
Width	260 mm (10.24 in)
Height	170 mm (6.69 in)

Mechanical Dimensions

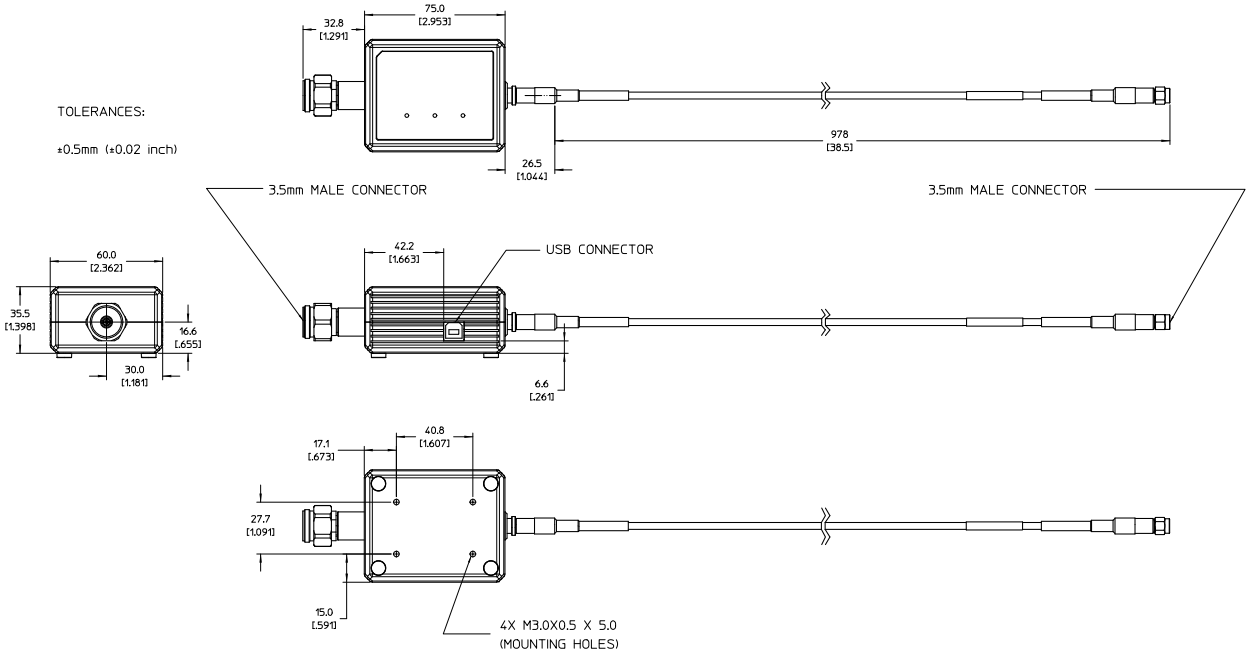


Figure 3-22 Mechanical Dimensions of the U7227A/C

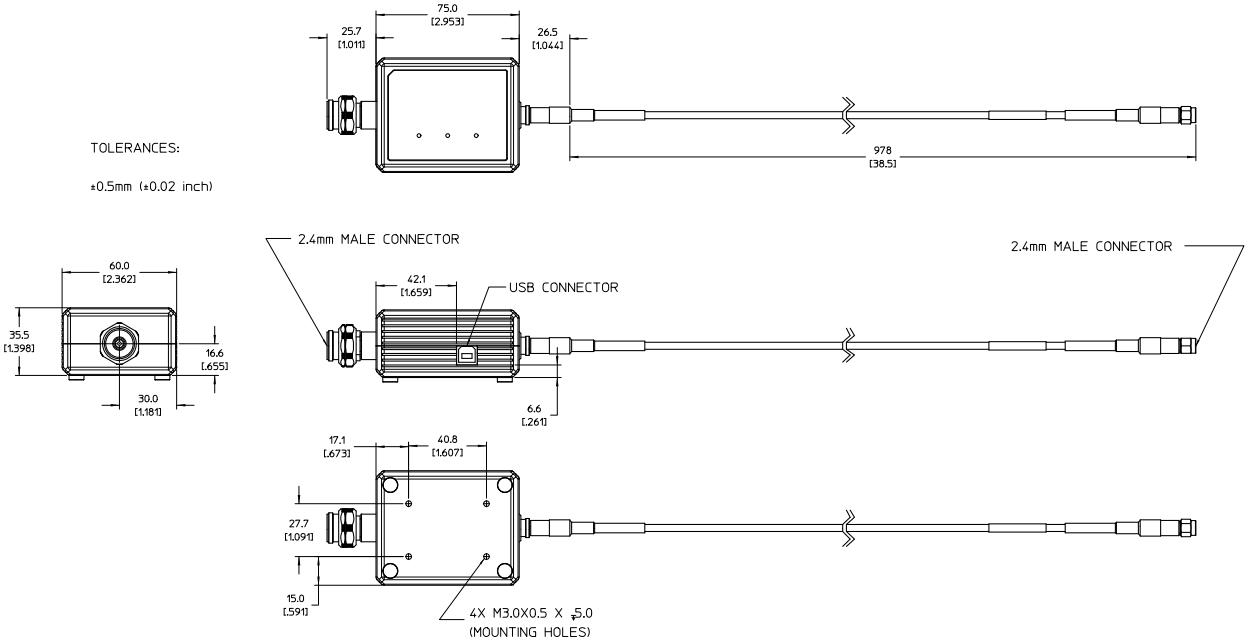


Figure 3-23 Mechanical Dimensions of the U7227F

Environmental Specifications

The U7227A/C/F is designed to fully comply with Keysight Technologies's product operating environment specifications. The following table shows the summarized environmental specifications for this product.

Table 3-6 U7227A/C/F Environmental Specifications

Temperature	
• Operating	0 to +55 °C
• Storage	–40 °C to +70 °C
Vibration	
• Operating	Random: 5 to 500 Hz, 0.21 grms
• Survival	Random: 5 to 500 Hz, 2.09 grms
	Swept Sine: 5 to 500 Hz, 0.5 grms
Shock	
• End-use handling	1.6 m/s
• Transportation	50 g, 8 m/s
Humidity	
• Operating	50% to 95% Relative Humidity (RH) at 40 °C
• Storage	90% RH at 65 °C
ESD immunity	
• Direct discharge	6 kV per IEC 61000-4-2
• Air discharge	15 kV per IEC 61000-4-2

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4
Operating Guides

This chapter provides simple quick-check instructions to verify the U7227A/C/F USB Pre-Amplifier functionality prior to usage.

Operating Instructions

Operator's Check

The operator's check is supplied to allow the operator to make a quick check of the U7227A/C/F prior to usage or if a failure is suspected.

CAUTION ESD exceeding the level specified in **Table 3-6** or the RF power applied is greater than the maximum specified as in **Table 3-2** may cause permanent damage to the device.

Operator's Check for the S-Parameter Test

Any network analyzer with a USB supply can be used for performance test verification. The equipment setup is illustrated in Figure 4-1.

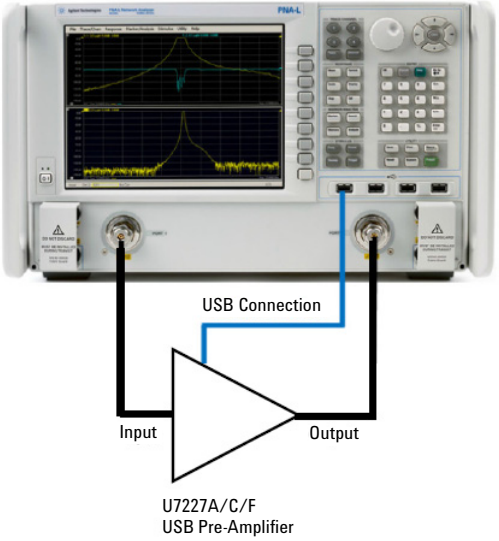

Figure 4-1 Quick-Check Configuration for the S-Parameter Test

Quick-Check Procedure

1 Set the following parameters on the network analyzer to perform 2-port measurements:

Table 4-1 S-Parameter Measurement Parameters

	U7227A	U7227C	U7227F
Start Frequency	10 MHz	100 MHz	2 GHz
Stop Frequency	4 GHz	26.5 GHz	50 GHz
Points	201	201	201
IFBW	100 Hz	100 Hz	100 Hz
Input Power	–30 dBm	–40 dBm	–50 dBm

Note: The same frequency settings (start frequency and stop frequency) and number of points apply for all parameters.

2 Calibrate the network analyzer using the appropriate calibration procedure.

3 Connect the input of the pre-amplifier to port 1 of the network analyzer and the output to port 2.

4 Connect the pre-amplifier to the USB supply of the network analyzer.

5 Obtain the measurement result for S11 (input return loss), S22 (output return loss), and S21 (gain).

6 Compare the measurement results with the specifications in Table 3-1 on page 22.

Operator's Check for the Noise Figure Measurement

1 Set the following parameters on the network analyzer to perform 2-port measurements:

Table 4-2 Noise Figure Measurement Parameters

	U7227A	U7227C	U7227F
Start Frequency	10 MHz	100 MHz	2 GHz
Stop Frequency	4 GHz	26.5 GHz	50 GHz
Points	201	201	201
Input Power	–30 dBm	–40 dBm	–50 dBm
Bandwidth	2 MHz	2 MHz	2 MHz
Gain	Medium	Medium	Low

2 Calibrate the network analyzer for noise figure measurements.

3 Connect the input of the pre-amplifier to port 1 of the network analyzer and the output to port 2.

4 Connect the pre-amplifier to the USB supply of the network analyzer.

5 Obtain the measurement result for noise figure.

6 Compare the measurement results with the specifications in Table 3-1 on page 22.

Service and Maintenance

Service

The U7227A/C/F does not have internal adjustments and should not be opened; it should only be repaired by service-trained personnel. Should it become necessary to return the U7227A/C/F for repair or service, contact your nearest Keysight Sales and Service Center.

Maintenance

The connectors of the U7227A/C/F, particularly the connector faces, must be kept clean. Keysight recommends that the connectors be periodically inspected and cleaned if necessary. For instructions on the connection and maintenance of your connectors, refer to the Connector Care Quick Reference Card (08510-90360).

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