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**USB-5681**

## SPECIFICATIONS

# USB-5681

RF Power Sensor Device

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## Definitions

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*Warranted* specifications describe the performance of a model under stated operating conditions and are covered by the model warranty.

The following characteristic specifications describe values that are relevant to the use of the model under stated operating conditions but are not covered by the model warranty.

- *Typical* specifications describe the performance met by a majority of models.
- *Nominal* specifications describe an attribute that is based on design, conformance testing, or supplemental testing.

Specifications are *Typical* unless otherwise noted.

## Conditions

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Minimum or maximum specifications are warranted under the following conditions unless otherwise noted.

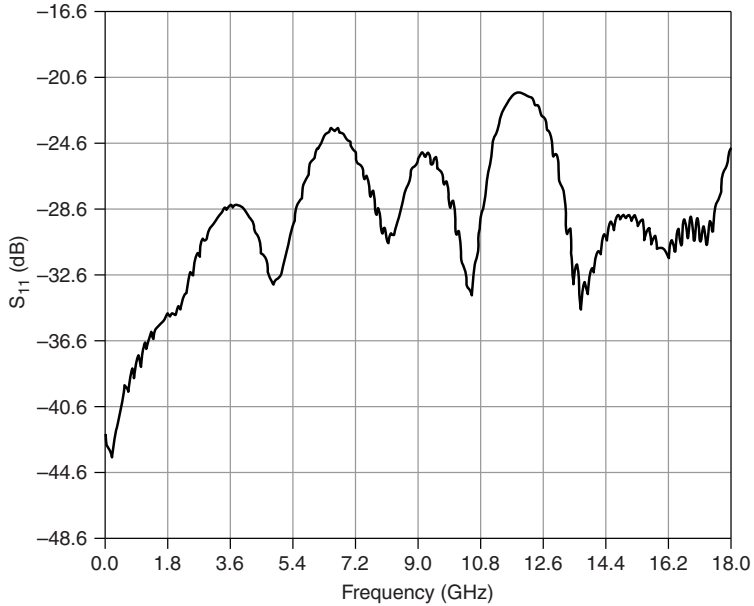
- 1 hour warm-up time at ambient temperature
- Calibration cycle maintained
- Temperature 0 °C to 55 °C

## General

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Frequency range	10 MHz to 18 GHz
Input range	- 40 dBm to +20 dBm
Input return loss	
10 MHz to <150 MHz	>22.12 dB
150 MHz to 2 GHz	>24.94 dB
>2 GHz to 12 GHz	>20.08 dB
>12 GHz to 18 GHz	>19.08 dB

**Figure 1. Power Meter Return Loss, Measured**



Measurement range

Range 1 .+20 dBm to -7 dBm, typical

Range 2 -7 dBm to -40 dBm, typical

Signal-channel bandwidth 50 kHz

## Uncertainty

Linearity <3% ( $\pm 0.13$  dB)

Calibration factor<sup>1</sup>

10 MHz <2.3% ( $\pm 0.10$  dB)

50 MHz to 18 GHz <1.5% ( $\pm 0.07$  dB)

<sup>1</sup> Expanded uncertainty with coverage factor  $K = 2$  for absolute power measurements on a continuous wave (CW) signal at 0 dBm and calibration frequencies 10 MHz, 50 MHz, 100 MHz, 300 MHz, 500 MHz, and 1 GHz to 18 GHz, in 1 GHz increments.

## Noise<sup>2</sup>

Measurement range 1	<8 $\mu$ W (-21 dBm)
Measurement range 2	<40 nW (-44 dBm)

## Zero set<sup>3</sup>

Measurement range 1	<1 $\mu$ W
Measurement range 2	<3 nW

## Zero drift<sup>4</sup>

Measurement range 1	<0.5 $\mu$ W
Measurement range 2	< 3 nW

Temperature compensation (0 °C to 50 °C)	<1.4% ( $\pm$ 0.06 dB)
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## Effect of digital modulation<sup>5</sup>

Power level $\geq$ 18 dBm	<1.4% ( $\pm$ 0.06 dB)
Power level <18 dBm	<0.5% ( $\pm$ 0.02 dB)

# System

Measurement	Average power
Measurement resolution	0.01 dB
Offset range	-100 dB to +150 dB
Averaging	
Averaging mode	Auto, repeat
Number of averages (repeat) <sup>6</sup>	1 to 40,000

<sup>2</sup> Expanded uncertainty with  $K = 2$  after zero operation when measured with 1 average, and 20 ms aperture time for 5 minutes. Effect of noise can be reduced by increasing the number of averages and/or increasing the aperture time. Noise decreases at a rate equal to the square root of the number of averages and aperture time.

<sup>3</sup> Expanded uncertainty with  $K = 2$  after zero operation when measured with 1 average and 20 ms aperture time for 5 minutes.

<sup>4</sup> Expanded uncertainty with  $K = 2$  after one hour warm-up and zero operation and one hour of operation, 1 average, 20 ms aperture time, and when keeping the temperature within  $\pm 1$  °C.

<sup>5</sup> Measurement error with reference to a CW signal of equal power and frequency at 25 °C.

<sup>6</sup> Maximum number of averages allowed in Continuous mode and Time Slot mode is 40,000. In Scope mode, the maximum number of averages is equal to 8,231,936 divided by data points.

## Auto-averaging

Resolution <sup>7</sup>	1 dB, 0.1 dB, 0.01 dB, 0.001 dB
Source	Time Slot mode: 1 to 128 slots; Scope mode: 1 to 1,024 data points

## Continuous Mode

Duty cycle correction	0.01% to 100%
Aperture time	0.01 ms to 300 ms
Measurement time <sup>8</sup>	$(\text{Number of Averages} \times a) + b$ , where $a$ and $b$ depend on the aperture time, as shown in the following table.

**Table 1. Measurement Time Variables**

Aperture Time	a (ms)	b (ms)
0.01	2	6.5
0.1	2.3	6.5
1	5.4	7.1
10	35.8	20.5
100	331	164

## Scope Mode

Capture time	0.01 ms to 300 ms
Data points	1 to 1,024
Resolution	0.01 ms
Measurement time <sup>9</sup>	$(\text{Capture Time} \times 6.69) + (\text{Data Points} \times 0.36 \text{ ms}) + 13.6 \text{ ms}$

<sup>7</sup> Averaging resolution of 0.001 dB is not available with the NI-568x SFP. This feature is only available when using the NI-568x instrument driver. Averaging resolution is defined as the place after the decimal to which the reading becomes stable.

<sup>8</sup> Times based on benchmark results. Performance may vary based on your system.

<sup>9</sup> Times based on benchmark results. Performance may vary based on your system. Formula assumes averaging is set to 1, and trigger source is set to Immediate.

# Time Slot Mode

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Maximum number of slots	128
Slot width	0.01 ms to 100 m
Maximum capture time	300 ms ( <i>Slot Width</i> × <i>Number of Slots</i> )
Resolution	0.01 ms
Exclusion periods <sup>10</sup>	
Start exclusion	0 ms to 100 ms
End exclusion	0 ms to 100 ms

# Trigger

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Source <sup>11</sup>	Immediate, external, internal, software
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## Internal Trigger

Range	-20 dBm to +20 dBm
Level accuracy	±0.5 dB, typical
Slope	Positive or negative
Delay range	-5 ms to 10 s
Delay resolution	10 μs

## External Trigger

Impedance	100 kΩ
Type	TTL/CMOS
Slope	Positive or negative
Delay range	-5 ms to 10 s
Delay resolution	10 μs
Voltage high threshold	2.0 V, typical
Voltage low threshold	1.2 V, typical
Hysteresis	0.8 V, typical

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<sup>10</sup> The start exclusion time plus the end exclusion time must be less than the slot width.

<sup>11</sup> Software trigger not available in the NI-568x SFP. This feature is only available when using the NI-568x instrument driver. Internal and external triggers are not available when using Continuous acquisition mode.

Maximum voltage	±20 V
Minimum pulse width	7.5 $\mu\text{s}$ <sup>12</sup>

## Maximum Damage Levels

Maximum DC voltage at RF port	±20 V
Absolute power	+30 dBm

## DC Power Requirements (5 V) from Host USB

Typical current	450 mA
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**Caution** You can impair the protection provided by the USB-5681 if you use it in a manner not described in this document.

## Calibration

Interval	1 year; calibration interval starts with the date the product is put into service by the customer
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## Physical Characteristics

Dimensions	25 mm × 45 mm × 110 mm, excluding RF connector and silicone cover
Weight	230 g (0.51 lb)

## Environmental

Specifications in this document are guaranteed under the following specified environmental conditions unless otherwise stated.

Maximum altitude	4,600 m (at 25 °C ambient temperature)
Pollution Degree	2

Indoor use only.

<sup>12</sup> The external trigger source is sampled approximately every 7.5  $\mu\text{s}$ .



## Operating Environment

Ambient temperature range	0 to 50 °C (Tested in accordance with MIL-PRF-28800F (Class 3).)
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Relative humidity range<sup>13</sup> (noncondensing)

At 50 °C	45%
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At 40 °C	75%
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At 30 °C	95%
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## Storage Environment

Ambient temperature range	-40 °C to +71 °C (Tested in accordance with MIL-PRF-28800F (Class 3).)
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Relative humidity range	5% to 95%, noncondensing (Tested in accordance with MIL-PRF-28800F (Class 3).)
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## Shock and Vibration

Operating Shock	30 g peak, half-sine, 11 ms pulse (Tested in accordance with MIL-PRF-28800F.)
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Random Vibration

Random vibration nonoperating	10 Hz to 500 Hz, Power spectral density 0.03 g <sup>2</sup> /Hz (Tested in accordance with MIL-PRF-28800F.)
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## Compliance and Certifications

### Safety

This product is designed to meet the requirements of the following electrical equipment safety standards for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA C22.2 No. 61010-1



**Note** For UL and other safety certifications, refer to the product label or the [Online Product Certification](#) section.

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<sup>13</sup> Tested in accordance with MIL-PRF-28800F (Class 3).

# Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326-1 (IEC 61326-1): Class A emissions; Basic immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions



**Note** In the United States (per FCC 47 CFR), Class A equipment is intended for use in commercial, light-industrial, and heavy-industrial locations. In Europe, Canada, Australia, and New Zealand (per CISPR 11), Class A equipment is intended for use only in heavy-industrial locations.



**Note** Group 1 equipment (per CISPR 11) is any industrial, scientific, or medical equipment that does not intentionally generate radio frequency energy for the treatment of material or inspection/analysis purposes.



**Note** For EMC declarations, certifications, and additional information, refer to the [Online Product Certification](#) section.

## CE Compliance

This product meets the essential requirements of applicable European Directives, as follows:

- 2014/35/EU; Low-Voltage Directive (safety)
- 2014/30/EU; Electromagnetic Compatibility Directive (EMC)

## Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit [ni.com/certification](https://ni.com/certification), search by model number or product line, and click the appropriate link in the Certification column.

## Environmental Management

NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the *Minimize Our Environmental Impact* web page at [ni.com/environment](https://ni.com/environment). This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

## Waste Electrical and Electronic Equipment (WEEE)



**EU Customers** At the end of the product life cycle, all products must be sent to a WEEE recycling center. For more information about WEEE recycling centers, National Instruments WEEE initiatives, and compliance with WEEE Directive 2002/96/EC on Waste Electrical and Electronic Equipment, visit [ni.com/environment/weee.htm](http://ni.com/environment/weee.htm).

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