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SPECIFICATIONS

USB-5683

RF Power Sensor Device

Contents

Definitions

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

NATIONAL INSTRUMENTS

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

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

Frequency range	10 MHz to 8 GHz
Input range	-60 dBm to +20 dBm
VSWR	
10 MHz to 150 MHz	<1.17 : 1
>150 MHz to 2 GHz	<1.12 : 1
>2 GHz to 8 GHz	<1.22 : 1
Measurement range	
Range 1	+4 dBm to +20 dBm, typical
Range 2	-16 dBm to <+4 dBm, typical
Range 3	-60 dBm to <-16 dBm, typical
Signal-channel bandwidth	50 kHz, typical

Uncertainty

Absolute Power Measurement Uncertainty[1]

Table 1. Measurement Uncertainty (dB), 0 °C to 50 °C

Power Measured (dBm)	Frequency (GHz)		
	≤0.05	>0.05 to 2	>2 to 8
-60 to <-16	0.14	0.14	0.14
-16 to <+4	0.14	0.14	0.13
+4 to +20	0.14	0.15	0.15

Table 2. Measurement Uncertainty (dB), 20 °C to 30 °C

Power Measured (dBm)	Frequency (GHz)		
	≤0.05	>0.05 to 2	>2 to 8
-60 to <-16	0.13	0.12	0.14
-16 to <+4	0.11	0.10	0.13
+4 to +20	0.11	0.10	0.10

Relative Power Measurement Uncertainty[2]

Table 3. Measurement Uncertainty (dB), ≤0.05 GHz

Initial Power Measured (dBm)	Final Power Measured (dBm)					
	0 °C to 50 °C			20 °C to 30 °C		
	+4 to +20	-16 to <+4	-60 to <-16	+4 to +20	-16 to <+4	-60 to <-16
-60 to <-16	0.14	0.13	0.03	0.08	0.09	0.03
-16 to <+4	0.14	0.04	0.13	0.06	0.03	0.09
+4 to +20	0.05	0.14	0.14	0.05	0.06	0.08

[1] Expanded uncertainty with $k = 2$ for a CW measurement after zeroing. Includes calibration factor and linearity; noise, zero set, and drift must be added.

[2] Expanded uncertainty with $k = 2$ for measurement of a change in power of a CW signal after zeroing. Includes calibration factor and linearity; noise, zero set, and drift must be added.

Table 4. Measurement Uncertainty (dB), >0.05 GHz to 2 GHz

Initial Power Measured (dBm)	Final Power Measured (dBm)					
	0 °C to 50 °C			20 °C to 30 °C		
	+4 to +20	-16 to <+4	-60 to <-16	+4 to +20	-16 to <+4	-60 to <-16
-60 to <-16	0.16	0.16	0.03	0.11	0.12	0.03
-16 to <+4	0.17	0.05	0.16	0.09	0.04	0.12
+4 to +20	0.06	0.17	0.16	0.06	0.09	0.11

Table 5. Measurement Uncertainty (dB), >2 GHz to 8 GHz

Initial Power Measured (dBm)	Final Power Measured (dBm)					
	0 °C to 50 °C			20 °C to 30 °C		
	+4 to +20	-16 to <+4	-60 to <-16	+4 to +20	-16 to <+4	-60 to <-16
-60 to <-16	0.16	0.16	0.04	0.12	0.14	0.04
-16 to <+4	0.17	0.05	0.16	0.10	0.04	0.14
+4 to +20	0.06	0.17	0.16	0.07	0.10	0.12

Table 6. Noise, Zero Set, Zero Drift Uncertainty

Power Measured (dBm)	Noise[3]	Zero Set[4]	Zero Drift[5]
-60 to <-16	<123 pW	<332 pW	<344 pW
-16 to <+4	<10.1 nW	<38.7 nW	<42.9 nW
+4 to +20	<0.856 µW	<1.07 µW	<0.996 µW

[3] Noise is specified as two-sigma (at three-sigma confidence) after zero operation when measured with 10.2 seconds of measurement time (measurement time = *Aperture Time* * *Number of Averages*). 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.

[4] Zero set is specified as the mean (at three-sigma confidence) after zero operation when measured with 256 averages and 40 ms aperture time for 1 hour, and when keeping the temperature within ±1 ºC.

[5] Zero drift is specified as two-sigma (at three-sigma confidence) after zero operation when measured with 256 averages and 40 ms aperture time for 1 hour, and when keeping the temperature within ±1 ºC.

Table 7. Effects of Digital Modulation[6]

Power Measured (dBm)	Uncertainty (dB)
-60 to <-16	+0.080/-0.048
-16 to <+4	+0.088/-0.038
+4 to +20	+0.067/-0.055

Power Measurement

Measurement	Average power
Measurement resolution	0.01 dB maximum
Offset range	-100 dB to +150 dB
Averaging	
Averaging mode	Auto, manual
Averaging type	Moving, repeat
Number of averages (manual)[7]	1 to 65,536
Auto-averaging	
Resolution[8]	1 dB, 0.1 dB, 0.01 dB
Source	Time Slot mode: 1 to 128 slots; or Scope mode: 1 to 16,384 data points

Continuous Mode

Duty cycle correction	0.001% to 100%
Aperture time	0.01 ms to 1 s

[6] Measurement error with reference to a CW signal of equal power and frequency at 20 ºC to 30 ºC.

[7] Maximum number of averages allowed in Continuous mode and Time Slot mode is 65,536. In Scope mode, the maximum number of averages is equal to 16,777,216 divided by the number of data points.

[8] 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.

Maximum buffer size	8,192
Measurement time[9]	Up to 1,000 measurements per second, unbuffered More than 10,000 measurements per second, buffered

Table 8. Measurement Time Examples

Aperture Time (ms)	Averages = 1, in ms	Averages = 10, in ms
0.01	1.0	1.5
0.1	1.2	3.0
1	4.0	19.1
10	34.6	187
100	347	1907

Scope Mode

Capture time	0.01 ms to 1 s
Data points	1 to 16,384
Resolution	0.01 ms maximum
Measurement time[10]	*Capture Time* * 6.2 + 0.013

Time Slot Mode

Maximum number of slots	128
Slot width	0.01 ms to 100 ms
Maximum capture time	1,000 ms (*Slot Width* * *Number of Slots*)
Resolution	0.01 maximum

[9] Times are typical based on benchmark results taken using an NI PXIe-8135 controller and an USB-5683. Performance may vary based on system configuration. Trigger source set to Immediate. Number of Averages = 1 for repeat average mode.

[10] Times are typical based on benchmark results taken using an NI PXIe-8135 controller and an USB-5683. Performance may vary based on system configuration. Trigger source set to Immediate. Number of Averages = 1 for repeat average mode.

Exclusion periods[11]	
Start exclusion	0 ms to 10 ms
End exclusion	0 ms to 10 ms

Trigger

Internal Trigger

Source[12]	Bus or Continuous (Auto, Single or Multiple)
Range	-35 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

Trigger In

Impedance	4 kΩ, nominal
Type	TTL/CMOS
Slope	Positive
Delay range	-5 ms to 10 s
Delay resolution	10 µs
Voltage high threshold	2.3 V, typical
Voltage low threshold	1.2 V, typical
Hysteresis	0.2 V, typical
Maximum voltage	±5.5 V
Minimum pulse width	100 ns
Latency[13]	10.6 µs, maximum
Repetition period	14.2 µs, minimum

Trigger Out

Trigger Out capability is not currently implemented.

[11] The start exclusion time plus the end exclusion time must be less than the slot width.

[12] 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.

[13] Latency is defined as the time delay between the sensor receiving the trigger and the measurement initiation.

Interface

RF connector	N (m)
Interface to host	USB 2.0 full speed (compatible with USB 1.0 and USB 1.1)
External trigger input	MCX(f)

Maximum Damage Levels

Maximum DC voltage at RF port	±20 V
Maximum power at RF port	+30 dBm (+34 dBm for 10 µs pulse, 10% duty cycle)
Maximum voltage at trigger input	5.5 V

DC Power Requirements (5 V) from Host USB

Typical current	450 mA

Caution You can impair the protection provided by the USB-5683 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

Physical Characteristics

Dimensions	110 mm x 45 mm x 25.6 mm, excluding RF connector and silicone cover
Weight	397 g (0.88 lb)

Caution Clean the hardware with a soft, nonmetallic brush. Make sure the hardware is completely dry and free from contaminants before returning it to service.

Environment

Maximum altitude	4,600 m operational
Pollution Degree	2

Indoor use only.

Operating Environment

Ambient temperature range	0 °C to 50 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2.)
Relative humidity range[14] (noncondensing)	
At 50 °C	45%
At 40 °C	75%
At 30 °C	95%

Storage Environment

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

Shock and Vibration

Operating shock	30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC 60068-2-27. Meets MIL-PRF-28800F Class 2 limits.)
Random vibration	
Operating	5 Hz to 500 Hz, 0.3 g_{rms}
Nonoperating	5 Hz to 500 Hz, 2.4 g_{rms} (Tested in accordance with IEC 60068-2-64. Nonoperating test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

[14] Tested in accordance with IEC 60068-2-56.

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 61010-1

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

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
- EN 55022 (CISPR 22): Class A emissions
- EN 55024 (CISPR 24): Immunity
- AS/NZS CISPR 11: Group 1, Class A emissions
- AS/NZS CISPR 22: 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 CE

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*, 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*. 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 NI products must be disposed of according to local laws and regulations. For more information about how to recycle NI products in your region, visit *ni.com/environment/weee*.

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