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USB-5683

DEVICE SPECIFICATIONS

NI USB-5683

10 MHz to 8 GHz RF Power Meter

This document lists specifications for the NI USB-5683 (NI 5683) RF power meter. Minimum or maximum specifications are warranted under the following conditions:

- 1 hour warm-up time at ambient temperature
- Calibration cycle maintained
- Temperature 0 °C to 50 °C unless otherwise noted

Typical values are used to define a non-warranty specification that at least 68% of units exhibit at ambient temperatures of 15 °C to 35 °C. Specifications that do not list tolerance values are typical values unless otherwise specified. Tolerance values represent the maximum variation.

Specifications are subject to change without notice. For the most recent device specifications, visit ni.com/manuals.

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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 Uncertainty¹

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 |

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.

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 Uncertainty²**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 |

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 |

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 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 |

Table 7. Effects of Digital Modulation⁶

| 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 |

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 °C.

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 °C.

⁶ Measurement error with reference to a CW signal of equal power and frequency at 20 °C to 30 °C.

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

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.

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

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 | <i>Capture Time</i> * 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 (<i>Slot Width</i> * <i>Number of Slots</i>) |
| Resolution | 0.01 maximum |
| Exclusion periods ¹¹ | |
| Start exclusion | 0 ms to 10 ms |
| End exclusion | 0 ms to 10 ms |

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

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

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.

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 μ s 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 NI 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 range¹⁴ (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

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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