SPECIFICATIONS

VRTS Base System

Automated Radar Measurement and Obstacle-Simulation System

This document lists specifications for the Vehicle Radar Test System (VRTS). The VRTS is an automated radar measurement and obstacle-simulation system that operates within the 76 GHz to 81 GHz frequency range. You can use the VRTS to test both the hardware and software of a vehicle's radar system.

Caution Observe all instructions and cautions in the user documentation. Using the model in a manner not specified can damage the model and compromise the built-in safety protection. Return damaged models to NI for repair.

Attention Suivez toutes les instructions et respectez toutes les mises en garde de la documentation utilisateur. L'utilisation d'un modèle de toute autre façon que celle spécifiée risque de l'endommager et de compromettre la protection de sécurité intégrée. Renvoyez les modèles endommagés à NI pour réparation.

Notice When used in conjunction with a mmWave radio head, the system is intended for use indoors in a shielded chamber test environment only, as test and measurement equipment. The product is intended for professional use only.

Notice An Experimental License is required to be filed directly with the FCC if a mmWave radio head is not used inside a shielded chamber test environment. Please refer to the FCC OET Experimental Licensing System website for additional guidance.

Contents

NATIONAL INSTRUMENTS

Definitions

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.
- *Typical-95* specifications describe the performance met by 95% (≈2σ) of models with a 95% confidence.
- *Nominal* specifications describe an attribute that is based on design, conformance testing, or supplemental testing.

Specifications are *Warranted* unless otherwise noted.

Conditions

Specifications are warranted by design and under the following conditions, unless otherwise noted:

- 30 minutes of warm-up time.
- Calibration cycle maintained. National Instruments recommends that the VRTS modules be calibrated every 12 months from the time the modules are initially powered on. The specific calibration interval depends on the accuracy required by the end user's application. Accuracy of the modules is not affected by non-operation when the modules are properly stored in their original packaging or equivalent.
- Chassis fan speed set to High.

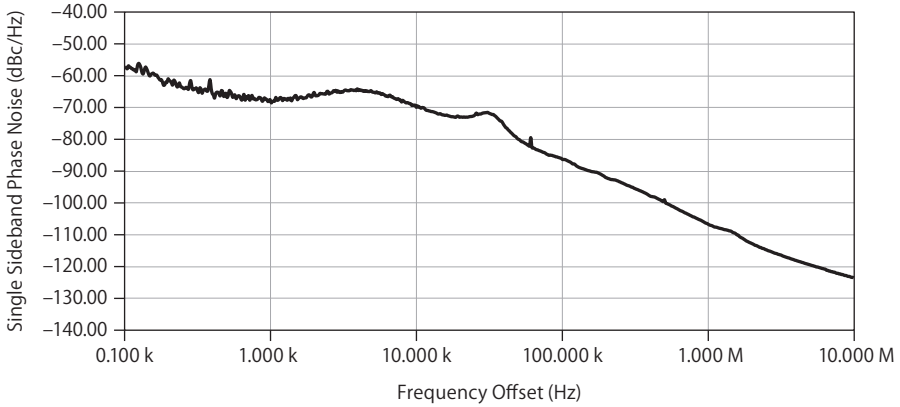
Obstacle Simulation

RF Parameters

Frequency range, standard	76 GHz to 77 GHz
Frequency range, configurable	76 GHz to 81 GHz[1]
Instantaneous bandwidth	1 GHz
Phase Noise, 77 GHz at 100 kHz offset	-85 dBc/Hz, typical

[1] Contact NI for alternative calibrations. The device performance is not warranted at an uncalibrated frequency.

Figure 1. Measured Phase Noise, 77 GHz (Typical)



Monostatic Antenna Configuration with Circulator (CCN 06301)

Rx input power (after Rx antenna):	
Maximum operating level for linear operation	-20 dBm
Absolute maximum (damage)	-4 dBm
Rx input VSWR (after Rx antenna)	2:1, typical
Max Tx output power	(before Tx antenna)-27 dBm
Tx EIRP (with included +20 dBi horn)	-7 dBm, nominal
Tx OIP3 (2x Tx signals 10 MHz apart)	12 dBm
Tx/Rx isolation	25 dB, typical
Antenna type	Rectangular Horn, 20 dBi, nominal WR-12, UG387/U flange
Antenna E-field orientation	Vertically polarized
Antenna polarization type	Linear vertical

Bistatic Bulkhead Antenna Configuration (CCN 05802)

Rx input power (after Rx antenna):	
Maximum operating level for linear operation	-26 dBm
Absolute maximum (damage)	-10 dBm
Rx input VSWR (after Rx antenna)	2:1, typical
Max Tx output power (before Tx antenna)	0 dBm
Tx EIRP (with included +14 dBi horn)	8 dBm, nominal
Tx OIP3 (2x Tx signals 10 MHz apart)	20 dBm, typical
Tx/Rx isolation	65 dB, typical
Antenna type	Rectangular Horn, 14 dBi, nominal WR-12, UG387/U
Antenna E-field orientation	Horizontally polarized
Antenna polarization type	Linear Horizontal

Bistatic Captive Antenna Configuration (CCN 05801)

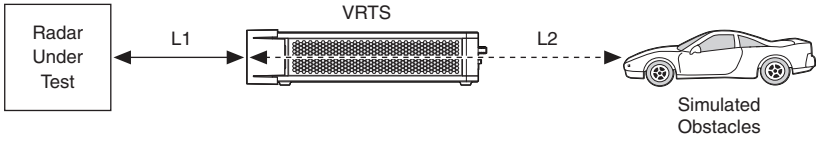
Rx input power (after Rx antenna):	
Maximum operating level for linear operation	-26 dBm
Absolute maximum (damage)	-10 dBm
Rx input VSWR (after Rx antenna)	2:1, typical
Max Tx output power (before Tx antenna)	14 dBm
Tx EIRP (with included +14 dBi horn)	28 dBm, nominal
Tx OIP3 (2x Tx signals 10 MHz apart)	27 dBm, typical
Tx/Rx isolation	65 dB, typical
Antenna type	Rectangular Horn, 14 dBi, nominal WR-12, UG387/U

Antenna E-field orientation	Horizontally polarized
Antenna polarization type	Linear Horizontal

Note Antenna orientation can be changed by rotating the mmWave radio head using the VRTS mounting bracket kit (NI part number 785766-01).

Obstacle Parameters

Figure 2. Distance between Devices and Simulated Obstacles



Number of obstacles	1 to 4 per PXI Express chassis (refer to the *VRTS Base System Getting Started Guide* for valid configurations)
Distance between VRTS and radar under test (L1)	0.7 m, minimum

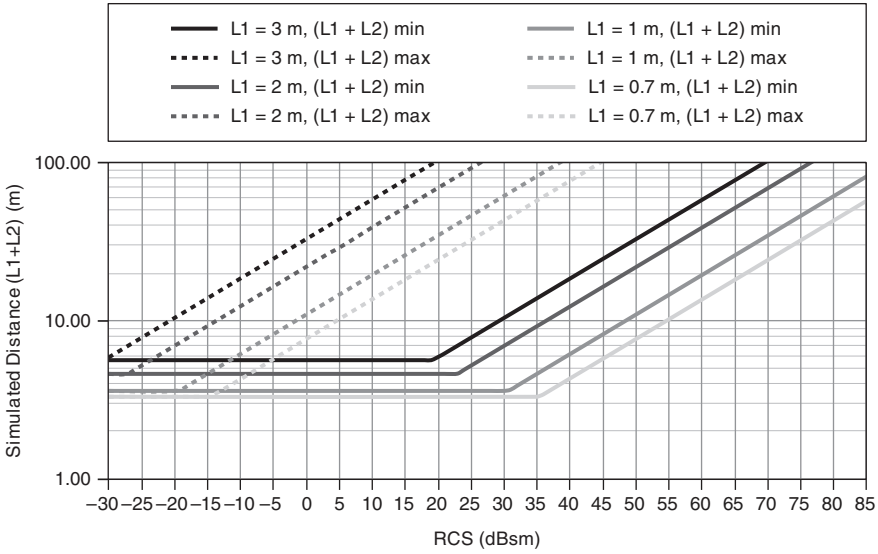
Note Evaluate the setup distance (L1) between the VRTS and the radar under test based on their combined specifications. Parameters of the radar under test, such as antenna far field distance, EIRP, and antenna beam width, influence L1 and may be adjusted to achieve optimum performance.

Shortest simulated distance (L2)	2.5 m, typical; 3 m, maximum
Longest simulated distance (L2)	>300 m
Distance resolution (3 m < L2 < 95m)	10 cm, nominal
Distance resolution (L2 > 95 m)	12 cm, nominal
Distance accuracy	±15 cm
Doppler range	0 to ±500 km/hour (75 kHz)
Doppler resolution	0.1 km/hour (15 Hz)
Doppler accuracy	±0.05 km/hour, typical (7.5 Hz)
Radar cross-section (RCS) Range[1]	105 dB (-20 dBsm to 85 dBsm), typical

[1] Spurious reflection may appear, >35 dB down for target above 10 m and RCS above 25 dBsm.

RCS dynamic range[1]	50 dB, minimum
RCS resolution	0.25 dB, typical

Figure 3. Simulated Obstacle Distance (L1+L2) Range vs RCS, Typical, Bistatic Captive Antenna Configuration (CCN 05801) [2]



[1] Refer to Figure 3 to observe total simulated distance range vs RCS where spurious reflections are at least 10 dB down from simulated object.

[2] Conditions: +30 dBm TxEIRP from sensor under test.

Figure 4. Simulated Obstacle Distance (L1+L2) Range vs RCS, Typical, Bistatic Bulkhead Antenna Configuration (CCN 05802)[1]

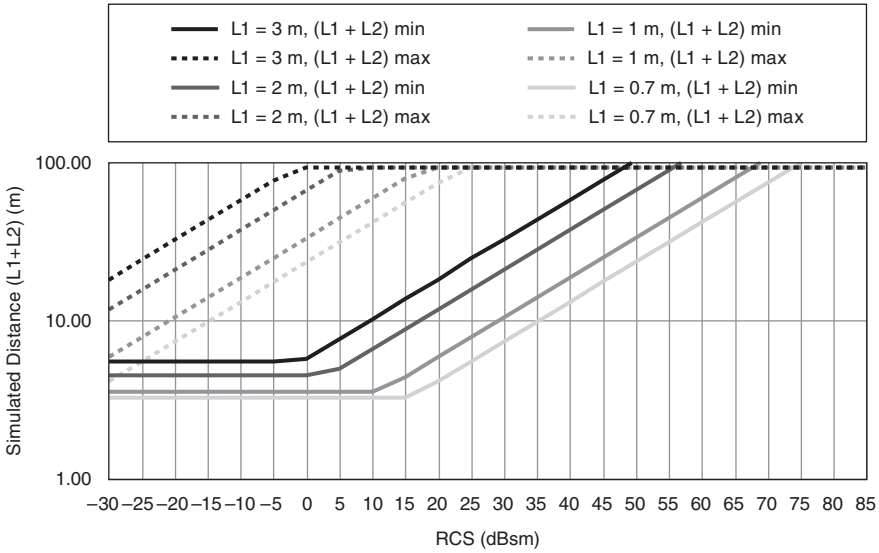
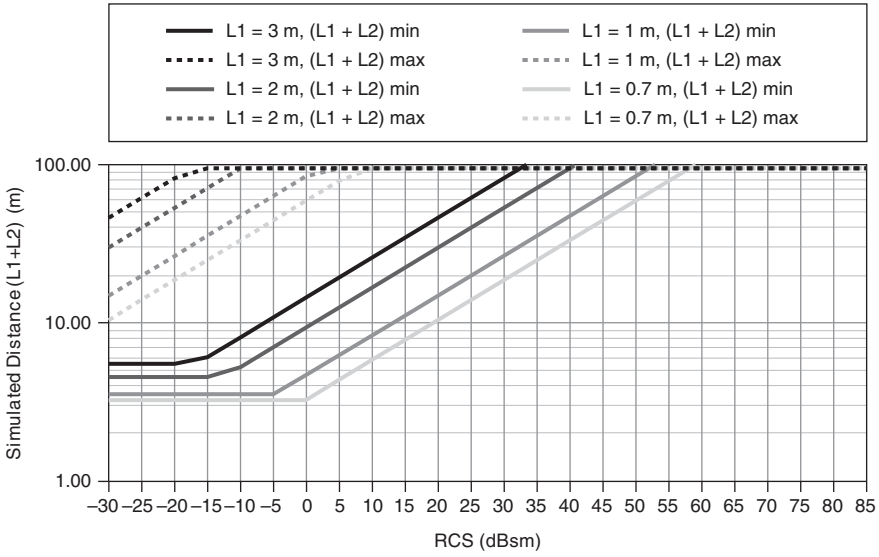


Figure 5. Simulated Obstacle Distance (L1+L2) Range vs RCS, Typical, Monostatic Antenna Configuration with Circulator (CCN 06301)[1]



[1] Conditions: +30 dBm TxEIRP from sensor under test.

Obstacle update rate	<5 ms per obstacle, typical

Measurement Specifications

Note Requires that the NI-RFmx SpecAn driver be installed on the system. Please refer to the *NI-VRTS Readme* to determine which version of NI-RFmx SpecAn to use.

Modulated Signal Parameters

Occupied bandwidth	1 GHz instantaneous bandwidth maximum
EIRP power measurement range (with manual entry of setup distance)	-30 dBm to +30 dBm

Note The VRTS system has multiple ways of performing real time over-the-air power measurements. For fast measurements, you could use the internal (calibrated) VST, which can perform power measurements concurrently with obstacle generation. For more accurate and traceable power measurements, an AUX Rx IF port is provided for power monitoring with a conventional (< 6 GHz) power meter. Note that speed and accuracy are dependent on the power sensor used. The accuracy specifications for two different methods are listed below.

EIRP power measurement repeatability (using the internal VST)	± 2 dB (CW signal ± 10 MHz F° and +25 °C ± 10 °C)
EIRP power measurement repeatability (using a power meter at the Rx IF Aux Out port of the mmRH-3608)	± 0.5 dB + power-meter uncertainty (CW signal ±10 MHz F° and +25 °C ± 10 °C)

Alignment Laser Specifications (Bistatic mmRH-3608 Configuration Only)

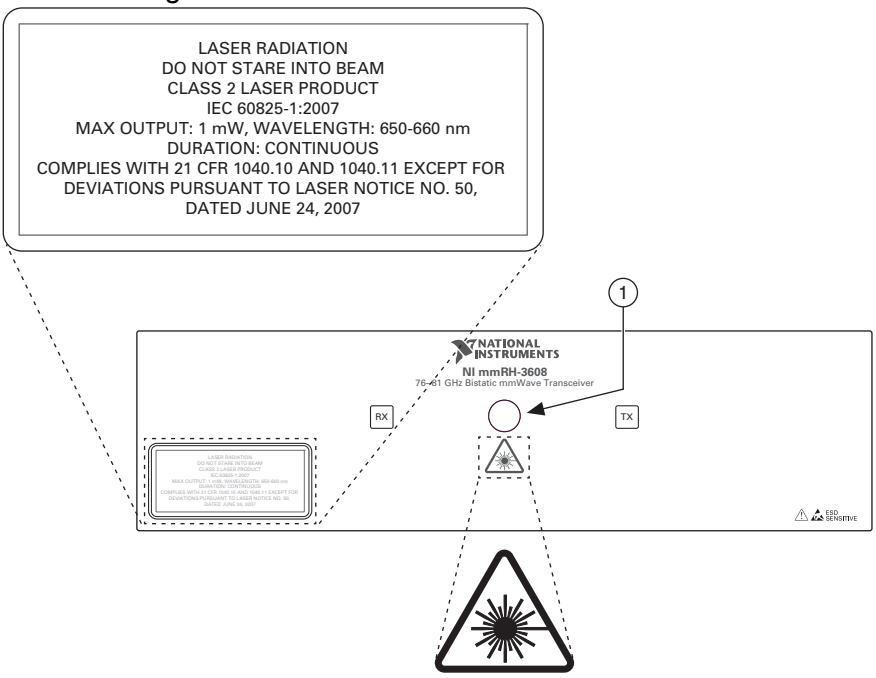
Caution This is a Class 2 (Class II) laser product and has visible laser radiation up to 1 mW emitting from the laser aperture. This product is for use as an alignment laser only, per CFR Title 21, Chapter I, Subchapter J, Part 1040.11(b). The product is safe for momentary exposures but can be hazardous for deliberate staring into the beam. DO NOT STARE INTO THE BEAM. Class 2 lasers can cause photochemical and thermal retinal injury to the eye, as well as skin reactions and burns with longer than momentary exposure. Adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. Dazzle, flash-blindness and afterimages may be caused by a beam from a Class 2 laser product, particularly under low ambient light conditions. This may have indirect general safety

implications resulting from temporary disturbance of vision or from startle reactions. Such visual disturbances could be of particular concern connected with performing safety-critical operations such as working with machines or at height, with high voltages, or driving. Users are instructed not to stare into the beam, and should perform active protective reactions by moving the head or closing the eyes and to avoid continued intentional intrabeam viewing.

Attention Ce produit est un laser de classe 2 (classe II) qui émet, par son ouverture, un rayonnement laser visible atteignant 1 mW. Ce produit doit être utilisé uniquement comme laser d'alignement, conformément au Titre 21 du CFR, chapitre I, sous-chapitre J, partie 1040.11 (b). Le produit est sans danger en cas d'exposition momentanée mais peut être dangereux lorsqu'on fixe délibérément le faisceau. NE PAS REGARDER FIXEMENT LE FAISCEAU. Les lasers de classe 2 peuvent provoquer des lésions rétiniennes photochimiques et thermiques ainsi que des réactions cutanées et des brûlures en cas d'exposition trop longue. Les ajustements ou l'exécution de procédures autres que celles spécifiées ici peuvent entraîner une exposition à des rayonnements dangereux. Le faisceau d'un produit laser de classe 2 peut entraîner l'éblouissement, un bref aveuglement et des images rémanentes, en particulier dans des conditions de faible luminosité ambiante. Cela peut avoir des implications générales indirectes sur la sécurité résultant de perturbations temporaires de la vision ou de réactions de surprise. De telles perturbations visuelles peuvent être particulièrement préoccupantes lors de la réalisation d'opérations critiques pour la sécurité telles que le travail sur des machines ou en hauteur, le travail avec des tensions élevées ou lors de la conduite. Les utilisateurs ont pour consigne de ne pas regarder fixement le faisceau et doivent réagir de façon active pour se protéger, en bougeant la tête ou en fermant les yeux, et éviter de continuer à regarder intentionnellement le faisceau.

Laser class	2
Wavelength	650 nm to 660 nm
Beam divergence	1.2 mrad
Duration	Continuous
Maximum power	1 mW

Laser Labeling



Physical Characteristics

Note These specifications apply to the required VRTS components. For information about other VRTS components, visit `ni.com/manuals`.

To clean the VRTS, wipe it with a dry towel.

Weight

mmRH-3608	2.8 kg (6.2 lb)
mmRH-3609	3.0 kg (6.6 lb)
NI-5692 (VDG)	1.1 kg (2.5 lb)

mmWave Radio Head Transceiver Panel Connectors

10 MHz REF IN	SMA-F
10 MHz REF OUT	SMA-F
TX RF COUPLER OUT	SMA-F

TX IF IN	SMA-F
RX IF COUPLER OUT	SMA-F
RX IF OUT	SMA-F
12 V 3.0 A MAX	Two-pin custom
DIO 0	Mini HDMI
DIO 1	Mini HDMI

mmWave Radio Head Mechanical Dimensions

Figure 6. Monostatic and Bistatic mmWave Radio Head Top View

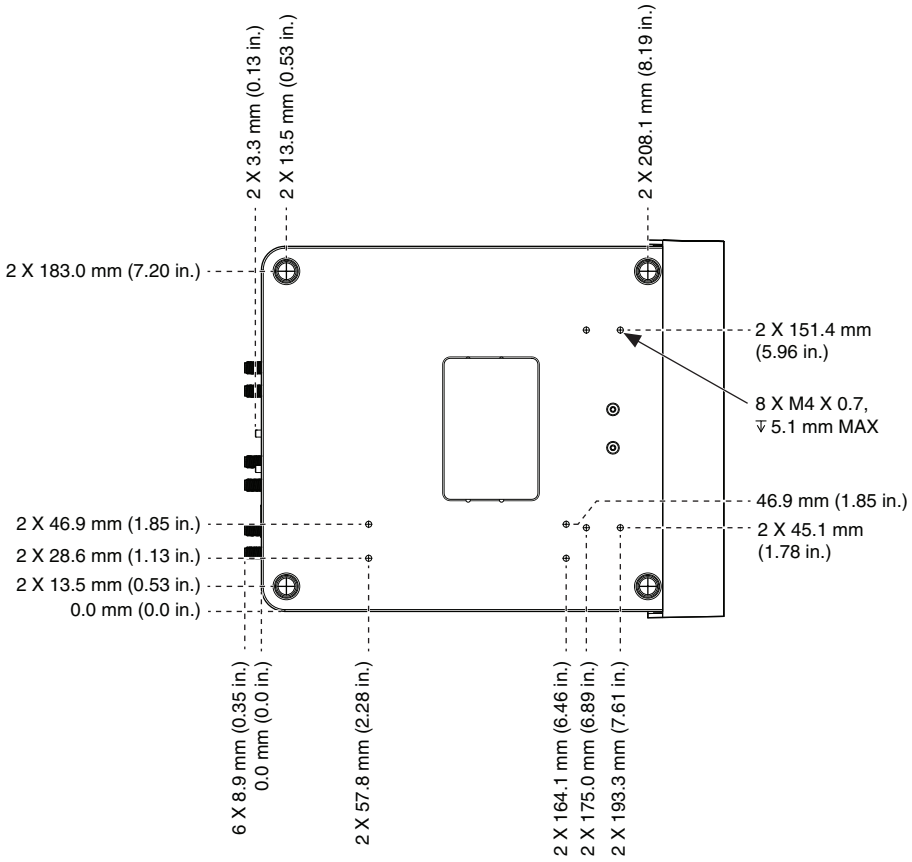


Figure 7. Monostatic and Bistatic mmWave Radio Head Length

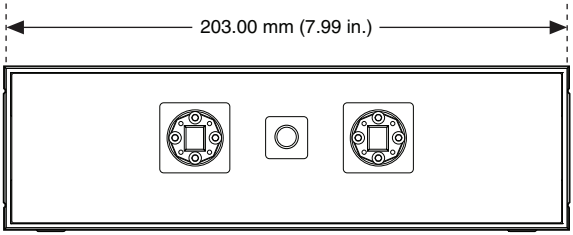


Figure 8. Monostatic and Bistatic mmWave Radio Head Rear View

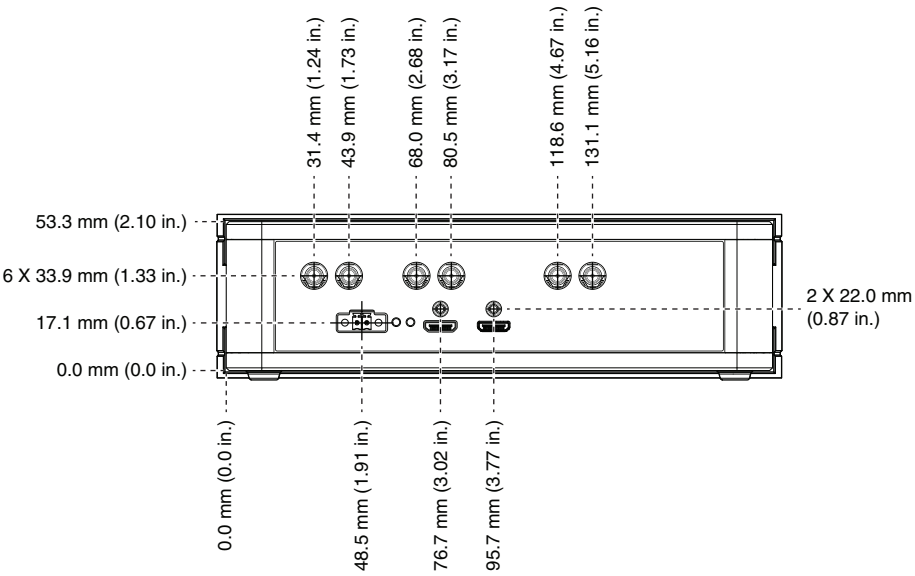


Figure 9. Monostatic mmWave Radio Head Front View

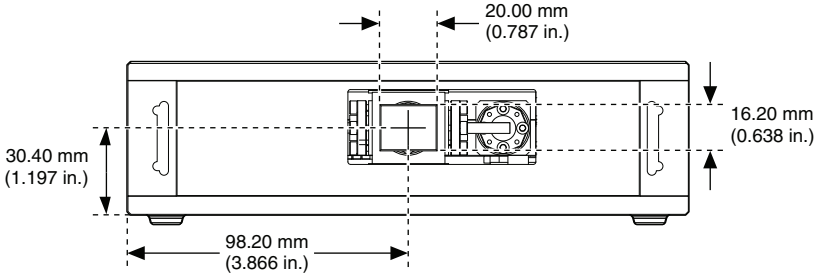


Figure 10. Monostatic mmWave Radio Head Side View

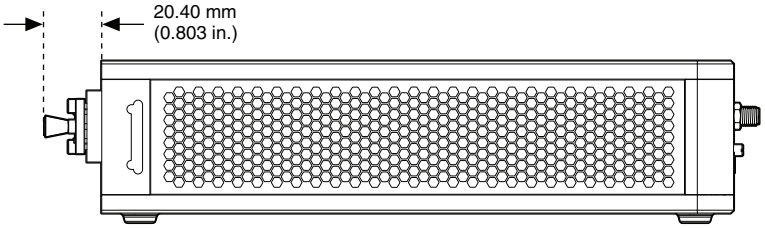


Figure 11. Bistatic Captive Antenna Configuration Front View

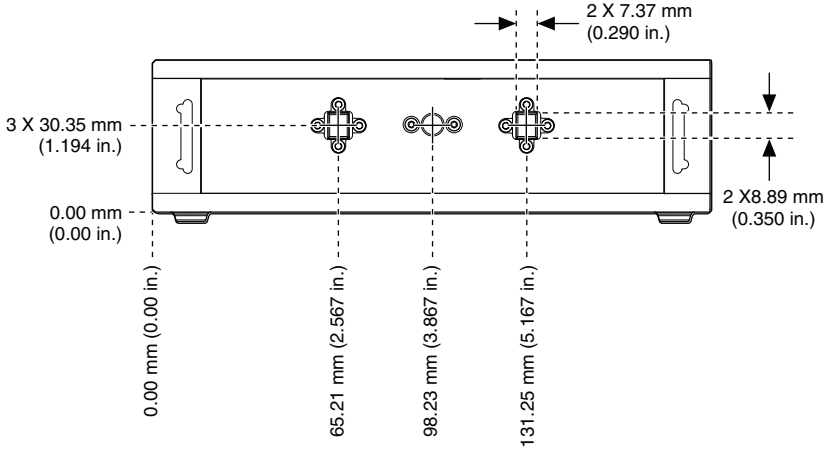


Figure 12. Bistatic Captive Antenna Configuration Side View

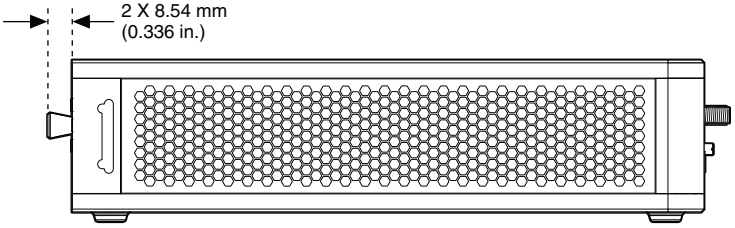


Figure 13. Bistatic Bulkhead Antenna Configuration Front View

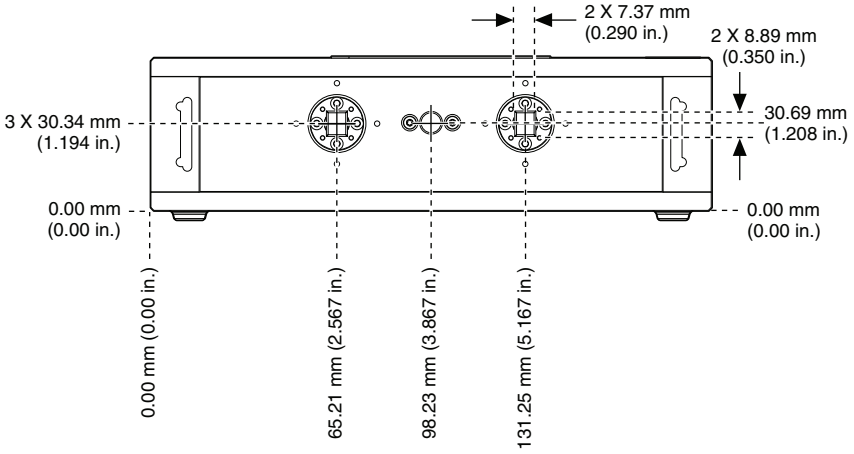
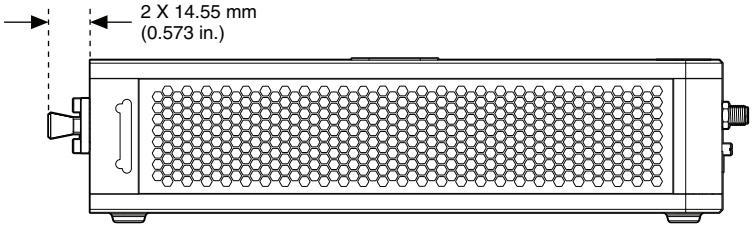


Figure 14. Bistatic Bulkhead Antenna Configuration Side View



Power Requirements

DC Input (mmWave Radio Head)

DC power	12 V, 3 A, maximum

Environment

Maximum altitude	2,000 m (800 mbar) (at 25 °C ambient temperature)
Measurement category[1]	I

[1] Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS voltage. MAINS is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

Caution Do not connect the system to signals or use for measurements within Measurement Categories II, III, or IV.

Note Measurement Categories CAT I and CAT O (Other) are equivalent. These test and measurement circuits are not intended for direct connection to the MAINs building installations of Measurement Categories CAT II, CAT III, or CAT IV.

Pollution degree	2

For indoor use only.

Operating Environment

Ambient temperature range	0 °C to 45 °C
Relative humidity range	10% to 90%, noncondensing

Storage Environment

Ambient temperature range	-40 °C to 71 °C
Relative humidity range	10% to 90%, noncondensing

Shock and Vibration

Shock	
Operating	30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC 60068-2-27 and IEC 60068-2-64. Meets MIL-PRF-28800F Class 2 limits)
Non-operating	50 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC 60068-2-27 and IEC 60068-2-64. Meets MIL-PRF-28800F Class 2 limits)
Random vibration	
Operating	5 Hz to 500 Hz, 0.3 grms (Tested in accordance with IEC 60068-2-64.)
Non-operating	5 Hz to 500 Hz, 2.4 grms (Tested in accordance with IEC 60068-2-64.)

Compliance and Certifications

Safety Standards

This product meets the requirements of the following standards of safety for electrical equipment 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.

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-003: 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 and 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 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 and Electronic Equipment, visit ni.com/environment/weee.

电子信息产品污染控制管理办法 （中国 RoHS）

中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 ni.com/environment/rohs_china。 (For information about China RoHS compliance, go to ni.com/environment/rohs_china.)

Worldwide Support and Services

The NI website is your complete resource for technical support. At ni.com/support you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

Visit ni.com/services for NI Factory Installation Services, repairs, extended warranty, and other services.

Visit ni.com/register to register your NI product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

A Declaration of Conformity (DoC) is our claim of compliance with the Council of the European Communities using the manufacturer's declaration of conformity. This system affords the user protection for electromagnetic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting ni.com/certification. If your product supports calibration, you can obtain the calibration certificate for your product at ni.com/calibration.

NI corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. NI also has offices located around the world. For telephone support in the United States, create your service request at ni.com/support or dial 1 866 ASK MYNI (275 6964). For telephone support outside the United States, visit the Worldwide Offices section of ni.com/niglobal to access the branch office websites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

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