DEVICE SPECIFICATIONS

NI PXIe-5693

RF Preselector Module

This document lists specifications for the NI PXIe-5693 (NI 5693). Specifications are warranted under the following conditions:

- 30 minutes warm-up time
- Calibration cycle maintained
- Chassis fan speed set to High. NI recommends using slot blockers and EMC filler panels in empty module slots to minimize temperature drift.
- NI-RFSA instrument driver version 2.6 or later is used

Specifications describe the warranted, traceable product performance over ambient temperature ranges of 0 ºC to 55 ºC, unless otherwise noted.

Note Values in this document are *specifications* unless otherwise noted.

Typical values describe useful product performance beyond specifications that are not covered by warranty and do not include guardbands for measurement uncertainty or drift. Typical values may not be verified on all units shipped from the factory. Unless otherwise noted, typical values cover the expected performance of units over ambient temperature ranges of 23 °C ± 5 °C with a 90% confidence level, based on measurements taken during development or production.

2σ specifications describe the 95th percentile values in which 95% of the cases are met with a 95% confidence for any ambient temperature of 23 °C ± 5 °C

Nominal values (or supplemental information) describe additional information about the product that may be useful, including expected performance that is not covered under *Specifications* or *Typical* values. Nominal values are not covered by warranty.

Specifications are subject to change without notice. For the most recent NI 5693 specifications, visit *ni.com/manuals*.

To access NI 5693 documentation, navigate to **Start»All Programs»National Instruments»NI-RFSA»Documentation**.

National Instruments RF devices are capable of producing and/or acquiring accurate signals within common Medical Implantable Communication System (MICS) frequency bands. NI RF devices are tested and verified in manufacturing for many measurements. For more

NATIONAL INSTRUMENTS

information about RF device applications, visit *ni.com/global* to contact a National Instruments branch office.

Hot Surface If the NI 5693 has been in use, it may exceed safe handling temperatures and cause burns. Allow the NI 5693 to cool before removing it from the chassis.

Caution The protection provided by the NI 5693 can be impaired if it is used in a manner not described in this document.

Contents

Frequency

Frequency range

Low-frequency bypass path....20 Hz to 30 MHz

Preselector path....20 MHz to 7.0 GHz

External filter path....20 MHz to 3.0 GHz

Preselector Filters

Figure 1. NI 5693 Preselector Filter Definition

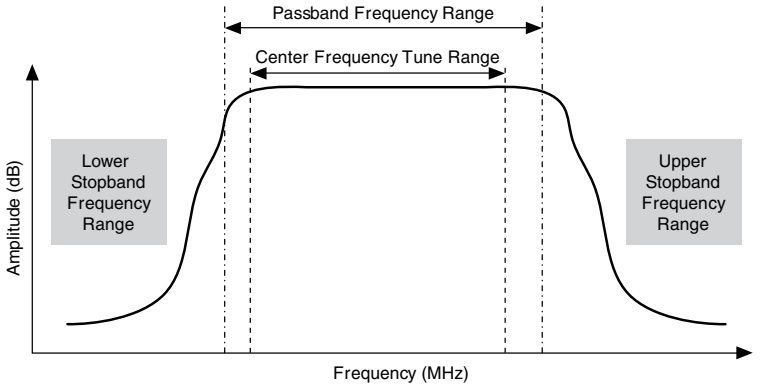


Table 1. NI 5693 Preselector Filters (Nominal)

Preselector Filter Band	Center Frequency Tune Range[1] (MHz)	Passband Frequency Range[2] (MHz)	Lower Stopband Frequency Range (MHz)	Upper Stopband Frequency Range (MHz)	Stopband Rejection (dB)
1	20 to 34	19 to 35	<14	>42	>20
2	>34 to 60	33 to 61	<27	>70	>20
3	>60 to 100	59 to 110	<49	>128	>20

[1] The preselector filter band selection is based on the center frequency tuning range. The lowest frequency preselector band is selected at the band-crossing frequencies.

[2] *Passband Frequency Range* is the calibrated range of the *Preselector Filter Band*.

Table 1. NI 5693 Preselector Filters (Nominal) (Continued)

Preselector Filter Band	Center Frequency Tune Range[1] (MHz)	Passband Frequency Range[2] (MHz)	Lower Stopband Frequency Range (MHz)	Upper Stopband Frequency Range (MHz)	Stopband Rejection (dB)
4	>100 to 160	90 to 170	<75	>185	>20
5	>160 to 225	140 to 245	<115	>285	>20
6	>225 to 350	205 to 370	<170	>420	>20
7	>350 to 555	330 to 575	<280	>660	>20
8	>555 to 950	530 to 975	<450	>1,120	>20
9	>950 to 1,560	910 to 1,600	<775	>1,920	>20
10	>1,560 to 2,000	1,520 to 2,040	<1,350	>2,320	>20
11	>2,000 to 2,500	1,960 to 2,540	<1,700	>2,860	>20
12	>2,500 to 3,000	2,460 to 3,040	<2,140	>3,460	>20
13	>3,000 to 3,800	2,960 to 3,840	<2,650	>4,350	>20
14	>3,800 to 4,600	3,560 to 4,640	<3,350	>5,050	>20
15	>4,600 to 5,800	4,560 to 5,840	<3,850	>6,550	>20
16	>5,800 to 7,000	5,760 to 7,040	<4,900	>8,250	>20

[1] The preselector filter band selection is based on the center frequency tuning range. The lowest frequency preselector band is selected at the band-crossing frequencies.

[2] *Passband Frequency Range* is the calibrated range of the *Preselector Filter Band*.

Notch Filters

Figure 2. NI 5693 Notch Filter Frequency Range Definition

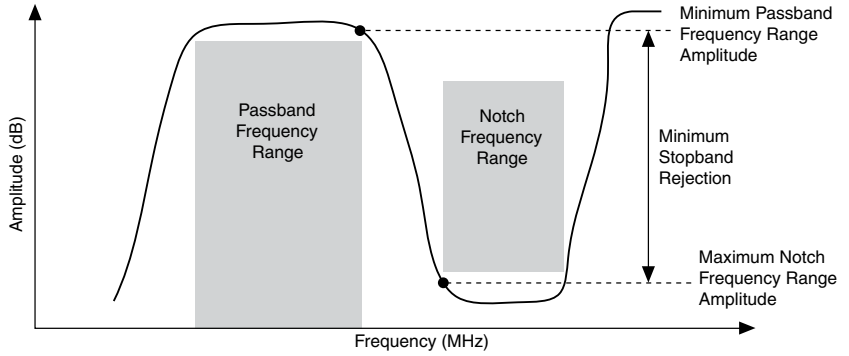


Table 2. NI 5693 Notch Filter (Nominal)

Notch Filter Band	Passband Frequency Range (MHz)	Notch Frequency Range (MHz)	Notch Filter Rejection[3] (dB)	Preselector Filter Band[3]
N1	32 to 44	55 to 75	>38	2
N2	60 to 77	88 to 108	>25	3
N3	90 to 112	50 to 75	>40	3
N4	118 to 166	88 to 108	>23	4

[3] Notch filter bands are a cascade of a preselector filter and a notch filter. Stopband rejection specifications for the preselector filter band apply in the notch filter bands.

Amplitude

Gain

Table 3. NI 5693 Gain (Typical)[4,5]

Tune Frequency Range (MHz)	23 °C ± 5 °C (dB)		0 °C to 55 °C (dB)	
	Preamplifier Enabled	Preamplifier Disabled	Preamplifier Enabled	Preamplifier Disabled
20 to 950	>23.5	>1.3	>22.6	>0.7
>950 to 2,000	>26.9	>-0.2	>25.9	>-0.9
>2,000 to 3,000	>15.9	>-2.0	>14.7	>-2.8
>3,000 to 5,800	>15.6	>0.1	>14.5	>-0.8
>5,800 to 7,000	>14.4	>-1.3	>13.2	>-2.3
Notch filters	—	>0.5	—	>-0.3
External filter	—	>1.14	—	>0.5

Gain Range

Table 4. NI 5693 Gain Range (Typical)[6]

Tune Frequency Range (MHz)	23 °C ± 5 °C (dB)		0 °C to 55 °C (dB)	
	Preamplifier Enabled	Preamplifier Disabled	Preamplifier Enabled	Preamplifier Disabled
Preselector path 20 to 950	>16.8	>21.6	>15.1	>20.2
Preselector path >950 to 2,000	>20.6	>20.9	>18.8	>19.4

[4] *Gain* is the maximum NI 5693 gain setting.

[5] Control the NI 5693 module gain by setting the reference level and the IF output power level. The module gain is defined by the following equation: *Module Gain = IF Output Power Level - Reference Level*.

[6] *Gain range* is the difference between the maximum and minimum NI 5693 module gain settings.

Table 4. NI 5693 Gain Range (Typical)[6] (Continued)

Tune Frequency Range (MHz)	23 °C ± 5 °C (dB)		0 °C to 55 °C (dB)	
	Preamplifier Enabled	Preamplifier Disabled	Preamplifier Enabled	Preamplifier Disabled
Preselector path >2,000 to 3,000	>13.5	>21.3	>11.3	>19.6
Preselector path >3,000 to 5,800	>21.1	>21.6	>18.7	>19.5
Preselector path >5,800 to 7,000	>21.3	>21.2	>18.8	>19.1
Notch filters	—	>22.4	—	>21.1
External filter	—	>21.8	—	>20.3

Gain Accuracy

Table 5. NI 5693 Gain Accuracy (Typical)[7]

Frequency	23 °C ± 5 °C (dB)	0 °C to 55 °C (dB)
20 MHz to 2.0 GHz	±0.55	±0.6
>2.0 GHz to 3.0 GHz	±0.55	±0.6
>3.0 GHz to 7.0 GHz	±0.55	±0.6

Low-Frequency Bypass Path

Maximum insertion loss.....<1.8 dB, nominal

[6] *Gain range* is the difference between the maximum and minimum NI 5693 module gain settings.

[7] The **Downconverter Gain** property and the `NIRFSA_ATTR_DOWNCONVERTER_GAIN` attribute are read-only. *Gain accuracy* is the difference between the value reported by NI-RFSA and the measured gain.

Noise Figure

Table 6. NI 5693 Noise Figure[8]

Frequency	23 °C ± 5 °C (dB)	0 °C to 55 °C (dB)
20 MHz to 150 MHz	13	13
	12, typical	12, typical
>150 MHz to 2.5 GHz	14.5	15
	13, typical	14.5, typical
>2.5 GHz to 3.2 GHz	15	16
	14, typical	15, typical
>3.2 GHz to 5.5 GHz	18	18.5
	16, typical	17, typical
>5.5 GHz to 7.0 GHz	18.5	19.1
	16, typical	17, typical

Settling Time[9]

Filter switching

Within preselector bands 1 to 12 and 13 to 16.....200 µs, nominal

Switching between preselector bands 1 to 4 and notch filters.....200 µs, nominal

Switching between preselector bands 1 to 12 and 13 to 16.....200 µs, nominal

Gain switching.....200 µs, nominal

Preamplifier switching

Preselector bands 1 to 12.....100 µs, nominal

Preselector bands 13 to 16.....100 µs, nominal

[8] Noise figure verification uses the maximum NI 5693 module gain with the preamplifier enabled.

[9] Settled to within <0.1 dB of final amplitude.

Linearity

Third-Order Intercept Points

Table 7. NI 5693 Third-Order Intercept Points In-Band, Preamplifier Enabled[10]

Filter Path	Frequency (MHz)	Third-Order Intercept Point (dBm)	
		23 °C ± 5 °C	0 °C to 55 °C
Preselector path	20 to 150	-2.0	-2.0
		-1, typical	-1, typical
	>150 to 2,500	-7.0	-7.5
		-5.0, typical	-5.0, typical
	>2,500 to 3,200	-5.5	-6
		-5.0, typical	-5.0, typical
	>3,200 to 5,500	-5.0	-6.5
		-1.0, typical	-2.0, typical
	>5,500 to 7,000	-4.5	-5.5
		0, typical	-1.0, typical

[10] The values in this table were obtained from two -30 dBm tones spaced 700 kHz apart and the preselector set to the maximum NI 5693 module gain with the preamplifier enabled.

Table 8. NI 5693 Third-Order Intercept Points In-Band, Preamplifier Disabled[11]

Filter Path	Frequency (MHz)	Third-Order Intercept Point (dBm)	
		23 °C ± 5 °C	0 °C to 55 °C
Preselector path	20 to 150	+20	+20
		+22, typical	+22, typical
	>150 to 2,500	+18	+17
		+21, typical	+20, typical
	>2,500 to 3,200	+17	+16
		+21, typical	+20, typical
	>3,200 to 5,500	+14	+14
		+20, typical	+18, typical
	>5,500 to 7,000	+15	+14
		+20, typical	+18, typical
External filter[12]	20 to 150	+23, nominal	+22.5, nominal
	>150 to 2,500	+20, nominal	+19.5, nominal
	>2,500 to 3,000	+21, nominal	+20.5, nominal

[11] Two -10 dBm tones spaced 700 kHz apart and the preselector set to the maximum NI 5693 module gain with the preamplifier disabled.

[12] The external filter path uses an external 3-inch RF coaxial cable connected between the EXT FILTER IN and the EXT FILTER OUT connectors on the NI 5693.

Table 9. NI 5693 Third-Order Intercept Points Out-of-Band, Preamplifier Enabled[13]

Filter Path	Frequency (MHz)	Third-Order Intercept Point (dBm)	
		23 °C ± 5 °C	0 °C to 55 °C
Preselector path	20 to 150	+10	+9
		+17, typical	+15, typical
	>150 to 2,500	0	-1
		+4, typical	+3, typical
	>2,500 to 7,000	+9	+8
		+17, typical	+17, typical

Table 10. NI 5693 Third-Order Intercept Points Out-of-Band, Preamplifier Disabled[14]

Filter Path	Frequency (MHz)	Third-Order Intercept Point (dBm)	
		23 °C ± 5 °C	0 °C to 55 °C
Preselector path	20 to 150	+38	+38
		+42, typical	+40, typical
	>150 to 2,500	+30	+28
		+35, typical	+32, typical
	>2,500 to 7,000	+29	+29
		+34, typical	+33, typical

[13] Two -25 dBm tones placed outside the preselector passband such that the third-order intermodulation product falls in-band. Preselector set to maximum module gain and preamplifier enabled.

[14] Two -5 dBm tones placed outside the preselector passband such that the third-order intermodulation product falls in-band. Preselector set to maximum module gain and preamplifier disabled.

Second Harmonic Intercept Points[15]

Table 11. NI 5693 Second Harmonic Intercept Points, Preamplifier Enabled (Typical)

Filter Path	Source Frequency (MHz)	Second Harmonic Intercept Point (dBm)	
		23 °C ± 5 °C	0 °C to 55 °C
Internal	20 to 250	+61	+60
	>250 to 2,000	+48	+47
	>2,000 to 3,500	+64	+63

Table 12. NI 5693 Second Harmonic Intercept Points, Preamplifier Disabled (Typical)

Filter Path	Source Frequency (MHz)	Second Harmonic Intercept Point (dBm)	
		23 °C ± 5 °C	0 °C to 55 °C
Internal	20 to 250	+69	+68
	>250 to 3,500	+74	+73
External	20 to 1,000	+37, nominal	+35, nominal
	>1,000 to 1,500	+40, nominal	+36, nominal

[15] Single tone, power at RF IN connector at -5 dBm (preamplifier disabled) or -25 dBm (preamplifier enabled). For each preselector filter band, the tone frequency is set to the maximum center frequency tune range frequency divided by 2.

[16] The *gain compression* measurement uses a two-tone desensitization method with an input referred power level and maximum module gain. This method places two tones within the preselector filter center frequency range. The lower amplitude tone power is set to -30 dBm with the preamplifier disabled and -50 dBm with the preamplifier enabled. The amplitude variation for the lower amplitude tone level cannot be great than 1 dB, as the higher amplitude tone power is increased from low power to the 1 dB gain compression specified input power.

Input Power at 1 dB Gain Compression

Table 13. NI 5693 Input Power at 1 dB Gain Compression (Typical)[16]

Frequency (MHz)	23 °C ± 5 °C (dBm)		0 °C to 55 °C (dBm)	
	Preamplifier Enabled	Preamplifier Disabled	Preamplifier Enabled	Preamplifier Disabled
20 to 150	-16	+6	-19	+4
>150 to 2,500	-21	+5	-26	+3
>2,500 to 3,200	-16	+5	-20	+1.5
>3,200 to 5,500	-12	+4	-16	+1.5
>5,500 to 7,000	-11	+5	-15	+1.5

Spurious Responses

Non-Input-Related (Residual) Spurs [17]

>20 MHz to 150 MHz.....-60 dBm, typical

>150 MHz to 2,500 MHz.....-81 dBm, typical

>2,500 MHz to 7,000 MHz.....-95 dBm, typical

RF Input Connector Emissions Level

Table 14. NI 5693 RF IN Emissions Level (Typical)[18]

Frequency (MHz)	23 °C ± 5 °C (dBm)	
	Preamplifier Enabled	Preamplifier Disabled
20 to 3,000	< -92	< -91
3,000 to 7,000	< -95	< -94

[17] 23 °C ± 5 °C. Applies only to the RF OUT connector with the RF IN connector terminated. Measurements use the maximum gain setting and calibration signal disabled.

[18] Calibration signal disabled.

Reverse Isolation for Frequencies 4.2 GHz to 8.2 GHz

Table 15. NI 5693 Reverse Isolation for Frequencies 4.2 GHz to 8.2 GHz

Signal Path	23 °C ± 5 °C (dBm)	
	Preamplifier Enabled	Preamplifier Disabled
Preselector filters 1 to 4	>39	>39
	>46, typical	>46, typical
Preselector filters 5 to 8	>38	>38
	>45, typical	>45, typical
Preselector filters 9 to 12	>35	>35
	>41, typical	>41, typical
Preselector filters 13 to 16	>35	>35
	>43, typical	>41, typical
Notch filter	>35	>35
	>37, typical	>37, typical
External filter	—	>33, typical
Low-frequency bypass path	—	>33, typical

Reverse Isolation

Table 16. NI 5693 Reverse Isolation (Nominal)[19]

Signal Path	23 °C ± 5 °C (dB)	
	Preamplifier Enabled	Preamplifier Disabled
Preselector filters 1 to 4	>49	>35
Preselector filters 5 to 8	>50	>36
Preselector filters 9 to 12	>57	>36
Preselector filters 13 to 16	>43	>41

[19] Center frequency set to device center frequency.

Calibration Signal

Frequency range.....34.5 MHz to 7.0 GHz, nominal

Table 17. NI 5693 Calibration Signal Frequencies (Nominal)

Start Frequency (MHz)	Stop Frequency (MHz)	Frequency Resolution (kHz)
34.5	68.75	1.5625
>68.75	137.5	3.125
>137.5	275	6.250
>275	550	12.50
>550	1,100	25.00
>1,100	2,200	50.00
>2,200	4,200	100.0
>4,200	4,400	100.0
>4,400	7,000	200.0

Calibration Signal Amplitude Accuracy

Table 18. NI 5693 Calibration Signal Amplitude Accuracy[20]

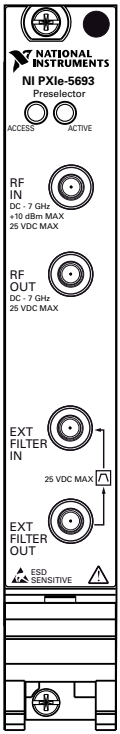
Frequency (MHz)	23 °C ± 5 °C (dB)	0 °C to 55 °C (dB)
34.5 MHz to 3.2 GHz	±0.9	±1.1
>3.2 GHz to 5.5 GHz	±1.2	±1.2
>5.5 GHz to 7 GHz	±1.1	±1.8

[20] Calibration tone power is referenced to the RF IN connector and is reported by the NI-RFSA **Cal Tone Power Referred to RF IN** property and the `NIRFSA_ATTR_CAL_TONE_POWER_REFERRED_TO_RF_IN` attribute. The calibration tone power is measured using an RF substitution technique that compares the RF power of a calibrated source as measured at the RF OUT connector with the calibration tone signal at the RF OUT connector.

Physical Characteristics

Hardware Front Panel

Figure 3. NI 5693 RF Preselector Module Front Panel



Front Panel Connectors

RF Input (RF IN)

Connector.....SMA female

Reference impedance.....50 Ω

Safe DC input voltage

Minimum.....-25 V

Maximum.....25 V

VSWR

Low-frequency bypass path.....<0.5 : 1
20 Hz to 30 MHz

Preselector filters 1 to 8.....<2.0 : 1

Preselector filters 9 to 10.....<2.6 : 1

Preselector filters 11 to 12.....<1.9 : 1

Preselector filters 13 to 16.....<3.6 : 1

External filter in connector.....<2.0 : 1

RF Output (RF OUT)

Connector.....SMA female

Reference impedance.....50 Ω

Safe DC input voltage

Minimum.....-25 V

Maximum.....25 V

VSWR

Low-frequency bypass path.....<1.5 : 1
>100 MHz

Preselector bands 1 to 8.....<1.8 : 1

Preselector bands 9 to 10.....<1.4 : 1

Preselector bands 11 to 12.....<1.4 : 1

Preselector bands 13 to 16.....<2.6 : 1

External filter out connector.....<1.7 : 1

External Filter Input/Output (EXT FILTER IN/EXT FILTER OUT)

Connector.....SMA female

Reference impedance.....50 Ω

Safe DC input voltage

Minimum.....-25 V

Maximum.....25 V

VSWR.....<2.0 : 1

Power

Power Limits

Table 19. NI 5693 Power Limits (Nominal)

Signal Path	RF IN Maximum Continuous Safe RF Power (dBm)	RF OUT Saturated Power (dBm)	RF OUT Maximum Continuous Safe RF Power (dBm)
Preselector bypass	+30	—	+30
Preselector with preamplifier disabled	+20	+15	+20
Preselector with preamplifier enabled	+20	+15	+20
External filter	+20	+15	+20

Power Requirements

3.3 V.....1.30 A, nominal

12 V.....0.85 A, nominal

Physical Dimensions

Size.....3U, Single-slot, PXI Express module
21.6 cm × 2.0 cm × 13.0 cm
(8.5 in. × 0.8 in. × 5.1 in.)

Weight.....465 g (16.4 oz)

Environment

Maximum altitude.....2,000 m (800 mbar) (at 25 °C ambient temperature)

Pollution Degree.....2

Indoor use only.

Operating Environment

Ambient temperature range.....0 °C to 55 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2. Meets MIL PRF-28800F Class 3 low temperature limit and MIL PRF-28800F Class 2 high temperature limit.)

Relative humidity range.....10% to 90%, noncondensing (Tested in accordance with IEC 60068-2-56.)

Storage Environment

Ambient temperature range.....- 41 °C to +71 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2. Meets MIL PRF-28800F Class 3 limits.)

Relative humidity range.....5% to 95%, noncondensing (Tested in accordance with IEC 60068-2-56.)

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.)

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.

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