DEVICE SPECIFICATIONS

NI PXIe-5694

IF Conditioning Module

This document lists specifications for the NI PXIe-5694.
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
- 10 MHz reference input uses a stable 10 MHz reference output signal with an accuracy of 10 MHz ± 0.5 ppm

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 5694 specifications, visit *ni.com/manuals*.

To access NI 5694 documentation, navigate to **Start»All Programs»National Instruments»NI-RFSA»Documentation**.

NATIONAL INSTRUMENTS

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

Hot Surface If the NI 5694 has been in use, it may exceed safe handling temperatures and cause burns. Allow the NI 5694 to cool before removing it from the chassis.

Caution The protection provided by the NI 5694 can be impaired if it is used in a manner not described in this document.

Contents

Electromagnetic Compatibility Guidelines

This product was tested and complies with the regulatory requirements and limits for electromagnetic compatibility (EMC) as stated in the product specifications. These requirements and limits are designed to provide reasonable protection against harmful interference when the product is operated in its intended operational electromagnetic environment.

This product is intended for use in industrial locations. There is no guarantee that harmful interference will not occur in a particular installation, when the product is connected to a test object, or if the product is used in residential areas. To minimize the potential for the product to cause interference to radio and television reception or to experience unacceptable performance degradation, install and use this product in strict accordance with the instructions in the product documentation.

Furthermore, any changes or modifications to the product not expressly approved by National Instruments could void your authority to operate it under your local regulatory rules.

Caution To ensure the specified EMC performance, operate this product only with shielded cables and accessories.

Caution Refer to the *Read Me First: Safety and Electromagnetic Compatibility* document for important safety and electromagnetic compatibility information. To obtain a copy of this document online, visit *ni.com/manuals*, and search for the document title.

Frequency

Input center frequency

IF conditioning bypass[1].....187.5 MHz, nominal

Signal conditioning downconversion disabled[2].....193.6 MHz, nominal

Signal conditioning downconversion enabled[3].....193.6 MHz, nominal

Output center frequency

IF conditioning bypass.....187.5 MHz, nominal

Signal conditioning downconversion disabled.....193.6 MHz, nominal

Signal conditioning downconversion enabled.....21.4 MHz, nominal

Table 1. NI 5694 Spectral Purity: 215 MHz LO Phase Noise (Typical)[4]

Offset Frequency	23 °C ± 5 °C (dBc/Hz)	0 °C to 55 °C (dBc/Hz)
100 Hz	-100	-98
1 kHz	-110	-108
10 kHz	-130	-128
100 kHz	-145	-143
1 MHz	-155	-153
2.5 MHz	-155	-153

1 Set the NI 5694 signal conditioning bypass path using Device Instantaneous Bandwidth property or the NIRFSA_ATTR_DEVICE_INSTANTANEOUS_BANDWIDTH attribute with a value greater than 20 MHz.

2 Select the NI 5694 IF signal conditioning path set by setting the Signal Conditioning Enabled property to Disabled or by setting the NIRFSA_ATTR_SIGNAL_CONDITIONING_ENABLED attribute to NIRFSA_VAL_DISABLED. This path is valid for a device instantaneous bandwidth less than or equal to 20 MHz.

3 Select the NI 5694 IF Downconversion path by setting the Signal Conditioning Enabled property to Enabled or by setting the NIRFSA_ATTR_SIGNAL_CONDITIONING_ENABLED to NIRFSA_VAL_ENABLED. This path is valid for a device instantaneous bandwidth less than or equal to 20 MHz.

4 Measured at the LO OUT connector using the NI PXIe-5693 10 MHz clock as a reference input signal.

Amplitude

Table 2. NI 5694 Gain (Typical)[5]

Signal Path	Step Gain Enabled Property	23 °C ± 5 °C Maximum Gain (dB)	23 °C ± 5 °C Nominal Gain Variation (dB)[6]
Signal conditioning bypassed	N/A	> -1.5	0.5
IF conditioning downconversion disabled	Disabled	-6.6	0 to 3
	Enabled	8.4	0 to 3
IF conditioning downconversion enabled	Disabled	4.1	0 to 3.3
	Enabled	19.3	0 to 3.5

Table 3. NI 5694 Gain Accuracy (Typical)[7]

Signal Path	Step Gain Enabled Property	23 °C ± 5 °C (dB)	0 °C to 55 °C (dB)
Signal conditioning bypassed	N/A	±0.40	±1.0
IF conditioning downconversion disabled	Disabled	±0.20	±0.42
	Enabled	±0.30	±0.69
IF conditioning downconversion enabled	Disabled	±0.30	±0.56
	Enabled	±0.30	±0.60

[5] You can control the NI 5694 module gain by setting the Reference Level and the IF Output Power Level properties or the NIRFSA_ATTR_REFERENCE_LEVEL and the NIRFSA_ATTR_IF_OUTPUT_POWER_LEVEL attributes. The NI 5694 module gain is defined by the following equation: *Module Gain = Reference Level - IF Output Power Level*.

[6] Gain variation covers path-to-path variations.

[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 actual measured gain.

Table 4. NI 5694 Gain Range (Typical)[8]

Signal Path	Step Gain Enabled Property	23 °C ± 5 °C (dB)	0 °C to 55 °C (dB)
IF conditioning downconversion disabled	Disabled	23.1	21.2
	Enabled	23.1	21.1
IF conditioning downconversion enabled	Disabled	22.7	20.3
	Enabled	22.7	20.3

Calibrated gain range (23 °C ± 5 °C).....25 dB, nominal

Gain resolution (23 °C ± 5 °C).....1 dB, nominal

Analog IF Bandwidth

Bandpass Filter Passband

Table 5. NI 5694 Bandpass Filter Passband (Typical)

Signal Path	Minimum 3 dB Bandwidth	Final IF Center Frequency	Filter Technology[9]
Signal conditioning bypassed	160 MHz	187.5 MHz	N/A
20 MHz filter	20 MHz	193.6 MHz	LC
5 MHz filter	5 MHz	193.6 MHz or 21.4 MHz	LC
1.4 MHz filter	1.4 MHz	193.6 MHz or 21.4 MHz	SAW
400 kHz filter	400 kHz	193.6 MHz or 21.4 MHz	SAW
30 kHz filter	30 kHz	21.4 MHz	Quartz crystal

[8] *Gain range* is the difference between the maximum and minimum NI 5694 module gain settings.
[9] LC refers to discrete component filters and SAW refers to surface acoustic wave filters.

Bandpass Filter Rejection

Table 6. NI 5694 Bandpass Filter Rejection (Typical)

Signal Path	Frequency Offset[10] (± MHz)	Stopband Rejection (dBc)
20 MHz filter	23.0	>30
5 MHz filter	11.0	>30
1.4 MHz filter	1.40	>28
400 kHz filter	0.525	>28
30 kHz filter	0.025	>30

Linearity

Table 7. NI 5694 Third-Order Intercept Point In-Band (Typical)[11]

Signal Path	Step Gain Enabled Property	23 °C ± 5 °C (dBm)	0 °C to 55 °C (dBm)
Signal conditioning bypassed	N/A	+40, nominal	+40, nominal
IF conditioning downconversion disabled	Disabled	+31	+31
	Enabled	+22	+21
IF conditioning downconversion enabled	Disabled	+21	+20
	Enabled	+16	+14

Table 8. NI 5694 Third-Order Intercept Point Out-of-Band[12]

Signal Path	Step Gain Enabled Property	23 °C ± 5 °C (dBm)	0 °C to 55 °C (dBm)
IF conditioning downconversion disabled	Disabled	+40	+40
	Enabled	+32	+32

[10] The frequency offset is relative to the IF center frequency output signal, which is either 193.6 MHz or 21.4 MHz.

[11] *In-band* refers to the two fundamental tones and the two relevant third-order intermodulation tone products falling within the relevant analog filter passband.

[12] *Out-of-band* third-order intermodulation refers to two tones that are spaced at 1.5 times the filter bandwidth such that the third intermodulation product falls at the passband center frequency.

Table 8. NI 5694 Third-Order Intercept Point Out-of-Band[12] (Continued)

Signal Path	Step Gain Enabled Property	23 °C ± 5 °C (dBm)	0 °C to 55 °C (dBm)
IF conditioning downconversion enabled	Disabled	+29	+28
	Enabled	+25	+24

Gain Compression

Table 9. NI 5694 Gain Compression (Typical)[13]

Signal Path	Step Gain Enabled Property	Filter Path	23 °C ± 5 °C (dBm)	0 °C to 55 °C (dBm)
IF conditioning downconversion disabled	Disabled	20 MHz	15.1	15.1
		5 MHz	15.2	15.1
		1.4 MHz	14.6	14.5
		400 kHz	15.0	15.0
	Enabled	20 MHz	6	5.5
		5 MHz	6	5.5
		1.4 MHz	8	8
		400 kHz	8	8

[12] *Out-of-band* third-order intermodulation refers to two tones that are spaced at 1.5 times the filter bandwidth such that the third intermodulation product falls at the passband center frequency.

[13] 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 filter passband. The lower amplitude tone level cannot have an amplitude variation greater than 1 dB as the higher amplitude tone power is increased.

Table 9. NI 5694 Gain Compression (Typical)[13] (Continued)

Signal Path	Step Gain Enabled Property	Filter Path	23 °C ± 5 °C (dBm)	0 °C to 55 °C (dBm)
IF conditioning downconversion enabled	Disabled	5 MHz	10.5	10
		1.4 MHz	13.5	13
		400 kHz	13.5	12.5
		30 kHz	11	10
	Enabled	5 MHz	-4.5	-5
		1.4 MHz	-1.5	-2.5
		400 kHz	-1.5	-3
		30 kHz	-4	-5.5

Settling Time[14]

To downconversion path[15].....500 ms, nominal

From downconversion path.....50 ms, nominal

Filter path.....200 µs, nominal

Gain path.....200 µs, nominal

Spurious Responses

IF rejection for IF conditioning downconversion enabled.....92 dBc, typical

Residual responses.....-81 dBm, typical

[13] 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 filter passband. The lower amplitude tone level cannot have an amplitude variation greater than 1 dB as the higher amplitude tone power is increased.

[14] Amplitude settled to <0.1 dB of final value.

[15] This value includes phase and frequency settling to less than 0.1 ppm when switching to downconversion enabled mode while utilizing the internal LO source.

Input-related spurs.....-96 dBc, typical
($M\times N$) at -15 dBm[16]

Reference clock harmonics.....-84 dBm, typical

Image rejection[17]

- 5 MHz filter path.....70 dBc, typical
- 1.4 MHz filter path.....66 dBc, typical
- 400 kHz filter path.....52 dBc, typical

LO feedthrough at IF IN connector.....-79 dBm, nominal

LO feedthrough at IF OUT.....-95 dBm, nominal
connector

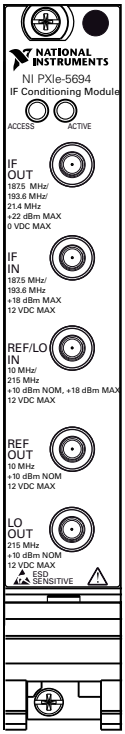
[16] $M\times N$ spurs apply to all paths except the 20 MHz filter path; the 20 MHz downconversion path is unspecified for spurious performance.

[17] Measurements use +10 dBm input power.

Physical Characteristics

Hardware Front Panel

Figure 1. NI 5694 IF Conditioning Module Front Panel



Front Panel Connectors

IF Input (IF IN)

Connector.....SMA female

Reference impedance.....50 Ω

Safe DC input voltage

Minimum.....-12 V

Maximum.....12 V

VSWR[18]

Signal conditioning bypass path.....<1.5:1, nominal

20 MHz filter.....<1.25:1, nominal

5 MHz filter.....<1.35:1, nominal

1.4 MHz filter.....<1.5:1, nominal

400 kHz filter.....<1.30:1, nominal

IF Output (IF OUT)

Connector.....SMA female

Reference impedance.....50 Ω

Safe DC input voltage

Minimum.....0 V

Maximum.....0 V

VSWR

Signal conditioning bypass path.....<1.35:1, nominal

187.5 MHz ± 80 MHz

IF conditioning.....<1.5:1, nominal

193.6 MHz ± filter bandwidth/2

IF conditioning.....<1.5:1, nominal

21.4 MHz ± Filter Bandwidth/2

Reference/LO Input (REF/LO IN)

Connector.....SMA female

Reference impedance.....50 Ω

Input frequency

REF IN[19].....10 MHz, ±5 ppm

LO IN[20].....215 MHz, nominal

Safe DC input voltage

Minimum.....-12 V

Maximum.....12 V

VSWR (10 MHz or 215 MHz).....<2:1, nominal

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18 VSWR measured across respective instantaneous bandwidth.

19 Use the Ref Clock Source property or the NI_RFSA_ATTR_REF_CLOCK_SOURCE attribute to select REF IN for the REF/LO IN connector.

20 Use the LO Source property or the NIRFSA_ATTR_LO_SOURCE attribute to select LO IN for the REF/LO IN connector.

Operating power

REF IN[19].....10 dBm ± 1 dB

LO IN[20].....10 dBm ± 1 dB

Reference Output (REF OUT)

Connector.....SMA female

Reference impedance.....50 Ω

Frequency.....10 MHz

Safe DC Input voltage

Minimum.....-12 V

Maximum.....12 V

VSWR.....<2:1, nominal

Output power.....10 dBm ± 1 dB, typical

LO Output (LO OUT)

Connector.....SMA female

Reference impedance.....50 Ω

Frequency.....215 MHz

Safe DC input voltage

Minimum.....-12 V

Maximum.....12 V

VSWR.....<2:1, nominal

Output power.....10 dBm ± 1 dB, typical

Power

Maximum Safe Continuous RF Power

IF IN.....+18 dBm

IF OUT.....+10 dBm

REF/LO IN.....+20 dBm

REF OUT.....+10 dBm

LO OUT.....+10 dBm

Table 10. NI 5694 Maximum Power Levels

Signal Path	IF IN Terminal Maximum Operating Power (dBm)[21]		IF OUT Terminal Maximum Power (dBm)
	Step Gain Enabled Property Disabled	Step Gain Enabled Property Enabled	
Signal conditioning bypassed	+10	+10	+22
IF conditioning downconversion disabled	0	-10	+22
IF conditioning downconversion enabled	0	-10	+22

Power requirements

3.3 V.....1.31 A

12 V.....1.40 A

Physical Dimensions

Size.....3U, One 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 (at 25 °C ambient temperature)

Pollution Degree.....2

Indoor use only.

[21] Value taken at the maximum Reference Level property or NIRFSA_ATTR_REFERENCE_LEVEL attribute setting.

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.)

Operational shock.....30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC-60068-2-27. Test profile developed in accordance with MIL-PRF-28800F)

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
- 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 and certifications, refer to the *Online Product Certification* section.

CE Compliance CE

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Online Product Certification

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 not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* 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 Electrical and Electronic Equipment, visit *ni.com/environment/weee.htm*.

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`.)

Where to Go for Support

The National Instruments Web site 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.

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*.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at *ni.com/support* and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, visit the Worldwide Offices section of *ni.com/niglobal* to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

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