

Last Revised: 2014-11-06 07:14:09.0

## 250 MS/s, 14-Bit Digitizer Adapter Module for NI FlexRIO

### NI 5761

- 250 MS/s sample rate at 14-bit resolution
- 4 channels, simultaneously sampled
- AC- and DC-coupled versions
- Requires an NI FlexRIO FPGA module
- Requires programming with LabVIEW FPGA or HDL

### Overview

The NI 5761 adapter module for NI FlexRIO is a broadband high-performance digitizer designed to meet a wide range of signal processing application needs. The module features four analog input channels with 14-bit resolution. With an analog bandwidth of 500 MHz and a sample rate of 250 MS/s, the NI 5761 is ideal for undersampling IF communications signals up to the 4th Nyquist zone. Eight built-in digital I/O lines are suitable for a variety of applications, from implementing custom triggering to control of system upconverters or downconverters.

[Back to Top](#)

### Application and Technology

The NI 5761 digitizer adapter module for NI FlexRIO uses the Texas Instruments ADS62P49 analog-to-digital converter (ADC), offering excellent 14-bit dynamic performance ideal for IF and RF communications applications:

Specification	Analog Input
Sample Rate	250 MS/s
Resolution	14 bits
Number of Channels	4
Bandwidth (AC-Coupled)	0.1 MHz to 500 MHz
Bandwidth (DC-Coupled)	DC to 500 MHz
Input Range (AC-Coupled)	2.07 V <sub>pk-pk</sub>
Input Range (DC-Coupled)	1.23 V <sub>pk-pk</sub>
Coupling	AC or DC
Input Impedance	50 Ω
SFDR (@ 123.17 MHz, AC-Coupled)	80 dB
SFDR (@ 122.1 MHz, DC-Coupled)	58 dB

Table 1. Key Typical Specifications for the NI 5761

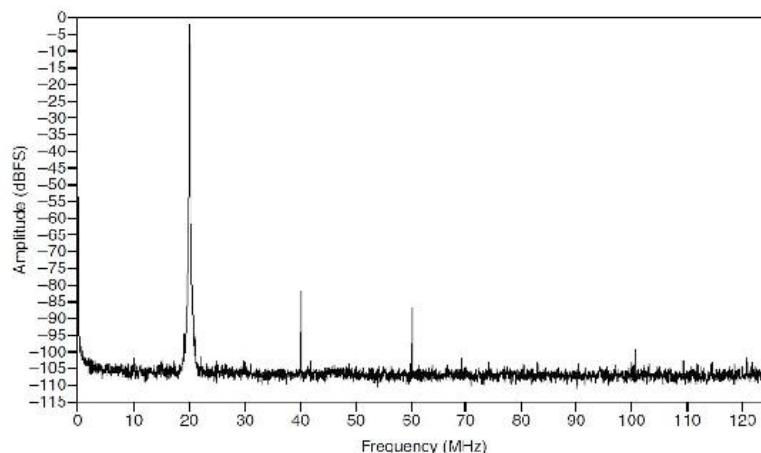
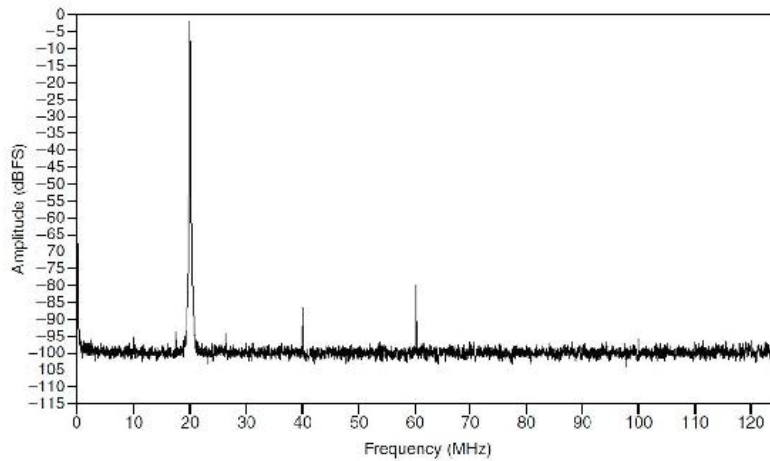


Figure 1. AC-Coupled Spectral Measurements: 20.1 MHz, -1 dBFS, 8192-Point FFT, 10 RMS Average



**Figure 2.** DC-Coupled Spectral Measurements: 20.1 MHz, -1 dBFS, 8192-Point FFT, 10 RMS Average

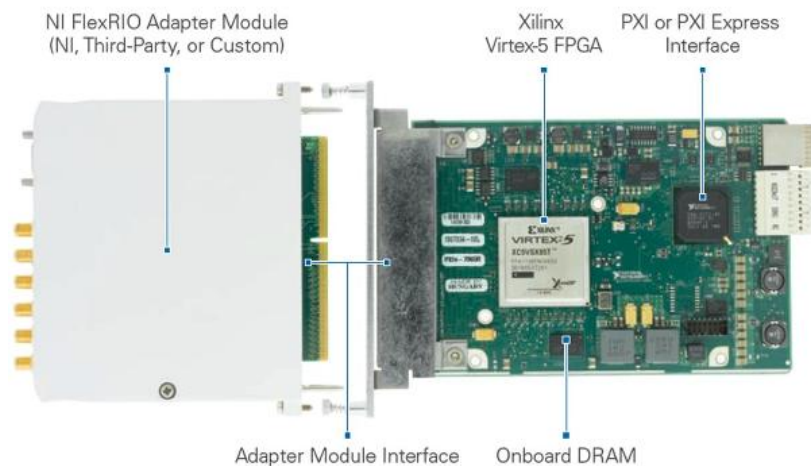
Coupled with an NI FlexRIO field-programmable gate array (FPGA) module, the NI 5761 provides a powerful solution for applications requiring a high-speed digitizer with excellent 14-bit dynamic performance and a user-accessible FPGA for custom real-time processing.

Application	Example Algorithms
Custom communications receivers	Custom modulation and demodulation, bit error rate test, fading profiles, additive noise
IF acquisition at the common frequencies of 10.7 MHz, 70 MHz, and 140 MHz, and band-limited direct RF acquisition	Digital downconversion, demodulation, packet assembly
Phase-coherent MIMO acquisition	Algorithm prototyping, cross-correlation
Signals intelligence	FFT operations, digital downconversion, channelization, triggering, cross-correlation
High-resolution time domain measurements	Custom data triggers, hysteresis, time in region, timing and voltage measurements

**Table 2.** Key Typical Specifications for the NI 5761

### About NI FlexRIO

The NI FlexRIO family consists of PXI and PXI Express FPGA modules coupled to I/O adapter modules. Programmed with the NI LabVIEW FPGA Module, these modules together provide high-performance I/O and user-defined hardware processing on the PXI platform.



**Figure 3.** NI FlexRIO Architecture

NI FlexRIO FPGA modules feature the latest in FPGA technology and high-performance bus interfaces.

Model	Bus/Form Factor	FPGA	FPGA Slices	FPGA DSP Slices	FPGA Memory (Block RAM)	Onboard Memory (DRAM)
NI PXIe-7965R	PXI Express	Virtex-5 SX95T	14,720	640	8,784 kbits	512 MB
NI PXIe-7962R	PXI Express	Virtex-5 SX50T	8,160	288	4,752 kbits	512 MB
NI PXIe-7961R	PXI Express	Virtex-5 SX50T	8,160	288	4,752 kbits	0 MB
NI PXI-7954R	PXI	Virtex-5 LX110	17,280	64	4,608 kbits	128 MB
NI PXI-7953R	PXI	Virtex-5 LX85	12,960	48	3,456 kbits	128 MB
NI PXI-7952R	PXI	Virtex-5 LX50	7,200	48	1,728 kbits	128 MB
NI PXI-7951R	PXI	Virtex-5 LX30	4,800	32	1,152 kbits	0 MB

**Table 3. NI FlexRIO FPGA Module Options**

PXI Express NI FlexRIO FPGA modules incorporate Xilinx Virtex-5 SXT FPGAs with up to 512 MB of onboard DRAM, which you can access at bandwidths up to 3.2 GB/s. In addition to general-purpose reconfigurable logic, SXT FPGAs are optimized for high-speed digital signal processing (DSP), with up to 640 DSP slices for single-cycle multiplication and filtering functions. PXI Express NI FlexRIO FPGA modules also feature the NI STC-3 application-specific integrated circuit (ASIC), providing an optimized, high-bandwidth PCI Express x4 communications link to the backplane of the PXI Express chassis. This ASIC reduces the FPGA resources needed to implement host communication and enables new data transfer technology in the unique peer-to-peer (P2P) streaming feature. With NI P2P data streaming technology, you can continuously transfer data to and from PXI Express NI FlexRIO FPGA modules at rates greater than 800 MB/s for additional processing and I/O integration. You can also stream to and from select PXI Express NI modular instruments for an even greater variety of I/O.

PXI NI FlexRIO FPGA modules feature Xilinx Virtex-5 LX FPGAs with up to 128 MB of onboard DRAM, which you can access at bandwidths up to 1.6 GB/s. They feature all the benefits of the PXI platform including synchronization, triggering, and high-speed data transfer to and from their hosts.

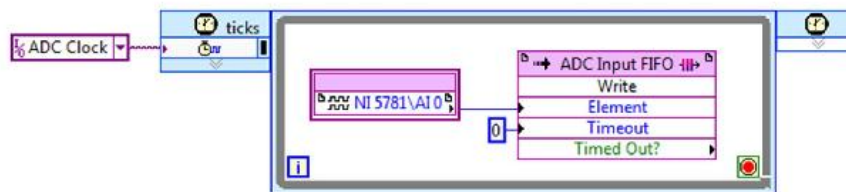
Feature	PXI NI FlexRIO FPGA Modules	PXI Express NI FlexRIO FPGA Modules
Xilinx Virtex-5 FPGAs	✓	✓
132-Line Line Adapter Module Interface	✓	✓
I/O Module Synchronization Clock	—	✓
Peer-to-Peer Data Streaming	—	✓

**Table 4. PXI and PXI Express FPGA Module Comparison**

National Instruments and third parties offer NI FlexRIO adapter modules, and you can build your own adapter modules using the NI FlexRIO Adapter Module Development Kit (MDK). With custom adapter modules, you can implement the exact analog and digital I/O your application requires, along with graphical FPGA programming provided by LabVIEW. View a current list of NI and third-party adapter modules at [ni.com/flexrio](http://ni.com/flexrio). This ability to easily create high-bandwidth P2P data streams helps provide scalable signal processing and I/O integration.

## LabVIEW FPGA

With the high-level graphical programming capabilities of LabVIEW FPGA, programming for the NI 5761 is far simpler than low-level HDL programming. Figure 4 depicts acquiring samples from a digitizer adapter module at its configured rate and placing the data into an FPGA FIFO.



**Figure 4. LabVIEW FPGA Code for Acquiring Data from an NI FlexRIO Digitizer Adapter Module**

From this point, you may implement your own processing, filtering, fast Fourier transform (FFT), or control. Figure 5 shows custom demodulation using IP from the FPGA RF Communications Library on [ni.com/labs](http://ni.com/labs).

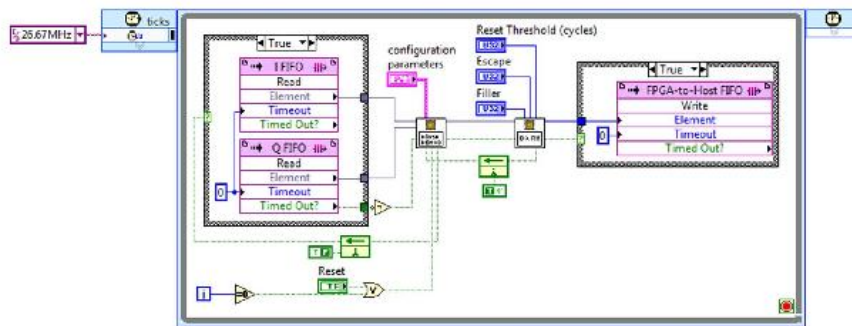


Figure 5. LabVIEW FPGA Code for Demodulating and Decoding I and Q Signals after 4X Decimation

For implementing a real-time spectrum analyzer, Figure 6 shows code that performs windowing, conversion to the frequency domain, comparison against a frequency mask, and assertion of a trigger when that mask is exceeded.

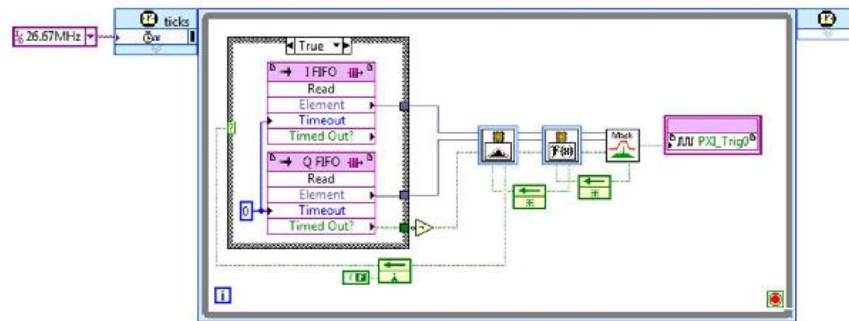


Figure 6. LabVIEW FPGA Code for Real-Time Spectrum Analyzer

Finally, Figure 7 shows a custom, 128-tap inline finite impulse response (FIR) filter with reloadable coefficients. After filtering, the data is generated through a digital-to-analog converter.

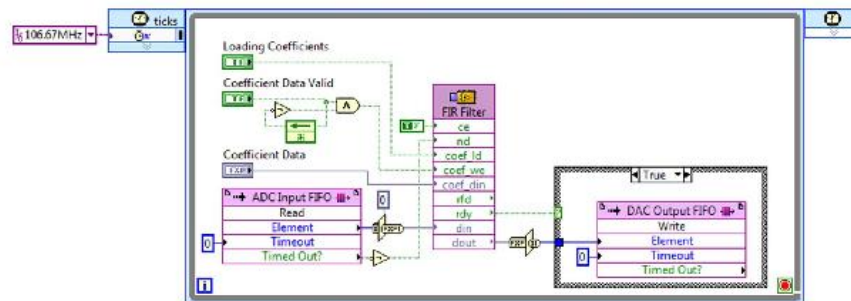


Figure 7. LabVIEW FPGA Code for an Inline Filter

[Back to Top](#)

## Support and Services

### System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at [ni.com/advisor](http://ni.com/advisor) to find a system assurance program to meet your needs.

### Technical Support

Get answers to your technical questions using the following National Instruments resources.

- **Support** - Visit [ni.com/support](http://ni.com/support) to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.
- **Discussion Forums** - Visit [forums.ni.com](http://forums.ni.com) for a diverse set of discussion boards on topics you care about.
- **Online Community** - Visit [community.ni.com](http://community.ni.com) to find, contribute, or collaborate on customer-contributed technical content with users like you.

## Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit [ni.com/repair](http://ni.com/repair).

## Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

- **Classroom training in cities worldwide** - the most comprehensive hands-on training taught by engineers.
- **On-site training at your facility** - an excellent option to train multiple employees at the same time.
- **Online instructor-led training** - lower-cost, remote training if classroom or on-site courses are not possible.
- **Course kits** - lowest-cost, self-paced training that you can use as reference guides.
- **Training memberships** and training credits - to buy now and schedule training later.

Visit [ni.com/training](http://ni.com/training) for more information.

## Extended Warranty

NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit [ni.com/warranty](http://ni.com/warranty).

## OEM

NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit [ni.com/oem](http://ni.com/oem).

## Alliance

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 700 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit [ni.com/alliance](http://ni.com/alliance).

[Back to Top](#)

## Detailed Specifications

This section lists the specifications of the NI FlexRIO adapter module (NI 5761). Pair these specifications with the specifications listed in the *NI FlexRIO FPGA Module Installation Guide and Specifications*. For more information about safety and electromagnetic compatibility refer to the *Read Me First: Safety and Electromagnetic Compatibility* document included in your hardware kit or available at [ni.com/manuals](http://ni.com/manuals).



**Caution** To avoid permanent damage to the NI 5761, disconnect all signals connected to the NI 5761 before powering down the module, and only connect signals after the module has been powered on by the NI FlexRIO FPGA module.



**Note** All numeric specifications are typical unless otherwise noted. All graphs illustrate the performance of a representative module.

Typical values describe useful product performance that are not covered by warranty. Typical values cover the expected performance of units over ambient temperature ranges of 23 ±5 °C with a 90% confidence level, based on measurements taken during development or production.

### Analog Input (AI CH 0 through AI CH 3)

#### General Characteristics

Number of channels	Four, single-ended, simultaneously sampled
Connector	SMA
Input impedance	50 Ω, per connector
Sample rate	
Internal Sample clock	250 MHz
External Sample clock	175 MHz to 250 MHz
Digital data range	±8,191
ADC part number	ADS62P49 <sup>1</sup> ; 14-bit resolution, dual ADC

#### AC-Coupled Specifications

Input range (normal operating conditions)	2.07 V <sub>pk-pk</sub>
Absolute maximum input	±10 V DC, 5 V <sub>pk-pk</sub> AC
Bandwidth (–3 dB)	0.1 MHz to 500 MHz
Bandwidth (–1 dB)	1 MHz to 250 MHz

The following table lists the AC-coupled spectral performance measurements. All values are measured with a 250 MHz external Sample clock.

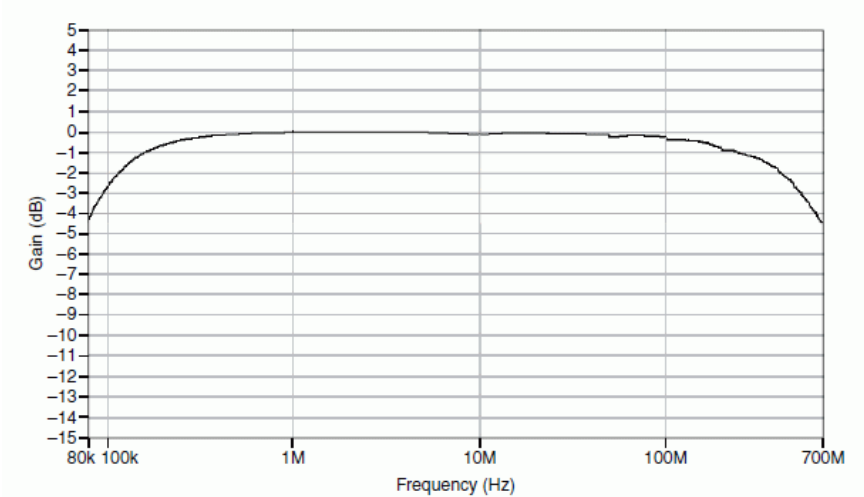
AC-Coupled Spectral Performance			
Measurement	20.17 MHz	70.17 MHz*	123.17 MHz*
SNR	72.5 dB	71.4 dB	70.5 dB
SINAD	72.3 dB	71.2 dB	70.3 dB
SFDR	88 dB	84 dB	80 dB
* These measurements were extrapolated from a -4 dBFS plot.			

Channel to channel isolation

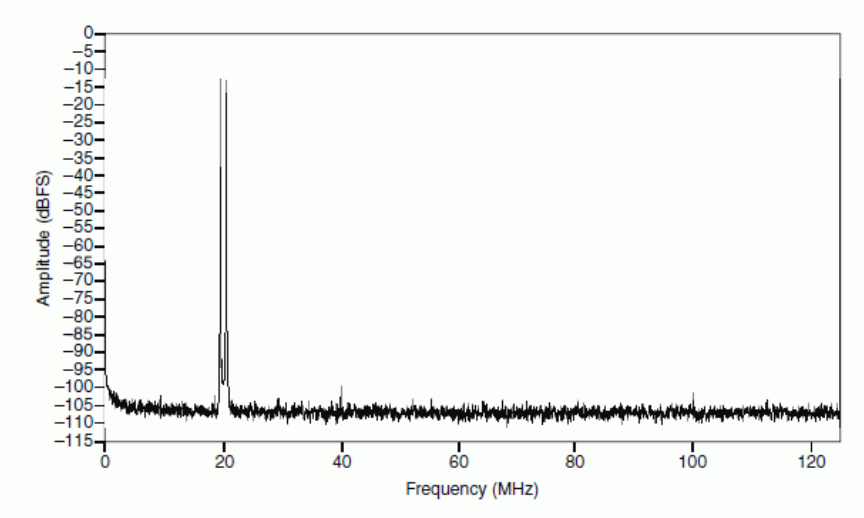
1 MHz	>90 dB
100.1 MHz	90 dB
501 MHz	80 dB

AC-Coupled Measurements

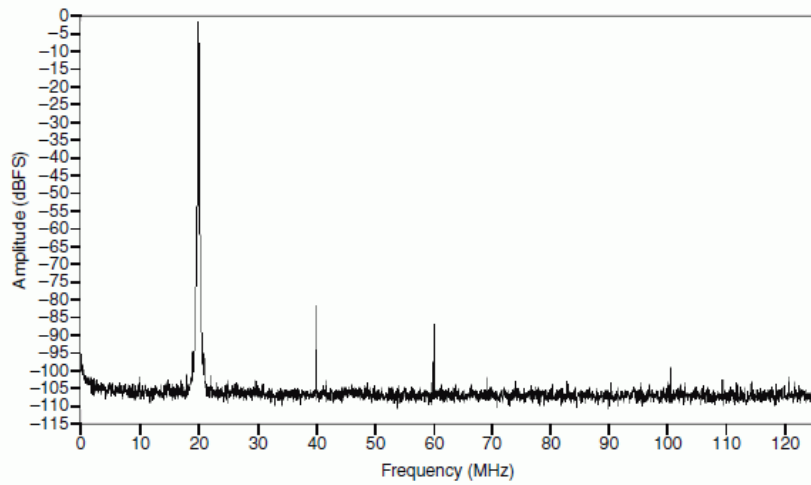
AC-Coupled Bandwidth (Passband)



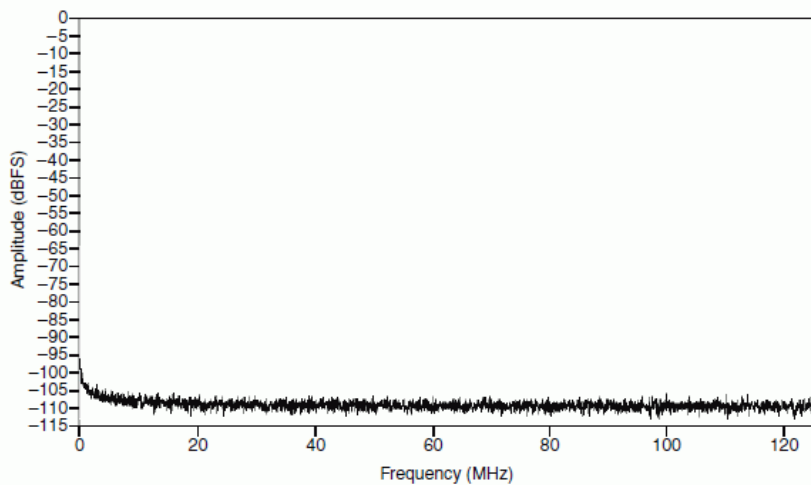
AC-Coupled Spectral Measurements: 19.5 MHz and 20.5 MHz, -13 dBFS, 8,192 Point FFT, 10 RMS Average



AC-Coupled Spectral Measurements: 20.1 MHz, -1 dBFS, 8,192 Point FFT, 10 RMS Average



AC-Coupled Spectral Measurements: Terminated, 8,192 Point FFT, 10 RMS Average



#### DC-Coupled Specifications

Input range (normal operating conditions)	1.23 V <sub>pk-pk</sub>
Absolute maximum input	±4.5 V DC
Bandwidth (–3 dB)	DC to 500 MHz
Bandwidth (–1 dB)	DC to 250 MHz

The following table lists the DC-coupled spectral performance measurements. All values are measured with a 250 MHz external Sample clock.

DC-Coupled Spectral Performance			
Measurement	20.1 MHz	70.1 MHz	122.1 MHz
SNR	65.7 dB	64.3 dB	63 dB
SINAD	65.2 dB	61.8 dB	56.6 dB
SFDR	76 dB	65 dB	58 dB

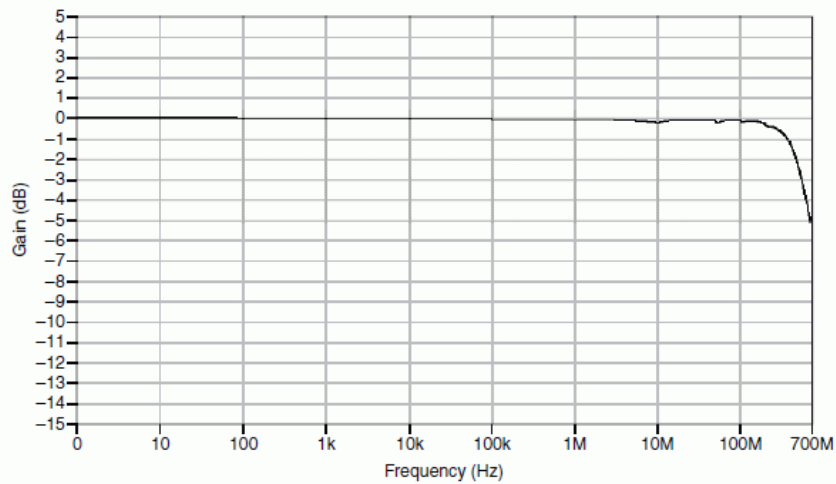
Channel to channel isolation	
1 MHz	>90 dB
100.1 MHz	80 dB
501 MHz	70 dB

**Note** To ensure proper device operation, DC-coupled channels on the NI 5761 must see 50 Ω at DC looking back at their source. If you are connecting a to source with an output impedance less than 50 Ω, you can add series resistance close to the source to properly bias the NI 5761 input terminals. You can also use the NI 5761 input

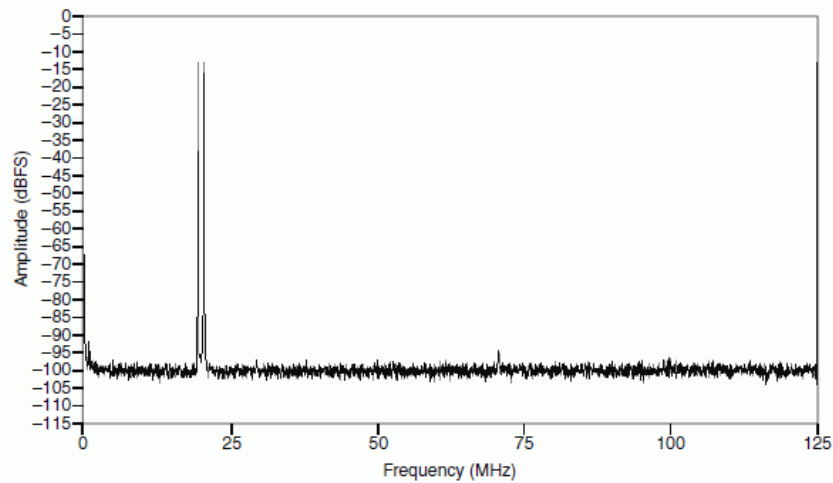
channel bias DACs to remove DC offset present in the system. For more information about programming the bias DACs, refer to the NI 5761 CLIP topics in the *NI FlexRIO Help*.

## DC-Coupled Measurements

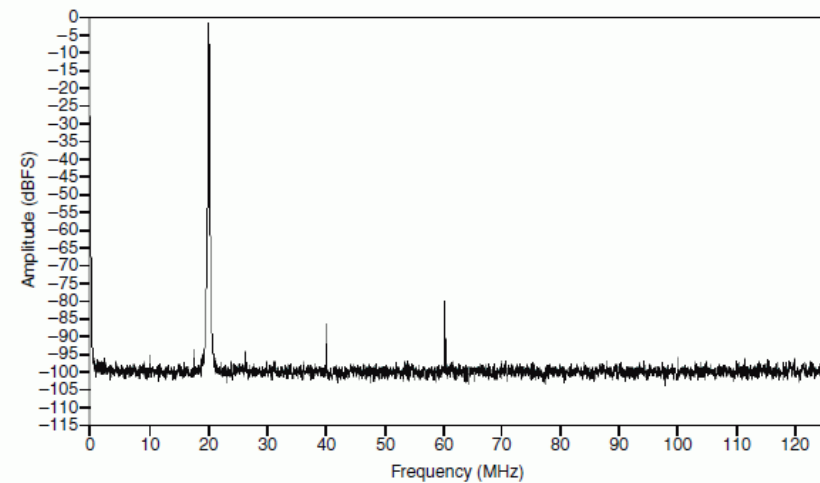
### DC-Coupled Bandwidth (Passband)



### DC-Coupled Spectral Measurements: 19.5 MHz and 20.5 MHz, -13 dBFS, 8,192 Point FFT, 10 RMS Average

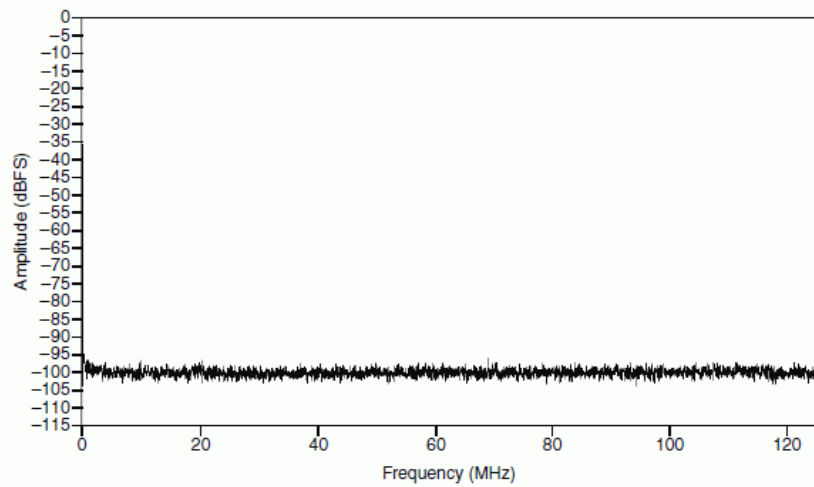


### DC-Coupled Spectral Measurements: 20.1 MHz, -1 dBFS, 8,192 Point FFT, 10 RMS Average

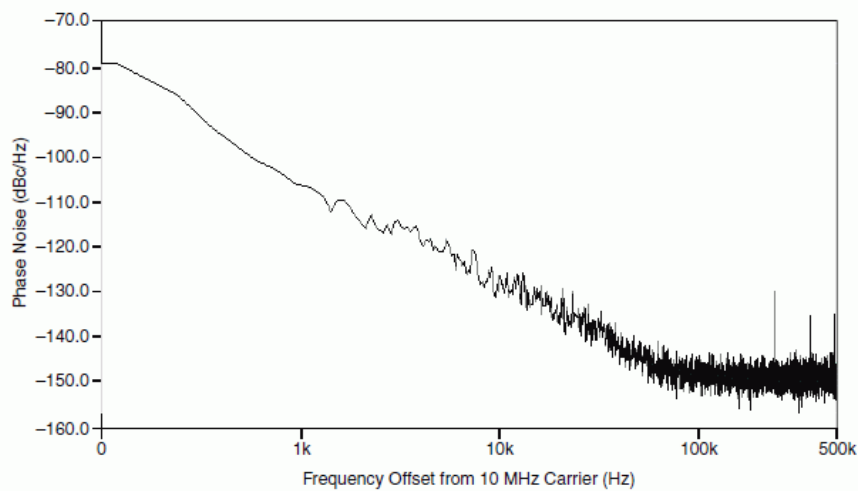


### DC-Coupled Spectral Measurements: Terminated, 8,192 Point FFT, 10 RMS Average





#### Analog Input Phase Noise



#### Internal Sample Clock

##### General Characteristics

Oscillator type	Fixed frequency synthesizer
Frequency	250 MHz
Reference spurs	<70 dBc
Phase noise	
10 kHz offset	-100 dBc/Hz
100 kHz offset	-120 dBc/Hz
Clock distribution part number	AD9512 <sup>2</sup> ; clock distribution
Reference clock sources	Internal, External through the CLK IN connector, or IoModSyncClk <sup>3</sup>
Internal reference type	TCXO
Internal reference stability	±1 ppm
Internal reference frequency	10 MHz

#### CLK IN

##### General Characteristics

Number of channels	1, single-ended
Connector	SMA

Input impedance	50 Ω																		
Input coupling	AC																		
External Sample Clock																			
Input voltage range	0.63 V <sub>pk-pk</sub> to 2.5 V <sub>pk-pk</sub>																		
Input frequency range	175 MHz to 250 MHz																		
Absolute maximum input	±10 V DC, 3.1 V <sub>pk-pk</sub> AC																		
External Reference Clock																			
Input voltage range	1.4 V <sub>pk-pk</sub> to 4.4 V <sub>pk-pk</sub>																		
Input frequency range	10 MHz																		
Absolute maximum input	±10 V DC, 5 V <sub>pk-pk</sub> AC																		
External Trigger																			
General Characteristics																			
Number of channels	1, single-ended																		
Connector	SMA																		
Input impedance	50 Ω																		
Input coupling	DC																		
<table><tr><th colspan="3">Input levels</th></tr><tr><th>Voltage Level</th><th>Minimum</th><th>Maximum</th></tr><tr><td>V<sub>IL</sub></td><td>0 V</td><td>0.7 V</td></tr><tr><td>V<sub>IH</sub></td><td>1.7 V</td><td>5.5 V</td></tr></table>		Input levels			Voltage Level	Minimum	Maximum	V <sub>IL</sub>	0 V	0.7 V	V <sub>IH</sub>	1.7 V	5.5 V						
Input levels																			
Voltage Level	Minimum	Maximum																	
V <sub>IL</sub>	0 V	0.7 V																	
V <sub>IH</sub>	1.7 V	5.5 V																	
Absolute maximum input	−0.5 V to 7 V																		
PFI<0..7>																			
General Characteristics																			
Number of channels	8 bidirectional																		
Connector type	Micro—D																		
Interface standard	2.5 V LVCMOS																		
<table><tr><th colspan="3">Interface logic</th></tr><tr><th>Voltage Level</th><th>Minimum</th><th>Maximum</th></tr><tr><td>V<sub>IL</sub></td><td>0 V</td><td>0.7 V</td></tr><tr><td>V<sub>IH</sub></td><td>1.7 V</td><td>5.5 V</td></tr><tr><td>V<sub>OL</sub></td><td>0 V</td><td>0.4 V</td></tr><tr><td>V<sub>OH</sub></td><td>1.9 V</td><td>2.5 V</td></tr></table>		Interface logic			Voltage Level	Minimum	Maximum	V <sub>IL</sub>	0 V	0.7 V	V <sub>IH</sub>	1.7 V	5.5 V	V <sub>OL</sub>	0 V	0.4 V	V <sub>OH</sub>	1.9 V	2.5 V
Interface logic																			
Voltage Level	Minimum	Maximum																	
V <sub>IL</sub>	0 V	0.7 V																	
V <sub>IH</sub>	1.7 V	5.5 V																	
V <sub>OL</sub>	0 V	0.4 V																	
V <sub>OH</sub>	1.9 V	2.5 V																	
Z <sub>in</sub>	17.5 kΩ																		
Z <sub>out</sub>	50 Ω																		
I <sub>out</sub>	2 mA																		
Maximum toggle frequency	500 kHz																		
Absolute maximum input	−0.5 V to 7 V																		
EEPROM Map																			

Byte Address	Size (Bytes)	Field Name
0x4	4	Serial Number
0x8	116	Reserved
0x7C	132	User Space



**Caution** Only write to *User Space*. Writing to any other offset may cause the NI 5761 to stop functioning.

## Power

Total power, typical operation 5.3 W

## Physical

Dimensions 12.9 × 2.0 × 12.1 cm (5.1 × 0.8 × 4.7 in.)

Weight 312 g (11 oz)

Front panel connectors 6 SMA and one Micro-D connector

## Environmental

The NI 5761 is intended for indoor use only.

Operating environment <sup>4</sup> 0 °C to 55 °C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

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

Altitude 2,000 m at 25 °C ambient temperature.

Pollution Degree 2

Storage environment

Ambient temperature range –20 °C to 70 °C, tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.

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



**Note** Clean the device with a soft, non-metallic brush. Make sure that the device is completely dry and free from contaminants before returning it to service.

## Safety Standards

This product is designed to meet 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 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 (IEC 61326): 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** For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.



**Note** For EMC compliance, operate this device with shielded cables and accessories.

## CE Compliance

This product meets the essential requirements of applicable European Directives 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 Declaration of Conformity for this product, visit [ni.com/certification](http://ni.com/certification), search by module number or product line, and click the appropriate link in the Certification column.

## Environmental Management

National Instruments 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](http://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](http://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](http://ni.com/environment/rohs_china)。  
(For information about China RoHS compliance, go to [ni.com/environment/rohs\\_china](http://ni.com/environment/rohs_china).)

<sup>1</sup> For additional information on the ADS62P49, refer to the Texas Instruments device data sheet at [www.ti.com](http://www.ti.com).

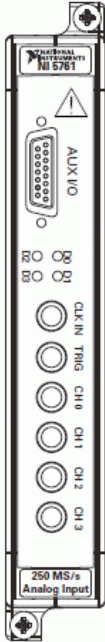
<sup>2</sup> For additional information about the AD9512, refer to the Analog Devices device data sheet at [www.analog.com](http://www.analog.com).

<sup>3</sup> IoModSyncCk is available only on the NI PXIe-796xR FPGA modules.

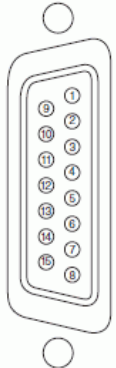
<sup>4</sup> For PXI/PXI Express chassis configurations that group NI FlexRIO adapter modules in three or more contiguous slots, National Instruments recommends limiting the ambient operating temperature to less than 50 °C.

[Back to Top](#)

## Pinouts/Front Panel Connections

Device Front Panel	Connector	Signal Description
	AUX I/O	Refer to Table 2 for the signal names and descriptions.
	D<0..3>	LEDs for custom configuration.
	CLK IN	Provides the NI 5761 with an external Sample clock or Reference clock.
	TRIG	Trigger input channel.
	CH 0	Analog input channels <0..3>.
	CH 1	
	CH 2	
	CH 3	

NI 5761 Front Panel Connectors

Micro-D Connector	Pin	Signal	Signal Description
	1	AUXIO0	General-purpose digital input or output channels.
	2	AUXIO1	
	3	AUXIO2	
	4	AUXIO3	
	5	AUXIO4	
	6	AUXIO5	
	7	AUXIO6	
	8	AUXIO7	
	9	GND	Ground.
	10	GND	
	11	GND	
	12	GND	
	13	GND	
	14	GND	
	15	GND	

NI 5761 AUX I/O Connector Pin Assignments

[Back to Top](#)

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