PXI RF Signal Conditioning

NI PXI-5690, NI PXI-5691, NI PXI-5695 *NEW!*

Key Amplifier Features
- Up to +24 dBm maximum output power
- Up to 30 dB gain
- 0.5 dB gain resolution
- Typical noise figure <5 dB
- Both fixed and programmable gain channels

Key Attenuator Features
- Up to 60 dB total attenuation
- 0.5 dB attenuation resolution
- 1.2:1 typical voltage standing wave ratio (VSWR)
- Both fixed and programmable attenuator channels

Operating System
- Windows 7/XP/2000/NT

Recommended Software
- LabVIEW
- LabWindows™/CVI
- C/C++/.NET

Driver Software (included)
- NI-5690

Overview

National Instruments PXI RF signal conditioning modules include low-noise/high-gain amplifiers and programmable attenuators. You can use these 3U PXI modules to optimize the dynamic range of PXI RF vector signal generators and analyzers. The NI PXI-5690 is a 100 kHz to 3 GHz, two-channel programmable amplifier and attenuator; the NI PXI-5691 is a 50 MHz to 8 GHz, two-channel programmable amplifier; and the NI PXI-5695 is a 50 MHz to 8 GHz, two-channel programmable attenuator.

RF Signal Conditioning Applications

You can use PXI programmable amplifiers with both RF signal generators and RF signal analyzers. When combined with RF vector signal generators, PXI RF amplifiers enable high-power signal generation. For example, the PXI-5691 offers up to 28 dB of gain and a 1 dB compression point of +21 dBm. Using this module, you can extend the upper power range of your vector signal generator.

When used with RF vector signal analyzers, the same programmable amplifiers can improve the noise floor of the measurement system. For example, with a typical noise figure of 5 dB at 2.5 GHz, the PXI-5691 programmable amplifier can be combined with the NI PXI-5663 RF vector signal analyzer to measure signals down to -163 dBm/Hz.

With PXI programmable attenuators, you can improve the power accuracy of your RF signal generator in lower power ranges. With an external attenuator, you generate RF signals in the most accurate range of the signal generator and attenuate the signal to the desired output power.

PXI RF Amplifiers

	PXI-5690 (2.5 GHz)	PXI-5691 (2.5 GHz)	PXI-5691 (6.6 GHz)
CH0 Gain	31 dB	28 dB	27 dB
CH0 Noise Figure	5.5 dB	5 dB	4 dB
CH0 P1dB	+18 dBm	+21 dBm	+21 dBm
CH0 IP3 (TOI)	+23 dBm	+33 dBm	+33 dBm
CH0 Max Output Power	+20 dBm	+25 dBm	+25 dBm
CH1 Max Gain	16 dB	28 dB	21 dB
CH1 Noise Figure	8 dB	5 dB	5 dB
CH1 P1dB	+16 dBm	+21 dBm	+21 dBm
CH1 IP3 (TOI)	+15 dBm	+33 dBm	+33 dBm
CH1 Max Output Power	+20 dBm	+25 dBm	+25 dBm

Note: All values are typical results at either 2.5 or 6.6 GHz.

Table 1. PXI RF Programmable Amplifiers Comparison

PXI-5690 RF Programmable Amplifier/Attenuator

The PXI-5690 is a 100 kHz to 3 GHz, two-channel programmable amplifier and attenuator with one fixed gain path and one programmable gain/attenuation path. The combined paths offer up to 37 dB of total signal gain at 2.5 GHz when signal paths are cascaded.

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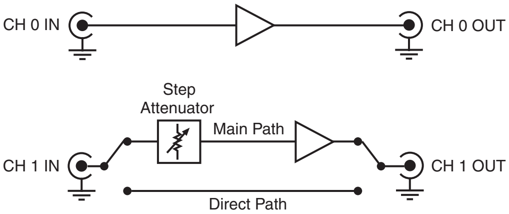

Figure 1. PXI-5690 Block Diagram

Channel 0 functions as a fixed gain preamplifier with a typical gain of 30 dB across all frequencies. This channel offers a low noise figure and a flat frequency response.

Channel 1 functions as a programmable preamplifier containing two user-selectable paths. The main path consists of a step attenuator followed by a fixed gain amplifier. The step attenuator is software programmable in 1 dB steps. In software, you can configure channel 1 to provide up to 10 dB of attenuation or up to 22 dB of gain – depending on frequency range. The direct path gives you the option of bypassing the attenuator-amplifier circuitry.

PXI-5691 RF Programmable Amplifier

The PXI-5691 is a 50 MHz to 8 GHz, two-channel programmable amplifier with one fixed gain path and one programmable gain path. The combined paths can provide up to 55 dB of total signal gain at 2.5 GHz when the two channels are cascaded.

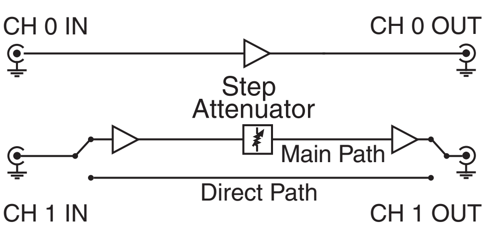

Figure 2. PXI-5691 Block Diagram

Channel 0 functions as a fixed gain preamplifier with a typical gain of more than 26 dB across all frequencies. This channel offers a low noise figure and a flat frequency response.

Channel 1 functions as a programmable preamplifier containing two user-selectable paths. The main path consists of fixed gain amplification preceded by a step attenuator that is adjustable by software in 0.5 dB nominal steps. The direct path gives you the option of bypassing the attenuator-amplifier circuitry.

PXI-5695 RF Programmable Attenuator

The PXI-5695 is a 50 MHz to 8 GHz, two-channel RF programmable attenuator with one fixed attenuation path and one programmable attenuation path. The combined paths can provide up to 70 dB of total attenuation at 2.5 GHz when cascaded.

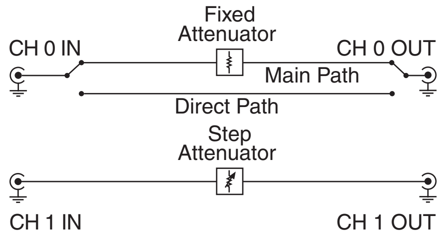

Figure 3. PXI-5695 Block Diagram

Channel 0 functions as a fixed attenuator with more than 27.5 dB of attenuation across all frequencies.

Channel 1 functions as a programmable attenuator with up to 42 dB of attenuation across all frequencies. You can control this attenuator programmatically in software with 0.5 dB resolution.

Software

You can programmatically control PXI-569x modules using NI-5690 programming software. This driver provides C-style and NI LabVIEW APIs to help you control both gain and attenuation. A block diagram of a basic LabVIEW example to control the PXI-5691 amplifier is shown in Figure 4.

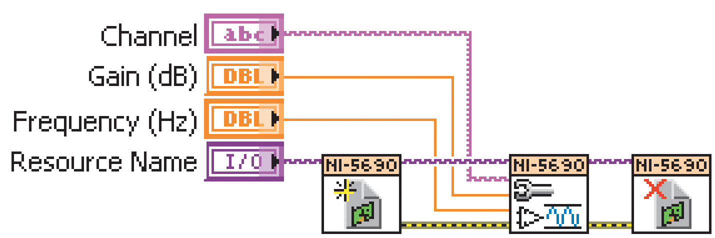

Figure 4. You can control PXI RF signal conditioning modules with NI LabVIEW software.

Ordering Information

NI PXI-5690	779465-01
NI PXI-5691	781035-01
NI PXI-5695	781036-01

BUY NOW

For complete product specifications, pricing, and accessory information, call 800 813 3693 (U.S.) or go to **ni.com/rf**.

NI PXI-5690 Specifications

Channel 0 (CH 0)

Main Path Specification

Gain calibration accuracy	±0.4 dB[1]
Gain variation by temperature	Less than -0.03 dB/°C
Maximum output power	+20 dBm
Output 1 dB compression	+18 dBm typical
Second harmonic at	+4 dBm, -40 dBc typical
Survival input power	-10 dBm maximum
DC voltage at input	±20 V maximum[2]

[1] Under 500 kHz, ±1.5 dB. For all frequencies, degrades by ±0.03 dB/°C outside by 15 to 35 °C temperature range.

[2] Nondamaging for steady-state DC only. Direct path passes input DC level to output.

Channel 1 (CH 1)

Main Path Specification

Gain calibration accuracy	±0.4 dB[1]
Gain variation by temperature	Less than -0.03 dB/°C
Maximum output power	+20 dBm
Output 1 dB compression	+16 dBm typical
Second harmonic at	+4 dBm, -40 dBc typical
Survival input power	+20 dBm maximum (with attenuation)
DC voltage at input	±20 V maximum[2]

[1] Under 500 kHz, ±1.5 dB. For all frequencies, degrades by ±0.03 dB/°C outside by 15 to 35 °C temperature range.

[2] Nondamaging for steady-state DC only. Direct path passes input DC level to output.

Direct Path Specification

Insertion loss calibration accuracy	±0.4 dB[1]
Survival input power	+20 dBm maximum (with attenuation)
DC voltage at input	±20 V maximum[2]

[1] Under 500 kHz, ±1.5 dB. For all frequencies, degrades by ±0.03 dB/°C outside by 15 to 35 °C temperature range.

[2] Nondamaging for steady-state DC only. Direct path passes input DC level to output.

Channel 0 Performance

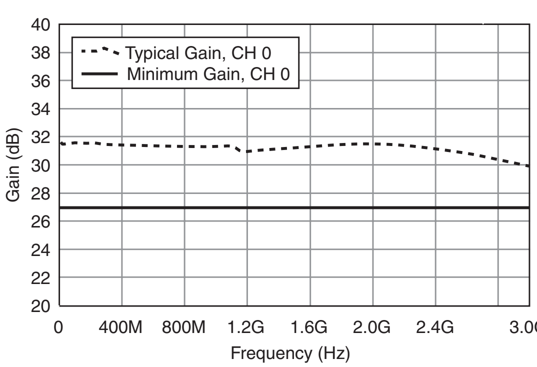

Figure 5. Gain

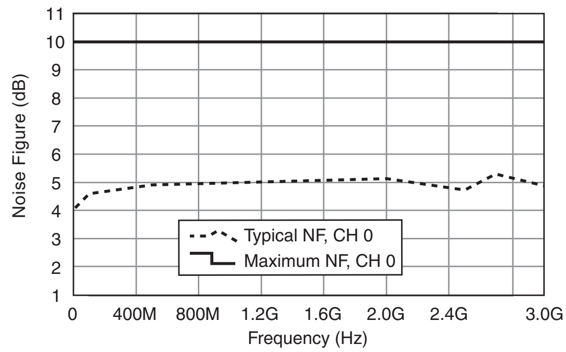

Figure 6. Noise Figure (NF)

Channel 1 Performance, Main Path

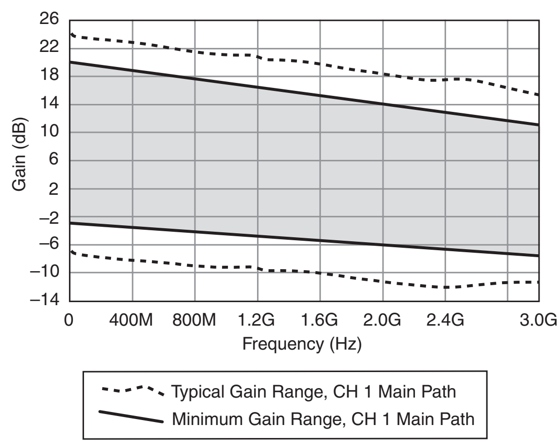

Figure 7. Programmable Gain Range

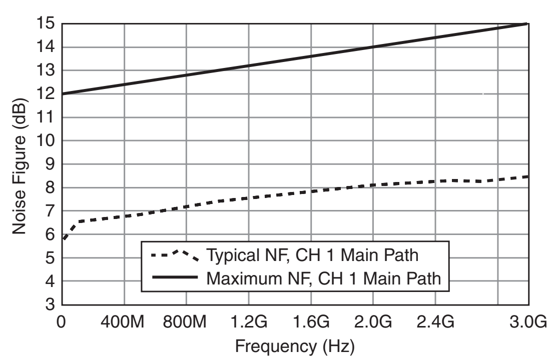

Figure 8. Noise Figure (NF)

NI PXI-5691 Specifications

Channel 0 (CH 0) Performance, Main Path

Level calibration accuracy	±0.9 dB[1]
Absolute maximum input power (no damage)	+30 dBm typical (7.1 V_{rms}, 10 V pk at 50 Ω)
Maximum reverse power (no damage)	+20 dBm maximum
Maximum output power (no damage)	+25 dBm maximum
DC voltage at input	±10 V typical[2]
Gain variation by temperature	$(-1.18*10^{-12} * F) - 0.01$ in dB/°C[3] F = Frequency in Hz

[1] Valid for T_{ref} ±5 °C. For temperatures other than T_{ref}, the level calibration accuracy is valid after applying the gain correction factor for ΔT.
[2] DC coupled from input to output, but only calibrated from 50 MHz to 8 GHz.
[3] Calculate the correction factor using the following equation:
*Δ Gain = (Gain Variation by temperature) * Δ* T
where $\Delta T = T_{sensor} - T_{ref}$
T_{sensor} = the temperature reading of the onboard temperature sensor in °C, as reported by the ni5690 Get Temperature VI or the ni5690_getTemperature function T_{ref} = 34 °C

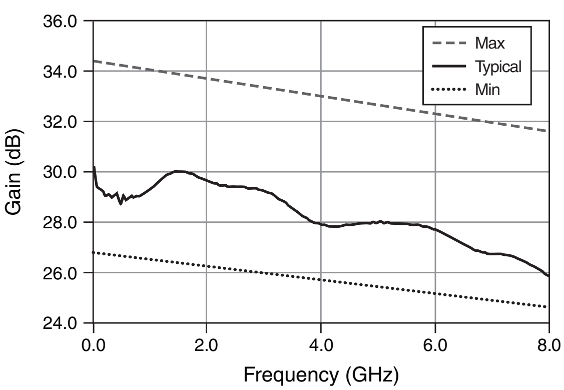

Figure 9. Measured Gain

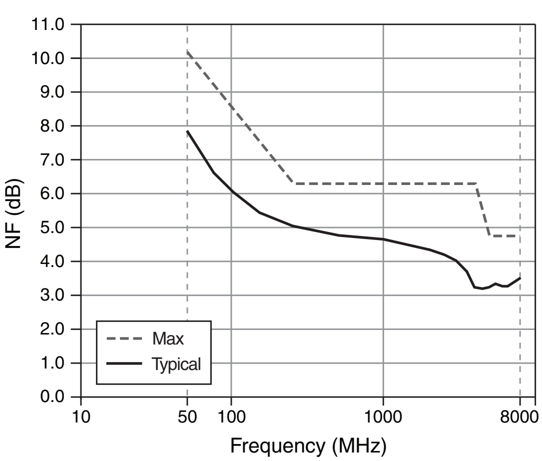

Figure 10. Measured Noise Figure

Channel 1 (CH 1) Performance, Main Path

Variable level range	+31.5 dB
Attenuation resolution	+0.5 dB typical
Level settling time	+4 µs maximum[1]
Level calibration accuracy	±0.9 dB[2]
Absolute maximum input power (no damage)	+30 dBm typical (7.1 V_{rms}, 10 V_{pk} at 50 Ω)
Maximum reverse power (no damage)	+20 dBm maximum
Maximum output power	+25 dBm maximum
DC voltage at input	±10 V typical
Gain variation by temperature	$(-1.34*10^{-12} * F) - 0.01$ in dB/°C[3] F = Frequency in Hz

[1] The attenuator settling time is measured to 0.5 dB of final value when switching from minimum to maximum attenuation. Achieving settling times closer to the final attenuation value may take substantially longer.
[2] Valid for T_{ref} ±5 °C. For temperatures other than T_{ref}, the level calibration accuracy is valid after applying the gain correction factor for ΔT.
[3] Calculate the correction factor using the following equation:
*Δ Gain = (Gain Variation by temperature) * Δ* T
where $\Delta T = T_{sensor} - T_{ref}$
T_{sensor} = the temperature reading of the onboard temperature sensor in °C, as reported by the ni5690 Get Temperature VI or the ni5690_getTemperature function T_{ref} = 34 °C

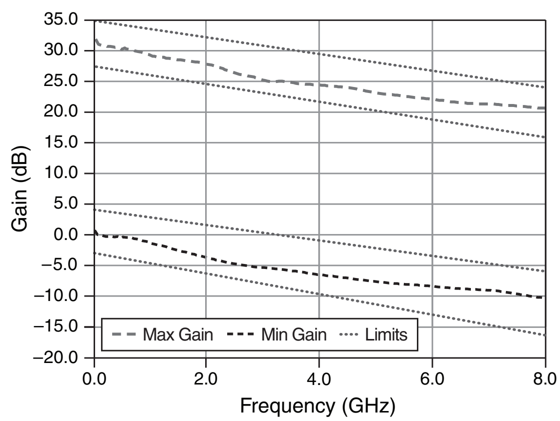

Figure 11. Measured Programmable Gain Range

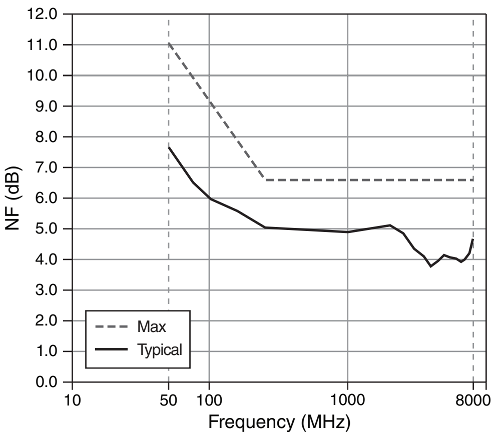

Figure 12. Measured Noise Figure

Channel 0/Channel 1 Cascaded Path Performance

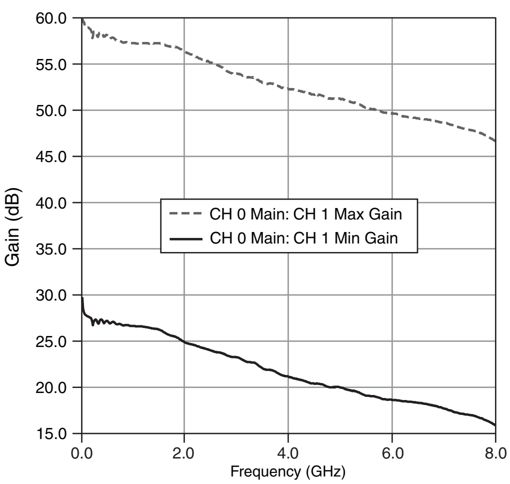

Figure 13. Measured Cascaded Gain Response

NI PXI-5695 Specifications

Channel 0 (CH 0) Performance, Main Path

Level calibration accuracy	±0.7 dB[1]
Maximum input power (operation)	+33 dBm maximum
(10 V_{rms}, 14 V_{pk})	
Absolute maximum input power (no damage)	+33 dBm maximum
Maximum reverse power (no damage)	+33 dBm maximum
DC voltage at input	±10 V maximum[2]
Gain variation by temperature	$(-4.66 \times 10^{-13} * F)$ in dB/°C[3] F = Frequency in Hz

[1] Valid for T_{ref} ±5 °C. For temperatures other than T_{ref}, the level calibration accuracy is valid after applying the gain correction factor for ΔT.
[2] DC coupled from input to output, but only calibrated from 50 MHz to 8 GHz.
[3] Calculate the correction factor using the following equation:
*Δ Gain = (Gain Variation by temperature) * Δ T*
where $\Delta T = T_{sensor} - T_{ref}$
T_{sensor} = the temperature reading of the onboard temperature sensor in °C, as reported by the ni5690 Get Temperature VI or the ni5690_getTemperature function T_{ref} = 26 °C

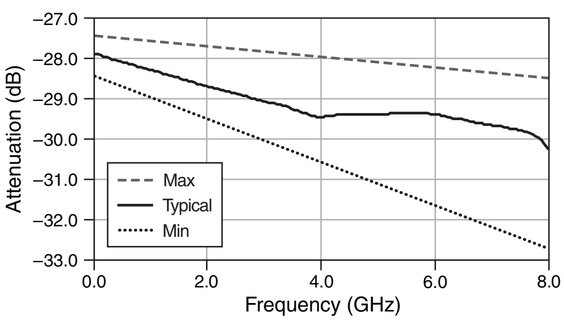

Figure 14. Measured Attenuation (Fixed Attenuator)

Channel 1 (CH 1) Performance

Programmable Path Specifications

Variable attenuator range	0 dB to +31.5 dB
Attenuation resolution	+0.5 dB typical
Level calibration accuracy	±0.7 dB[1]
Attenuation settling time	+4 µs maximum[2]
Maximum input power (operation)	+27 dBm maximum (5 V_{rms}, 7 V_{pk})
Absolute maximum input power (no damage)	+27 dBm maximum
Maximum reverse power (no damage)	+26 dBm maximum
Gain variation by temperature	$(-2.69 \times 10^{-13} * F)$ in dB/°C[3] F = Frequency in Hz

[1] Valid for T_{ref} ±5 °C. For temperatures other than T_{ref}, the level calibration accuracy is valid after applying the gain correction factor for ΔT.
[2] The attenuator settling time is measured to 0.5 dB of final value when switching from minimum to maximum attenuation. Achieving settling times closer to the final attenuation value may take substantially longer.
[3] Calculate the correction factor using the following equation:
*Δ Gain = (Gain Variation by temperature) * Δ T*
where $\Delta T = T_{sensor} - T_{ref}$
T_{sensor} = the temperature reading of the onboard temperature sensor in °C, as reported by the ni5690 Get Temperature VI or the ni5690_getTemperature function T_{ref} = 26 °C

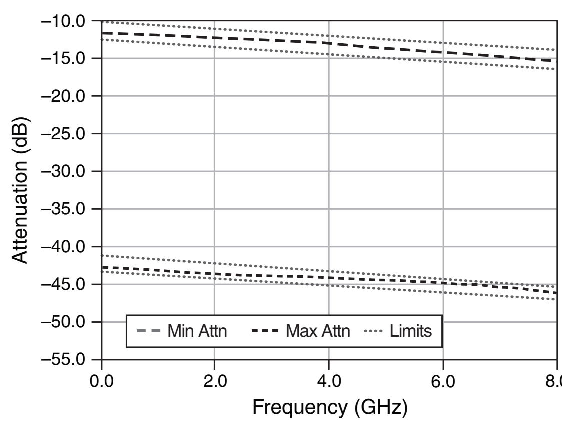

Figure 15. Measured Programmable Attenuation Range

Channel 0/Channel 1 Cascaded Path Performance

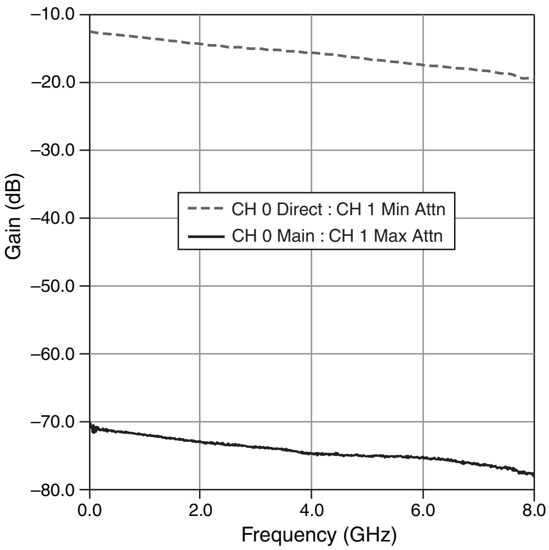

Figure 16. Cascaded Response

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