Keysight N5106A

PXB Baseband Generator and Channel Emulator

Data Sheet

KEYSIGHT TECHNOLOGIES

Definitions

Specification (spec): Represents warranted performance. Because this instrument is primarily digital in nature, there are no analog performance specifications.

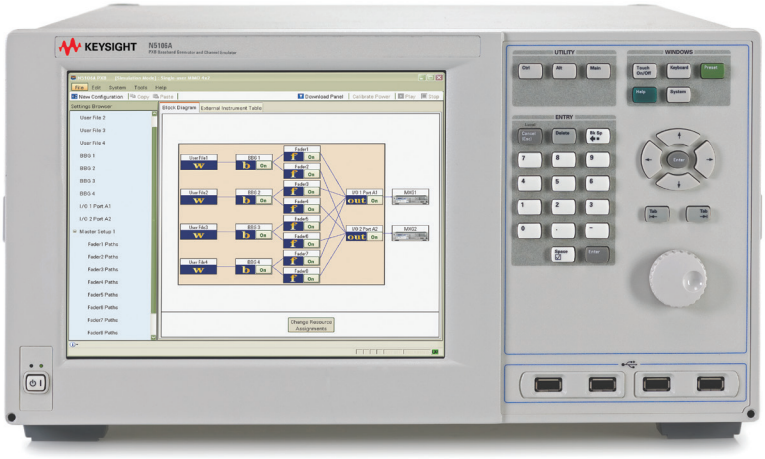
Typical (typ): Represents characteristic performance that is non-warranted. Describes performance that will be met by a minimum of 80% of all products.

Nominal (nom): Represents characteristic performance that is non-warranted. Represents the value of a parameter that is most likely to occur; the expected mean or average.

Measured (meas): Represents characteristic performance that is non-warranted. Represents the value of a parameter measured during the design phase.

Note: All graphs contain measured data from several units at room temperature (approximately 25 °C) unless otherwise noted.

General Characteristics



N5106A PXB baseband generator and channel emulator

Supported use cases and configurations

Use cases	Configurations
Baseband generation[1]	1, 2, 4, 6 channels
Baseband generation and sum[1]	2, 4 channels
Baseband generation and fading[1]	1, 2 channels
Single-user MIMO[1,3]	1x2, 1x4, 1x8, 2x1, 2x2, 2x4, 2x6, 2x8, 4x2, 4x4
Multi-user MIMO[1,3]	2x2, 2x4, 4x2, 4x4
RF and digital I/Q fading[1, 2]	1, 2 channels, 1 channel with interferer
MIMO RF and digital I/Q fading[1, 2, 3]	1x2, 2x2, 2x4, 2x6, 2x8, 4x2, 4x4
Signal capture	1 channel
E5515C (8960) fading	1, 2 channels, 1x2 (Rx diversity), 1 channel with interferer

1. This use case supports RF output with vector MXG/ESG and digital I/Q output with N5102A.
2. This use case supports RF input with PXA/MXA/EXA and digital I/Q input with N5102A.
3. MXGs and ESGs cannot be used together for MIMO configurations.

Baseband Generator Characteristics (Requires Option EFP)

Number of baseband generators Up to 6

Signal bandwidth

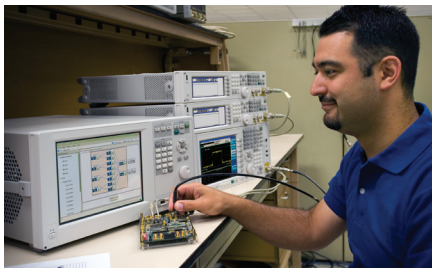
PXB output interface		Bandwidth
Analog I/Q outputs[2]		160 MHz[3]
Digital bus[4]	N5102A digital signal interface module	120 MHz
	N5162/82A MXG vector signal generators[5]	100 MHz
	E4438C ESG vector signal generators[6]	80 MHz

Arbitrary waveform memory generator	512 Msa (2 GB) per baseband
Sample rate	1 kSa/sec to 150 MSa/sec[1]
Resolution	14 bits[7]
Baseband frequency offset range	–80 MHz to 80 MHz[8]
Compatible signal formats	Signal Studio, E4438C, N5162/82A, Advanced Design System (ADS), SystemVue 2008, custom I/Q waveforms[9]
Numeric formats	Two's complement, offset binary
Waveform length	256 samples to 512 Msa
Waveform loading speed10	LAN to PXB hard drive: 4 MB/s (nom) PXB hard drive to arbitrary waveform memory: 20 MB/s (nom) External eSATA hard drive to PXB arbitrary waveform memory: 20 MB/s (nom)
RMS values for power control	Measured, previous RMS, user entered, waveform header RMS

When connected to the MXG/ESG via the digital bus, the PXB has negligible contribution to RF flatness, EVM, and ACP. See MXG/ESG data sheet for performance details.

1. Each baseband generator can individually set sample rate.
2. The PXB connected to the E4438C ESG via analog I/Q provides automatic power calibration at RF up to 120 MHz. RF power management when connected via the PXB's analog I/Q outputs to all other signal generators requires manual power calibration.
3. 60 MHz I and 60 MHz Q.
4. When the PXB output is connected via digital bus to the MXG/ESG, bandwidth is limited by the vector signal generator.
5. Requires MXG firmware revision A.01.44 or later.
6. Requires ESG firmware revision C.05.23 or later. Contact division for demo firmware.
7. 16-bit I/Q waveforms created for the E4438C and N5162/82A are compatible with the PXB. For optimal performance, PXB waveforms should be created with 16-bit resolution. Refer to the online documentation for more information.
8. Baseband offset range is limited by output instrument when connected via digital bus.
9. Users load waveforms into the PXB baseband generator for playback. See online documentation for details on custom waveform format.
10. Performance varies depending on external PC and LAN connection

Fader Characteristics (Requires Option QFP)



Simulate real-world conditions to test mulit-format receivers more quickly and validate design robustness earlier in the development cycle with the PXB.

Number of faders Up to 8

Fading bandwidth

Internal baseband generation and fading		Maximum bandwidth
Analog I/Q outputs[1]		160 MHz[2]
Digital bus[3]	N5102A digital signal interface module	120 MHz
	N5162/82A MXG vector signal generators[4]	100 MHz
	E4438C ESG vector signal generators[5]	80 MHz

External RF input for fading		Maximum bandwidth
Digital bus[6]	N9010A EXA[7], N9020A MXA[7], and N9030A PXA[8] vector signal analyzer	40 MHz[11]
	N5102A digital signal interface module	120 MHz
	E5515C (8960) wireless communications test set[9]	Standard dependent[10]

RF input -40 dBm to 15 dBm with EXA/MXA/PXA

RF output –115 dBm to 0 dBm with MXG
–115 dBm to –10 dBm with ESG

Paths per fader 6 paths @ 160 MHz
12 paths @ 80 MHz
24 paths @ 40 MHz

Paths per fader with fader interleaving for 4x4 and 2x8 (Option 169) 6 paths @ 80 MHz
12 paths @ 40 MHz
24 paths @ 20 MHz

Power accuracy When connected to the MXG/ESG via the digital bus, the PXB has negligible contribution to power accuracy. This is in comparison to the signal generators set to the same conditions separately. See MXG/ESG data sheet for performance details.

1. The PXB connected to the E4438C ESG via analog I/Q provides accurate power calibration at RF up to 160 MHz. RF power management when connected via the PXB's analog I/Q outputs to all other signal generators requires external power calibration.
2. 80 MHz I and 80 MHz Q.
3. When the PXB output is connected via digital bus to the MXG/ESG, bandwidth is limited by the vector signal generator.
4. Requires MXG firmware revision A.01.44 or later.
5. Requires ESG firmware revision C.05.23 or later.
6. When the PXB input is connected via digital bus to the PXA/MXA/EXA, fading bandwidth is limited by the vector signal analyzer.
7. Requires MXA firmware revision A.01.61 or later, EXA firmware revision A.04.26 or later.
8. Requires PXA firmware revision A.06.06 or later.
9. Requires E5515C-004 and the relevant Lab Application(s). Review online documentation or the configuration guide for Lab Application revision requirements.
10. EGPRS2-A and downlink dual carrier GSM requires RF fading.
11. Requires Option B25 for 25 MHz or B40 for 40 MHz bandwidth.

Fader Characteristics (Requires Option QFP) continued...

Predefined channel models	W-CDMA, HSDPA, HSUPA, COST 259, TD-SCDMA, cdma2000®, cdmaOne, 1xEV-DO, GSM, EDGE, WLAN, TETRA, 802.16 OFDM, 802.16 OFDMA, LTE (includes high speed train), MBRAI models for DVB-T and DVB-H
Predefined MIMO channel models[2]	LTE: 3GPP standard 36.101 Annex B,modified SCME urban micro-cell, SCME urban micro-cell, SCME urban macro-cell, WINNER II, single cluster EPA, single cluster SCME, 2D uniform (requires Option TFP) Mobile WiMAX™: channel model for MTG RCT (requires Option RFP)
Repetition interval	> 7 days
Random seed	89 bits
Fading types	Pure Doppler, Rayleigh, Rician, Suzuki, log normal
Spectral shape	Classical 3 dB, classical 6 dB, flat, rounded, Jakes classical, Jakes rounded, Gaussian
Rayleigh distribution	0.5 dB from –30 to + 10 dB of mean power level Deviation from CDF, filtered noise
Rician	
Power ratio (k) range	–84 dB to 84 dB
LOS AoA	0 to 360°
Path delay	0 to 2 ms
Resolution	0.1 ns
Accuracy	±(0.4 ns + 0.2% path delay) (meas)
Phase shift	0 to 360°
Resolution	0.01°
Path loss	0 to 84 dB
Resolution	0.01 dB
Accuracy	0.1 dB (meas)
Vehicle speed[1]	0 to 864 km/h @ 2 GHz
Resolution	0.01 km/h
Doppler frequency[1]	0 Hz to 1.6 kHz
Resolution	0.001 Hz
Accuracy	0.05% (meas)
Angle of arrival (AoA)	0 to 360°
Resolution	0.01°
Angle of departure (AoD)	0 to 360°
Resolution	0.01°
AoA Azimuth spread	0 to 360°
Resolution	0.01°
AoD Azimuth spread	0 to 360°
Resolution	0.01°
Log normal	
Standard deviation	0 to 12 dB
Decorrelation length	1 m to 1 km
MIMO correlation source	From wireless standard, from custom antenna setup, from custom correlation matrix
Custom correlation matrix	Channel to channel, path to path
Path configuration source	From wireless standard, custom
Antenna patterns	Omni-directional, three-sector, six-sector, uncor-
related, EMPro	user specified (2D and 3D antenna models from or equivalent)
Antenna spacing	–20 to 20 wavelengths in X and Y coordinates

1. Doppler frequency of vehicle speed is coupled to the carrier frequency setting in the Fader Setup view.
2. Implemented as filtered noise.

Dynamic Fading

Number of dynamic paths	Up to 24
Number of states[1]	1 to 5000
Requested dwell time[2]	10 ms to 1000s
Resolution	10 ms
Path loss	0 to 84 dB
Resolution	0.01 dB
Path delay	0 to 2 ms
Resolution	0.1 ns
Path UE speed	0 to 1726.8/carrier frequency in km/hr
Resolution	0.01 km/hr

Signal Capture Characteristics (Requires Option FFP)

Number of channels: Up to 1

Signal capture bandwidth

PXB input interface		Maximum bandwidth
Digital bus[3]	N5102A digital signal interface module	120 MHz
	N9010A EXA, N9020A MXA, and N9030A PXA vector signal analyzer	40 MHz[7]

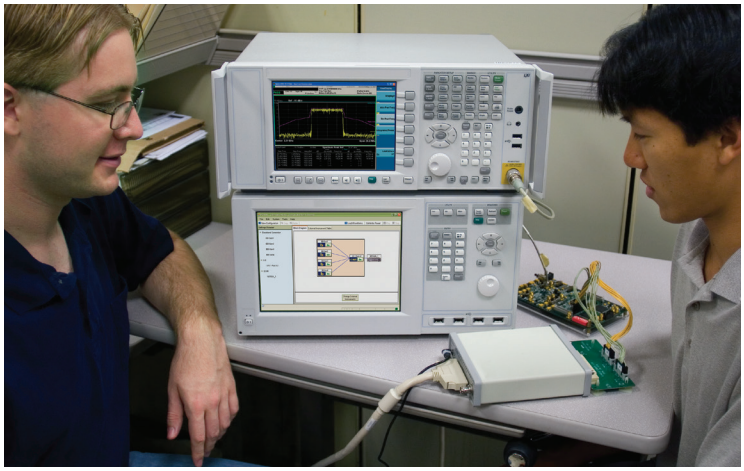
Signal capture sample rate[4]	1 kSa/sec to 150 MSa/sec
Signal capture depth[4]	256 samples to 512 Msa (2 GB) per channel
Signal capture duration[4]	Signal capture depth / sample rate
Resolution	14 bits
Trigger type	Free run, master trigger, magnitude
Trigger value[5]	0 to 46340
Trigger time delay[6]	0 to 2147483.647 seconds
Trigger sample delay	0 to 2147483647 samples
Trigger position	0 to 100%

Additive White Gaussian Noise (AWGN) Characteristics (Requires Option JFP)

AWGN bandwidth	Up to 120 MHz
Signal to noise (S/N) ratio	–20 dB to +40 dB
Resolution	0.1 dB
Accuracy	0.3 dB (meas)
Crest factor	12.88 dB
Units	SNR, Eb/No
Optimization	Constant signal power, constant noise power, constant SNR
Output MUX	Signal + noise, signal only, noise only
Repetition interval	> 7 days

1. States are defined in Microsoft Excel. The Excel template is included with the firmware installation.
2. Actual dwell time is calculated based on requested dwell time and UE speed. Refer to the help system for details.
3. When the PXB input is connected via digital bus, signal capture bandwidth is limited by the input device.
4. Each signal capture channel supports an independent sample rate, depth, and duration.
5. For magnitude trigger only.
6. Trigger time delay is variable, based on sample rate. It is the trigger sample delay/sample rate.
7. Requires Option B25 for 25 MHz or B40 for 40 MHz bandwidth.

Digital I/O Characteristics



Test baseband chipsets with the PXB and the N5102A digital signal interface module.

Logic types (requires N5102A)1	Single-ended: LVTTL, CMOS (1.5 V, 1.8 V, 2.5 V, 3.3 V) Differential: LVDS
Number of I/O ports2	2 per I/O card, up to 8 total
Resolution	14 bits
Baseband frequency offset	–80 MHz to 80 MHz3
I/Q skew	–2 ns to 2 ns
Resolution	1 ps
I/Q gain balance	–4 dB to 4 dB
Resolution	0.01 dB
Delay	0 to 500 ns
Resolution	1 ps
Quadrature skew	–30 to 30°
Resolution	0.01°

1. Logic types available when connected to N5102A digital signal interface module.
2. Each output port must be designated as analog or digital in the PXB user interface. The same port cannot be used for both simultaneously.
3. Baseband offset range is limited by output instrument when connected via digital bus.

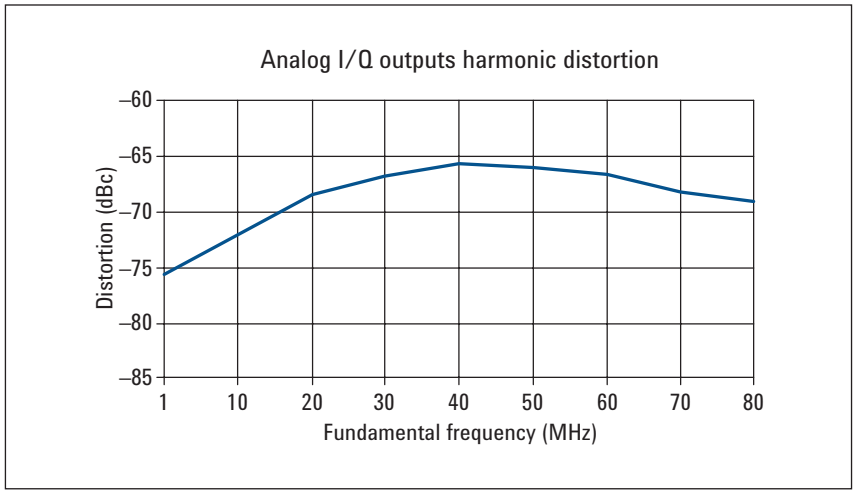
Analog Output Characteristics

Port type	Analog I/Q, single-ended and differential
Number of analog I/Q ports[1]	2 per I/O card, up to 8 total
Level	1.0 Vpp single-ended, 2.0 Vpp differential; 50 Ω
Resolution	14 bits
Baseband frequency offset	–80 MHz to 80 MHz[2]
I/Q skew	–2 ns to 2 ns
Resolution	1 ps
I/Q gain balance	–4 dB to 4 dB
Resolution	0.01 dB
Delay	0 to 500 ns
Resolution	1 ps
Quadrature skew	–30 to 30°
Resolution	0.01°
Common I/Q offset	–2.5 V to 2.5 V
Resolution	10 mV
Differential I offset	–25 mV to 25 mV
Resolution	1 mV
Differential Q offset	–25 mV to 25 mV
Resolution	1 mV
I/Q peak level	0 V to 1 Vpk
Resolution	10 mV

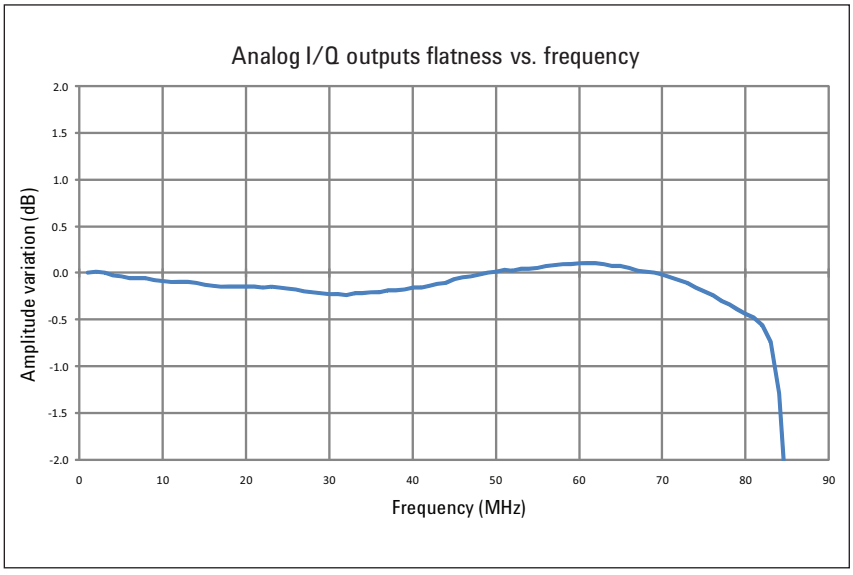
1. Each output port must be designated as analog or digital in the PXB user interface. The same port cannot be used for both simultaneously.
2. Baseband offset range is limited by output instrument when connected via digital bus.

Analog Output Characteristics continued...

Maximum reverse power	Max DC voltage 20 VDC (nom) 250 kHz to 500 MHz 1 W (nom)
Flatness[1]	1 dB (typ)
Spurious free dynamic range[1]	< –76 dBc (typ)
Harmonics[1]	



Phase noise[1] 10 MHz sinewave at 10 kHz offset	–147 dBc/Hz (typ)
Noise floor[1] 10 MHz sinewave at 1.9 MHz offset	–152 dBc/Hz (typ)
Flatness[1,2]	



1. These values apply at the PXB analog I/Q outputs only. When connected to the MXG/ESG via the digital bus, the PXB has negligible contribution. See MXG/ESG data sheet for performance data.
2. These values apply to SN MY50460000 and higher.

Frequency Reference Characteristics

Internal time base reference	OCXO, 10 MHz, stability ±0.01 ppm, from +20 to +30 °C Aging ±0.1 ppm/year for the first year Aging ±0.15 ppm/year for the first 2 years Operating temperature range is from 0-40 °C
External reference input	1 MHz to 100 MHz, –5 to +10 dBm; 50 Ω
Reference output	10 MHz, 0.9 Vpp ±10%; 50 Ω

Clock, Trigger, and Marker Characteristics

Channel synchronization	< 21 ns
Trigger source	Software, hardware, bus (GPIB, LAN)
External trigger in	3.3 V CMOS (nom)
Trigger delay	0 to 100 ms
Trigger jitter	5 ns
Trigger to analog I/Q out latency	250 ns (nom)
Trigger to RF latency	N5182A MXG: 600 ns (nom) E4438C ESG: 1.3 us (nom)
N5102A latency[1]	
Input	500 ns @ 100 MHz sample rate, 60 us @ 1 MHz
Output	400 ns @ 100 MHz sample rate, 25 us @ 1 MHz
N5102A synchronization	N5102A and PXB operate on independent (non-transparent) clock domains. Best case synchronization between multiple N5102A units and PXB is ± 1 sample (with re-sampling off)
RF to RF latency[2, 3]	N5182A MXG through digital bus: 33 us (nom) N5182A MXG through analog I/Q: 22 us (nom) E4438C ESG through digital bus: 27 us (nom) E4438C ESG through analog I/Q: 22 us (nom)
Marker outputs[4]	3 markers per I/O port 3.3V CMOS (nom)
Marker source	Separate marker file, markers embedded in waveform, dynamic marker generation
Marker delay	0 to 1,024 samples (settable in time)
Marker polarity	Positive, negative

1. Does not include PXB and RF latency.
2. Latency is measured from the signal analyzer's RF input to the signal generator's RF output.
3. Power calibration not performed when connecting the PXB to the MXG through analog I/Q.
4. Markers are labeled 1, 3, and 4. Marker 2 is reserved for internal use only.

General Chassis Characteristics

Dynamic marker type	Periodic, range detect, zero detect
Operating system	Windows® XP for Embedded Systems
Programming language	SCPI[1]
Connectivity	Gigabit LAN, IEEE 488 GPIB
Non-volatile storage	160 GB hard drive total 90 GB available for waveform and user data on D: partition (supplemented by external USB drives)
Available chassis slots	Up to 6 baseband cards (or 12 DSP blocks) and up to 4 I/O cards
Power requirements	100 to 120 VAC 50 to 60 Hz, or 200 to 240 VAC 50 to 60 Hz (automatically selected); < 875 W typical, 1075 W maximum
Operating temperature	10 to 40 °C
Acoustic noise	Idle: 57 dBA (nom) Normal: 60 dBA (nom) Worst case: 70 dBA (nom) Typical Keysight equipment: Normal = 54 dBA (nom)
Weight	Fully loaded: < 33 kg (72 lb)

PXB rear panel view.

Dimensions	222 mm H x 426 mm W x 584 mm D (8.75 in H x 16.8 in W x 23 in D)

System clock rear panel connectors

EXT I/O CLK IN	Reserved for future use
EXT SYNC	Reserved for future use
EXT TRIG IN	External trigger signal used to trigger the start of the FPGA process 3.3 V CMOS [male SMB] Damage level: < 0 V and > 3.3 V

1. Does not apply to Signal Studio programming control.

General Chassis Characteristics continued...

EXT REF IN	Input for an external frequency reference signal 1 MHz to 100 MHz, –5 to + 10 dBm; 50 Ω [male SMB] Lock range: ±5 ppm Damage level: < 0 V and > 3.3 V
10 MHz OUT	10 MHz reference output used to lock the frequency reference of other test equipment to the PXB 900 mVpp; 50 Ω [male SMB] Damage level: < 0 V and > 3.3 V
100 MHz SYS CLK OUT	100 MHz system clock output 2 Vpp; 50 Ω [male SMB] Damage level: < 0 V and > 3.3 V
I/O CLK OUT	Reserved for future use
TRIGGER OUT	Routed from hardware or software trigger input TTL; 100 Ω [male SMB] Damage level: < 0.5 V and > 5.5 V
AUX I/O	Provides additional digital signal interface and feedback 3.3 V CMOS [male 20 pin mini delta] Damage level: < 0 V and > 3.3 V

CPU host controller rear panel connectors

MONITOR	VGA connection of an external monitor
USB SLAVE (top)	Standard USB 2.0 ports, Type A connect to external peripherals such as a mouse, keyboard, printer, DVD drive, or hard drive
USB MASTER (top)	USB 2.0 port, Type B USB TMC (test and measurement class) connects to an external PC controller to control the PXB and for data transfers over a 480 Mbps link
LAN	Network interface used to control the PXB
remotely	

CPU host controller rear panel connectors (continued...)

GPIB	A general purpose interface bus (IEEE 488 GPIB) connection that can be used for remote operation
INTERCONNECT 1 & 2	Reserved for future use
eSATA	This port provides access to external eSATA Hard Disk Drive (HDD) storage devices to increase system file storage capacity with higher transfer rates than the USB port
PCIe x4 FROM UPSTREAM	Reserved for future use
PCIe x4 TO DOWNSTREAM	Reserved for future use
USB (bottom)	Reserved for future use

General Chassis Characteristics continued...

I/O card(s) rear connectors	
CLOCK IN	Reserved for future use
TRG IN	Reserved for future use
MKR OUT	Marker outputs for each I/O board channel numbered 1, 3 and 4 (marker 2 is reserved for internal use) 3.3 V CMOS [male SMB] Damage level: < 0 V and > 3.3 V
CLOCK OUT	Reserved for future use
DIGITAL BUS	Digital bus connectors enable operation with other test equipment such as the PXA/MXA/EXA signal analyzer, MXG and ESG vector signal generator, and N5102A digital signal interface module
I+, I–	Analog I/Q modulation from the internal baseband generator 2 Vpp; 50 Ω [male SMB] Damage level: < –15 V and > 15 V
Q+, Q–	Analog I/Q modulation from the internal baseband generator 2 Vpp; 50 Ω [male SMB] Damage level: < –15 V and > 15 V

Literature

Keysight N5106A PXB Baseband Generator and Channel Emulator, Photo Card, 5989-8969EN

Keysight N5106A PXB Baseband Generator and Channel Emulator, Configuration Guide, 5989-8972EN

MIMO Channel Modeling and Emulation Test Challenges, Application Note, 5989-8973EN

Solutions for Validation of LTE Devices – Testing MIMO Over-the-Air Using the Two-Stage Method, 5990-8898EN

Theory, Techniques and Validation of Over-the-Air Test Methods for Evaluating the Performance of MIMO User Equipment, 5990-5858EN

Ten Things You Should Know About MIMO SM (Spatial Multiplexing), Poster, 5989-9618EN

GPS Receiver Testing, Application Note, 5990-4943EN

Keysight CMMB Conformance Testing Using the PXB with N7623B Signal Studio for Digital Video, Application Note, 5990-4978EN

Additional Resources

Web

For more information or to view product literature online, please visit:
www.keysight.com/find/pxb
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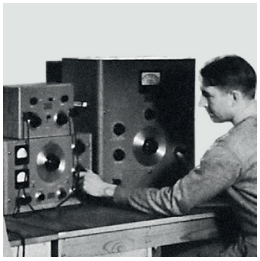

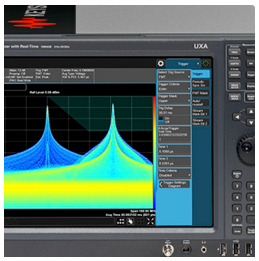

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