iQnxn **plus**

LitePoint IQnxn^{Plus}™

MIMO R&D Test System with
IQsignal for WiMAX Software Suite

LITEPOINT

IQnxn^{plus} MIMO R&D Test System

Introduction

The LitePoint IQnxn^{plus}™ MIMO Test System is optimized for the test needs of IC and product developers and test and system engineers, evaluating wireless MIMO products. The system is critical in R&D, QA, design verification, and product evaluation. In its default configuration, the IQnxn^{plus} MIMO Test System supports WiMAX testing; support for other wireless standards is optional. SISO testing is included for supported wireless technologies.

Core to the IQnxn^{plus} MIMO Test System is the array of synchronized VSA and VSG modules integrated in each of the one-box, single-channel test units in the system. The IQnxn^{plus} MIMO Test System comes in a minimum 2x2 Starter Kit configuration and can be expanded to a 3x3 or 4x4 configuration by adding IQnxn^{plus} Expansion units. Synchronization of individual units is achieved by adding the IQnxn^{plus} Synchronization Unit (part of the Starter Kit) and properly interconnecting the trigger and synchronization signals.

The IQnxn^{plus} application software includes LitePoint IQsignal™ for WiMAX graphical user interface programs for analysis and generation of WiMAX MIMO and SISO signals. Building custom (automated) test programs is supported through the C++ software API.

The IQnxn^{plus} MIMO Test System is compatible with optional LitePoint software products including the family of IQfact™ automated test programs, Bluetooth Add-On Software, and IQwave™ programs.

Please contact your local LitePoint Sales Representative for further information and a demonstration. For a current list of local sales resources, go to www.litepoint.com and click Contact.

Application areas:

- Product Development
- Design Verification Test
- System Test
- Quality Assurance/Control
- Product Evaluation
- Performance Evaluation and Optimization

Features:

- Synchronized VSA and VSG resource for testing multi-stream MIMO devices
- Scalable from 2x2 to 4x4 configurations
- Supported frequency ranges: 2.15 to 2.7 GHz, 3.3 to 3.8 GHz, and 4.9 to 6.0 GHz
- Easy to use through IQsignal graphical user interface programs
- Mobile WiMAX 802.16e-2005 / WirelessMAN-OFDMA MIMO
- Includes support for both mobile and fixed SISO WiMAX signals
- Also supports WiFi 802.11n MIMO, legacy WiFi, and Bluetooth (optional)
- C++ API interface for automated testing
- Supports IQfact chipset-specific turnkey automated test programs
- Test platform consists of multiple MIMO-enabled one-box test units and common synchronization unit.
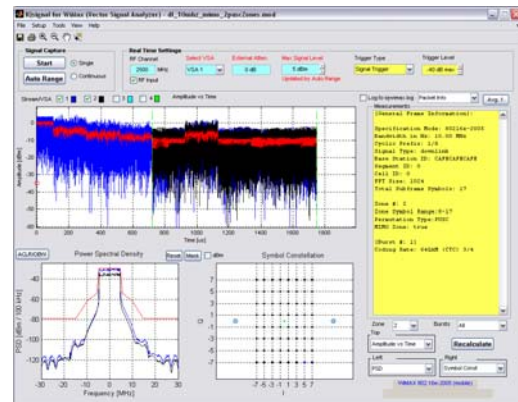

Figure 1. IQnxn^{plus} MIMO Test System (2x2 Starter Kit configuration)

Figure 2. The IQsignal for WiMAX analysis screen

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1. Functionality

The IQnxn^plus MIMO Test System is expressly designed to test the physical (PHY) layer functionality and performance of MIMO WiMAX and WiFi products including mobile devices, network interface cards, access points, and embedded components. The system specifically targets MIMO testing, but with the available IQsignal software suites, it can also test SISO device.

The IQnxn^plus MIMO Test System interfaces with the Device Under Test (DUT) through multiple synchronized VSA and VSG subsystems to meet the requirements of multi-stream MIMO architectures. The test system is modular, consisting of multiple IQnxn^plus Test Units, and an IQnxn^plus Synchronization Unit to provide the necessary reference and synchronization. The basic, Starter Kit configuration of the IQnxn^plus MIMO Test System contains two IQnxn^plus Test Units with two VSA and two VSG subsystems for testing 2x2 architectures - two transmitters with two receivers. The system can be expanded to 3x3 or 4x4 configurations by adding one or two IQnxn^plus Expansion Test Units.

The IQnxn^plus MIMO Test Systems is a complete PHY layer test solution for mobile and fixed WiMAX and WiFi products. To test WiMAX devices, the IQnxn^plus MIMO Test System supports generating and analyzing all 802.16e-2005 / WirelessMAN-OFDMA and 802.16-2004 / WirelessMAN-OFDM PHY waveforms in the 2.15 to 2.7 GHz, 3.3 to 3.8 GHz, and 4.9 to 6.0 GHz frequency bands. For WiFi, the system provides equivalent capabilities for 802.11a/b/g/n PHY waveforms in the 2.4 to 2.5 GHz and 4.9 to 6.0 GHz frequency bands. WiFi and Bluetooth support is offered as a separate system option.

The comprehensive IQsignal for WiMAX software suite shipped with the instrument allows for testing of both MIMO and SISO WiMAX products through an easy-to-use GUI or a C++ Application Programming Interface (API) for laboratory automation or manufacturing test needs. The software automatically scales to the IQnxn^plus MIMO Test System configuration. The supplied manufacturing APIs enable compatibility to Litepoint's highly successful IQmax™, IQview™, and IQflex™ one-box test Instruments eliminating variations in test results from different test platforms.

2. Software

For WiMAX test, the IQnxn^plus MIMO Test System is bundled with the IQsignal for WiMAX Signal Analysis Software Suite, a powerful WiMAX signal analysis and generations toolbox, supporting both SISO and MIMO signals. Operating on a separate PC under the Windows® Operating System and connected to IQnxn^plus MIMO Test Systems via TCP/IP over Ethernet, IQsignal for WiMAX provides an intuitive graphical user interface that is easy to master. Users can interactively control and analyze IQnxn^plus measurements and operations either when connected to an IQnxn^plus system or off-line from previously captured waveforms.

To allow automated testing, the IQnxn^plus MIMO Test System includes a C++ API, also compatible with the LitePoint IQmax, IQview, and IQflex platforms. The API supports a complete IQnxn^plus command set and associated DLL files for the development of test programs. Whether used for product characterization during the development process or for quality assurance in manufacturing, the APIs support test setup, data capture, signal analysis, and result-handling as well as general communications and error-handling functions.

3. VSA Operation

The IQnxn^plus MIMO Test System incorporates an array of 2, 3 or 4 VSA resources needed to test today's mobile WiMAX MIMO (wave 2 and beyond) and WiFi 802.11n multi-transmitter, multi-receiver devices. The system can also analyze SISO WiMAX (fixed or wave 1) or legacy 802.11a/b/g devices, or MIMO devices operating in legacy modes.

IQsignal for WiMAX analyzes signals from WiMAX MIMO devices using 802.16e signal formats. The software supports all mandatory and optional downlink and uplink MIMO modes defined for wave 2 mobile WiMAX devices.

The IQsignal software offers advanced analysis of waveforms captured by the VSA or retrieved from file, including a range of EVM and spectral measurements. For example, IQsignal can easily analyze frequency settling and phase noise that occurs during a burst transmission. Such capabilities significantly help in understanding and debugging RF performance-related issues.

In the case of multi-stream MIMO signal testing, all waveform signals and analysis results are available for each of the data streams. The user can select to display data for individual, multiple, or all streams.

The IQnxn^plus MIMO Test System with IQsignal supports in-band transmit analysis through a graphical display of these tests including:

- Spectrum (PSD) and mask display. With this display active, the program can also provide OBW and ACLR results.
- Symbol constellation—either for an entire zone or for individual bursts.
- Spectral flatness and delta spectral flatness.
- Waveform display in the time domain.

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To support product debugging, various other graphical displays are supported by IQsignal, including:

- Phase noise versus time
- Frequency error versus time
- CCDF (to support compression analysis)
- Spectrogram
- EVM (versus OFDM subcarriers; versus time)

Besides the graphical display of VSA measurements, IQsignal also presents relevant numerical data including:

- EVM (all, data, pilots); either for an entire zone or for individual bursts
- Power (peak, average)
- CINR (preamble, data)
- Frequency error
- Symbol timing error
- Integrated phase noise
- I/Q imbalance (amplitude, phase)
- Reed-Solomon errors (if applicable)

The average of numerical data over multiple captures can be displayed as well (sliding window of configurable size).

IQsignal additionally provides a wide range of compensation methods that can be used for advanced analysis of a captured signal's sensitivity to certain impairments. For example, the available compensation methods when analyzing OFDM signals include:

- Phase tracking (off, fast)
- Channel estimation (based on averaging of the long training sequence, or averaging of the full packet)
- Symbol timing tracking
- Frequency synchronization (based on long training sequence, or full packet)
- Amplitude tracking

IQsignal can save a signal capture for use with the VSG (with or without an automatic "cleanup" function). It also has the capability to export raw symbol data or decoded payload data to a text file.

It is possible to remotely control the IQsignal application using text commands or scripts. The software includes a TCP/IP based command server for that purpose, which supports text commands equivalent to GUI operations.

4. VSG Operation

The IQsignal software also controls the IQnxn^{plus} MIMO Test System's VSG capabilities. The user can load any WiMAX signal waveform from file (both SISO and MIMO waveforms are supported), apply optional impairments, and control the transmit characteristics. The software comes with a rich library of pre-defined WiMAX test signals, but the user can also load previously captured-and-saved waveforms. As a third option, it is possible to load WiMAX waveforms that have been generated with the optional LitePoint IQwave™ utility. Once the waveform file has been loaded to the VSG, specific signal impairments can be introduced, such as phase error or I&Q amplitude imbalance. The VSG control utility allows adjusting the transmit frequency, the RF or baseband power level, and whether the transmitter should operate continuously or only transmit a specific number of packets. Typically the packets are transmitted in free-run mode, but an external trigger input signal can optionally be used to control the transmission of packets.

5. Additional Software

A number of additional software programs come with the IQnxn^{plus} MIMO Test System (on the IQnxn^{plus} Applications CD), including:

- IQtest™ Solutions Administration Tool for general set-up of the instrument
- IQdebug™ tool debugs and monitors the instrument plus makes basic measurements
- IQdiagnostic™ program verifies the functional operation of the instrument systems
- IQsignal for WiFi application, IQsignal for WiFi MIMO; both require WiFi options for each IQnxn^{plus} Test Unit

Some relevant optional LitePoint software:

- IQwave™ software for waveform generation (WiFi and WiMAX versions available)
- LabVIEW™ API software interface for IQnxn™, IQview, IQflex and IQmax
- IQfact family of automated test programs for manufacturing and DVT

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6. Applications Information

For developers of wireless products the MIMO Test Systems can analyze the functionality and performance of the DUT through the intuitive and powerful GUI of the IQsignal software applications. A single instrument can verifiy all key radio parameters of a prototype. The VSA functions of the system can be used for transmitter analysis, while the VSG allows verification of the receiver by generating well-defined and customizable test signals.

For more advanced and/or automated product or design verification, e.g. in QA or DVT testing, the system offers the LitePoint Unified (C++) API as a standardized interface. A developer can build custom test scripts or complete automated test programs taking full advantage of the capabilities of the IQnxn*plus* instrument. This provides a powerful means to automate product characterization, regression testing, etc.

7. IQnxn*plus* MIMO Test System Control and Synchronization

Several synchronization, reference, and control signals are needed to have the multiple VSA and VSG resources of an IQnxn*plus* MIMO Test System operate as a single unit. This involves connecting marker and trigger signals from the individual IQnxn*plus* Test Units, as well as connecting the synchronization signals from the IQnxn*plus* Synchronization Unit. The various input and output signals are supplied to support the ability to expand the system from the minimum 2x2 (two VSA and two VSG resources) to a maximum of 4x4. Details of the connection of these signals are included in the Quick Start Guide shipped with the system.

The gain control of the VSA units can either be independent or controlled by the master VSA. Captures from each VSA unit are synchronized to occur within one 80 MHz sample. The trigger of the master unit can be set to free run, external, or RF power. The trigger of the slave units is controlled by the master.

8. Hardware Specifications

8.1. General

control interfaces		• IQsignal Signal Analysis Software Applications—Windows-based tools on external PC connected via Ethernet • TCP/IP command server for automated, remote control—capabilities equivalent to IQsignal GUI • LitePoint API —command set with DLL interface to support C++ programming of test scripts and automated test software • IQdebug— a Windows-based debugging tool on external PC connected via Ethernet
connectivity		• TCP/IP over 10/100/1000 BaseT Ethernet • default IP address: 192.168.100.254 • ports 4000, 5001, 5002 must be open for access through a firewall
internal reference oscillator	frequency	10.000 MHz
	initial accuracy	± 0.1 ppm
	short term accuracy (1 second)	≤ 1 x 10^{-12}
	temperature stability	± 0.15 ppm (0°C to +55°C)
	aging	± 0.25 ppm/year

Note: all performance specified at 25°C

8.2. MIMO System Performance

The hardware specifications in the sections above apply to each individual IQnxn*plus* Test Unit in the IQnxn*plus* MIMO Test System. The additional specifications in the table below apply to the complete MIMO system consisting of up to 4 IQnxn*plus* one-box Test Units and the IQnxn*plus* Synchronization Unit.

Frequency reference	frequency	10.000 MHz
	initial accuracy	± 0.1 ppm
	short term accuracy (1 second)	≤ 1 x 10^{-12}
	temperature stability	± 0.15 ppm (0°C to +55°C)
	aging	± 0.25 ppm/year
Combined integrated RF phase noise		≤ 0.5 degrees rms (100 Hz – 1 MHz) = -41 dBc

Note: all performance specified at 25°C

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8.3. VSA Unit Performance

frequency[1]		• Baseband • 2150 - 2700 MHz • 3300 - 3800 MHz • 4900 - 6000 MHz
frequency resolution		250 kHz
analog bandwidth		60 MHz (± 30 MHz quadrature)
quantization		14 bits
sampling frequency		80 MHz at ADC
sampling resolution		1 sample
acquisition buffer		2^{20} samples (~1,000,000 samples)
pre-trigger capture		$(2^{20} - 1)$ samples (~1,000,000 samples)
sampling filter amplitude variation		≤ 0.25 dB (0 – 10 MHz offset frequency)
sampling filter group delay variation		≤ 300 ps (0 – 10 MHz offset frequency)
RF port	input power level	-40 to +30 dBm (some exceptions below)
	power measurement accuracy	• specification: ± 1.0 dB (valid for extended input power level range: -50 to +30 dBm) • typical: ± 0.5 dB
	residual EVM	• specification: ≤ -40 dB • specification (input power level ≥ -30 dBm): ≤ -43 dB • typical: ≤ -46 dB, phase tracking enabled
	noise level (at lowest attenuation setting)	• noise floor: ≤ -70 dBm (in 60 MHz BW) • noise figure: ≤ 25 dB
	amplitude flatness	≤ 0.2 dB (0 – 10 MHz offset frequency)
	integrated phase noise	≤ 0.5 degrees rms (100 Hz – 1 MHz)
	input return loss	≥ 10 dB
baseband port	input voltage level	• 5 - 1000 mVrms • ± 1.5 V peak
	residual EVM	• 5 mVrms ≤ baseband input ≤ 150 mVrms • specification: ≤ -48 dB
	noise level (at lowest attenuation setting)	• noise floor: ≤ -70 dBm (in 60 MHz BW) • noise figure: ≤ 25 dB
	residual I/Q DC offset	≤ 2 mV
	residual I/Q amplitude imbalance	typical: 1% (f<10MHz)
	residual I/Q phase imbalance	typical: 0.5 degrees (f<10MHz)
	integrated phase noise	typical: ≤ 0.1 degrees rms (100 Hz – 1 MHz)

Note: all performance specified at 25°C

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[1] Note: setting VSA and VSG to different frequencies is not supported

8.4. VSG Unit Performance

frequency[1]		- Baseband 2150 - 2700 MHz 3300 - 3800 MHz 4900 - 6000 MHz
frequency resolution		250 kHz
analog bandwidth		70 MHz (± 35 MHz quadrature)
quantization		14 bits
sampling frequency		80 MHz
sampling resolution		1 sample
waveform length		2^{20} samples (~1,000,000 samples)
pre-trigger capture		$(2^{20} – 1)$ samples (~1,000,000 samples)
DAC filter amplitude variation		typical: ≤ 0.25 dB (0 – 20 MHz offset frequency)
DAC filter group delay variation		typical: ≤ 400 ps (0 – 20 MHz offset frequency)
RF port	output power level	-95 to 0 dBm (modulated signal) -95 to +10 dBm (CW)
	power accuracy	- specification: ± 1.0 dB - typical: ± 0.6 dB
	EVM	≤ -43 dB (output level -95 to 0 dBm)[2]
	SNR	100 kHz resolution BW - specification: ≥ 55 dB (output level ≥ -15 dBm) - typical: 70 dB
	undesired sideband	≤ -45 dBc (0.1 – 10 MHz; CW output)
	carrier leakage	≤ -45 dBc (CW output) ≤ -90 dBm (between packets, when enhanced gap rejection condition enabled)
	spurious	- specification: ≤ -50 dBc (in-band) - typical ≤ -20 dBc out-of-band (harmonics, to 0 dBm output level) ≤ -35 dBc or ≤ -80 dBm (whichever is higher) out-of-band (non-harmonic)
	integrated phase noise	≤ 0.5 degrees rms (100 Hz – 1 MHz)
	output return loss	≥ 10 dB
baseband port	output voltage level	≤ 1000 mVrms ± 1.5 V peak
	dynamic range	≥ 60 dB
	EVM	≤ -48 dB
	SNR	100 kHz resolution BW ≥ 65 dB
	I/Q DC offset	≤ 2 mV immediately after automatic DC offset calibration (upon any level change)
	I/Q amplitude imbalance	typical: 1% (f<10MHz)
	I/Q phase imbalance	typical: 0.5 degrees (f<10MHz)
	integrated phase noise	typical: ≤ 0.1 degrees rms (100 Hz – 1 MHz)

Note: all performance specified at 25°C

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[2] With "gap power off" function disabled (see section 9.4)

9. IQsignal for WiMAX Software - Measurement, Display and Control Parameters

9.1. VSA Measurement Parameters

capture mode	single / continuous	enables one-shot or non-stop data capture and analysis
sample interval	100 μs, 200 μs, 300 μs, 400 μs, 500 μs, 1 ms, 2 ms, 3 ms, 4 ms, 5 ms, 10 ms	The sample interval is limited by the 2^{20} buffer size and 80 MHz A/D sample rate.
signal type	• 802.16-2004 / WirelessMAN-OFDM (fixed WiMAX)	• Automatically detected: Signal type (up- / downlink subframe), Bandwidth, Modulation / coding, Cyclic Prefix length
	• 802.16e-2005 / WirelessMAN-OFDMA (mobile WiMAX)	• Automatically detected: Signal type (up- / downlink subframe), Bandwidth, Modulation / coding, Cyclic Prefix length, Uplink fields. • Supported modes: PUSC, FUSC, AMC2x3. • The software can be set to do automatic detection of the up- and downlink maps, or these can be user-defined (GUI)
decode	on / off	enables payload decoding
input mode	baseband / RF	selects type of signal input and enables appropriate ports
IQ swap	on / off	interchanges I and Q channel signals on input ports
triggers	• free run • external trigger • signal trigger (RF input mode only)	• data capture trigger mechanism • signal trigger requires input power ≥ -30 dBm
max signal level	• RF input: -60 to +30 dBm in 1 dB increments • baseband input: -60 to +30 dBV in 1 dB increments	• peak signal level at instrument input, affecting display ranges • can be determined automatically (Auto Range function) • limited by VSA performance
external attenuation	-25.0 to 125.0 dB with 0.1 dB resolution	• attenuation between DUT output and test system input (applied as a correction to measurements) • RF input mode only
acquire new	on / off	acquire new signal capture for analysis or reload current capture from test platform
EVM & power averaging	1, 10, 20, 40, 60, 80, 100	• number of measurements (captures) used to calculate average EVM and power • LitePoint API allows arbitrary number of measurements to be used
Rx IF	0 MHz, 5 MHz, 10 MHz, 11 MHz	• to assess Tx performance at IF, down convert the signal to 5 MHz, 10 MHz, or 11 MHz and input it to the baseband ports • to assess Tx performance at baseband or at a supported RF channel, set to 0 MHz
RF channel (RF mode only)	• user-defined center frequency (resolution is HW dependent)	
phase tracking / correction	• off • symbol-by-symbol correction	• phase tracking method • symbol-by-symbol correction is specified by IEEE standard for EVM calculation but will mask measurement of Tx phase noise
channel estimate	• raw (averaging over long training sequence) • raw (averaging over full packet)	• channel estimation method • averaging over long training sequence is most common in practical receiver implementations
symbol timing tracking	on / off	• enable timing jitter correction • symbol timing tracking is specified by IEEE standard
frequency sync	• long training sequence (includes short training sequence if present) • full data packet	• carrier frequency error estimation method • estimation based on short or long training sequence is most common in practical receiver implementations

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amplitude tracking	on / off		enable automatic gain control

Note: the specified corrections are implemented prior to measurement taking; for example, EVM is calculated after any specified corrections are applied, thereby affecting the results.

9.2. VSA Measurement Results – Graphical Display

amplitude vs. time	instantaneous, and peak power averaged over a symbol duration (dBm) versus time
spectrogram	• 3D plot of power spectral density versus time • time is displayed on x-axis; frequency offset on y-axis; color coding represents power (maximum strength is red; minimum strength is green)
PSD	• power spectral density (dBm/Hz) versus frequency offset • spectrum mask per IEEE 802.16 for 10 and 20 MHz channels (scaled for other bandwidths) • center frequency ± 30 MHz • resolution bandwidth 100 kHz (LitePoint API produces 1024-point FFT) • function to calculate OBW and ACLR results (user enters parameters)
symbol constellation	visual display of each demodulated symbol in the I/Q complex plane (color of data symbols depends on stream; pilot tones are green). Shown for individual (selected) burst or all combined
spectral flatness	variation from average energy as a function of OFDM subcarrier number (dB).
spectral delta	power delta between adjacent subcarriers (dB).
phase noise (PSD)	phase noise power spectral density (dBc/Hz) versus frequency offset
phase error (time)	integrated phase error of pilot tones (degrees) versus time
CCDF (complementary cumulative distribution function)	probability of peak signal power being greater than a given power level versus peak-to-average power ratio (dB). Shown over all data or payload only.
I & Q signals	I/Q signal voltages (Vrms) versus time
frequency error	• frequency error (kHz) versus time • frequency error during short and long training sequences
EVM versus carrier	Error Vector Magnitude averaged over all symbols for each subcarrier (dB) versus OFDM subcarrier number
EVM versus time	Error Vector Magnitude averaged over all subcarriers (dB) versus time

Note: when analyzing MIMO signals, graphical data is available for each stream.

9.3. VSA Measurement Results — Numerical Data

packet information	• Signal type, down and uplink • Bandwidth, cyclic prefix • Modulation and coding per burst (rate ID) • Number of symbols (fixed WiMAX) or slots (mobile WiMAX) for each rate ID type
peak power	peak power over all symbols (dBm)
average power (all)	average power of complete data capture (dBm)
average power (no gap)	average power over all symbols after removal of any gap between packets (dBm)
average power (preamble)	average preamble power (dBm)
average power (syms)	average power over all symbols, excluding preamble (dBm)
LO (DC) leakage	variation from center carrier (dBc)
EVM all	EVM averaged over all symbols and all subcarriers (dB; %)
EVM data	EVM averaged over all symbols and all data subcarriers (dB; %)
EVM pilots	EVM averaged over all symbols and all pilot subcarriers (dB; %)
EVM unmod	EVM averaged over all unmodulated subcarriers (dB; %) (mobile WiMAX only)
CINR (preamble)	Carrier to Interference plus Noise Ratio (dB) of preamble
CINR (data)	Carrier to Interference plus Noise Ratio (dB) of data zone
I/Q amplitude error	I/Q amplitude imbalance (%)
I/Q phase error	I/Q phase imbalance (degrees)
frequency error	carrier frequency error (kHz)
symbol clock offset	symbol clock frequency error (ppm)
rms phase noise	integrated phase noise (degrees)
OFDMA ranging	ranging code and power level of initial and periodic ranging bursts (mobile WiMAX and if present only)
Reed-Solomon errors	number of symbols with RS errors (valid only if payload decoding is enabled; fixed WiMAX only)

Note: when analyzing MIMO signals, some measurement results are provided per stream, some are combined; this is clearly indicated.

9.4. VSG Signal Parameters

Tx mode	continuous / # packets (1 to 65,334)	enables continuous transmission or transmission of the specified number of repetitions of the stored waveform
RF channel (RF output mode only)	user-defined value (in MHz)	channel center frequency (resolution is HW dependent)
CW signal	• on / off • frequency offset	to generate CW signal (instead of waveform) at configurable offset from center frequency
IQ swap	on / off	interchanges I and Q channel signals on output ports
RF output	on / off	generate signal on RF port instead of I&Q baseband interfaces
signal level	• -98.0 dBm to 10.0 dBm with 0.1 dB resolution • -98.0 dBV to 10.0 dBV with 0.1 dB resolution	• desired average signal level of output signal • reference level is preamble power (16e downlink signal) or data power (all others)
VSG offset	user defined value (in dB)	• power offset for individual VSG, relative to VSG1
transmit trigger	• free run • external trigger	• packet transmission trigger mechanism
gap power off	yes / no	drop transmitted power to zero during gaps between packets
common mode voltage	• yes / no • If yes, I and Q channels can be set together or independently from 0.000V to 3.000V with 0.001V resolution	sets common mode output voltage of baseband outputs
signal impairments	• I/Q amplitude imbalance: -10.00% to +10.00% with resolution of 0.01% • I/Q phase imbalance: -10.00 degrees to +10.00 degrees with resolution of 0.01 degrees • I/Q group delay imbalance: -1.00 ns to +1.00 ns with resolution of 0.01 ns • I-channel DC offset: -1.00 to +1.00 with resolution of 0.001 (units of Volts for baseband output; dBV for RF output) • Q-channel DC offset: -1.00 to +1.00 with resolution of 0.001 (units of Volts for baseband output; dBV for RF output)	

10. Interfaces

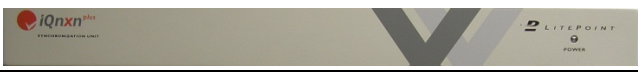### 10.1. IQnxn^{plus} Test or Expansion Unit

Caution: all front and rear connector interfaces are ESD sensitive

front panel			
	RF ports	type N female (2 connectors)	• RF signal • Software configurable as input or output • 50 Ohms • RF input: 1 Watt maximum (+30 dBm) • DC Voltage: 30 Vdc maximum, Inputs DC blocked.
	I/Q baseband receive	BNC female (4 connectors)	• differential I&Q baseband input signals: I-, I+, Q-, Q+ • 50 Ohms
	I/Q baseband transmit	BNC female (4 connectors)	• differential I&Q baseband output signals: I-, I+, Q-, Q+ • 50 Ohms
	power	pushbutton	• on/off (safe shutdown)
anel			
	10/100/1000 Mbps Ethernet	RJ-45 (2 connectors)	TCP/IP connectivity (use left port)
	USB ports	USB Type B (4 connectors)	USB 2.0 compatible (all equivalent)
	10 MHz reference	BNC female	• external 10 MHz reference clock input connector • 1 kΩ • 0.1 to 2.0 Vrms input level
	RF LO in	SMA female	proprietary interface; from IQnxn^{plus} Synchronization Unit only
	trigger input 1	BNC female	• rising-edge input trigger signal for VSA • 5V TTL/CMOS interface • input voltage ≥ 0.5V, ≤ 5.5V • pulse width ≥ 25 ns
	trigger input 2	BNC female	• rising-edge input trigger signal for VSG • 5V TTL/CMOS interface • input voltage ≥ 0.5V, ≤ 5.5V • pulse width ≥ 25 ns
	marker output	BNC female	• rising-edge output trigger signal • TTL/CMOS-compatible interface • pulse width ≥ 25 ns • delay to 1st sample output = 12.5 ns + 1 sample
	AC in	15A IEC connector	• for use with country-specific cord and plug • 100–240 VAC, 50-60 Hz • 300 W max
	0 / 1	switch	master AC power switch

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	unused ports	• 15-pin D-sub (VGA monitor port) • 6-pin mini-DIN female (PS2 keyboard port) • 6-pin mini-DIN female (PS2 mouse port) • 36-pin D-sub (1284-C) parallel port • DB-9 female RS-232 serial port	FOR USE BY AUTHORIZED PERSONNEL ONLY

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10.2.   IQnxn*plus* Synchronization Unit

Caution: all front and rear connector interfaces are ESD sensitive

front panel			
rear panel			
	USB port	USB Type A	USB 2.0 compatible
	10MHz reference input	BNC female	• external 10 MHz reference clock input connector • 1 kΩ • 0.1 to 2.0 Vrms input level
	10 MHz reference outputs (5x)	BNC female	• 10 MHz reference clock source outputs • Connect to IQnxn*plus* Test Unit only
	RF LO outputs (4x)	SMA female	proprietary interface; to IQnxn*plus* Test Unit only
	IF LO outputs (4x)	SMA female	proprietary interface; for future use
	AC in	15A IEC connector	• for use with country-specific cord and plug • 100–240 VAC, 50–60 Hz • 43 W max
	0 / 1	switch	master AC power switch

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11. Physical and Environmental

11.1.   IQnxn^{plus} Test or Expansion Unit

dimensions	480 mm x 100 mm x 500 mm (with brackets, bumpers and feet installed)
weight	8.1 kg (17.8 lbs)
power consumption	300W maximum (AC powered)
operating temperature	0°C to +55°C (IEC 68-2-1, 2, 14)
storage temperature	-40°C to +70°C (IEC 68-2-1, 2, 14)
operating humidity	15% to 95% relative humidity, non-condensing (IEC 68-2-30)
recommended calibration cycle	12 months
warranty	12 months hardware, 12 months software updates

11.2.   IQnxn^{plus} Synchronization Unit

dimensions	480 mm x 60 mm x 500 mm (with brackets, bumpers and feet installed)
weight	3.2 kg (7.0 lbs)
power consumption	43 W maximum (AC powered)
operating temperature	0°C to +55°C (IEC 68-2-1, 2, 14)
storage temperature	-40°C to +70°C (IEC 68-2-1, 2, 14)
operating humidity	15% to 95% relative humidity, non-condensing (IEC 68-2-30)
recommended calibration cycle	12 months
warranty	12 months hardware, 12 months software updates

12. External PC System Minimum Requirements

PC	Intel Pentium processor or compatible, 500MHz (1GHz or higher recommended)
operating system	Microsoft Windows 2000 (SP3 or higher), Windows XP (SP1 or higher) US English versions
memory	512MB of RAM
disk space	500MB of available hard disk space
monitor	1024 x 768 resolution
connectivity	TCP/IP over 10/100BaseT Ethernet (Gbit Ethernet recommended)

13. Compliance

EMI compatibility	• 89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC • EN55011/ CISPR 11: 1998 + A1+A2 • EN61326-1: 1997 + A1 + A2 • FCC Part 15 Class A / 04.99 • IC CS003
safety	• 73/23/EEC revised by 93/68/EEC • EN61010-1: 1993 + A2: 1995 • UL 61010A R4.02 • CAN/CSA c22.2 No. 1010

14. Shipping Contents

The IQnxn^{plus} MIMO 2x2 Starter Kit consists of two IQnxn^{plus} Test Units, an IQnxn^{plus} Synchronization Unit, and various assembly materials, cabling etc. The Starter Kit is shipped in three boxes.

14.1.　　IQnxn^{plus} Test or Expansion Unit

Actual unit: IQnxn^{plus} Test Unit (with 2 2U high rack mount brackets attached)
AC Power Cable, USA plug
Ethernet Networking Cable
BNC cables (3x) and BNC T-adapter
RF N-type loopback cable
Documentation Envelope with Calibration Certification, Warranty Certificate

14.2.　　IQnxn^{plus} Synchronization Unit

Actual unit: IQnxn^{plus} Synchronization Unit (with 2 1U high rack mount brackets attached)
AC Power Cable, USA plug
Instrument joiner handles (2x) and brackets (2x), screws to assemble IQnxn^{plus} MIMO 2x2 Starter Kit
USB cable to connect synchronization unit to IQnxn^{plus} Test Unit
Custom semi-rigid RF SMA cables (4x) for RF LO connection
IQnxn^{plus} Applications CD
Documentation Envelope with IQnxn^{plus} MIMO Test System Quick Start Guide, Calibration Certification, Warranty Certificate

15. Order Information

ORDER CODE	PRODUCT DESCRIPTION
IQNXNPLUSKIT	LitePoint IQnxn^{plus} MIMO 2x2 Starter Kit

16. Available Product Options, Related Products

ORDER CODE	PRODUCT DESCRIPTION
IQNXNPLUSKIT-XWR	IQnxn^{plus} MIMO Starter Kit 1 year extended warranty and software updates (includes one annual calibration)
IQNXNPLUSKIT-CAL	IQnxn^{plus} MIMO Starter Kit annual calibration
IQNXNPLUSKIT-CAL/PP	IQnxn^{plus} MIMO Starter Kit annual calibration, prepaid
IQNXNPLUSEU	LitePoint IQnxn^{plus} Expansion Unit
IQNXNPLUSEU-XWR	IQnxn^{plus} Expansion Unit 1 year extended warranty and updates. Includes one annual calibration
IQNXNPLUSEU-CAL	IQnxn^{plus} Expansion Unit annual calibration
IQNXNPLUSEU-CAL/PP	IQnxn^{plus} Expansion Unit annual calibration, prepaid
IQNXNPLUSWIFI	System option to add WiFi/BT test capabilities to IQnxn^{plus}
LABAPI	LabVIEW v8.0 API for IQnxn^{plus}, IQview, IQflex and IQmax
IQWAVE-WIMAX	IQwave for WiMAX software
IQW802-11ABGN	IQwave for WiFi software
IQfact Test Programs	Consult Factory for latest availability and order codes

LitePoint IQnxn^{plus} MIMO Test System
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LitePoint IQnxn^{plus} MIMO Test System
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