



IQ201X

Connectivity Test System



Data Sheet

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IQ201X Connectivity Test System

Introduction

LitePoint's IQ201X Connectivity Test System is the first product to specifically address the testing needs of multi-radio products and devices (Multicom™), which include some combination of multiple wireless functionalities. The IQ201X test system provides the solution to the crucial test needs of these products and devices by testing WiFi, Bluetooth, GPS, FM, WiMAX, NFC, ZigBee, and WAVE technologies in a single, integrated instrument. Manufacturers of advanced mobile handsets and other multi-radio devices are being forced to test these growing wireless functionalities in a single integrated circuit (IC) or module. By addressing the imperative needs of wireless test capabilities in a concurrent test architecture, the IQ201X test system allows for significantly reduced test times.

The IQ201X test system provides a variety of RF ports allowing flexible connection to accommodate a number of device configurations. GPS, NFC and FM signals are carried on dedicated RF ports, while WiFi, WiMAX, Bluetooth, and WAVE run on common ports. Using concurrent testing, the IQ201X tests functions, such as GPS and FM, in parallel with WiFi or Bluetooth. As a result, users can test multi-radio devices much more quickly. In addition to concurrent test capabilities, the IQ201X test system offers sequence-based test (SBT) and Fast Packet Error Rate (PER) test, reducing test time up to six fold for WiFi transmit tests and four fold in WiFi receive tests.

Users can achieve maximum equipment utilization through technology application licensing. For example, an IQ201X test system can be purchased initially with the desired options, then other test features can be added using a software license key. This avoids the cost and downtime associated with upgrades that require sending the unit back to a service center. By tailoring the IQ201X to a manufacturing line's specific needs, users gain production flexibility and save on capital expenditures.

Features

- Full support to most common wireless standards
 - WiFi (802.11 a/b/g/n)
 - WAVE (802.11p)
 - Bluetooth (1.0 / 2.0 / 2.1 / 3.0 / 4.0)
- Optional support to several application-specific wireless standards for maximum versatility
 - GPS
 - FM TX / RX
 - WiMAX (802.16 d/e)
 - Near Field Communication (ISO 18092)
 - ZigBee (802.15.4)
- Key communication frequency support
 - 76 to 108 MHz (FM)
 - 1.57542 GHz (GPS)
 - 2.15 to 2.7 GHz (WiFi, BT, WiMAX, ZigBee)
 - 3.3 to 3.8 GHz (WiMAX)
 - 4.9 to 6 GHz (WiFi, WiMAX)
 - 5.9 to 6 GHz (WAVE)
- Reduced test time with concurrent test capability
 - GPS and FM can be tested independent of WiFi / BT / WiMAX / NFC / ZigBee / WAVE
- Superior Equipment Utilization
 - Standards-based SW licensing allows for purchasing of only the required capabilities initially and the convenience of easily adding additional capabilities
 - Ability to purchase other standards at any time

Basic Functional Description

The IQ201X test system uses multiple hardware blocks to provide concurrent test capabilities for GPS and FM technologies in parallel with WiFi, Bluetooth, WiMAX, ZigBee, NFC, and WAVE technologies. Multiple vector signal generator (VSG) sections provide signal generation capabilities for FM transmit (76 to 108 MHz), GPS transmit (1.57542 GHz), WiFi / WAVE transmit (2.15 to 2.7 GHz and 4.9 to 6 GHz), Bluetooth transmit (2.4 to 2.5 GHz), WiMAX transmit (2.15 to 2.7 GHz, 3.3 to 3.8 GHz, and 4.9 to 6 GHz), ZigBee transmit (2.4 to 2.5 GHz), and Near Field Communication (NFC) transmit from DC to 35 MHz.

Multiple vector signal analyzer (VSA) sections provide matching capabilities covering identical frequency bands as the VSG sections. Each VSA section consists of two digitizer (DIG) channels (I and Q) and associated quadrature downconverter. The VSG section consists of two arbitrary waveform generator (AWG) sections and a quadrature upconverter. NFC testing utilizes the independent AWG channels and DIG channels of the VSA and VSG sections to provide or accept signals to BNC connectors on the rear panel of the IQ201X test system.

The IQ201X test system includes software libraries specific to the particular communication standard of interest. A variety of signal creation and analysis routines are provided and are available through either a graphical user interface (GUI) or a C++ API. All data captured on the IQ201X test system is sent to the controlling PC over a USB 2.0 link and then processed according to the user's instructions. All measurement functions provided in the GUI are also available through the C++ API for custom test-program automation in either manufacturing or design characterization testing.

Four RF device connection ports allow the IQ201X test system to accommodate a wide range of DUT configurations containing multiple communication standards. The IQ201X test system includes dedicated RF connection ports for GPS and FM DUT connections, and two common ports that allow for WiFi, WiMAX, and Bluetooth DUT connections. These dedicated ports allow the user to easily configure the IQ201X test system to the precise port topology of their DUT, ensuring maximum flexibility.

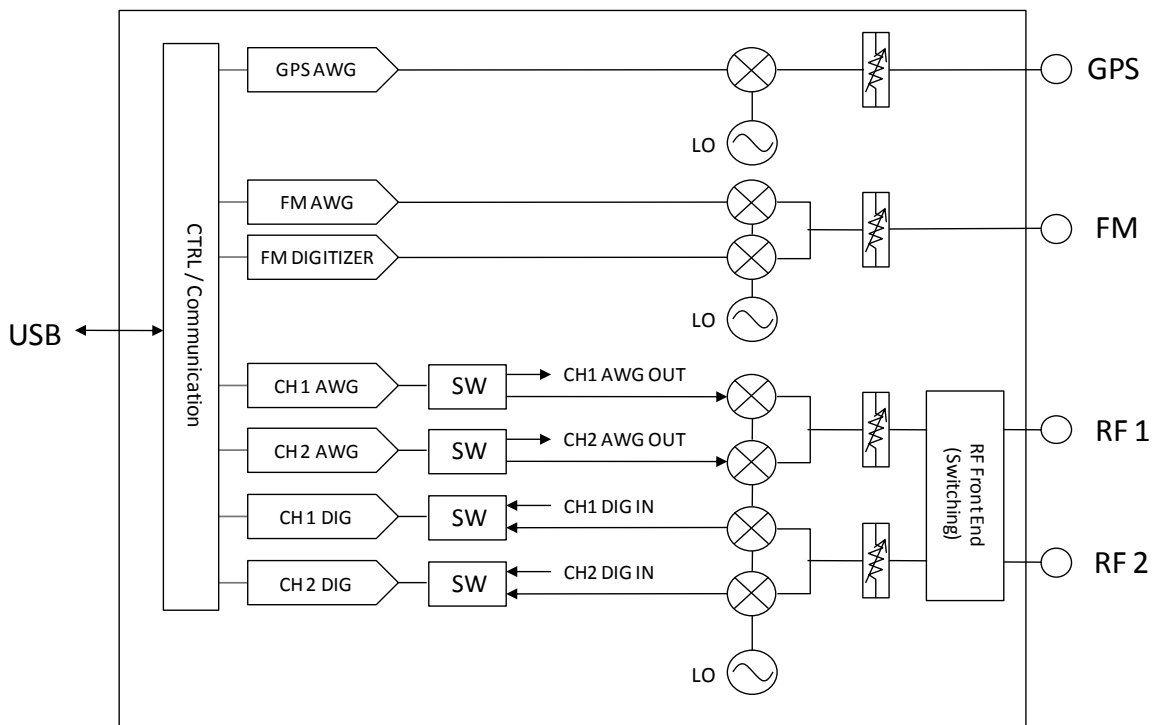


Figure 1: IQ201X Test System—Hardware Block Diagram

Typical Use Scenario

The IQ201X test system addresses the RF calibration, verification, and testing needs of all connectivity radios within the supported multi-radio devices. With a single insertion, the test station can test a multitude of radio devices. Users can implement a wide range of DUT cabling scenarios using the IQ201X's port flexibility. Table 1 provides example connection scenarios showing flexibility for DUT connections.

Table 1: Example Connection Scenarios

Device Port Scenario	IQ201X Connection Path
GPS + Bluetooth	GPS and RF1 (RF2) ports with coupler or combiner
WLAN (802.11 a/g)	RF1 or RF2 ports
WLAN + Bluetooth	RF1 or RF2 ports
GPS + FM	GPS and FM ports with coupler or combiner
Near Field Communication	DIG1, DIG2 and AWG1, AWG2 ports

Users can apply the IQ201X test system as a standalone configuration, or in concert with configurations that support concurrent testing of multiple technologies. For example, the system can be used to test a DUT for GPS only in a standalone configuration, or it can be used to test a multi-radio DUT that combines GPS with other technologies, such as WiMAX and FM.



Figure 2: IQ201X Test System—Testing Connectivity Functions of a Mobile Device

Manufacturing Test Versatility

The IQ201X test system is designed to provide high-volume device manufacturers with key advantages for multi-radio device testing.

These include:

- Concurrent test architecture
- Sequence-based test resulting in greatly reduced test times
- Software-licensable standards / capabilities
- Common hardware configuration
- Simplicity of a one-box testing with a unified interface

Concurrent Test Architecture

The IQ201X test system can test multiple device radios in parallel. This can greatly reduce the test time as more and more radios are added to the Multicom devices. As an example, a typical Multicom device might contain the following radios / functions:

- WLAN (802.11)
- Bluetooth
- GPS
- FM (TX or TX/RX)

Using traditional test approaches, all these radios would be tested serially, possibly even at different test stations. This results in increased device insertions (connections) which results in more handling time and possible damage because of handling errors. Additionally, the tests are run serially resulting in test times that increase as more and more device functionality is added.

With concurrent testing, the IQ201X test system allows for reduced test time, which could be as much as 75% in this scenario. Figure 4 illustrates this reduction in test time where GPS and FM are tested in parallel with the WiFi and Bluetooth capabilities.

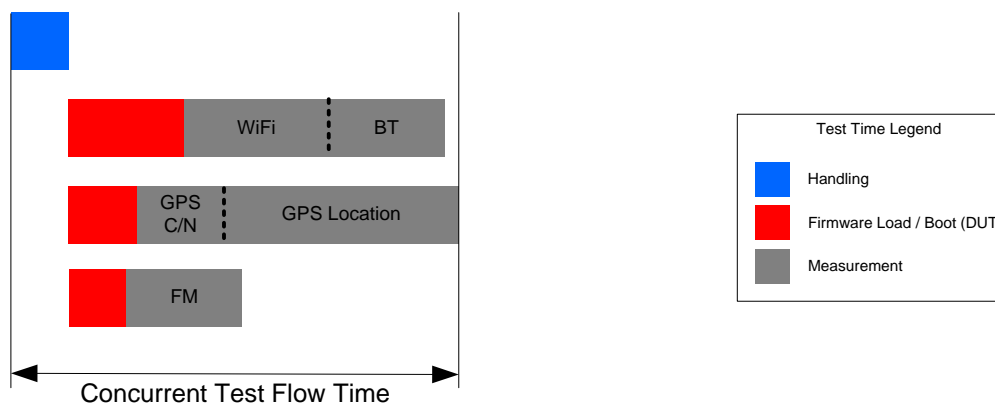


Figure 3: Concurrent Test Flow

Sequence Based Test (SBT)

The IQ201X test system features proprietary, sequence-based test flow capability, which dramatically reduces WiFi test-time for supported devices.

Sequence-based test reduces the test time for WiFi technologies in the key area of transmit multi-data-rate EVM / Power measurements. In transmit multi-data-rate testing, the IQ201X test system can sequence or step in concert with the device under test because the test system can send outputs at different data rates. With the appropriate device driver and test sequence support, the IQ201X test system can capture the various data-rate bursts from the DUT in a single capture, reducing the communication time to the DUT and thereby reducing test times by up to six times for transmit testing and calibration.

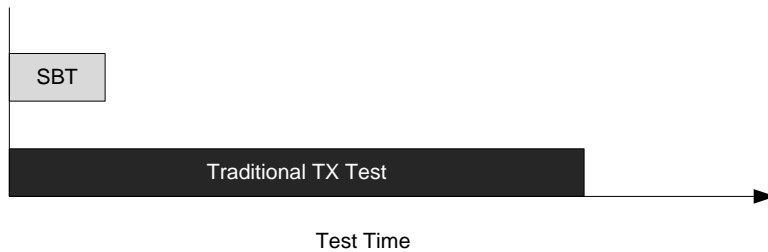


Figure 4: WiFi SBT Transmit (Tx) Test Time vs. Traditional Test Approaches

Fast Packet Error Rate (PER)

While performing a PER receive (Rx) test, when packets are transmitted to the DUT, the IQ201X test system uses specialized built-in circuits to detect the acknowledgement signals from the DUT. These acknowledgement signals provide confirmation of the received data, and PER can be calculated without requiring extensive DUT communication. This approach to PER receive testing, named Fast PER, provides up to four times reduction in test and calibration time as compared with traditional approaches.

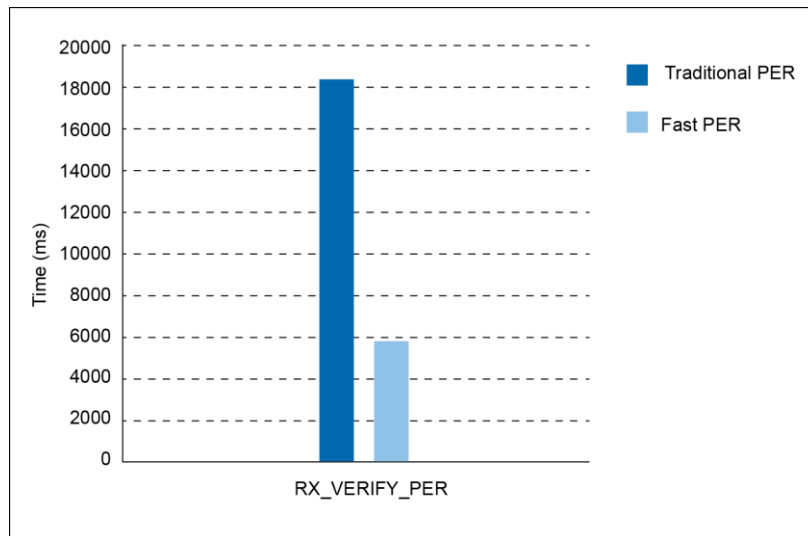


Figure 5: WiFi Fast PER vs. Traditional PER Receive (RX) Test Time

Software Licensable Standards

Device manufacturers often face unpredictable combination of devices and manufacturing volumes. Having a unified “superset” test system that allows for testing of every possible device combination and permutation often results in capital equipment that is underutilized, resulting in more test capabilities than what is actually needed. Alternatively, with standards-specific test systems, balancing the demand for capabilities to test new technologies in short time-periods — often measured in days— is difficult.

The IQ201X test system features a common hardware platform with standards-specific features that are enabled through software licenses. These licenses can be purchased as needed, enabling capabilities to be “turned on” in the field, without the need to send equipment back to a service center or the factory. As a result, manufacturers can quickly add new measurement capabilities to their existing IQ201X installed testers and rapidly meet production needs. Conversely, manufacturers can begin their IQ201X installations with only WiFi and Bluetooth testing capabilities, and add other standards as their needs grow. This provides an overall optimum equipment and capital utilization.

LitePoint offering of software licensable standards include:

- GPS
- FM TX / RX
- WiMAX (802.16 d/e)
- Near Field Communication (ISO 18092)
- ZigBee (802.15.4)

Users of IQ201X test systems can refer to the IQ201X User Guide for a complete description of the measurement supported by each software option.

One-Box Tester Simplicity with a Unified Interface

The IQ201X test system carries on the LitePoint tradition of providing measurement capabilities that are focused on addressing the exact needs of manufacturing testing. The IQ201X test system provides measurement coverage for up to six different standards —all with a unified software and hardware interface. This helps eliminate the complexity of the test system having to communicate with multiple instruments and software interfaces. A single USB connection provides the essential control connectivity to the IQ201X test system. And, the compact size of the IQ201X (2U high and only 13 inches wide) test system ensures that the utilization of the production floor space is minimized.

In the production floor, the complete connectivity test and calibration coverage provided by the IQ201X test system allows for easy accommodation of rapid changes in product configurations. The unified hardware that is common between test stations in an IQ201X test system allows for new standards to be added with only an update to the existing software license file. The manufacturing test and calibration system can therefore respond to quick changes in market needs with a minimal disruption to the factory floor.

Software Designed for Multi Radio Devices

The IQ201X test system features software that is designed to ease the testing of multi-radio devices. A C++ application programming interface (API) and a graphical user interface (GUI) provides a consistent look and feel across the multiple supported standards. Additionally, the GUI is arranged by technology, allowing users to quickly find the relevant measurement functions and controls needed to test their Multicom devices. The user can easily choose the technology of interest using the technology dashboard which then launches the appropriate settings window. Each technology is contained in its own window, allowing the user to quickly switch back and forth between technologies to adjust settings and analyze data.

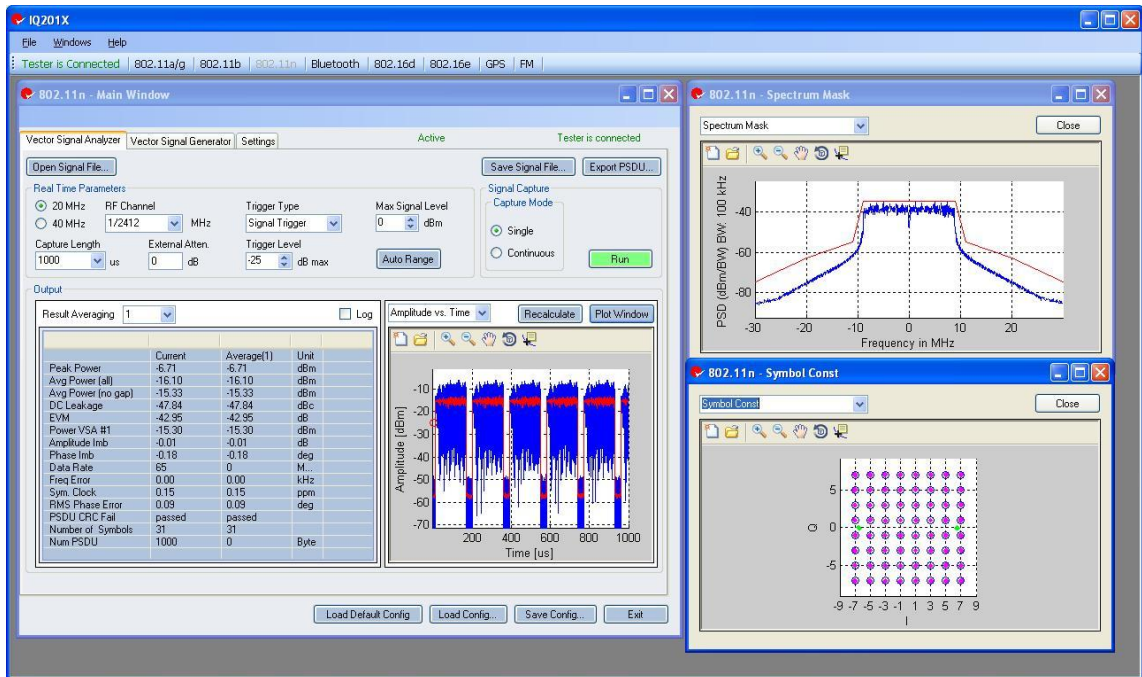


Figure 6: IQ201X Graphical User Interface (802.11 Example Shown)

General Technical Specifications

Analyzer

Parameter	Port Designations	Range
Input Frequency Range	NFC Ports - DIG1, DIG2	DC to 30 MHz
	FM Port	76 to 108 MHz
	RF1 / RF2 Ports	2150 - 2700 MHz 3300 - 3800 MHz 4900 - 6000 MHz
Input Power Range	NFC Ports - DIG1, DIG2	Up to 1000 mV RMS
	FM Port	-60 to -110 dBm
	RF1 / RF2 Ports	+30 to -148 dBm/Hz
Control Interface		USB 2.0 type B
Power Requirements		100-240 VAC, < 300 W, 50-60 Hz

Analyzer—Signal Trigger

Parameter	Range
Absolute Minimum Value	-40 dBm
Absolute Maximum Value	Limited by the Maximum Input Power
Accuracy	< +/- 2 dB

Generator

Parameter	Port Designations	Range
Output Frequency Range	NFC Ports - DIG1, DIG2	DC to 35 MHz
	FM Port	76 to 108 MHz
	RF1 / RF2 Ports	2150 - 2700 MHz 3300 - 3800 MHz 4900 - 6000 MHz
	GPS Port	1.57542 GHz (fixed)
Output Power Range	NFC Ports - DIG1, DIG2	5 to 1000 mV RMS
	FM Port	-60 to -110 dBm
	RF1 / RF2 Ports (CW)	+10 to -95 dBm (1 Hz BW)
	GPS Port	-60 to -145 dBm

Timebase

Oscillator type	OCXO
Frequency	10MHz
Initial accuracy (25°C after 60 min. warm-up)	< +/- 0.05ppm
Maximum aging	< +/- 0.1ppm per year
Temperature stability	< +/-0.05ppm over 0°C to 50°C range, referenced to 25°C
Warm-up time (to within +/-0.1ppm at 25°C)	< 30 minutes

Wireless LAN (802.11 a/b/g/n) Hardware Technical Specifications

Analyzer

Input frequency range	2400 - 2500 MHz 4900 - 6000 MHz
Input power range	+30 to -148 dBm/Hz
Measurement Bandwidth	60 MHz (\pm 30 MHz quadrature)
Quantization	14 bits
Input Return Loss	> 10 dB
Spurious	< -55dBc (50 kHz RBW)
Harmonics	out-of-band: \leq -45 dB in-band: \leq -55 dB (100 kHz resolution BW)
Integrated Phase Noise	< 0.5 degrees (f<2.5 GHz) < 0.8 degrees (f<6 GHz) 0.5 degrees (100 Hz – 1 MHz) (typical)
Signal to Noise Ratio	\geq 55 dB (measured in 100 kHz resolution bandwidth)
Waveform Capture Duration	400 ms

Generator

Output frequency range	2400 - 2500 MHz 4900 - 6000 MHz
Output power range	-95 to 0 dBm (modulated) -95 to +10 dBm (CW)
Output power accuracy	\pm 1.0 dB (+ 5 to -95 dBm) \pm 0.5 dB typical
Signal Bandwidth	70 MHz (\pm 35 MHz quadrature)
Quantization	14 bits
Output Return Loss	> 10 dB
Spurious	Specification: \leq -20 dBc out-of-band (harmonics, to 0 dBm output level) \leq -35 dBc or \leq -80 dBm (whichever is higher) out-of-band (non-harmonic) Typical: \leq -50 dBc (in-band)
Harmonics	Out-of-band: \leq -45 dB in-band: \leq -55 dB (100 kHz resolution BW)
Integrated Phase Noise	< 0.5 degrees (100 Hz – 1 MHz) (typical)
Signal to Noise Ratio	\geq 55 dB (measured in 100 kHz resolution bandwidth) (specification) \geq 70 dB (measured in 100 kHz resolution bandwidth) (typical)
Carrier leakage	\leq -45 dBc (CW output) \leq -90 dBm (between packets, when enhanced gap rejection condition enabled)
Waveform Duration	400 ms

Wireless LAN (802.11 a/b/g/n) Measurement Specifications

Measurement	Description	Performance
EVM	All: EVM averaged over all symbols and all subcarriers (dB) 802.11a/g/n OFDM signals only	Residual VSA EVM: ≤ -35 dB (1.78%) (-5 dBm to -35 dBm) ≤ -41 dB (0.89%) typical Residual VSG EVM: ≤ -38 dB (-95 to -10 dBm output power) ≤ -35 dB (-10 to -5 dBm output power)
	Data: EVM averaged over all symbols and all subcarriers (dB) 802.11a/g/n OFDM signals only	
	Pilots: EVM averaged over all symbols and all subcarriers (dB) 802.11a/g/n OFDM signals only	
	PSDA EVM Average: EVM averaged over all PSDU data symbols (or, if "11b std Tx mod acc" is selected, over last 1000 chips) (dB) 802.11b/g DSSS signals only	
	PSDA EVM Average Peak: EVM value (dB) 802.11b/g DSSS signals only	
Peak power	Peak power over all symbols (dBm)	± 1.0 dB (specification)
RMS Power	All: Average power of complete data capture (dBm)	± 0.5 dB (typical)
	No Gap: Average power over all symbols after removal of any gap between packets (dBm)	
Max avg power	Peak value of the amplitude as a moving average over 40 samples (dBm)	
I/Q amplitude error	I/Q amplitude imbalance (%) and approximate contribution to EVM (dB)	
I/Q phase error	I/Q phase imbalance (degrees) and approximate contribution to EVM (dB)	
Frequency error	Carrier frequency error (kHz)	
Symbol clock error	Symbol clock frequency error (ppm)	
RMS phase noise	Integrated phase noise (degrees)	
PSD	Power spectral density (dBm/Hz) versus frequency offset Center frequency ± 40 MHz LitePoint API produces 1024-point FFT	
Spectral flatness	Reflects variation of signal energy as a function of OFDM subcarrier number 802.11a/g OFDM signals only	
Sidelobe analysis (spectral mask, LO leakage)	Center peak and peaks of 1 st and 2 nd upper/lower sidelobes (dB) 802.11b/g DSSS signals only	
CCDF (complementary cumulative distribution function)	Probability of peak signal power being greater than a given power level versus peak-to-average power ratio (dB)	
Power on / Power down ramp	On: Relative power level (% of average) versus time Power-on time from 10% to 90% Power-on time from 90% power level to detected start of packet (not provided for 802.11a/g OFDM signals)	
	Off: Relative power level (% of average) versus time (802.11b/g CCK signals only)	

Measurement	Description	Performance
	Power-off time from 90% to 10% (not reliable for 802.11a/g OFDM signals) Power-off time from _ 90% power level to detected end of packet (not provided for 802.11a/g OFDM signals)	
Eye diagram	I and Q channels versus time (802.11b/g DSSS signals only)	
PSDU data	Recovered binary data sequence, including the MAC header and Frame Check Sequence, if present	
Raw Capture Data	I and Q signals versus time	
General waveform analysis	DC offset, RMS level, minimum/maximum amplitude, peak-to-peak amplitude, RMS I- and Q-channel levels	
CW frequency analysis	Frequency of CW tone	

Bluetooth (1.0, 2.0, 2.1, 3.0, 4.0) Hardware Technical Specifications

Analyzer

Input frequency range	2400 - 2500 MHz
Input power range	+30 to -148 dBm (1 Hz BW)
Measurement Bandwidth	60 MHz (\pm 30 MHz quadrature)
Quantization	14 bits
Input Return Loss	> 10 dB
Spurious	< -55dBc (50 kHz RBW)
Harmonics	out-of-band: \leq -45 dB in-band: \leq -55 dB (100 kHz resolution BW)
Integrated Phase Noise	0.5 degrees (100 Hz – 1 MHz) (typical)
Signal to Noise Ratio	\geq 55 dB (measured in 100 kHz resolution bandwidth)
Power Measurement Accuracy	\pm 1.0 dB (specification) \pm 0.5 dB (typical)
Waveform Capture Duration	400 ms

Generator

Output frequency range	2400 - 2500 MHz
Output power range	-95 to 0 dBm (modulated) -95 to +10 dBm (CW)
Signal Bandwidth	70 MHz (\pm 35 MHz quadrature)
Quantization	14 bits
Output Return Loss	> 10 dB
Spurious	Specification: \leq -50 dBc (in-band) Typical \leq -20 dBc out-of-band (harmonics, to 0 dBm output level) \leq -35 dBc or \leq -80 dBm (whichever is higher) out-of-band (non-harmonic)
Harmonics	Out-of-band: \leq -45 dB In-band: \leq -55 dB (100 kHz resolution BW)
Integrated Phase Noise	< 0.5 degrees (f<2.5 GHz) < 0.8 degrees (f<6 GHz) 0.5 degrees (100 Hz – 1 MHz) (typical)
Signal to Noise Ratio	\geq 55 dB (measured in 100 kHz resolution bandwidth) (specification) \geq 70 dB (measured in 100 kHz resolution bandwidth) (typical)
Carrier leakage	\leq -45 dBc (CW output) \leq -90 dBm (between packets, when enhanced gap rejection condition enabled)
Power Accuracy	\pm 1.0 dB (specification) \pm 0.6 dB (typical)
Waveform Duration	400 ms

Bluetooth (1.0, 2.0, 2.1, 3.0, 4.0) Measurement Specifications

Measurement	Description	Performance
TX output power	Transmit DUT output power (dBm)	VSA Measure Power Accuracy: ± 1.0 dB (specification) ± 0.5 dB (typical)
TX output spectrum	Transmit DUT power spectral density	
20 dB bandwidth	Bandwidth between the +/- 20 dB down points of the modulation waveform	
In-band emissions (Adjacent Channel)	Spurious emission measured at +/- 5 MHz of DUT TX frequency only.	
Modulation Characteristics	Average and Peak Frequency deviation (Hz)	
Carrier frequency Tolerance	Carrier frequency offset (Hz)	
Carrier frequency Drift	Carrier frequency change over the Bluetooth burst (Hz)	
Relative transmit Power (EDR)	Average power of complete data capture (dBm)	VSA Measure Power Accuracy: ± 1.0 dB (specification) ± 0.5 dB (typical)
Carrier frequency stability (EDR)	Frequency drift over the Bluetooth EDR burst duration (Hz)	
Receive sensitivity	Receive sensitivity test using LitePoint or user-generated waveforms	Source Power Accuracy: ± 1.0 dB (specification) ± 0.6 dB (typical)
Maximum Input Signal Level	Assuming single-ended BER measurement	
C/I and Receiver Selectivity Performance	IQ2010 capability provides the <i>wanted signal</i> only. No <i>interfering signal</i> is available.	
Blocking Performance	IQ2010 capability provides the <i>wanted signal</i> only. No <i>interfering signal</i> is available.	
Intermodulation Performance	IQ2010 capability provides the <i>wanted signal</i> only. No <i>interfering signal</i> is available.	
Bit error rate (BER)	Bit error rate for 1 and 3 Mbps data rates	Source Power Accuracy: ± 1.0 dB (specification) ± 0.6 dB (typical)
RMS EVM (EDR)	RMS EVM for Bluetooth EDR	Residual VSA EVM: ≤ -30 dB (3.1%) (≥ -35 dBm power to + 10 dBm)
Peak EVM (EDR)	Peak EVM for Bluetooth EDR	Residual VSG EVM: ≤ -30 dB (3.1%) (≥ -35 dBm power to + 10 dBm)

WiMAX (802.16 d/e) Hardware Technical Specifications

Analyzer

Input Frequency Range	2150 - 2700 MHz 3300 - 3800 MHz 4900 - 6000 MHz
Input Power Range	+30 to -148 dBm/Hz
Measurement Bandwidth	60 MHz (\pm 30 MHz quadrature)
Quantization	14 bits
Input Return Loss	> 10 dB
Spurious	< -55 dBc (50 kHz RBW)
Harmonics	Out-of-band: \leq -45 dB In-band: \leq -55 dB (100 kHz resolution BW)
Integrated Phase Noise	< 0.5 degrees (100 Hz – 1 MHz) (typical)
Signal To Noise Ratio	\geq 55 dB (measured in 100 kHz resolution bandwidth)
Waveform Capture Duration	400 ms

Generator

Output frequency range	2150 - 2700 MHz 3300 - 3800 MHz 4900 - 6000 MHz
Output power range	-95 to 0 dBm (modulated) -95 to +10 dBm (CW)
Signal Bandwidth	70 MHz (\pm 35 MHz quadrature)
Quantization	14 bits
Output Return Loss	> 10 dB
Spurious	specification: \leq -50 dBc (in-band) typical \leq -20 dBc out-of-band (harmonics, to 0 dBm output level) \leq -35 dBc or \leq -80 dBm (whichever is higher) out-of-band (non-harmonic)
Harmonics	out-of-band: \leq -45 dB in-band: \leq -55 dB (100 kHz resolution BW)
Integrated Phase Noise	0.5 degrees (100 Hz – 1 MHz) (typical)
Signal to Noise Ratio	\geq 55 dB (measured in 100 kHz resolution bandwidth) (specification) \geq 70 dB (measured in 100 kHz resolution bandwidth) (typical)
Carrier leakage	\leq -45 dBc (CW output) \leq -90 dBm (between packets, when enhanced gap rejection condition enabled)
Waveform Duration	400 ms

WiMAX (802.16 d/e) Measurement Specifications

Measurement	Description	Performance
Power	Peak Power: Peak power over all symbols (dBm)	± 1.0 dB (specification) ± 0.5 dB (typical)
	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)	
EVM	EVM (all): EVM averaged over all symbols and all subcarriers (dB; %)	Residual VSA EVM: ≤ -40 dB (1.00%) (at ≥ -30 dBm to -10 dBm input) ≤ -46 dB (0.50%) typical Residual VSG EVM: ≤ -43 dB (> -30 dBm to -10 dBm output)
	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; %) (802.16e only)	
	EVM (carrier): Error Vector Magnitude averaged over all symbols for each subcarrier (dB) versus OFDM subcarrier number	
	EVM (time): Error Vector Magnitude averaged over all subcarriers (dB) versus time	
Capture Mode	Selects one-shot or streaming data analysis (single / continuous)	
Sample Interval	Sample Interval time: 100 μ s, 200 μ s, 300 μ s, 400 μ s, 500 μ s, 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	Automatically detected: Signal type (up- / downlink subframe), Bandwidth, Modulation / coding, Cyclic Prefix length (802.16d)	
	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) (802.16e-2005 / WirelessMAN-OFDMA mobile WiMAX)	
Amplitude vs. Time	Instantaneous, and peak power averaged over a	

Measurement	Description	Performance
	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 along with spectral mask per IEEE 802.16 for 10 and 20 MHz channels (scaled for other bandwidths) Resolution bandwidth 100 kHz (LitePoint API produces 1024-point FFT)	
Symbol Constellation	Visual display of each demodulated symbol in the I/Q complex plane. The 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	
I/Q Phase Error	I/Q phase imbalance (degrees)	
I/Q Amplitude Error	I/Q amplitude imbalance (%)	
Frequency Error	frequency error (kHz) versus time	
LO (DC) Leakage	Relative power to center carrier (dBc)	
CINR (preamble)	Carrier to Interference plus Noise Ratio (dB) of preamble	
CINR (data)	Carrier to Interference plus Noise Ratio (dB) of data zone	
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)	

WiMAX (802.16 d/e) Signal Settings

Measurement	Description	Performance
TX Mode	Selects continuous or specified number of packets to be transmitted (continuous / # packets (1 to 65,334))	
RF Channel	Center frequency of channel to be transmitted (MHz)	
CW Signal	Selects a CW signal to transmit	
Signal Level	Sets average power of transmitted signal (-98.0 dBm to 10.0 dBm with 0.1 dB resolution)	± 1.0 dB (specification) ± 0.6 dB (typical)
Transmit Trigger	Selects trigger mode (free run / external trigger)	
Gap Power Off	Sets transmitted power to minimum during gaps between data packets (On / Off)	
Signal Impairments	<ul style="list-style-type: none"> • 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) 	

FM Hardware Technical Specifications

FM Analyzer

Parameter	Specification	Accuracy
Input Frequency Range	76 to 108 MHz	
Input Power Range	+10 to -40 dBm	± 1.0 dB (specification) ± 0.5 dB (typical)
Input Impedance	50 Ω	± 5%
Input Power Resolution	0.1 dB Step	
Input Deviation Range	1 k Hz to 100 kHz (10 Hz step)	
Frequency Accuracy	Same as Reference Timebase	
Harmonic Performance (in band, <+/- 100 kHz)	-65 dBc	
Harmonic Performance (out of band, > +/- 100 kHz)	-40 dBc	
Spurious (in band, <+/- 100 kHz)	-65 dBc	
Spurious (out of band, > +/- 100 kHz)	-40 dBc	

FM Generator

Parameter	Specification	Performance
Output Frequency Range	76 to 108 MHz	
Frequency Resolution	1 Hz	
Output Power Range	-40 to -110 dBm	± 1.0 dB (levels ≥ -100 dBm to -40 dBm)
Output Power Resolution	0.1 dB Step	
Output Impedance	50 Ω	±5%
FM Deviation Range	1 k Hz to 75 kHz	
FM Deviation Resolution	10 Hz	
Frequency Deviation Accuracy	+/- 3%	
AM Modulation Index	0 to 75%	
AM Modulation Frequency	0 to 1 MHz	
Phase Noise	-80 dBc/Hz at 10 kHz offset	
Harmonic Performance (in band)	-65 dBc	
Harmonic Performance (out of band)	-40 dBc	
Spurious (in band)	-60 dBc	
Spurious (out of band)	-40 dBc	
Modulation Accuracy	+/- 10 Hz	

FM Interference Source

Parameter	Specification	Notes
Interference Source	CW / Mono FM	
Interference Source Frequency Range	- 5 to 5 MHz	Relative to Carrier
Output Power Range	-30 dB to +40 dB	Relative to Carrier
Output Power Accuracy	+/- 1 dB	Relative to Carrier
Peak Deviation	1 kHz to 75 kHz (1 kHz resolution)	
Deviation Accuracy	100 Hz	
Number of Audio Tones	1	
Audio Frequency Range	200 Hz to 15 kHz in steps of 200 Hz	

Audio Analyzer

Audio Frequency Range	10 Hz to 15.5 kHz
Minimum Resolution Bandwidth	200 Hz
Maximum Resolution Bandwidth	100 kHz
FFT Side Range	32 to 32,768 points
De-emphasis	25, 50, 75 μ s
Total Harmonic Distortion	<0.01%
Signal to Noise Measurement Range	< 80 dB
Signal to Noise Measurement Resolution	0.1 dB
Signal to Noise Measurement Accuracy	+/- 2 dB
Stereo Separation	60 dB

Audio Generator (internal source)

Parameter	Specification	Notes
Audio Frequency Range	10 Hz to 15.5 kHz	
Frequency Resolution	1 Hz	
Total Harmonic Distortion	<0.01%	
Stereo Separation	60 dB	
Pilot Signal Frequency	19 kHz (+/- 1Hz)	
Pilot Frequency Deviation	\leq 10 kHz	
Audio Weighting	ITUR 468, C-message, A-weighting, C-weighting	
Number of audio tones	12	Maximum 8 tones in right channel
Minimum tone separation	10 Hz	
Amplitude range	-36 dB to 0 dB	
Pre-emphasis	0, 25, 50, 75 μ s	

RDS / RBDS Specifications

Subcarrier Frequency	57 kHz (+/- 3 Hz)
Frequency Deviation	≤ 10 KHz
Subcarrier Phase	0 or 90 degrees
Number of RDS Groups (TX)	1 (up to 4 blocks)
Number of RDS Groups (RX)	2 (up to 8 blocks)
User Defined Information Bits	≤ 64

FM Measurement Specifications

Measurement	Description	Performance
Signal into Noise and Distortion (SINAD)		< 80 dB
Total Harmonic Distortion + Noise (THD+N)	THD measurement	< 80 dB
Audio Frequency	Audio frequency measurement	<15 kHz (Resolution 500 Hz)
RMS Frequency Deviation	Frequency Deviation (RMS)	< 100 kHz (Resolution 1 Hz), +/- 10%
Peak Frequency Deviation	Frequency Deviation (Peak)	< 100 kHz (Resolution 1 Hz), +/- 10%
Carrier Power Measurement	Average power value of carrier	+/- 2 dB
Power Spectral Density (PSD)	Spectrum of RF signal	+/- 1 MHz
Measurement Resolution	Resolution Bandwidth	1 kHz to 300 kHz
RDS Data Decode	Displays RDS binary data	Up to 2 groups (128 bits)
RDS Block Error Rate	Measures RDS block error rate	

GPS Hardware Technical Specifications

Frequency	1575.42 MHz (L1 block)
Output Power Range	-60 dBm to -145 dBm
Number of Channels	6
Power Resolution	0.25 dB
Power Accuracy	+/- 1.0 dB
Frequency Accuracy	+/-0.01 ppm
Doppler Offset	+/- 10 kHz (1 Hz step)
Spurious	< -40 dBc
Carrier Phase Noise	< 1 degree RMS

Near Field Communication (NFC) Hardware Technical Specifications

Analyzer

Channels	2
Voltage Range	5 to 1000 mV RMS (50 Ohm)
Analog Bandwidth	30 MHz
Quantization	14 bits
Sampling Rate	80 MHz
Waveform Capture Duration	400 ms

Generator

Channels	2
Voltage Range	< 1000 mV RMS (50 Ohm)
Analog Bandwidth	35 MHz
Quantization	14 bits
Sampling Rate	80 MHz
Waveform Duration	400 ms

Port Descriptions

Front Panel

I/O	Function	Type
Power Switch	Power on/off	Pushbutton Switch
Power Indicator	LED Red – Powered Up, Standby LED Green – Powered Up, Running	LED indicator
RF Port 1	WiFi, WiMAX, Bluetooth	N female
RF Port 2	WiFi, WiMAX, Bluetooth	N female
FM Port	FM TX / RX	N female
GPS Port	GPS TX	N female

Rear Panel

I/O	Function	Type
Trigger 1 input	TTL compatible trigger input	BNC female
Trigger 2 input	TTL compatible trigger output	BNC female
10MHz Ref Input	10MHz reference input	BNC female
Marker Out	TTL compatible trigger output	BNC female
AWG CH1 Out	NFC Signal output 1	BNC female
AWG CH2 Out	NFC Signal output 2	BNC female
DIG CH1 IN	NFC Signal input 1	BNC female
DIG CH2 IN	NFC Signal input 2	BNC female
USB	USB 2.0 compatible connection to external PC Controller	USB type B
AC in	AC power input	100-240VAC (automatically switched) 50 - 60 Hz Includes hard power switch

Physical and Environmental

Dimensions	Measurement in Inches Unit with Handle: 15.5" W x 4" H x 20" D Unit without Handle: 14.7" W x 3.3" H x 17.1" D Measurement in Millimeters Unit with Handle: 393 mm W x 102 mm H x 508 mm D Unit without Handle: 373 mm W x 84 mm H x 434 mm D
Weight	6.8 kg
Power consumption	<300 W
Operating temperature	+10°C to +55°C (IEC EN60068-2-1, 2, 14)
Guaranteed Specification	+20°C to +30°C ambient
Storage temperature	-20°C to +70°C (IEC EN60068-2-1, 2, 14)
Operating humidity	15% to 95% relative humidity, non-condensing (IEC EN60068-2-30)
EMC	EN 61326 Immunity for industrial environment, Class B emissions
Safety	IEC 61010-1, EN61010-1, UL3111-1, CAN/CSA-C22.2 No. 1010.1
Mechanical vibration	IEC 60068, IEC 61010 and MIL-T-28800D, class 5
Mechanical shock	ASTM D3332-99, Method B
Recommended calibration cycle	12 months
Warranty	12 months hardware 12 months software updates

Control PC Minimum Requirements

PC	Intel Pentium dual core processor or compatible, 1GHz (2 GHz or higher recommended)
Operating system	Windows XP (SP2 or higher), US English versions
Memory	1024MB of RAM
Disk space	500MB of available hard disk space
Monitor	1024 x 768 resolution
Connectivity	USB 2.0

Programming Interface and Graphical User Interface (GUI)

Programming Interface and Compatibility

Programmatic interface	C++ API (LitePoint IQapi)
Driver compatibility	C++ LabVIEW 8.5 (using LitePoint supplied driver)

Graphical User Interface (GUI)

IQ 201X Applications	WiFi (802.11) WiMAX (802.16 d/e) GPS FM (TX / RX) Bluetooth (1.0, 2.0, 2.1, 3.0, 4.0) NFC (ISO 18092) ZigBee (802.15.3) WAVE (802.11p)	GUI supports built-in measurement and signal generation functions per standard as appropriate
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Ordering Information

Order Code	Description
IQ2010	IQ2010 Hardware with WiFi, Bluetooth, FM (TX/RX) and GPS.
IQ2010-WLAN-BT	IQ2010 Hardware with WiFi and Bluetooth.
IQ2010-GPS	GPS Software Option for IQ2010-WLAN-BT.
IQ2010-FM	FM Software Option for IQ2010-WLAN-BT.
IQ2010-FMAUD	Audio Analysis Option Requires IQ2010-FM Option Includes LitePoint Audio Interface Module (AiM) Hardware Includes Audio Analysis Software (API and GUI)
IQ2010-NFC	NFC Software Option
IQ2010-WiMAX	WiMAX Software Option
ZBSW	ZigBee Software Package CD

Upgrades

Order Code	Description
IQ2010-GPS-UG	Field Upgrade: GPS Software Option for IQ2010-WLAN-BT.
IQ2010-FM-UG	Field Upgrade: FM Software Option for IQ2010-WLAN-BT.
IQ2010-NFC-UG	Field Upgrade: NFC Software Option
IQ2010-WiMAX-UG	Field Upgrade: WiMAX Software Option

Calibration and Warranties

Order Code	Description
IQ2010-CAL	IQ2010 One Annual Calibration
IQ2010-XWR	1 Year Extended warranty (includes 1 calibration) Must be ordered within 90 days of original instrument purchase
IQ2010-XWR2	2 Year Extended warranty (includes 2 calibrations) Must be ordered within 90 days of original instrument purchase

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