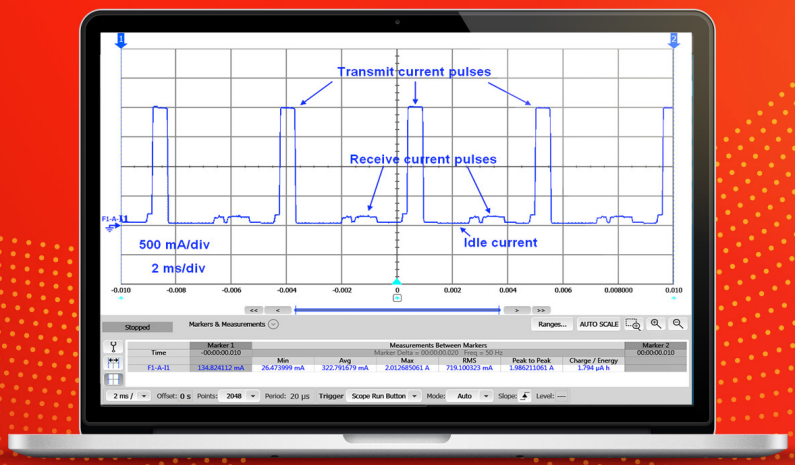

TECHNICAL OVERVIEW

N9084EM0E Short Range Communication and IoT X-Series Measurement Application

Short Range Communication and IoT Measurement Applications

The short range communication and IoT measurement applications transform the X-Series signal analyzers with multi-touch into standards-based RF transmitter testers. The applications provide fast, one-button RF conformance measurements to help you design, evaluate, and manufacture your transmitter. The measurement applications closely follow the standards, allowing you to stay on the leading edge of your design and manufacturing challenges.

X-Series Measurement Applications

X-Series measurement applications increase the capability and functionality of Keysight Technologies, Inc. signal analyzers to speed time to insight. They provide essential measurements for specific tasks in general-purpose, cellular communications, wireless connectivity applications, covering established standards or modulation types.

Applications are supported on both benchtop and modular, with the only difference being the level of performance achieved by the hardware you select.

- Complies with LoRa®, ZigBee (IEEE 802.15.4) and Z-Wave (ITU G.9959) RF transmitter tests
- Provide one-button measurements with pass/fail per the standard
- Use multi-touch user interface and SCPI remote interface
- Extend test assets with transportable licenses between X-Series signal analyzers with multi-touch UI

KEYSIGHT TECHNOLOGIES

X-Series measurement applications can help you:

- Gain more insight into device performance with intuitive display and graphs for your application. Select from our library of over 25 different measurement applications.
- Ensure that your design meets the latest standard. Updates are made to the X-Series measurement applications as standards evolve.
- Apply the same measurement science across multiple hardware platforms for consistent measurement results over your design cycle from R&D to production.
- Choose the license structure that meets your business needs. We provide a range of license types (node-locked, transportable, floating or USB portable) and license terms (perpetual or time-based).

Short Range Communication and IoT Measurement Application Top Features

802.15.4 O-QPSK modulation analysis

Figure 1 is an 802.15.4 O-QPSK modulation analysis at 2.45 GHz free ISM band showing constellation, spectrum, Raw time waveform, and error summary information including Offset EVM, EVM, Mag Error, Phase Error, Freq Error, Clock Error, I/Q offset, Quad Error, Gain Imbalance, Rho.

- Upper left: constellation
- Upper right: raw main time
- Lower Left: spectrum
- Lower right: Error summary metric

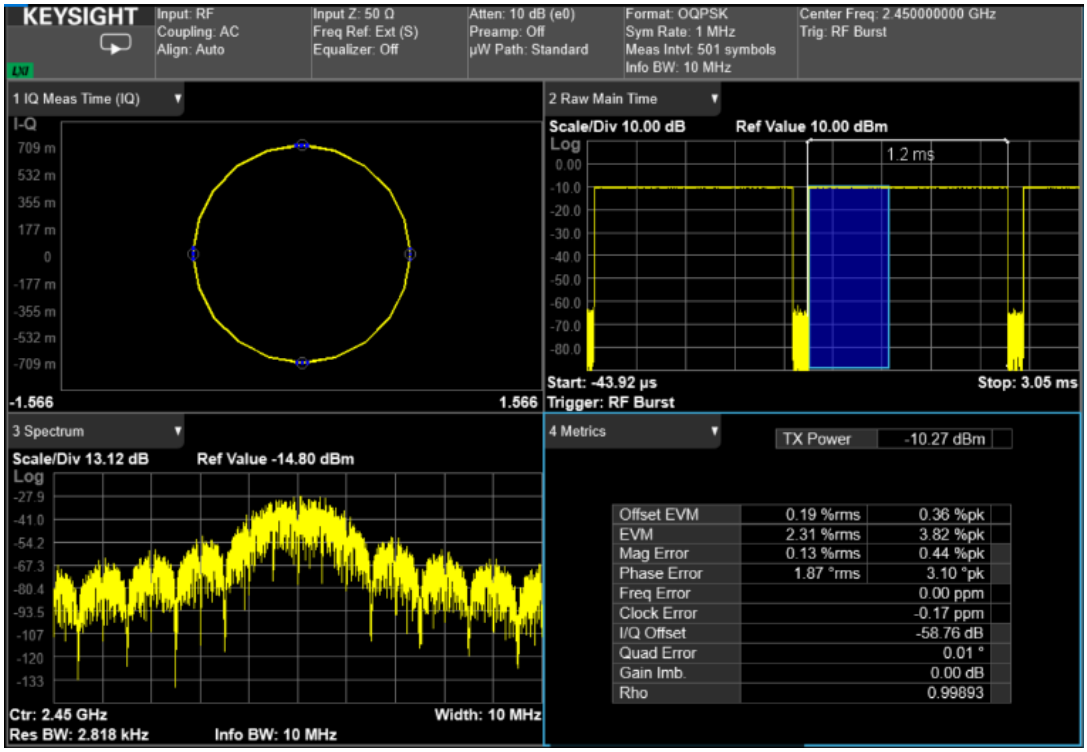

Figure 1. 802.15.4 O-QPSK mod analysis at 2.45 GHz

802.15.4 BPSK modulation analysis

Figure 2 is 802.15.4 BPSK modulation analysis at 915 MHz band with data rate at 40kb/s showing constellation, spectrum, Raw time waveform, and error summary information including EVM, Mag Error, Phase Error, Freq Error, I/Q offset, and amplitude drop

- Upper left: constellation
- Upper right: raw main time
- Lower Left: spectrum
- Lower right: Error summary metrics

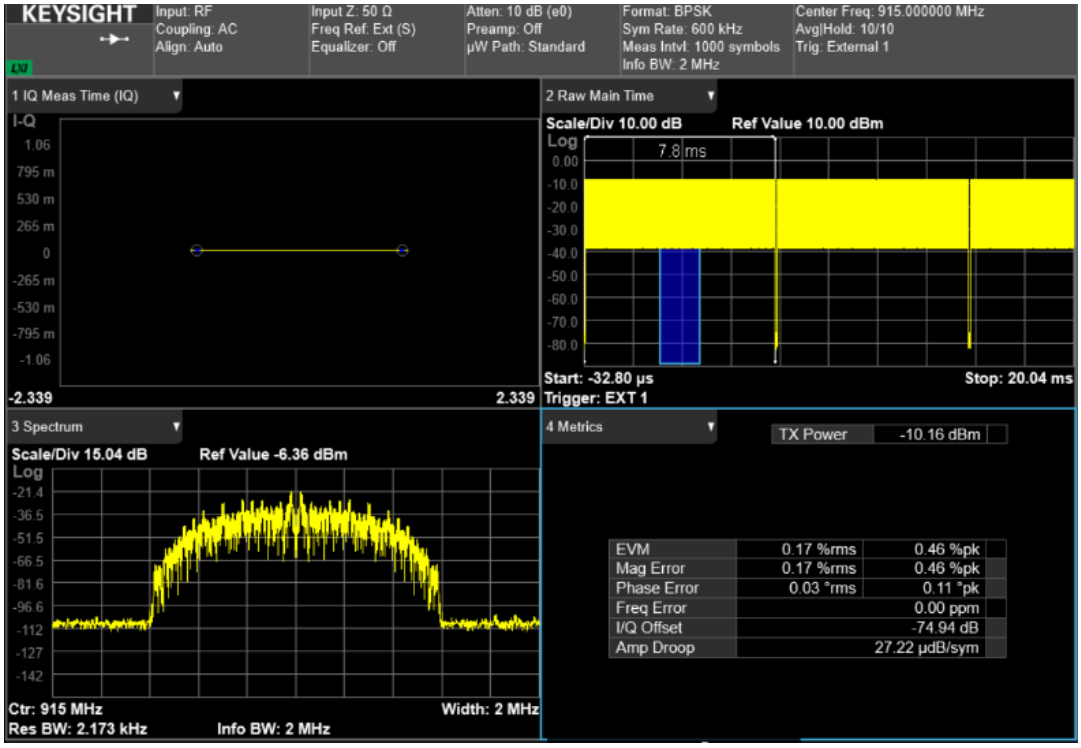

Figure 2. 802.15.4 BPSK mod analysis at 915 MHz

ITU G.9959 Z-Wave modulation analysis

Figure 3 is ITU G.9959 Z-Wave GFSK modulation analysis at 868.48 MHz band with data rate as R3 100 kpbs showing constellation, spectrum, Raw time waveform, and error summary information including FSK Error, Mag Error, Carrier Freq Offset, Deviation, and Clock Error

- Upper left: constellation
- Upper right: raw main time
- Lower Left: spectrum
- Lower right: Error summary metrics

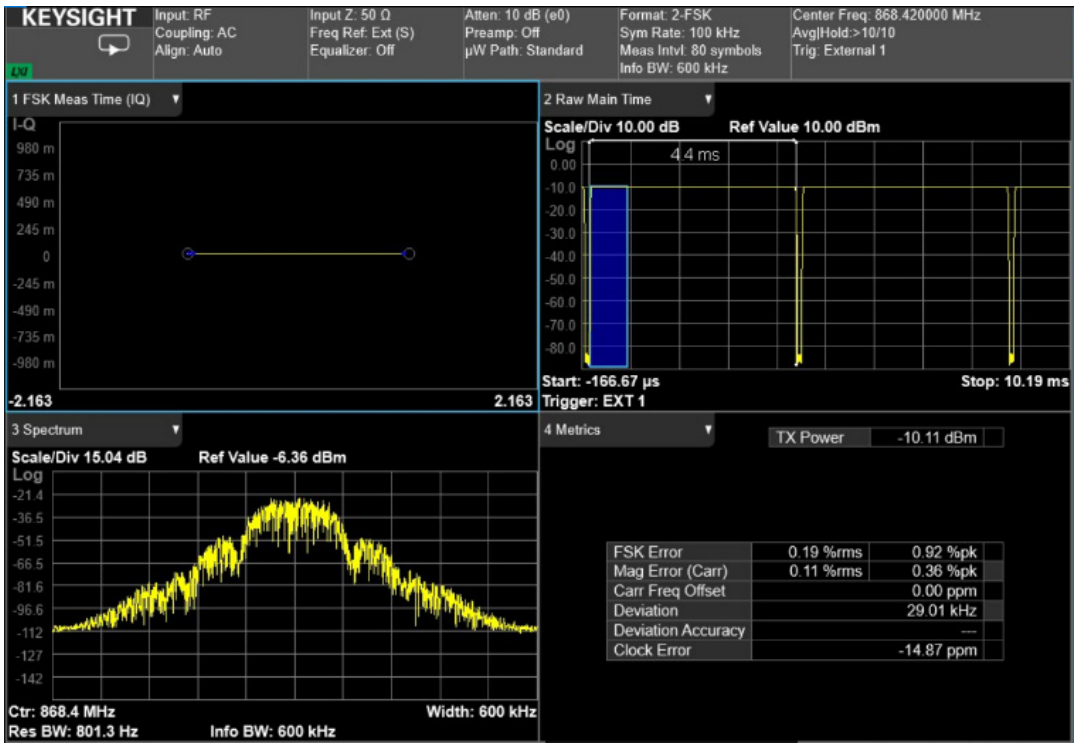

Figure 3. ITU G.9959 Z-Wave GFSK mod analysis at 868.48 MHz

ITU G.9959 Z-Wave modulation analysis

Figure 4 is an G.9959 Z-Wave GFSK modulation analysis at 868.48 MHz band with data rate as R3 100 kpbs showing the decode results with PER, Error Packets and Total Packets (Total packet number can be specified manually under the Meas Setup-> Decode setting)

- Upper: PER results with error packets and total packets
- Lower: Decode bits

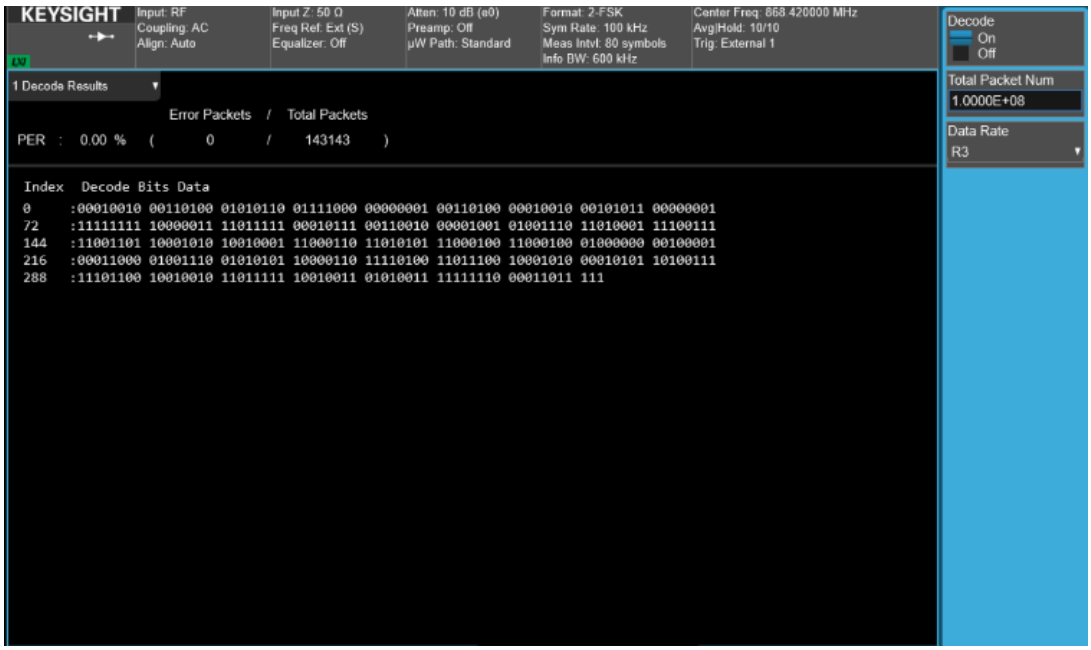

Figure 4. ITU G.9959 Z-Wave Decode results

LoRa® modulation analysis

Figure 5 is LoRa® Chirp Spread Spectrum (CSS) modulation analysis at 915 MHz band with 125 kHz bandwidth showing the results with RF Spectrum, AF Spectrum, Demod waveform and error summary metrics including LoRa Deviation Peak+/-, (Pk-Pk)/2, RMS, Carrier Power, Carrier Frequency Error, Burst Length, Payload Length and Preamble Length

- Upper left: RF Spectrum
- Upper right: Demod waveform
- Lower left: AF spectrum
- Lower right: Error summary metrics

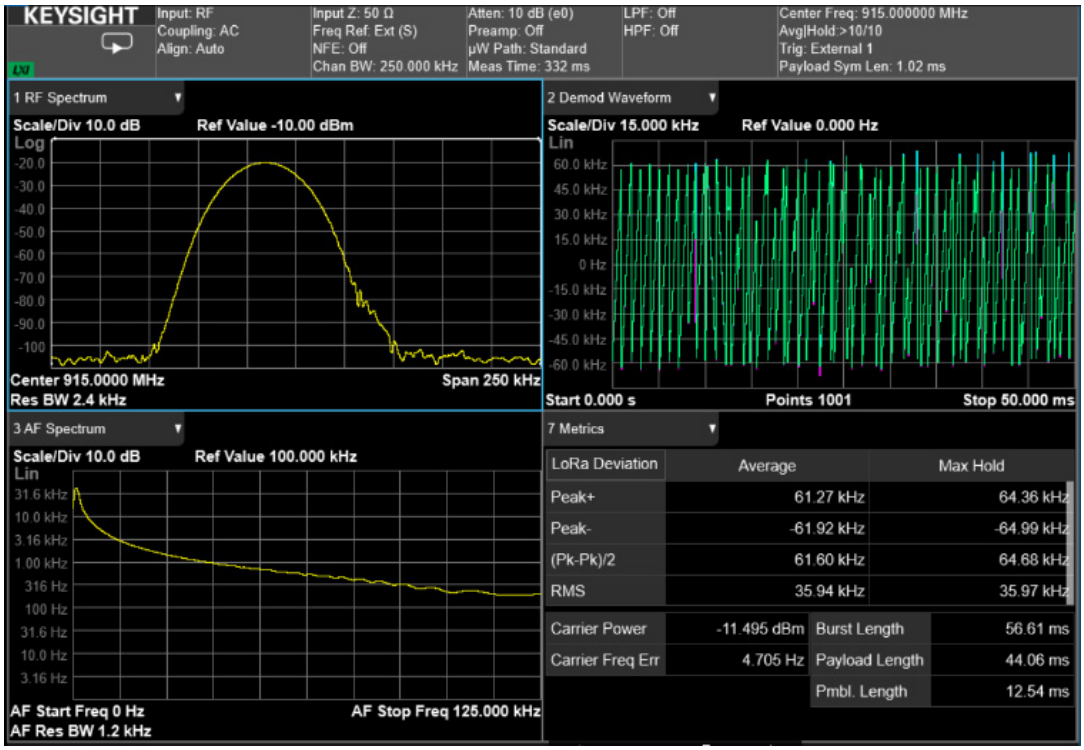

Figure 5. LoRa® modulation analysis

LoRa® modulation analysis

Figure 6 is LoRa® Chirp Spread Spectrum (CSS) modulation analysis at 915 MHz band with 125 kHz bandwidth showing the frequency drift results with Frequency Drift trace result, Frequency Drift result table including LoRa deviation, Carrier Power, Carrier Frequency Error, Burst Length, Payload length, Preamble length, Frequency Drift RMS, Pk+/Pk-, Max Hold Drift Pk+, Min Hold Drift Pk-

- Upper: Frequency Drift Result trace
- Lower: Frequency Drift Result Table

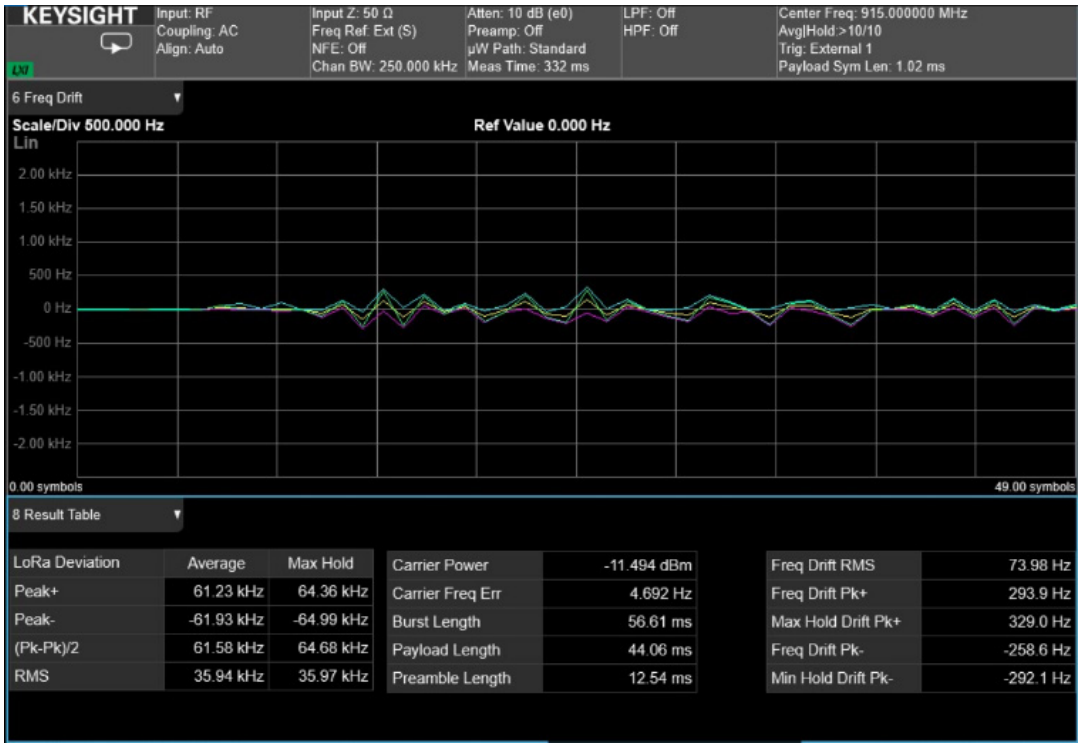

Figure 6. LoRa® modulation analysis Frequency Drift

Measurement Summary

One-button Standards-based Measurements

802.15.4 O-QPSK RF Requirements

IEEE 802.15.4 paragraph #	Transmitter test	N9084EM0E measurement applications
12.3.1	Operating Frequency Band	Applied to all measurements
12.3.2	Transmit power spectral density (PSD) mask	Spectrum emission mask (SEM)
12.3.3	Symbol Rate	Modulation Analysis (Clock Error)
12.3.8	EVM	Modulation Analysis (Offset EVM, EVM)
12.3.9	Transmit center frequency tolerance	Modulation Analysis (frequency error)
12.3.10	Transmit Power	Channel Power

802.15.4 BPSK RF Requirements

IEEE 802.15.4 paragraph #	Transmitter test	N9084EM0E measurement applications
13.3.1	Operating Frequency Band	Applied to all measurements
13.3.2	Transmit power spectral density (PSD) mask	Spectrum emission mask (SEM)
13.3.3	Symbol Rate	Modulation Analysis (Clock Error)
13.3.8	EVM	Modulation Analysis (EVM)
13.3.9	Transmit center frequency tolerance	Modulation Analysis (frequency error)
13.3.10	Transmit Power	Channel Power

ITU G.9959 Z-Wave RF Requirements

G.9959 paragraph #	Transmitter test	N9084EM0E measurement applications
A.3.1.1	Operating Frequency Band	Applied to all measurements
A.3.1.2	Transmit frequency error	Modulation Analysis (frequency error)
A.3.1.3	RF data rate	Modulation Analysis (Clock Error)
A.3.1.6	RF Power measurement	Channel power
A.3.1.7	Transmit power adjustment	Channel power
A.3.1.10	Receiver spurious requirement	Spurious emission

Measurement Details

802.15.4 O-QPSK and BPSK Measurement Application

Standard Presets	
Short Range Comm Standard	802.15.4
Profiles	OQPSK 2450 MHz, 780MHz[1], 868MHz[1], 915 MHz[1] BPSK 915 MHz BPSK 868/950 MHz
Demodulation Settings	
Modulation Format	Offset QPSK or BPSK
Symbol Rate	O-QPSK (200kHz, 500 kHz, 1 MHz) BPSK (300 kHz or 600 kHz)
Ref Filter	Half Sine (default), Raised Cosine, Root Raised Cosine, Gaussian, Rectangular
Decode	On/Off; Total Packet Number (default as 1.0E+8)
Limit Test	On/Off Tx Power: -50 dBm RMS: 35% RMS Offset EVM: 35% Frequency Error: 40.0 ppm Clock Error: 40.0 ppm
Measurements/displays	Monitor Spectrum I/Q waveform Spectrum measurement (Channel Power, Occupied BW, ACP, SEM, Power Stat CCDF, and Spurious Emission) Modulation analysis • Raw main time • Spectrum • I/Q Meas Time & Spectrum • I/Q Ref Rime& Spectrum • Error Vector Time • Error Vector Spectrum • Mag Error • Phase Error • Channel frequency response • EQ impulse response • Error Summary Metrics Table • Demod Bits Table • Decode Results Table

1. This requires N9084EM0E version above 2020.0701 and firmware above A.27.0x.

Measurement Details

ITU G.9959 Z-Wave Measurement Application

Standard Presets	
Short Range Comm Standard	Z-Wave
Profiles	R1 (9.6 kbps) FSK R2 (40 kbps) FSK R3 (100 kbps) FSK
Demodulation Settings	
Modulation Format	2-FSK
Symbol Rate	9.6 kHz, 40 kHz or 100 kHz
Ref Filter	Gaussian (default), Half Sine, Raised Cosine, Root Raised Cosine, Rectangular
Gaussian BT	0.6
Decode	On/Off w/ Total Packet Number (default as 1.0E+8) Data Rate as R1, R2 or R3
Limit Test	On/Off Tx Power: -50 dBm RMS FSK Error: 35% Frequency Error: 27.0 ppm Clock Error: 27.0 ppm
Measurements/displays	Monitor Spectrum I/Q waveform Spectrum measurement (Channel Power, Occupied BW, ACP, SEM, Power Stat CCDF, and Spurious Emission) Modulation analysis • Raw main time • Spectrum • FSK Meas Time & Spectrum • FSK Ref Rime& Spectrum • FSK Error Time • FSK Error Spectrum • Mag Error (Carrier) • Phase Error • Error Summary Metrics Table • Demod Bits Table • Decode Results Table

Measurement Details

LoRa® Measurement Application[1]

Standard Presets	
IoT Standard	LoRa CSS
Profiles	7.8125 kHz, 10.4167 kHz, 15.625 kHz, 20.8333 kHz, 31.25 kHz, 41.667 kHz, 62.5 kHz, 125 kHz, 203.125 kHz, 250 kHz, 406.25 kHz, 500 kHz, 812.5 kHz, 1.625 MHz
Demodulation Settings	
Modulation Format	CSS (Chirp Spread Spectrum)
Spread Factor	SF5, SF6, SF7, SF8, SF9, SF10, SF11, SF12
BW	7.8125 kHz, 10.4167 kHz, 15.625 kHz, 20.8333 kHz, 31.25 kHz, 41.667 kHz, 62.5 kHz, 125 kHz, 203.125 kHz, 250 kHz, 406.25 kHz, 500 kHz, 812.5 kHz, 1.625 MHz
Programmed Preamble Length	8 default (4 to 65512)
Highpass filter	Off (default), 20 Hz, 50 Hz, 300 Hz, 400 Hz, and Manual
Lowpass filter	Off (default), 300 Hz, 3 kHz, 15 kHz, 30 kHz, 80 kHz, 100 kHz (>20 kHz Bessel), 300 kHz and Manual
Decode	On/Off; Total Packet Number (default as 1.0E+8)
Measurements/displays	Monitor Spectrum I/Q waveform Spectrum measurement (Channel Power, Occupied BW, ACP, SEM, Power Stat CCDF, and Spurious Emission) RF Envelope RAW Demod Waveform Frequency Drift Trace Marker Table Demod Bits Decode Bits[2] Decode Info[2] Metrics Table • LoRa deviation: Pk+, Pk-, (Pk-Pk)/2, RMS (Average and Max Hold) • Carrier Power (dBm) • Carrier Frequency Error (Hz) • Burst Length • Payload Length • Preamble Length • Result Table • Frequency Drift: RMS, Pk+, Pk-, • Frequency Drift: Max Hold Drift Pk+, Min Hold Drift Pk-

1. This requires N9084EM0E version above 2019.1101 and firmware above A.25.0x.
2. This requires N9084EM0E version above 2020.0701 and firmware above A.27.0x.

Key Specifications

Definitions

- Specifications describe the performance of parameters covered by the product warranty.
- The specifications apply to single carrier case only, unless otherwise stated.
- 95th percentile values indicate the breadth of the population (≈2σ) of performance tolerances expected to be met in 95% of cases with a 95% confidence. These values are not covered by the product warranty.
- Typical values are designated with the abbreviation "typ." These are performance beyond specification that 80% of the units exhibit with a 95% confidence. These values are not covered by the product warranty.
- Nominal values are designated with the abbreviation "nom." These values indicate expected performance, or describe product performance that is useful in the application of the product, but is not covered by the product warranty.

Note: Data subject to change.

Supported Standards

Technology	Short Range Communication and IoT
Model-Option	N9084EM0E
Standard versions	IEEE 802.15.4 (2015)
	ITU G.9959 (2012)
	LoRa CSS

Key Specifications

Description	UXA	PXA	MXA	EXA
802.15.4 EVM (Modulation Accuracy)				
802.15.4 O-QPSK (2450 MHz, Offset EVM)		0.25% (nom.)		
802.15.4 BPSK (868/950 MHz)		0.50% (nom.)		
802.15.4 BPSK (915 MHz)		0.50% (nom.)		
Frequency Error Range				
802.15.4 O-QPSK (2450 MHz)		± 80 ppm (nom.)		
802.15.4 BPSK (868/950 MHz)		± 50 ppm (nom.)		
802.15.4 BPSK (915 MHz)		± 80 ppm (nom.)		
Frequency Error Accuracy				
802.15.4 O-QPSK (2450 MHz)		± 1Hz+tfa[1] (nom.)		
802.15.4 BPSK (868/950 MHz)		± 1Hz+tfa[1] (nom.)		
802.15.4 BPSK (915 MHz)		± 1Hz+tfa[1] (nom.)		
Z-Wave FSK Error				
Z-Wave R1 FSK (9.6 kbps)		0.58% (nom.)		
Z-Wave R1 FSK (40 kbps)		0.78% (nom.)		
Z-Wave R1 FSK (200 kbps)		0.80% (nom.)		
Frequency Error Range				
Z-Wave R1 FSK (9.6 kbps)		± 60 ppm (nom.)		
Z-Wave R1 FSK (40 kbps)		± 60 ppm (nom.)		
Z-Wave R1 FSK (200 kbps)		± 60 ppm (nom.)		
Frequency Error Accuracy				
Z-Wave R1 FSK (9.6 kbps)		± 50Hz+tfa[1] (nom.)		
Z-Wave R1 FSK (40 kbps)		± 50Hz+tfa[1] (nom.)		
Z-Wave R1 FSK (200 kbps)		± 50Hz+tfa[1] (nom.)		

1. tfa = transmitter frequency × frequency reference accuracy.

For a complete list of specifications refer to the appropriate specifications guide.

UXA: http://www.keysight.com/find/uxa_specifications
PXA: http://www.keysight.com/find/pxa_specifications
MXA: http://www.keysight.com/find/mxa_specifications
EXA: http://www.keysight.com/find/exa_specifications

Ordering Information

Flexible Licensing and Configuration

Perpetual: License can be used in perpetuity.
Time-based: License is time limited to a defined period, such as 12-months.
Node-locked: Allows you to use the license on one specified instrument/computer.
Transportable: Allows you to use the license on one instrument/computer at a time. This license may be transferred to another instrument/computer using Keysight's online tool.
Floating: Allows you to access the license on networked instruments/computers from a server, one at a time. For concurrent access, multiple licenses may be purchased.
USB portable: Allows you to move the license from one instrument/computer to another by end-user only with certified USB dongle, purchased separately.
Software support subscription: Allows the license holder access to Keysight technical support and all software upgrades

Short Range Communication and IoT measurement application (N9084EM0E)

Model	Software License Type	Support Contract	Support Subscription (12-month)[2]
N9084EM0E-1FP	Node-locked perpetual	R-Y5C-001-A[2]	R-Y6C-001-L[2]
N9084EM0E-1FL	Node-locked 12-month	R-Y4C-001-L[1]	Included
N9084EM0E-1TP	Transportable perpetual	R-Y5C-004-A[2]	R-Y6C-004-L[2]
N9084EM0E-1TL	Transportable 12-month	R-Y4C-004-L[1]	Included
N9084EM0E-1NP	Floating perpetual, single site	R-Y5C-002-A[2]	R-Y6C-002-L[2]
N9084EM0E-1NL	Floating 12-month, single site	R-Y4C-002-L[1]	Included
N9084EM0E-1UP	USB portable perpetual	R-Y5C-005-A[2]	R-Y6C-005-L[2]
N9084EM0E-1UL	USB portable 12-month	R-Y4C-005-L[1]	Included

One moth software support subscription[3]

Model	Software License Type
R-Y6C-501[3]	1-month software support subscription for node-lock license
R-Y6C-502[3]	1-month software support subscription for floating license, single site
R-Y6C-504[3]	1-month software support subscription for transportable license
R-Y6C-505[3]	1-month software support subscription for USB portable license

1. All time-based X-Series measurement application licenses includes a 12-month support contract which also includes the 12-month software support subscription as same duration.
2. Support contract must bundle software support subscription for all perpetual licenses in the first year. All software upgrades and Keysight support are provided for software licenses with valid support subscription.
3. After the first year, software support subscription may be extended with annual or monthly software support subscription

Hardware Configuration

For optimizing measurements on 5G NR measurement applications, Keysight recommends a minimum level of X-Series multi-touch instrument hardware functionality at each instrument performance point.

Supported instruments include:

Benchtop:

- UXA N9040B or N9041B[1]
- PXA N9030B
- MXA N9020B
- EXA N9010B
- CXA N9000B

1. Currently this measurement application has only been qualified for N9041B Input 1 Port.

N90x0B X-Series Signal Analyzer (Multi-touch)

Description	Description	Additional information
Analysis bandwidth	100 MHz or wider	5G NR now supports analysis bandwidth >100 MHz options as 125/160/255/510MHz or 1 GHz, which can be chosen depending on the specified signal analyzer
Precision Frequency Reference	-PFR	Recommended: For enhanced frequency accuracy and repeatability for lower measurement uncertainty
Electronic Attenuator	-EA3	Recommended: Fast and reliable attenuation changes ideal for manufacturing without the wear associated with mechanical attenuators up to 3.6 GHz in 1 dB steps
Pre-amplifier	3.6 GHz (-P03) or higher	Recommended: For maximizing the measurement sensitivity
Fine Resolution Step attenuator	-FSA	Recommended: Useful for maximizing useable dynamic range to see signals

Additional Information

Literature

X-Series Measurement Application Brochure 5989-8019EN

Web

Shor Range Communication and IoT X-Series measurement app, multi-touch UI product webpage: www.keysight.com/find/N9084E

X-Series measurement applications: www.keysight.com/find/X-Series_Apps

X-Series signal analyzers: www.keysight.com/find/X-Series

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

KEYSIGHT TECHNOLOGIES

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