M9080A & M9082A LTE FDD/TDD

X-Series Measurement Application for M9391A PXIe Vector Signal Analyzer

Technical Overview

Challenge the Boundaries of Test

Agilent Modular Products

- Perform LTE FDD and TDD base station (eNB) and user equipment (UE) transmitter test
- Perform RF conformance tests for all LTE bandwidths
- Measure beyond physical layer using the transport layer channel decoding capability
- PC-based SCPI remote interface and manual user interface
- Leverage built-in, context-sensitive help with SCPI command reference
- Transportable license supports up to four M9391A PXIe VSA channels in one mainframe

Anticipate ___Accelerate ___Achieve

Agilent Technologies

LTE FDD and TDD measurement applications for modular instruments

Expand the capabilities of your M9391A PXIe vector signal analyzer (PXI VSA) with Agilent's library of measurement applications - the same applications used to increase the capability and functionality of its X-Series signal analyzers. Eight of the most popular applications are now available for use with Agilent's M9391A new modular PXI VSA. When you combine the raw hardware speeds of the PXI VSA and the X-Series measurement applications for modular instruments, you can test more products in less time while ensuring measurement continuity from design to manufacturing.

The LTE FDD and LTE TDD measurement applications transform M9391A PXIe vector signal analyzers (PXI VSA) into 3GPP LTE standard-based RF transmitter testers. The applications provide fast, RF conformance measurements to help you speed up manufacturing of your LTE base station (eNB) and user equipment (UE) devices. The measurement applications closely follow the 3GPP standard allowing you to stay on the leading edge of your design and manufacturing challenges.

The LTE FDD and LTE TDD measurement applications are two in a common library of several measurement applications in the Agilent X-Series, an evolutionary approach to signal analysis that spans instrumentation, measurements, and software. Proven algorithms and a common user interface across the X-Series analyzers and modular PXI VSAs create a consistent measurement framework for signal analysis that ensures repeatable results and measurement integrity so you can leverage your test system software through all phases of product development. In addition to fixed, perpetual licenses for our X-Series measurement applications, we also offer transportable licenses which can increase the value of your investment by utilizing up to four M9391A PXI VSAs with one software license.

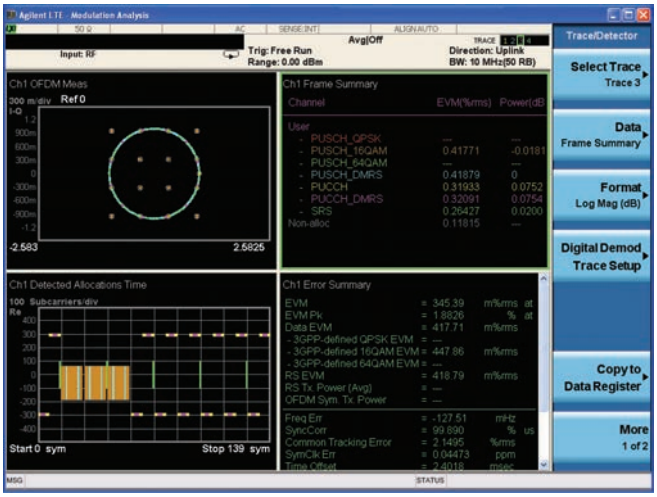

Figure 1. M9080A and M9082A LTE FDD/TDD X-Series measurement application for modular instruments.

Agilent's X-Series applications for modular instruments also include a unique "Resource Manager" that provides direct access to PXI VSA hardware drivers for the fastest power and spectrum-based measurements, while simultaneously using the X-Series applications for fast modulation quality measurements.

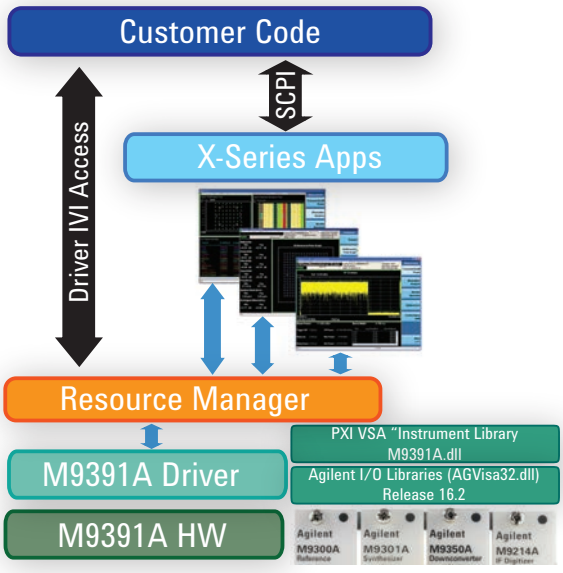

Figure 2. Resource manager included with all X-Series measurement applications for modular instruments.

Technology overview

Developed by the Third Generation Partnership Project (3GPP), LTE is the evolution of the Universal Mobile Telecommunication System (UMTS) towards an all-IP broadband network. LTE's evolved radio access technology—the E-UTRA—provides a framework for increasing data rates and overall system capacity, reducing latency, and improving spectral efficiency and cell-edge performance. It is documented in the 3GPP Release 8 and Release 9 specifications.

LTE accommodates both paired spectrum for Frequency Division Duplex (FDD) and unpaired spectrum for Time Division Duplex (TDD) operation. There is a high degree of commonality between FDD and TDD modes. These two modes are coordinated in the sense that they both share the same underlying framework, including radio access schemes orthogonal frequency division multiple access (OFDMA) for the downlink, and single-carrier frequency division multiple access (SC-FDMA) for the uplink. Both modes share a single radio-access specification, equally applicable to paired and unpaired spectrum. From a specification perspective, the few significant differences between FDD and TDD mode are on the physical layer, in particular, the frame structure. The differences in higher layers are very few.

Table 1. Physical layer comparisons of LTE FDD and LTE TDD

	LTE FDD	LTE TDD
Radio access mode	FDD	TDD
Radio frame length	10 ms (20 slots, 10 sub-frames)	10 ms (20 slots, 10 sub-frames)
Transmission scheme	Downlink: OFDMA Uplink: SC-FDMA	Downlink: OFDMA Uplink: SC-FDMA
Channel bandwidth, 1 Resource Block (RB) = 180 kHz	1.4 MHz (6 RB), 3 MHz (15 RB), 5 MHz (25 RB), 10 MHz (50 RB), 15 MHz (75 RB), 20 MHz (100 RB)	
Data type	Packet switched for both voice and data. No circuit switched.	
Data modulation	Downlink: QPSK, 16QAM, 64QAM Uplink: QPSK, 16QAM, 64QAM (UE category 5 only)	
Peak data rate (Mbps)	Downlink (using 64QAM): 100 (SISO); 172.8 (2x2 MIMO); 326.4 (4x4 MIMO) Uplink (single transmit antenna): 50 (QPSK); 57.6 (16QAM); 86.4 (64QAM) Note: TDD rates are a function of up/downlink asymmetry	
MIMO technology	Downlink (up to 4 transmit antennas): Single user (SU)-MIMO spatial multiplexing (open loop and close loop), transmit diversity, cyclic delay diversity, dedicated beamforming (beamforming is particularly interesting for LTE TDD) Uplink (single transmit antenna per UE): Multi-user MIMO (MU-MIMO) – more than one UE transmit in the same time-frequency resource.	

RF transmitter tests

With the modular PXI VSAs and the LTE FDD and TDD measurement applications, you can perform RF transmitter measurements on BTS and UE devices in time, frequency, and modulation domains. Measurement setups are simplified with automatic detection of downlink channels and signals. For eNB conformance testing, measurement is simplified by recalling E-TM presets according to the 3GPP TS 36.141 conformance document. The measured results can be viewed by resource block, sub-carrier, slot, or symbol. Graphical displays with color coding and marker coupling allow you to search for problems faster and troubleshoot the found problems quicker. For manufacturing, "conformance EVM" measurement provides up to 2x speed improvement over the traditional EVM measurement.

In addition, the measurement applications allow you to test beyond the physical layer by using the transport layer decoding functionality. Troubleshoot transport layer problems and verify the channel encoding is correct by getting access to data at different points in the encoding chain such as: de-mapped, de-interleaved, de-scrambled, de-ratematched, and decoded data.

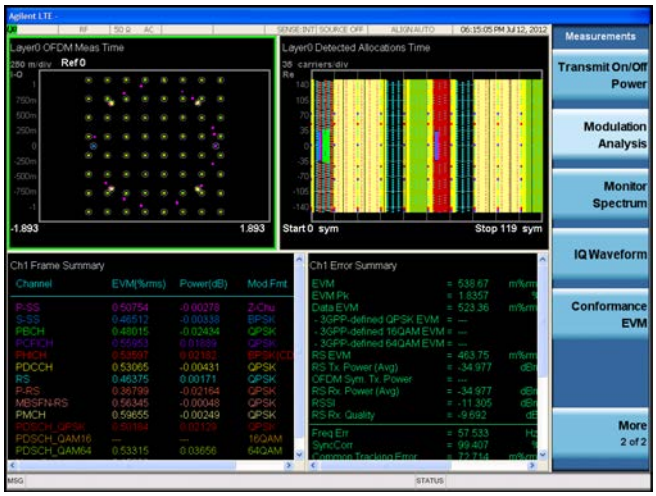

Figure 3. Downlink modulation analysis measurement showing constellation, detected allocation, frame summary, and error summary information. Measurements are color-coded based on channel type for ease of troubleshooting.

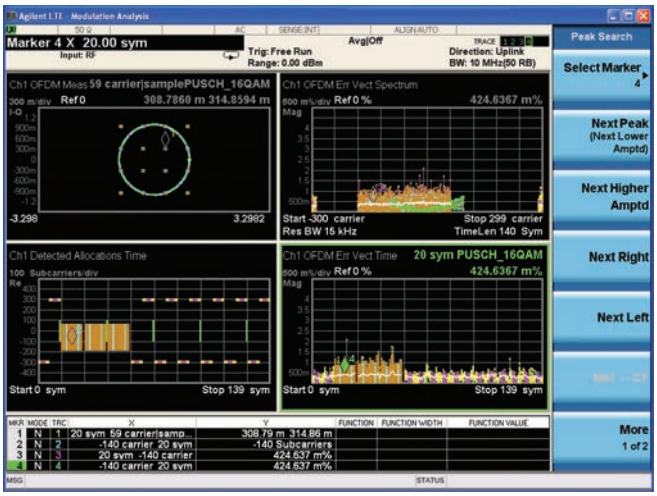

Figure 4. Uplink modulation analysis measurement showing constellation, EVM vs. subcarrier, detected allocation, and EVM vs. symbol information. Measurements are color-coded based on channel type and up to 12 markers with marker coupling between measurements are used for ease of troubleshooting.

Standards-based RF transmitter test

Table 2. Required base station (eNB) RF transmitter measurements and the corresponding measurements in M9080A and M9082A and 89600 VSA

3GPP TS36.141 subclause	Transmitter test	E-TM required	M9080A (FDD) and N/M9082A (TDD) measurement applications	89600 VSA options BHD (FDD) and BHE (TDD)
6.2	Base station output power	E-TM1.1	Channel power	Channel power using band power marker
6.3.1	RE power control dynamics	E-TM 2; E-TM 3.1; E-TM 3.2; E-TM 3.3	Modulation analysis[1]	Error summary trace[1]
6.3.2	Total power dynamic range	E-TM 2; E-TM 3.1	OFDM Symbol Tx. Power (OSTP)[2]	OFDM Sym.Tx Power[3]
6.4	Transmit ON/OFF power (TDD only)	E-TM1.1	Transmit ON/OFF Power (M9082A only)	Not available
6.5.1	Frequency error	E-TM 2; E-TM 3.1; E-TM 3.2; E-TM3.3	Freq error[2]	Freq error[3]
6.5.2	Error vector magnitude	E-TM 2; E-TM 3.1; E-TM 3.2; E-TM3.3	EVM[2]	EVM[3]
6.5.3	Time alignment between transmitter branches	E-TM 1.1	MIMO summary	MIMO info table
6.5.4	DL RS power	E-TM 1.1	RS Tx Power (RSTP)[2]	RS Tx Power[3]
6.6.1	Occupied bandwidth	E-TM 1.1	OBW	OBW[4]
6.6.2	Adjacent channel leakage power ratio	E-TM 1.1, E- TM 1.2	ACP	ACP[4]
6.6.3	Operating band unwanted emissions	E-TM 1.1, E-TM 1.2	Spectrum emission mask	Not available[5]
6.6.4	Transmitter spurious emission	E-TM 1.1	Spurious emissions	Not available[5]
6.7	Transmitter intermodulation	E-TM 1.1	ACP	ACP [4]

1. *RE power control dynamic range is the difference between the power of an RE and the average RE power for a BS. No specific test for RE power control dynamic range. The EVM test provides enough test coverage for this requirement.*
2. *These values are found in "Error Summary" table under Mod Analysis measurement or under Conformance EVM measurement for M9080A and M9082A.*
3. *These values are found in "Error Summary" trace.*
4. *Measurement parameters must be set up manually within the 89600 VSA software or if 89600 VSA is used with an Agilent spectrum or signal analyzer, these measurements can be set up manually using the spectrum analyzer mode.*
5. *If 89600 VSA used with an Agilent spectrum or signal analyzer, these measurements can be set up manually using the spectrum analyzer mode.*

Table 3. Required user equipment (UE) RF transmitter measurements and the corresponding measurements in M9080A and M9082A and 89600 VSA

3GPP TS 36.521-1 subclause	Transmitter test	M9080A (FDD) and M9082A (TDD) measurement applications	89600 VSA Options BHD (FDD) and BHE (TDD)
6.2.2	UE maximum output power (MOP)	Channel power	Channel power using band power marker
6.2.3	Maximum power reduction (MPR)	Channel power	Channel power using band power marker
6.2.4	Additional maximum power reduction (A-MPR)	Channel power	Channel power using band power marker
6.2.5	Configured UE transmitted output power	Channel power	Channel power using band power marker
6.3.2	Minimum output power	Channel power	Channel power using band power marker
6.3.3	Transmit off power	Channel power	Channel power using band power marker
6.3.4	On/off time mask	Transmit on/off power	Not available
6.3.5	Power control	Not available	Not available
6.5.1	Frequency error	Frequency error[1] & frequency error per slot[2]	Frequency error and frequency error per slot trace
6.5.2.1	EVM	EVM[1]	EVM
6.5.2.2	IQ-component	IQ offset[1] and IQ offset per slot[2]	IQ offset and IQ offset per slot
6.5.2.3	In-band emissions for non-allocated RB	In-band emissions[2]	In-band emissions
6.5.2.4	Spectrum flatness	Equalizer channel freq response per slot[3]	Per slot equalizer channel frequency response
6.6.1	Occupied bandwidth	Occupied BW	OBW[4]
6.6.2.1	Spectrum emission mask	Spectrum emission mask	Not available[5]
6.6.2.2	Additional spectrum emission mask	Spectrum emission mask	Not available[5]
6.6.2.3	Adjacent channel leakage power ratio (ACLR)	ACP	ACP[4]
6.6.2.4	Additional ACLR requirements	ACP	ACP[4]
6.6.3.1	Transmitter spurious emission	Spurious emissions	Not available[5]
6.6.3.2	Spurious emission band UE co-existence	Spurious emissions	Not available[5]
6.6.3.3	Additional spurious emissions	Spurious emissions	Not available[5]
6.7	Transmit intermodualtion	ACP	ACP[4]

1. *These values are found in "Error Summary" table under Mod Analysis measurement or under Conformance EVM measurement for M9080A and M9082A.*
2. *These measurements are part of the Mod Analysis measurement. Once in Mod Analysis, they are found under [Trace/Detector] -> {Data} > {Demod Error}.*
3. *This measurement is part of the Mod Analysis measurement. Once in Mod Analysis, it is found under [Trace/Detector] -> {Data} > {Response}.*
4. *Measurement parameters must be set up manually within the 89600 VSA software or if 89600 VSA is used with an Agilent spectrum or signal analyzer, these measurements can be set up manually using the spectrum analyzer mode.*
5. *If 89600 VSA is used with an Agilent spectrum or signal analyzer, these measurements can be set up manually using the spectrum analyzer mode.*

Measurement details

All of the RF transmitter measurements as defined by the 3GPP standard, as well as a wide range of additional measurements and analysis tools, are available with a press of a button (Tables 4 and 5). These measurements are fully remote controllable via the IEC/IEEE bus or LAN, using SCPI commands.

Uplink/downlink support

Supported downlink (eNB) channels/signals: P-SS; S-SS; RS; PBCH; PCFICH; PHICH; PDCCH; PDSCH; PMCH; MBSFN-RS; P-RS

Supported uplink (UE) channels/signals: PRACH; SRS; PUCCH; PUCCH-DMRS; PUSCH; PUSCH-DMRS

Table 4. List of eNB measurements provided by M9080A and M9082A measurement applications for modular instruments

Technology	LTE FDD	LTE TDD
X-Series measurement applications for modular instruments	**M9080A**	**M9082A**
Modulation quality (error summary table):		
EVM (RMS, peak, data, RS)	●	●
Channel power	●	●
RS Tx. power (RSTP)	●	●
OFDM symbol Tx. power (OSTP)	●	●
RS Rx. power (RSRP)	●	●
RS Rx. quality (RSRQ)	●	●
RSSI	●	●
Frequency error	●	●
Common tracking error	●	●
Symbol clock error	●	●
Time offset	●	●
IQ (Offset, gain imbalance, quad error, timing skew)	●	●
Conformance EVM	●	●
Demodulated error traces:		
EVM vs. frequency (sub-carrier)	●	●
EVM vs. time (symbol)	●	●
EVM vs. resource block	●	●
EVM vs. slot	●	●
Frequency error per slot	●	●
Power vs. resource block	●	●
Power vs. slot	●	●
Symbols table:		
Numerical values of demodulated symbols (encoded)	●	●
Decoded symbol table:		
Numerical values of demodulated data include demapped, deinterleaved, descrambled, deratematched, and decoded data	●	●
Downlink decode table:		
Decode information from PBCH, PDCCH, PHICH, and PCFICH	●	●
Frame summary table:		
EVM, power, modulation format, number of allocated RB and RNTI for all active channels and signals	●	●

Table 4. (continued)

Technology	LTE FDD	LTE TDD
X-Series measurement applications for modular instruments	**M9080A**	**M9082A**
TX diversity MIMO (up to 4 Tx antenna) traces:		
Info table		
RS power	●	●
RS EVM	●	●
RS CTE	●	●
RS timing	●	●
RS phase	●	●
RS symbol clock	●	●
RS frequency	●	●
IQ gain imbalance	●	●
IQ quadrature error	●	●
IQ time skew	●	●
Channel frequency response	●	●
Channel frequency response difference	●	●
Equalizer impulse response	●	●
Common tracking error	●	●
Detected allocations trace (resource block vs. symbol)	●	●
Response:		
Equalizer channel frequency response	●	●
Instantaneous equalizer channel frequency response		
Equalizer channel frequency response difference		
Instantaneous equalizer channel frequency response difference		
Equalizer impulse response		
Channel power	●	●
ACP	●	●
Transmit on/off power		●
Spectrum emission mask (SEM)	●	●
Spurious emissions	●	●
Occupied bandwidth	●	●
CCDF	●	●
Monitor spectrum	●	●
I/Q waveform	●	●

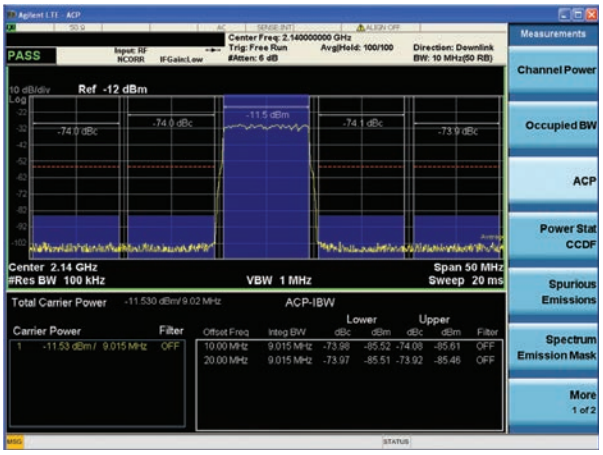

Figure 5. ACLR measurement with LTE main and adjacent carriers.

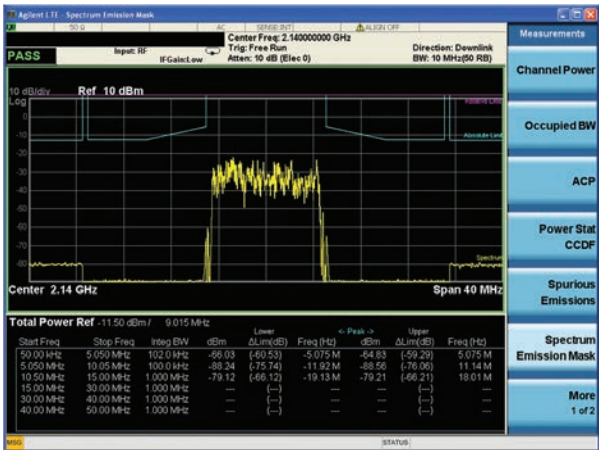

Figure 6. SEM measurement.

Table 5. List of UE measurements provided by M9080A and M9082A measurement applications for modular instruments

Technology	LTE FDD	LTE TDD
X-Series measurement applications for modular instruments	**M9080A**	**M9082A**
Modulation quality (error summary trace):		
EVM (RMS, peak, data, RS)	●	●
Frequency error	●	●
Common tracking error	●	●
Symbol clock error	●	●
Time offset	●	●
IQ (offset, gain imbalance, quad error, timing skew)	●	●
Channel power	●	●
In-band emissions result	●	●
Spectral flatness result	●	●
Conformance EVM	●	●
In-band emissions	●	●
Spectrum flatness (Eq. ch freq response per slot)	●	●
Demodulated error traces:		
EVM vs. frequency (sub-carrier)	●	●
EVM vs. time (symbol)	●	●
EVM vs. resource block	●	●
EVM vs. slot	●	●
IQ offset per slot	●	●
Frequency error per slot	●	●
Power vs. resource block	●	●
Power vs. slot	●	●
Symbols table:		
Numerical values of demodulated symbols (encoded)	●	●
Decoded symbol table:		
Numerical values of demodulated data: Demapped, descrambled, deratematched and decoded data	●	●
Uplink decode table:		
Decode information from PUSCH and PUCCH	●	●
Frame summary table:		
EVM, power, modulation format and number of allocated RB for all active channels and signals.	●	●
Detected allocations trace (resource block vs. symbol)	●	●
Response:		
Equalizer channel frequency response	●	●
Instantaneous equalizer channel frequency response	●	●
Equalizer channel frequency response difference	●	●
Instantaneous equalizer channel frequency response difference	●	●
Equalizer impulse response	●	●
Equalizer channel frequency response per slot	●	●
Channel power	●	●
ACP	●	●
Transmit on/off power	●	●
Spectrum emission mask (SEM)	●	●
Spurious emissions	●	●
Occupied bandwidth	●	●
CCDF	●	●
Monitor spectrum	●	●
I/Q waveform	●	●

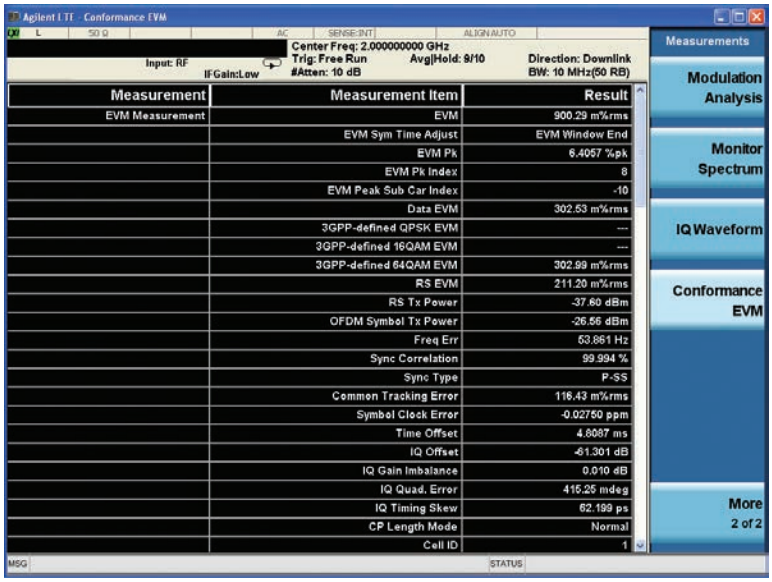

Figure 7. Conformance EVM measurement showing all required modulation quality metrics. This measurement is optimized for manufacturing because of its fast measurement speed.

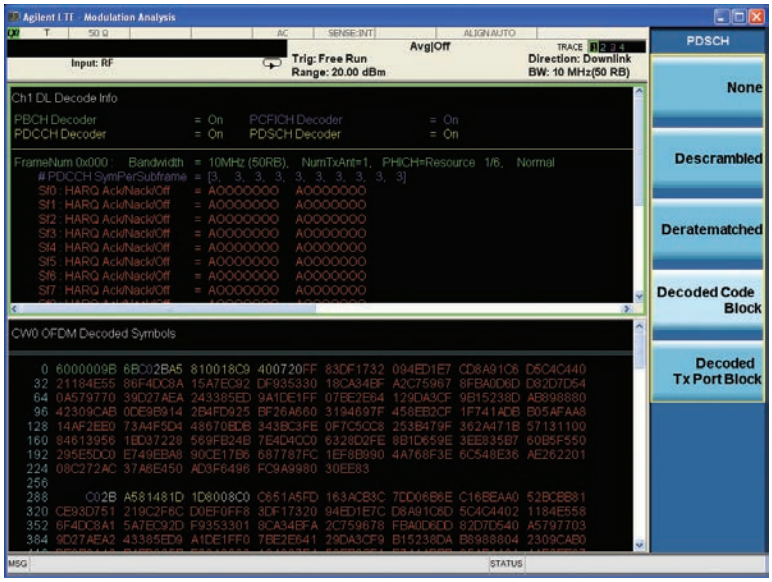

Figure 8. Downlink transport layer channel decoding measurement showing decoded information for PBCH, PDCCH, PCFICH and PHICH channels.

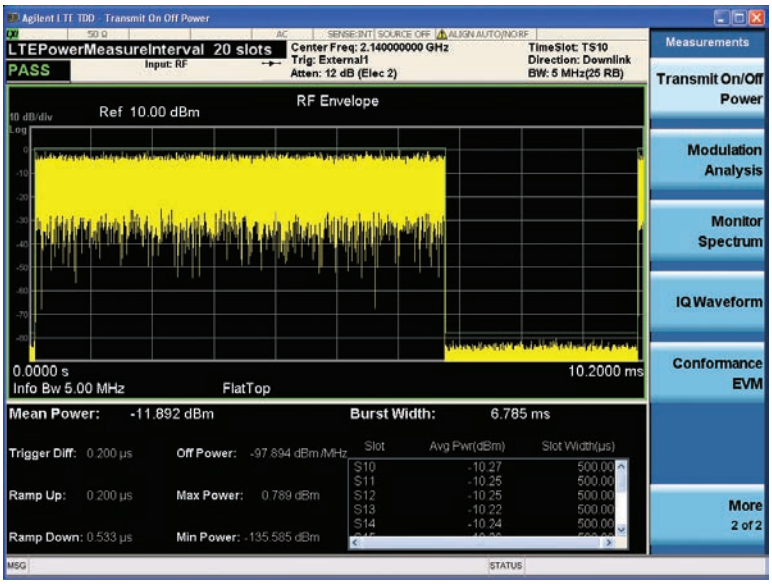

Figure 9. Transmit ON/OFF power measurement of an LTE TDD downlink signal.

Key specifications

Definitions

- Specifications describe the performance of parameters covered by the product warranty.
- 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 devices and standards

Device type	Base station (eNB) and user equipment (UE)
Standard version	The LTE demodulator supports signals that are compliant with the following 3GPP technical specifications: 36.211 V9.1.0 (March 2010) 36.212 V9.4.0 (September 2011) 36.213 V9.3.0 (September 2010) 36.214 V9.2.0 (June 2010)
	EVM calculations and conformance testing are compatible with these specifications: 36.141 V9.10.0 (July 2012) 36.521-1 V9.8.0 (March 2012)

For a complete list of specifications, please refer to the M9391A datasheet at literature number 5991-2603EN.

Performance specifications

Description	M9391A PXI VSA, nominal
Demodulation	
LTE FDD E-TM, 10 MHz BW, 2 GHz	*-52 dB*
LTE FDD E-TM, 10 MHz BW, <1 GHz	*-51 dB*
LTE TDD E-TM, 10 MHz BW, 2 GHz	*-49 dB*
LTE TDD E-TM, 10 MHz BW, <1 GHz	*-50 dB*
Adjacent Channel Power	
Adjacent channel	*-64.9 dB*
Alternate channel	*-66.4 dB*

Ordering information

Software licensing and configuration

Transportable, perpetual license: This allows you to run the application using an embedded PXI PC controller or external PC, plus it may be transferred from one controller or PC to another. One software license supports up to four modular PXI VSA channels in one PXI mainframe.

Try before you buy!

Free 30-day trials of X-Series measurement applications provide unrestricted use of each application's features and functionality on your modular PXI VSA.

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System Requirements

Topic	Windows 7 Requirements	Windows XP Requirements
Operating system	Windows 7 Professional, Enterprise or Ultimate (32-bit and 64-bit)	Windows XP Professional, SP3 (32-bit)
Processor speed	2 GHz or faster 32-bit (x86), or 2 GHz or faster 64-bit (x64) processor	
Available memory	1 GB, minimum	
Additional drives	DVD to load software, transfer requires network access, USB flash drive, USB hard drive or USB DVD	

M9080A & M9082A LTE FDD & TDD measurement applications

Model-option	Description	Notes
M9080A-1TP	LTE FDD measurement application, transportable perpetual license	For M9391A PXI VSA
M9082A-1TP	LTE TDD measurement application, transportable perpetual license	For M9391A PXI VSA

Hardware configuration

M9391A PXI VSA

Description	Model-Option	Additional information
M9391A-F03 or -F06	3 GHz or 6 GHz frequency range	One required
M9391A-B04 or -B10 or -B16	40 MHz, 100 MHz or 160 MHz analysis bandwidth	One required
M9391A-300	PXIe frequency reference	Recommended
M9391A-M01 or -M05 or -M10	Memory options (512MB, 2GB, or 4GB)	Recommend 1Gsa/4GB memory

Related literature

N9080A and N9082A Self-Guided Demonstration, Literature Number 5990-6385EN
N9080A & W9080A LTE Measurement Application Measurement Guide, Part Number N9080-90006
N9082A & W9082A LTE TDD Measurement Application Measurement Guide, Part Number N9082-90002
3GPP Long Term Evolution: System Overview, Product Development, and Test Challenges, Application Note, Literature Number 5989-8139EN
Stimulus-Response Testing for LTE Components, Application Note, Literature Number 5990-5149EN
Measuring ACLR Performance in LTE Transmitters, Application Note, Literature Number 5990-5089EN
TD-LTE E-UTRA Base Station Transmit ON/OFF Power Measurement Using an Agilent X-Series Signal Analyzer, Application Note, Literature Number 5990-5989EN
User's and Programmer's Reference Guide is available in the library section of the N9080A, W9080A, N9082A and W9082A product pages.
M9391A PXIe Vector Signal Analyzer Data Sheet, literature number 5991-2603EN
M9391A & M9381A PXIe Vector Signal Analyzer & Generator Configuration Guide, literature number 5991-0897EN
X-Series Measurement Applications for Modular Instruments Brochure, literature number 5991-2604EN

Web

Product pages:
www.agilent.com/find/M9080A
www.agilent.com/find/M9082A

X-Series measurement applications for modular instruments:
www.agilent.com/find/pxi-X-series_apps

M9391A PXIe vector signal analyzer:
www.agilent.com/find/M9391A

X-Series signal analyzers:
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Application pages:
www.agilent.com/find/lte

The Modular Tangram

The four-sided geometric symbol that appears in this document is called a tangram. The goal of this seven-piece puzzle is to create identifiable shapes—from simple to complex. As with a tangram, the possibilities may seem infinite as you begin to create a new test system. With a set of clearly defined elements—hardware, software—Agilent can help you create the system you need, from simple to complex.

Challenge the Boundaries of Test

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(BP-3-1-13)

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Printed in USA, September 26, 2013
5991-3010EN