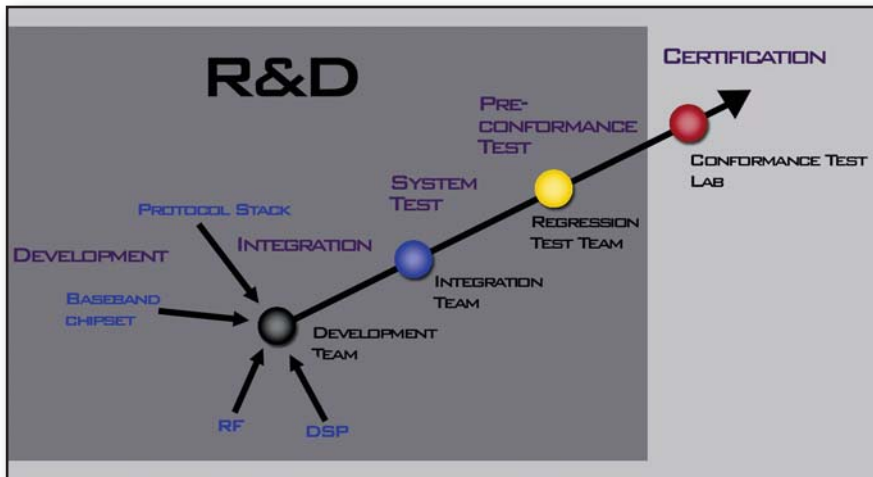




# Aeroflex Leads Market with Complete End-to-End Testing of LTE

November 2009



# LTE TEST CHALLENGES

The dawn of a growing economy, increasing demand for wireless data in mobile devices and rapid adoption of Long Term Evolution (LTE) by network operators worldwide indicate LTE will experience aggressive expansion rates in the coming years.

Manufacturers of LTE infrastructure and devices need reliable test instruments capable of addressing the challenges brought forward by this fast growing standard. Among the requirements of the LTE Evolved Universal Terrestrial Radio Access Network are higher data rates, multiband support, wider bandwidths, reduced latency, more complex modulation and antenna configurations that need to be thoroughly tested to deliver the value customers expect.

*“The inherent complexities of LTE require equipment to be thoroughly tested to deliver the value customers expect”*

Moreover, LTE is being deployed in two major variants, Frequency Division Duplex (FDD) and Time Division Duplex (TDD). These technologies will enable operators to maximize spectrum utilization and TD-LTE is looks to be adopted by the single biggest cell phone market in the world: China.

For the next generation of mobile devices to achieve the ambition of providing a mobile broadband experience to match the hopes and expectations of network operators, it will be necessary to test the new LTE devices using a layer-by-layer approach. A complete end-to-end test scenario must make use of real-world signal conditions. Ensuring performance is maintained throughout the cell will be a concern, especially as the number of users in the cell grows, and with it, the signal noise level.

To thoroughly and efficiently test LTE devices requires comprehensive test coverage: RF, baseband and protocol. Aeroflex addresses these challenges with a growing portfolio that puts this capability within reach.

# SYNERGIES IN AEROFLEX'S PORTFOLIO

Aeroflex's commitment to LTE reflects the decision of GSM/UMTS and CDMA network operators to implement LTE as the mobile broadband technology of choice for next-generation networks. Aeroflex has already demonstrated our ability to deliver early solutions for the design, development, and deployment of both LTE terminals and network infrastructure with the Aeroflex 7100 digital radio test set and the TM500 test mobile.

We've demonstrated our pedigree to meet the LTE test challenge. We've already delivered a comprehensive portfolio of solutions designed to satisfy a variety of LTE test requirements. However, our commitment does not end here. We are forging ahead with the development of solutions covering all aspects of LTE test.

We aim to be the most complete supplier of LTE test equipment in the world.

*"With the aggressive LTE technology demonstration and roll-out plans of both equipment suppliers and network operators, the need for the early availability of test systems is paramount."* — Bill Burrows, Business Development Director

The long trajectory of LTE testing provided Aeroflex with an in-depth understanding of the LTE standard. We've amassed all the key test requirements and the essential elements that define system performance, to guarantee flawless deployment.

The complete Aeroflex portfolio of LTE test solutions is aimed at addressing all aspects of LTE test. The portfolio encompasses LTE test solutions from R&D through manufacturing. It spans the entire LTE equipment supply chain from chipsets to end user services, including base stations and handsets.

## OVERVIEW OF AEROFLEX LTE TEST PRODUCTS

### TM500 Test Mobile

- The TM500 is now the industry's de-facto testing standard, fully supporting LTE network development, verification, and optimization, both in the lab and over the air

### 7100 LTE Digital Radio Test Set

- The fact that the Aeroflex 7100 is tested against, and interoperable with, the TM500—and supports the same dated release of the standard—gives mobile device and chipset vendors high confidence in the successful operation of the device on a live network

### PXI 3000 Series Test System

- The PXI 3000 Series test system takes LTE test confidence to the production floor endorsed
- Includes a winning portfolio of LTE test solutions and an enviable track record in production testing

### 3410 Series Digital RF Signal Generator

- With EVM performance enhancements, the 3410 Series digital RF signal generator provides the ideal solution for R&D and manufacturing
- Provides the ultimate in linearity and repeatability for component or sub-assembly test

	Infrastructure Testing	Terminal Testing			
Development Stage	TM500	7100	3410 Series	PXI 3000	7000
R&D	X	X	X	x	x
IOT	X	X			
Conformance	X	X			X
Production	X		x	X	

# 7000 SERIES VECTOR ANALYZER GENERATOR



## 7000 Vector Analyzer Generator

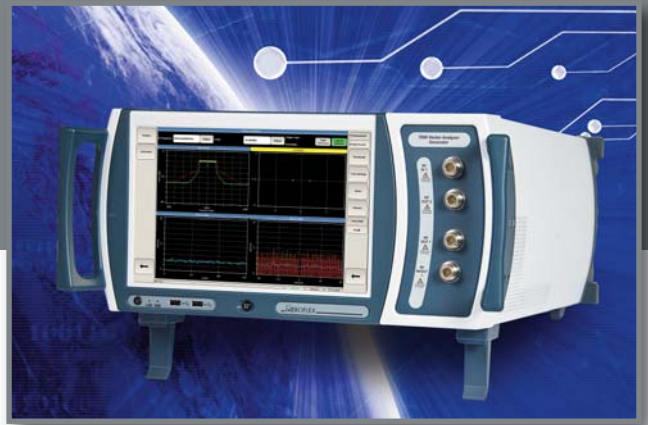
Designed as a test tool for the RF engineer working in the broadband wireless and cellular industries, the 7000 Series provides generation and analysis of complex signals in a one box solution. Designed to support both emerging and existing wireless standards, the 7000's synthetic test instrumentation architecture results in a flexible and future-proof test solution for all future signal generation and analysis requirements.

With a frequency range from 1 MHz to 6 GHz and an instantaneous measurement and analysis bandwidth of 90 MHz, the 7000 has the unique capability to house a second fully functional signal generator for receiver selectivity and amplifier distortion characterization.

Driven by an intuitive touch screen display the 7000 Series integrates the functions of signal generation and analysis into a single instrument focused on the measurement. The front panel connectors give access to the individual instruments or can be combined to provide a duplex port (RF IN/OUT) for direct testing at the antenna port of wireless devices.

The integrated vector signal generator has all the performance offered by stand alone generators with an output level up to +12 dBm and a typical phase noise of -115 dBc (20 kHz offset) at 2 GHz. The integrated arbitrary waveform generator (AWG) has a memory size of 2 GB for generation of standard and user specific modulated signals. Libraries of technology-based test signals are available to the AWG to provide stimulus for the Device Under Test. In addition, Aeroflex's IQCreator<sup>®</sup> waveform construction tool can be used to generate user specific waveforms as well as package custom ASCII or BIN files (e.g. MATLAB or Mathcad format). All of the above capabilities can be replicated with the addition of a second vector signal generator. The output of the second generator can be taken directly from the front panel connector to provide a locator oscillator (LO) for an external mixer, or can be combined at the RF IN/OUT port for receiver selectivity testing.

The vector signal analyzer performs both spectrum and time domain analysis of the input signal for RF component testing, characterization and alignment of wireless devices. With an input power capability of +33 dBm and a noise spectral density of >-120 dBm/Hz at the RF IN/OUT port, the analyzer provides a wide dynamic range for signal analysis. ACLR and spectral mask measurements of 3G terminals can be made in a single step with a typical measurement range of 68 dB.



To support the basic measurement capability of the 7000 Series, a range of technology specific measurement suites are available. The suites contain both the stimulus waveforms and the signal analysis capability enabling a simple selection of the measurement characteristics. The measurement suites are updated at regular intervals to track the standards, and additional suites will become available to extend the capability of the 7000.

The LTE FDD measurement suite is a library of measurement functions designed to characterize LTE FDD signals in accordance with the requirements of ETSI TS 36.521-1 (3GPP release 8).

- Transmit signal quality
- Error Vector Magnitude (EVM)
- Symbol clock error
- In-band emissions for non-allocated resource block
- Output RF spectrum emissions
  - Spectrum emission mask
  - CCDF
- Frequency error
- IQ skew/gain imbalance
- IQ-component (carrier leak)
- Spectrum flatness
- Occupied bandwidth
- Adjacent channel leakage power ratio

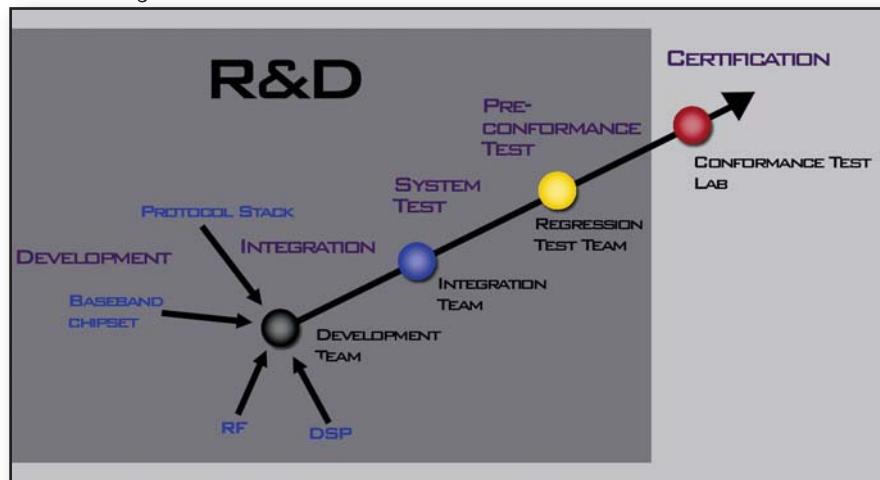
LTE analysis is supported for uplink (SC-FDMA) transmissions for all bandwidths, 1.4 MHz to 20 MHz, and modulation types QPSK, QAM16, and QAM64. In addition to numerical measurement results, the measurement suite provides trace displays for spectrum emission mask, CCDF, constellation plots, EVM vs. Carrier, and EVM vs. Symbol.

EVM analysis for uplink PUSCH is supported. A user defined window position can be selected when performing EVM measurements. This helps to track down problems associated with baseband timing and windowing.

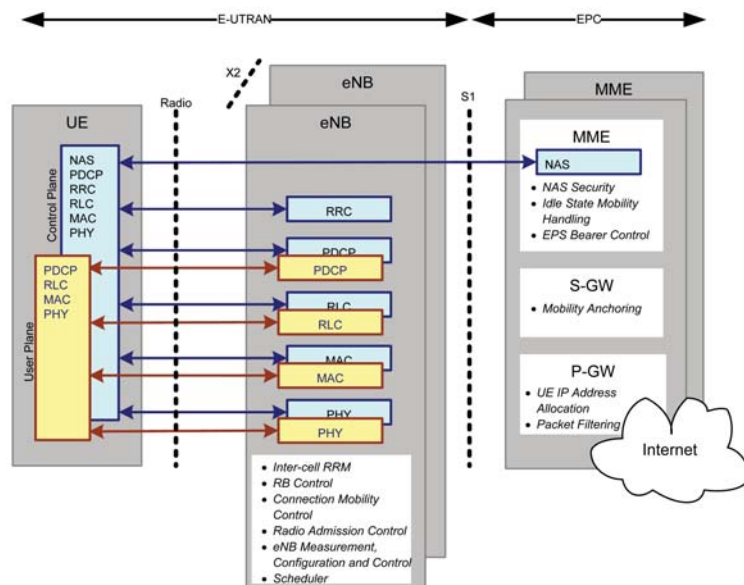


## Covering All Phases of LTE Terminal Testing

The Aeroflex 7100 Digital Radio Test Set is a compact, bench top instrument that provides easy to use test features covering the entire spectrum of R&D test activities for LTE terminal devices, starting with initial RF, baseband and protocol stack development, through integration, regression, and pre-certification testing.



The 7100 incorporates a 3GPP Rel-8 compliant protocol stack and physical layer to emulate an eNB (evolved Node B) and the EPC (Evolved Packet Core) network, covering all potential spectrum allocations up to 6 GHz. A comprehensive range of RF tests is included, including some based on the 3GPP TS 36.521 RF test specification, covering all key transmitter, receiver, and transceiver measurements. These tests use the built-in protocol stack to configure the correct RF conditions for testing. An integrated IMS server allows complete functional testing to be performed, permitting end-to-end throughput and latency to be measured in a controlled environment.





## Advanced Protocol Testing

Protocol testing is based on the Aeroflex Script Editor environment and uses a C++ API to construct signalling sequences. A message editor allows programmers to build customized messages for use in protocol test scripts. All protocol layers can be tested:

- MAC
- RLC
- RRC
- PDCP
- NAS
- IMS

## Growing to Meet Your Requirements

As the LTE standards mature, additional test capability will be introduced, including:

- TDD mode for non-paired frequency bands expected to be deployed in China
- 2x2 MIMO for testing data throughput robustness at high data rates
- Second RF interface for handover testing between different carrier frequencies
- Built-in fading simulator for real-world signal simulation of actual network conditions
- Digital I/Q interface for baseband testing without the RF transceiver connected, essential in module design stages

Because LTE terminals will be combined with other access technologies, the 7100 will be extended to include these protocols, enabling comprehensive inter-system handover testing:

- WCDMA/HSPA
- GSM/GPRS/EDGE
- CDMA2000 1xRTT, EvDO

The 7100's large touchscreen display and built-in PC provides intuitive access to this comprehensive set of test features:

- RF parametric measurements
- Functional testing
- Network simulation
- Protocol testing
- End-to-end performance testing





## LTE User Equipment Manufacturing Throughput

The PXI 3000 offers LTE device and component manufacturers a proven, fast and flexible solution that addresses the challenges of LTE production testing. Aeroflex designed its LTE manufacturing test solution to leverage the benefits the PXI 3000 has delivered to leading mobile device and chipset manufacturers worldwide.

Built upon the success and experience gained from pioneering R&D test systems from Aeroflex, the PXI 3000 LTE measurement suite achieves similar measurement performance with the benefits of increased speed and flexibility derived from the modular PXI platform. This enables a smooth transition from product development to volume production for LTE manufacturers seeking to rapidly respond to the ramp to volume in LTE devices while maintaining quality and reducing costs.

PXI 3000 uses several techniques to maximize manufacturing throughput and yield in device testing enhancing the ability to rapidly respond to market demand.

<b>Parametric testing</b>	Accurate characterization of RF functionality achieving high first pass yield
<b>Parallel testing</b>	Leverage on the power of multi-core processors to perform concurrent processing and data capture for system test
<b>Multi-standard support</b>	Complete the entire range of tests required for LTE and legacy standards co-existing in the device to increase production throughput

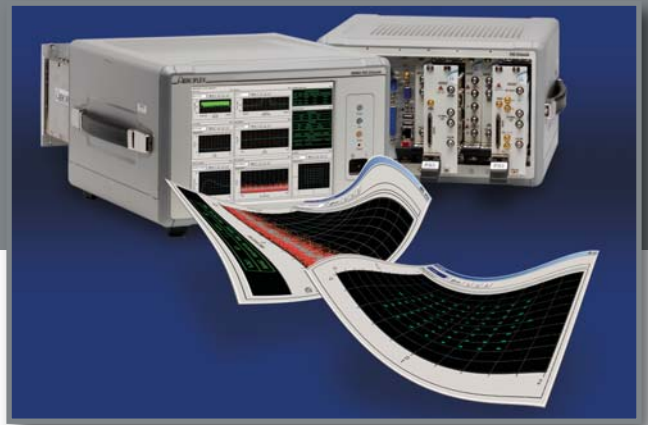
## PXI 3000 LTE Test Capabilities

LTE analysis is supported for uplink (SC-FDMA) transmissions for all bandwidths 1.4 MHz to 20 MHz and modulation types QPSK, QAM16 and QAM64. Using any combination of Aeroflex PXI RF digitizers and signal generators enables LTE testing covering all 3GPP frequency bands.

In addition to numerical measurement results, the LTE measurement suite provides trace displays for spectrum emission mask, CCDF, constellation plots, EVM vs. Carrier and EVM vs. Symbol. Fully programmable software interfaces using VB, C++ or .NET enable users to easily modify and adapt the test systems to particular requirements.

Uplink and downlink LTE FDD stimulus response measurements on components used in LTE-based products can also be performed using IQCreator wave generation software. IQCreator is an additional offering with all Aeroflex PXI digital RF signal generator modules.

The modularity of the PXI 3000 platform facilitates gradual capacity expansions as the need arises. Initial systems can be deployed for single antenna devices and when production of UEs with dual transmit antennas is initiated, the system can be expanded for 1x2 MIMO support with a simple upgrade.



## Multi-Standard Support

The consequences of LTE success as the point of convergence from most legacy standards means devices will need to simultaneously support older wireless protocols.

Devices that integrate LTE and one or more of the multiple legacy standards will inevitably extend the time required for testing, impacting throughput. The modularity of the PXI 3000 software architecture enables testing multiple standards in a single operation, preserving production output.

*“Testing devices that integrate LTE and one or more of the multiple legacy standards can be achieved in a single operation due to the PXI 3000 software architecture.”*

Further improvements in throughput are achieved using the same system to test connectivity interfaces such as Bluetooth and wireless LAN in the same test cycle. Given current market trends, and the compatibility of LTE with legacy standards, devices will continue to support a larger number of cellular and connectivity interfaces.



### PXI 3000 Measurement Suites

GSM/EDGE

UMTS

CDMA2000/1xEVDO

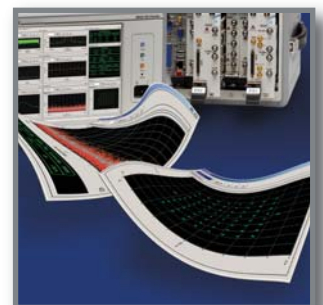
WLAN 802.11a/b/g/n

WiMAX

Bluetooth

LTE FDD

The increased complexity of testing brought forward by the LTE standard requires a flexible and accurate solution capable of improving productivity. The PXI 3000 is ideally suited for LTE device manufacturing tests achieving remarkable throughput improvements without sacrificing accuracy and performance.





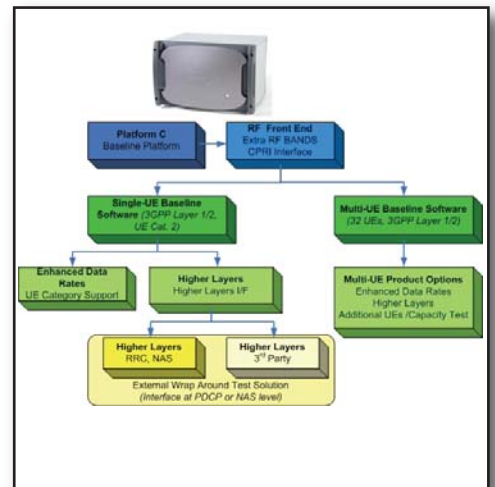
## LTE Infrastructure Testing Now

The TM500 LTE product range is a major development by Aeroflex to support the current and future technologies based around 3GPP's LTE programs. Based upon a new and scalable software defined radio platform, the TM500 LTE provides a set of product options targeting development, testing and demonstration of 3GPP LTE infrastructure equipment.

Launched in 2007, the initial product in the range is the the TM500 LTE FDD Single UE. This has been in use with the major infrastructure vendors worldwide, making the TM500 LTE the leading product in UTRAN base station test equipment.

The range now also includes options for higher layers, higher category UEs, TDD, and Multi-UE operation. With its layered operation and automation interfaces, the TM500 LTE can additionally operate within an automated or wrap around test configuration. The Multi-UE test system targets scheduler, load, and capacity test.

The figure to the right illustrates the current and near term product options available with the TM500 LTE product line. Further product options extend the TM500 LTE's capability by adding support for higher data rates (to UE Cat. 5).

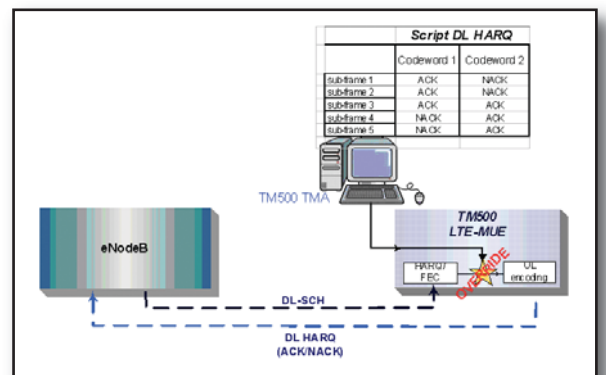


TM500 LTE product family

## LTE Layer 1 Layer 2

The TM500 LTE FDD Layer 1/Layer 2 product provides full 3GPP LTE functionality of PHY, MAC, and RLC layers supporting 3GPP category 2, 3, and 4 UEs. These provide 2x2 DL MIMO with data rates up to 150 Mbps DL, 50Mbps UL.

Through experience in WCDMA test and LTE demonstration systems, Aeroflex has developed a wide range of features and tools to support LTE e Node B and network equipment development, integration, and test. The TM500 incorporates test modes for an incremental, layered approach to development and testing of the LTE stack. Specific test modes targeting HARQ, MAC, RLC, and PDCP operation are provided. These modes enable detailed functionality to be tested at a modular level and, thus, very early testing of eNode B features.

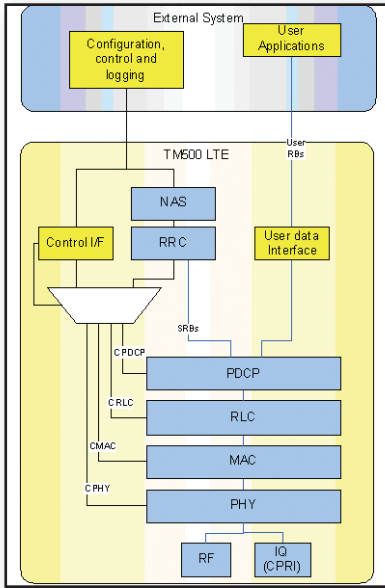


Control override of DL HARQ operation

Operation of the TM500 LTE is via the Aeroflex integrated and flexible control and logging user interface (the TMA). The TMA provides a set of comprehensive control, measurement, data logging, display, and analysis tools for use at all layers. The TM500 LTE can also be operated via an external automated or wrap around test system. The TM500 additionally supports enhanced test features, including the scripted override of L1/L2 control information enabling early test of closed control loops or to simulate error or fault conditions.



## LTE Higher Layers



TM500 LTE higher layers

A “single box” solution is available for 3GPP LTE testing by adding the Higher Layers option. This adds full PDCP, RRC, NAS, and USIM functionality to the baseline TM500 LTE Layer 1/Layer 2 product. The full 3GPP LTE compliant stack runs internally on the TM500 LTE platform minimizing Layer 3 latencies and with real-time dynamic state behavior.

The TM500 LTE simulates the behavior of a real handset with USIM and AT command interfaces, but with the added advantage of full control and logging of all Layer 1, 2, and 3 operations via a single common front end GUI for configuration.

There are also test features including scripted control of measurement reports and negative test scenarios.

The TM500’s modular software design also enables it to be incorporated into automated and wrap around test systems with control either at PDCP level or via AT commands at NAS level.



## LTE Multi-UE

Aeroflex introduced the concept of “Multi-UE” testing for cellular infrastructure with the TM500 HSDPA Multi-UE product whereby the operation of large numbers of UEs are simulated within a single cost effective platform.

At Layer 1/Layer 2, Multi-UE testing enables load and stress testing of the e Node B as well as validation and optimization of the complex data scheduling algorithms. With the addition of higher layers and higher numbers of UEs, the TM500 LTE can support system load and capacity testing scenarios.

The baseline TM500 LTE Multi-UE product provides 32 UEs with PHY, MAC, and RLC functionality, as well as higher layer full stack operation as an option. The scalable platform enables future options to increase the number of simulated UEs from 32 to 96 and beyond to support capacity test scenarios.

## Future

As the 3GPP LTE specifications develop in the coming years to support the LTE advanced functionality of Release 9, 10, and beyond, the TM500 LTE provides both a committed roadmap and clear migration path.

The future TM500 LTE roadmap already includes enhanced Multi-UE and capacity test support plus higher data rates to DL 300 Mbps and UL 75 Mbps using 4x4 DL MIMO. Aeroflex is monitoring 3GPP LTE-A developments, as well as working closely with our customers in order to develop new options and tools as cellular technology advances.

The TM500 LTE provides a clear migration path through the powerful and scalable Software Defined Radio platform. This not only supports the future LTE technology roadmap, but also maximizes return on investment.



# 3410 SERIES DIGITAL RF SIGNAL GENERATOR



The addition of LTE FDD modulation capabilities to IQCreator enhances the Aeroflex LTE-ready product portfolio. LTE FDD reproduction can now be achieved in the 3410 Series digital RF signal generator, which is particularly suitable for receiver testing of RF front end receivers and amplifiers.

Exploiting the patented high dynamic range wideband IQ modulation system and the dual-channel arbitrary waveform generator (AWG), the 3410 Series ensures that LTE signals are delivered with excellent linearity and accuracy. The large AWG is able to store and generate long complex sequences of waveforms (or one single waveform), so that rigorous testing can be accomplished faster and without lengthy interruptions for downloading.

Waveforms created in IQCreator and played from the 3410 Series allow control over LTE data framing and modulation parameters. This makes them ideally suited to the needs of RF design engineers performing stimulus response measurements on components used in LTE based products.



The fully featured 3410 Series is designed for the most exacting test requirements of today's advanced wideband digital radio receivers and power amplifiers. The use of touch screen technology with an intuitive user interface combine to make an easy to operate instrument for both technicians and advanced users.

With its electronic attenuator and fast frequency switching speed, the 3410 Series offers "no compromise" capabilities in both R&D and manufacturing environments.

# SUMMARY OF KEY FEATURES



## 7000 Key Features

- Combined vector signal analyzer and generator
- 1 MHz to 6 GHz frequency range
- 90 MHz generation and analysis bandwidth
- Second signal generator option
- Supports multiple cellular and wireless broadband standards
- Ideal for characterization of mobile devices and modules

## 7100 Key Features

- 6 GHz frequency range as standard
- Optional second RF transceiver, 6 GHz
- Integrated protocol stack
- Comprehensive RF measurements based on 3GPP TS36.521
- Functional tests built-in
- Programmable protocol testing with C++ API

## PXI 3000 Key Features

- High speed, scalable modular architecture
- Comprehensive parametric characterization of LTE FDD signals
- Support for multi-standard tests (2G, 3G, Bluetooth and WLAN)
- Standard programmable interfaces (VB, C++ and .NET)
- Concurrent asynchronous processing with multi-core processors
- 3 GHz or 6 GHz frequency range

## TM500 Key Features

- 3GPP LTE FDD and TDD
- L1, L2, RRC and full system level modes
- Single UE, multi-UE and capacity test solutions
- 150 Mbps, 20 MHz, MIMO, multiple RF bands, and CPRI
- Cabled or over the air operation
- Comprehensive logging, control, display, and analysis tools

## 3410 Series Key Features

- Up to 6 GHz frequency coverage
- Supports free IQCreator® waveform creation software including LTE FDD
- Best in class adjacent channel performance and linearity
- 500  $\mu$ s frequency setting time

**CHINA Beijing** Tel: [+86] (10) 6539 1166 • Fax: [+86] (10) 6539 1778  
**CHINA Shanghai** Tel: [+86] (21) 5109 5128 • Fax: [+86] (21) 6457 7668  
**FINLAND** Tel: [+358] (9) 2709 5541 • Fax: [+358] (9) 804 2441  
**FRANCE** Tel: [+33] 1 60 79 96 00 • Fax: [+33] 1 60 0177 69 22  
**GERMANY** Tel: [+49] 8131 2926-0 • Fax: [+49] 8131 2926-130  
**HONG KONG** Tel: [+852] 2832 7988 • Fax: [+852] 2834 5364  
**INDIA** Tel: [+91] (0) 80 4115 4501 • Fax: [+91] (0) 80 4115 4502  
**JAPAN** Tel: [+81] 3 3500 5591 • Fax: [+81] 3 3500 5592  
**KOREA** Tel: [+82] (2) 3424 2719 • Fax: [+82] (2) 3424 8620  
**SCANDINAVIA** Tel: [+45] 9614 0045 • Fax: [+45] 9614 0047  
**SPAIN** Tel: [+34] (91) 640 11 34 • Fax: [+34] (91) 640 06 40  
**UK Cambridge** Tel: [+44] (0) 1763 262277 • Fax: [+44] (0) 1763 285353  
**UK Stevenage** Tel: [+44] (0) 1438 742200 • Fax: [+44] (0) 1438 727601  
Freephone: 0800 282388 (UK only)  
**USA** Tel: [+1] (316) 522 4981 • Fax: [+1] (316) 522 1360  
Toll Free: 800 835 2352 (US only)

[www.aeroflex.com](http://www.aeroflex.com)

[info-test@aeroflex.com](mailto:info-test@aeroflex.com)

As we are always seeking to improve our products, the information in this document gives only a general indication of the product capacity, performance and suitability, none of which shall form part of any contract. We reserve the right to make design changes without notice. All trademarks are acknowledged. Parent company Aeroflex, Inc. ©Aeroflex 2009.



Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven and customer-focused.