# Infrastructure Test System

## TM500 LTE-A

### 3GPP LTE Test

The industry standard test system for 3GPP LTE infrastructure development, test AND demonstrations

- Functional, performance and load testing of LTE/LTE-A base station and network equipment
- 3GPP LTE-A compliant operation at Physical Layer, Layer 2, and higher layers (RRC/NAS)
- 300 Mbps, 40 MHz, two Carriers Carrier Aggregation, MIMO, enhanced Inter-Cell Interference Coordination (eICIC), Transmission mode 9 (TM9), closed loop, multiple RF bands, handover and CPRI
- Comprehensive control, measurement, data logging, display and analysis tools at all layers
- Powerful and scalable software defined radio platform to support the future LTE-A technology roadmap and maximize return on investment
- Innovative test features to boost engineering productivity including high speed baseband logging, traffic data generators, and parameter override of closed control loops
- Remote and automation API
- Operation in the lab test and over the air (single UE)
- Part of the TM500 product family that includes 3GPP LTE Multi-UE and capacity test solutions. Builds upon the successful LTE TM500 Test Mobile
- Builds on heritage of global standard HSPA/HSPA+ TM500 WCDMA Test Mobile
- Worldwide technical support and sales network

**TM500 SYSTEM OVERVIEW**

The 3GPP's Long Term Evolution – Advanced (LTE-A) programs are expected to deliver an increasingly better mobile user experience through improvements in end-user throughputs, sector capacity, and user plane latency. To achieve this it requires some significant changes in parts of the network infrastructure and mobile user equipment.

The TM500 LTE-A product range is a major addition to the Aeroflex TM500 family of 3GPP test mobiles and a substantial commitment by Aeroflex to support the current and future technologies required for 3GPP LTE-A.

Built upon a proven and scalable software defined radio platform that has become the industry standard for LTE since 2007, the TM500 LTE-A provides a set of product options targeting development, demonstration and testing of 3GPP LTE-A infrastructure equipment. The initial product in the range is the TM500 LTE-A FDD Single UE.

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

Through years of experience in WCDMA/HSPA+, LTE and working closely with customers on LTE development and demonstrations, the TM500 LTE-A is primarily designed to help support and accelerate the overall development and test program. The TM500 LTE-A offers the earliest access to the latest 3GPP functionality, before real handsets, as well as layered operation and a high degree of logging and control.

Productivity enhancing tools simplify the development and running of test scenarios and include advanced test features such as forced errors and event triggering. Highly flexible operation enables the TM500 LTE-A to be used in many customer configurations including in the lab, over the air, manually or remotely or as part of an automated test system.

## REL-10 CARRIER AGGREGATION

One of the Rel-10 headline features is carrier aggregation.

With carrier aggregation, the UE utilizes two or more Component Carriers.

Each component carrier can be up to 20 MHz.

It means that with 40 MHz BW the data rates supported are doubled compared to the 20 MHz LTE.

40 MHz bandwidth with 2x2 MIMO per carrier supports up to 300 Mbps in the DL.

Carrier Aggregation, however, is not just about increased data rates. It offers spectrum flexibility by utilizing continuous and non-continuous spectrum. Non-continuous spectrum can be located in different 3GPP bands. It means that a UE can utilize up to 20 MHz in Band 7 and up to 20 MHz in Band 1 for instance.

The TM500 Carrier aggregation solution supports continuous and non-continuous spectrum allocation.

Additionally, asymmetric UL and DL bandwidth allocation is allowed in line with deployment needs.

Carrier aggregation also supports cross carrier scheduling which means that the signalling received by a UE on the primary component carrier can be used to schedule the secondary component carrier which reduces the signalling over the air.

The measurement user tools enable the user to selectively log and display measurement information from the test. Key KPI measurements such as the BLER, throughputs and other detailed measurements from Layer 1, 2 and/or 3 tests can be displayed in real time using the charting facility. In addition, all measurements are logged to file for post test analysis. These log files can be used to replay test sessions within the charting tool or can be exported to other tools for further analysis.

For LTE-A, the measurements are provided per component carrier or aggregated giving a detailed visibility for all layers.

## GENERAL

3GPP Release 10 (Dec 2011)

UE Category 2 operation with data rates to DL 50 Mbps, UL 25 Mbps

UE Category 3 and 4 option with data rates to DL 150 Mbps, UL

50 Mbps

UE Category 5 option with data rates to DL 300 Mbps, UL 75 Mbps

40 MHz with 2 Rx per component carrier and data rates up to 300 Mbps in DL

FDD and TDD support

## REL-10 ENHANCED INTER CELL INTERFERENCE COORDINATION

Another of the Rel-10 headline functionality is the enhanced Inter Cell Interference Coordination (eICIC) that targets performance improvement in heterogeneous network deployments.

This represents the extension to the time domain of the Rel-8 and Rel-9 interference coordination techniques (that were based on a frequency domain approach and were transparent to the UE).

eICIC allows for coordination between cells of different type (macro, pico etc …) belonging to an heterogeneous deployment and with overlapping coverage in order to reduce interference in some transmission instances. This allows for exploiting techniques such as load balancing to offload UEs from a sometimes "too loaded" macro cell to a smaller cell (targeting overall network performance improvement).

Unlike Rel-8 and Rel-9 techniques, eICIC is not transparent to the handsets that have to support measurement restrictions for Resource Radio Management (RRM), Radio Link Failure (RLF) and Channel State Indication (CSI). Different subframe patterns to be used for the measurement restrictions are signalled from the network to the handset.

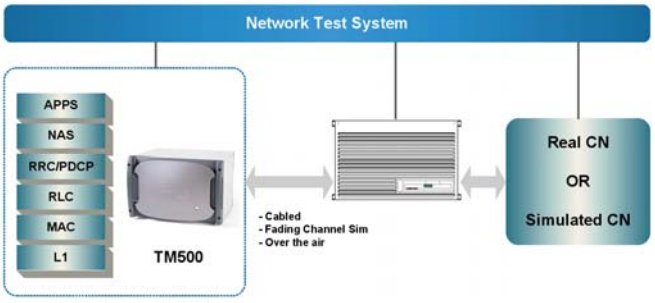
TM500 single UE supports over the air operations and could be used in a live heterogeneous network to verify the benefits of eICIC.

On top of supporting the necessary measurement restrictions, TM500 single UE supports also test features such as UE feedback override on the different subframe patterns allowing users to build dedicated test cases.

Rel-10 transmission mode 9 (TM9) is also supported for 2x2 MIMO. This involves the TM500 supporting the Channel State Information (CSI) feedback calculation based on the newly specified CSI-RS and the demodulation of the DL signal based on the Rel-10 Demodulation Reference Signal (DMRS).


## TYPES OF TESTING (OPERATIONAL CONFIGURATIONS)

The TM500 can be operated in a number of configurations.




### In the lab

The TM500 LTE-A operates as a 3GPP specification compliant UE test peer to support functional development, debug, integration and test of LTE-A eNode-B and core network equipment. The TM500 LTE-A single UE can operate at component, module and system level and with or without the use of a fading channel simulator.

### Outdoors

Designed for using over the air, the TM500 supports the requirements of early drive testing and proof of concept trials, exercising new features of the LTE-A technology.

### Demonstration

The TM500 is ideal for demonstrating leading edge LTE-A technology, including maximum rate transmissions, MIMO operation, etc. Using its IP Driver interface, the TM500 LTE-A can support real time applications via a TCP/IP connection including high definition video streaming, files transfer and web browsing, etc. The layered operation of the TM500 LTE-A enables it to support the demonstration of partial as well as full complete network equipment configurations.

## CONTROL AND LOGGING

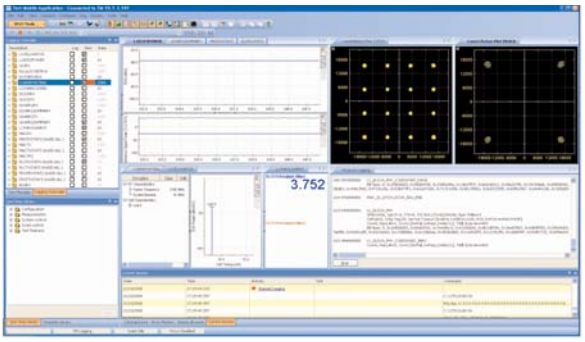
Management of the TM500 LTE-A is carried out through the Test Mobile Application (TMA) software supplied with the system. The TM500 LTE-A can also be controlled by an external system, such as a customer's remote automated test system.

TMA is an integrated software suite that provides an easy and intuitive user interface for: creating and running test scripts; data logging and measurements as well as the analysis of test sessions and data. To enhance productivity, the TMA incorporates valuable features such as test step and template libraries, drag and drop selection, session browser, command line, error monitor, real time logging and graphical charting windows.

**Script Production:** The TMA includes script control tools that provide a fast and easy way to create and control test scripts via a PC-based graphical user interface. The tool includes a library of test command sequences that enable easy configuration of the test mobile and the associated 3GPP parameters. The TMA also validates the test scripts, detecting any sequencing or parameter range errors before executing the test scenario on the TM500.

**Measurements and Data Logging:** The measurement tools enable the user to selectively log and display measurement information from the test. Detailed measurements from Layer 1, 2 and/or 3 tests can be displayed in real time using the charting facility. In addition, all measurements are logged to file for post test analysis. These log files can be used to replay test sessions within the charting tool or can be exported to other tools for further analysis.

**Event Triggering:** A new event-based triggering tool allows the user to start the measurement logging based upon a specific event, such as a 3GPP measurement or handover request. This powerful feature allows the user to define, coordinate and analyze detailed test scenarios.



## TEST MODES

The TM500 incorporates a number of test modes which enable an incremental, layered approach to development and testing of the LTE-A stack from the PHY layer and upwards. Detailed functionality can be tested at a modular level, enabling very early testing of eNode-B features even during the development stage. The TM500 supports test features that enable early uplink and downlink operation to be validated independently. In addition, 3GPP control signalling can be overridden and scripted to enable early test of closed control loops or to simulate error or fault conditions.

**HARQ Mode** This mode of operation provides detailed test features targeting analysis of the PHY layer and HARQ retransmission processes. Independent BER and BLER analysis are supported for each HARQ process using data source/sinks configured to standard PN or user defined data sequences. Used in conjunction with the charting measurement tools, these features enable the user to monitor the real time operation of the UL and DL physical data link.

**MAC Mode** The MAC mode adds analysis of the full eNode-B MAC operation to the PHY / HARQ functionality. MAC mode adds MAC header monitoring, MAC PDU creation and MAC SDU extraction to the HARQ mode. The received payload data is evaluated for each logical channel and HARQ using data sinks. BLER is measured using the post-HARQ CRC results. Each logical channel can be connected to a separate data source or sink.

MAC mode adds MAC PDU/SDU creation/extraction, headers and control elements monitoring. User has full visibility of the MAC procedures such as UL time alignment, logical channel prioritization and contention resolution. The received payload data is evaluated for each logical channel and HARQ using data sinks. BLER is measured using the post-HARQ CRC results. Each logical channel can be connected to a separate data source or sink.

**RLC Mode** The RLC mode supports full RLC functionality including Transparent Mode, Unacknowledged Mode and Acknowledged Mode operation. This enables the user to analyze the RLC, MAC and PHY operation within the eNode-B. The data content is transmitted and received as RLC PDUs, bypassing the PDCP layer. RLC mode control is via specific configuration commands as well as providing scripted control for SDU insertion into RLC buffers and for logging of data and state information.

**PDCP Mode** This mode adds PDCP header functionality, enabling features such as PDU duplication and discard detection that may occur during handover procedures.

**Higher Layers** Provides NAS mode support.

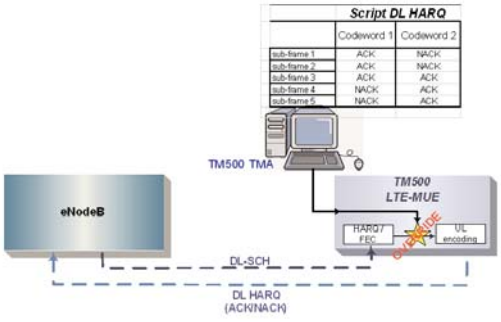
## TEST CAPABILITIES/FEATURES

To help accelerate testing and integration, the TM500 LTE-A incorporates enhanced test and analysis features. These can also be used to simulate test scenarios, enabling early module level testing during development and integration phases.

**Scripted Control and Corruption** LTE-A relies on a number of closed control loops which report information such as channel quality, RF propagation conditions and data integrity. Typical closed loop parameters include CQI, MIMO feedback (CSI), power control and HARQ. Such information is normally based on real time measurements of the over the air environment. To simplify the simulation and repeatability of such scenarios, the TM500 LTE-A provides the ability to override these signalled values using script commands and to corrupt the control information.

### EXAMPLE Configuration – Downlink HARQ Override

In a laboratory environment with a static, cable connection between the TM500 LTE-A and the eNode-B it is likely that BLER will be zero. If suitable fading channel simulator and interference generator equipment is not available this can limit the testing of HARQ. The TM500 LTE-A provides the capability for early HARQ testing by DL HARQ ACK/NACK override. Using the TMA, the user scripts a sequence of ACK/NACKs for one or two codewords. The user defined HARQ is then fed into the eNode-B over the UL.




**DL-HARQ Override**

### Data Generation and Evaluation

The ethernet interface can be used to source and sink real data from any application running on a PC. Alternatively the TM500 LTE-A is able to transmit pre-defined data on the uplink and analyze received data on the downlink. Data can also be routed via an interface for external generation or analysis. The TM500 LTE-A also includes a data service generator tool with which traffic data can be generated in profiles that simulate those encountered with real world applications running over the network. A real data application option (supporting simulation of very sophisticated and realistic traffic profiles, such as VoIP, etc …) is also available for multi-UE and load product variations. These features are very powerful in providing repeatable and deterministic data generation and analysis.

## AUTOMATED AND REMOTE OPERATION

Remote and automated operation is essential for modern test equipment. With the TM500 LTE-A remote and automated control interfaces, the TM500 LTE-A system can be controlled via a standard ethernet interface from the next room or another country. The TM500 LTE-A automation interface enables the supplied management software or the customer's own control system to operate the TM500 LTE-A commands, measurements, data logging and displays. The automation interface also supports control of multiple TM500s.

## SUPPORT

Aeroflex has an experienced, knowledgeable and highly responsive customer support team for the TM500. The team provides global support from both local in-country offices and from the core engineering group. Support is delivered on-site as well as helpdesk, email and telephone as appropriate. Benefits of the support package also include hands-on support and training plus access to 3GPP specification migration updates and feature enhancements via a dedicated customer FTP site.

Aeroflex can also provide customised premium warranty support and training to meet specific needs on request.

# *SPECIFICATION*

## *GENERAL*

***Specification Version***

*3GPP Release 8 (Dec 2011)*

***UE Capability***

*UE Category 2 operation with data rates to DL 50 Mbps, UL 25 Mbps*
*UE Category 3 and 4 option with data rates to DL 150 Mbps, UL 50 Mbps*
*UE Category 5 option with data rates to DL, 300 Mbps, UL 75 Mbps*

*Carrier Aggregation with data rates up to DL 300 Mbps, UL 50 Mbps*

***RF Frequency Bands***

*Available E-UTRA FDD Bands : 1, 2, 3, 4, 5, 7, 8, 9, 10, 11,12, 13, 14, 17, 18, 19, 20,21, 24, 25 with other bands available on request*

*Available E-UTRA TDD Bands: 38, 39, 40, 41 with other bands available on request*

*All 3GPP bands supported through the use of Multi-Band radio card (covering the frequency range 400 MHz – 4 GHz)*

***Power Class***

*Class 3 (+23 dBm)*

***Max RF Input Power***

*-25 dBm*

## *PHYSICAL LAYER FEATURES*

*OFDM DL; SC-FDMA UL; Cyclic Prefix;*

*DL Modulation QPSK, 16 QAM, 64 QAM;*

*UL Modulation QPSK, 16 QAM, 64 QAM (with UE Cat 5 option); VRB;*

*DL and UL adaptation*

*Diversity: DL Tx and RX diversity ; SISO; MIMO : 2x2 ; 4x2 ; 4x4 [with UE Cat 5 option]*

***Physical Channels***

*P-SCH/ S-SCH / RS; PUSCH; PBCH; PUCCH, SRS; PRACH; PDSCH; PCFICH; PDCCH; PHICH*

## *LAYER 2 FEATURES*

*HARQ; MAC; RLC (TM, UM, AM); PDCP header; IP Driver*

***Transport Channels***

*RACH; UL-SCH; DL-SCH; PCH; BCH/D-BCH*

## *PROCEDURES*

*UL closed loop power control; group and sequence hopping; PUSCH hopping; UL control information CQI (SISO and MIMO), PMI, RI; UL timing control; initial cell search; persistent scheduling; random access procedures*

## *MEASUREMENTS*

***Layer 1 Receive***

*Modulation; SIR estimation; CQI; UL grant, DL assignment; PMI; RSSI; Reference Signal Received Power and Quality (RSRP and RSRQ)*

***Layer 1 Signalling***

*MIMO control information; DL resources assignment; UL scheduling grant; HARQ signalling plus decoded transport block size; CRC result; BER, BLER and L1 data throughput etc.*

***Layer 1 Transmit***

*CQI; PMI; repetition factors; HARQ information; UL/DL timing offset; buffer occupancy Tx power etc.*

*Comprehensive measurements and logging allow verification that RF Rx/Tx switching time requirements are met.*

***Layer 2***

*MAC transmit and receive statistics; overhead due to padding ratio; RLC*

***Latency***

*L1 and L2 latency measurements*

***Transport Monitoring***

*Data extraction from test points within the L1/L2 encoder and decoder chain including FEC, MAC, RLC and PDCP inputs and outputs*

***ENHANCED TEST FEATURES***

*Comprehensive analysis tools including real-time charting of constellations and throughput*

*PN sequence and Fixed Frame data generators and evaluators supporting BER/BLER*

***Override of Uplink Control***

*PMI, CQI, HARQ ACK/NACK, buffer occupancy information and ARQ status*

***Override of Received Downlink Control Information***

*Including HARQ, grant information, timing adjust and MIMO control signalling*

***Forced Errors and Negative Test Features***

*Including forced corruption of UL-SCH enabling validation of e-Node B HARQ operation ; L1L2 control channel miss*

***Discontinuous Reception (DRX)***

*Functional test that eNodeB behaves as expected during DRX cycle*

## PHYSICAL, ENVIRONMENTAL AND SAFETY

***Voltage Range***

*90 to 250V AC*

***Nominal Power Consumption***

*350 VA*

***AC Frequency Range***

*50 – 60 Hz*

***Dimensions (HWD)***

*31 cm x 38 cm x 39 cm*

*12.2" x 14.9" x 15.4"*

***Mass***

*22 kg (48.5 lbs.)*

***Operating Temperature Range***

*0°C to 40°C*

***Storage Temperature Range***

*-40°C to +70°C*

***Humidity***

*10% to 90% RH (non-condensing)*

## CERTIFICATION

***Safety***

*IEC/EN 6101-1*

***EMC***

*IEC/EN 61326-1 RF Emission Class A, Immunity Table 1.*

***RoHS***

*Compliant*

## INTERFACES

***RF***

*Independent Rx/Tx connector N-type (female)*

*Duplexed Rx/Tx connector N-type (female)*

***Digital***

*CPRI (optional)*

***Frequency Reference***

*10 MHz external reference*

*Separate IN/OUT, SMC*

***Timing Trigger***

*Timing marker. Separate IN/OUT, SMC*

*Two USB ports*

***Controller***

*Ethernet (GbE) 1000 Base-T with RJ-45*


## PC SPECIFICATION

*The recommended minimum PC (not supplied) specification for running the TM500 PC controller application is shown below:*

***Processor***

*Intel® Viiv™ Core™ 2 Duo E6320 processor*

***Operating System***

*Windows™ XP Professional*

***Memory***

*2048 MB*

***Display***

*1600 x 900*

***Hard Drive***

*250 GB*

***Ethernet***

*10/100/1000 Base-T*

## ORDERING INFORMATION

The following lists the TM500 LTE FDD Single UE product codes and available options

| Baseline | Product Code |
|---|---|
| HW Platform | TM500-C |
| Two RF Module | See below |
| SUE FDD L1L2 SW | TK700-C |

### *Options*

| | |
|---|---|
| Support | SA067 |
| Higher layer I/F | TK520-C |
| RRC | TK525-C |
| RoHC | TK526-C |
| NAS | TK527-C |
| UE Cat 3 upgrade | TK513-C |
| UE Cat 4 upgrade | TK514-C |
| UE Cat 5 upgrade | TK515-C |
| LTE-A CA Baseline FDD S-UE | TK700-C |
| LTE-A CA Baseline TDD S-UE | TK701-C |
| LTE-A eICIC S-UE | TK785-C |
| 3GPPLTE-A Tx mode 9 | TK702-C |

Available RF Bands for FDD

| | |
|---|---|
| Band 1&9 Module | TK-580-C |
| Band 1&7 Module | TK-581-C |
| Band 12&13 Module | TK-584-C |
| Band 1&4&10 Module | TK-585-C |
| Band 1&11 Module | TK588-C |
| Band 1&8 Module | TK587-C |
| Band 1&18 Module | TK589-C |
| Band 1&20 Module | TK590-C |
| Band 1&21 Module | TK594-C |
| Band 1&14 Module | TK591-C |
| Band 1&19 Module | TK592-C |
| Band 1&25 Module | TK790-C |
| Band 1&24 Module | TK598-C |
| Band 1&2 Module | TK574-C |
| Band 1&3 Module | TK595-C |
| Band 1&5 Module | TK561-C |

Other bands available on request

Available RF Bands for TDD

| | |
|---|---|
| Band 1&38 Module | TK586-C |
| Band 1&39 Module | TK593-C |
| Band 1&40 Module | TK583-C |
| Band 1&41 Module | TK562-C |
| Multi-band radio card (FDD/TDD) | TK599-C |
| CPRI | TK505-C |

### Packages

Package deals are available for purchase of multiple units/options. Contact your local Aeroflex Sales Office for further information.

## ADDITIONAL TM500 LTE PRODUCTS

Other TM500 LTE products available:

| | |
|---|---|
| LTE FDD Single UE SW | TK503-C |
| LTE FDD Multi-UE | TK506-C |

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AEROFLEX
A passion for performance.



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

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