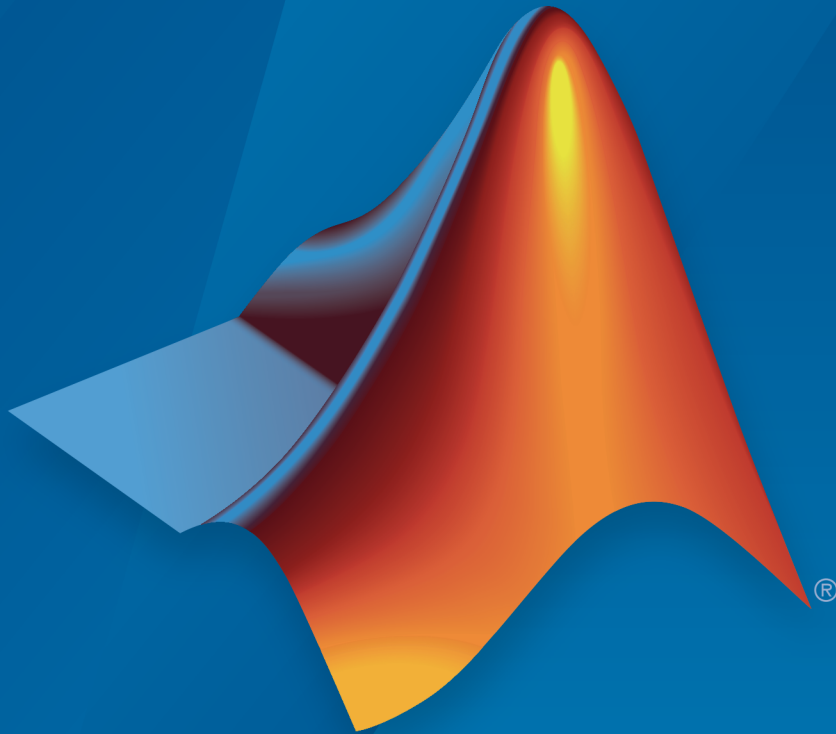


# LTE System Toolbox™ Release Notes



# MATLAB®

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The MathWorks, Inc.  
3 Apple Hill Drive  
Natick, MA 01760-2098

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# R2015a

**Version: 2.0**

**New Features**

**Bug Fixes**

## **UMTS Downlink and Uplink Waveform Generation Functions: Generate standard-compliant W-CDMA, HSPA and HSPA+ signals**

This release adds UMTS (W-CDMA, HSPA and HSPA+) waveform generation functions, `umtsDownlinkWaveformGenerator` and `umtsUplinkWaveformGenerator`. Additionally reference channel functions, `umtsDownlinkReferenceChannels` and `umtsUplinkReferenceChannels`, are provided so that you can readily produce a configuration structure initialized to define RMC, FRC H-Set and test models defined in 3GPP standards. The reference channel function output configuration structure serves as input to the associated waveform generation function.

## **Coordinated Multipoint (CoMP) Transmission and Reception Simulation: Mitigate interference and improve performance at the edge of an LTE cell**

This release features an example demonstrating CoMP dynamic interference mitigation cooperation between multiple base stations.

- “CoMP Dynamic Point Selection with Multiple CSI Processes”

## **SIB1 Message PDSCH Support: Generate and receive LTE downlink waveforms carrying SIB1 for cell search and network access**

This release enables you to generate LTE waveforms carrying SIB1 message using the `lteRMCDLTool` function.

## **TM9/TM10 RMC waveform generation: Create TM9/TM10 waveforms containing CSI-RS for channel quality measurements**

The `lteRMCDL` function now returns the 3GPP standard defined CSI-RS RMC configurations and the `lteRMCDLTool` can now generate these waveforms containing CSI-RS. New RMCs added to `lteRMCDL` and the `lteRMCDLTool` GUI in this release are 'R.43', 'R.44', 'R.45', 'R.45-1', 'R.48', 'R.50', and 'R.51'.

## **Additional Featured Examples: SIB1, EPDCCH, working with live LTE signals, multicell interference, EVM measurement, HDL verification, UMTS**

This release adds and/or enhances several examples

- 
- “Cell Search, MIB and SIB1 Recovery”
  - “Enhanced Physical Downlink Control Channel (EPDCCH) Generation”
  - “Working with Live LTE Signals using Software-Defined Radio (SDR)”
  - “Effect of Inter-Cell Interference on PDSCH Throughput”
  - “PDSCH Error Vector Magnitude (EVM) Measurement”
  - “Verification of HDL Implementation of LTE OFDM Modulator and Detector”
  - “UMTS Downlink Waveform Generation”
  - “UMTS Uplink Waveform Generation”





# R2014b

**Version: 1.2**

**New Features**

**Bug Fixes**

## **Enhanced physical downlink control channel (EPDCCH) and its demodulation reference signal (DM-RS) generation functions in support of 3GPP Release 11**

R2014b adds support for the creation of Release 11 compliant enhanced physical downlink control channel (EPDCCH) transmissions. For details, see the command line help for `lteEPDCCH` and `lteEPDCCHIndices`. Additionally, `lteEPDCCHDMRS` and `lteEPDCCHDMRSIndices` allow you to generate the associated demodulation reference signals (DM-RS).

## **Channel quality indicator (CQI) and rank indicator (RI) estimation functions for modulation and coding scheme (MCS) selection**

R2014b adds support for adaptive modulation and coding scheme (MCS) selection. `lteCQISelect` performs channel quality indicator (CQI) estimation, `lteRISelect` performs rank indicator (RI) estimation, and `lteMCS` provides a lookup between MCS values and the corresponding transport block size (TBS) and modulation order.

## **Unifying function for extracting physical channel symbols and signals from a resource grid**

R2014b adds support for extracting physical channel symbols and signals from a resource grid. For details, see the command line help for `lteExtractResources`.

## **Zero-power channel state information reference signals (CSI-RS) generation functions in support of 3GPP Release 10**

R2014b adds support for zero-power CSI-RS. New parameters added to `lteCSIRS`, `lteCSIRSIndices`, and `ltePDSCHIndices` allow you to define zero-power CSI-RS via the standardized 16-bit bitmap representation.

# R2014a

**Version: 1.1**

**New Features**

**Compatibility Considerations**

## **Standard-compliant models for LTE and LTE-Advanced (Releases 8, 9, and 10)**

The LTE System Toolbox™ product provides standard-compliant functions and tools for the design, simulation, and verification of long-term evolution (LTE) and LTE-Advanced communications systems. LTE-Advanced comprises changes made to releases 9 and 10 of the LTE Standard.

## **End-to-end physical layer transmit and receive processing functions, including OFDM (downlink) and SC-FDMA (uplink)**

The LTE System Toolbox product provides standard-compliant functions for end-to-end physical layer transmit and receive processing. These functions include OFDM modulation for downlink and SC-FDMA modulation for uplink.

## **MIMO antenna transmission and UE-specific beamforming functions**

The LTE System Toolbox product provides standard-compliant functions for multiple-input, multiple-output (MIMO) antenna transmission and user equipment (UE)-specific beamforming.

## **Channel estimation, synchronization, and MIMO receiver functions**

The LTE System Toolbox product provides standard-compliant MIMO receiver functions for synchronization, channel estimation, equalization, and signal recovery procedures.

## **Standard-compliant propagation channel models**

The LTE System Toolbox product provides standard-compliant functions for modeling propagation channels. These functions include models for MIMO fading channel, EPA, EVA, and ETU, moving propagation channel, and high-speed train MIMO channel.

## **Test models and reference measurement channel (RMC) waveform generators**

The LTE System Toolbox product provides standard-compliant functions and tools for generating E-UTRA test models (E-TM) and reference measurement channel (RMC) waveforms.

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## Interactive tools for conformance and BER testing

The LTE System Toolbox product provides interactive tools for conformance and BER testing. You can create and reuse a conformance test bench to verify that your designs, prototypes, and implementations comply with the LTE standard.

## Recovery of low-level parameters, such as cell identity

The LTE System Toolbox product provides for the recovery of low-level parameters, such as cell identity.

## Apps for generating waveforms and analyzing throughput

This release adds the following four new apps to the MATLAB® apps gallery.

- **LTE Downlink RMC Generator** — used for selection of parameters for and generation of downlink reference measurement channel (RMC) waveforms. For more information, see `lteRMCDLTool`
- **LTE Uplink RMC Generator** — used for selection of parameters for and generation of uplink reference measurement channel (RMC) waveforms. For more information, see `lteRMCULTool`
- **LTE Test Model Generator** — used for selection of parameters for and generation of E-UTRA test model (E-TM) waveforms. For more information, see `lteTestModelTool`
- **LTE Throughput Analyzer** — used to perform the PDSCH demodulation performance test and plot throughput performance graphs. For more information, see `lteDLConformanceTestTool`

## Function names and output behavior changed

Previous versions of the LTE System Toolbox product used different function names. In version 1.0, the LTE System Toolbox product contains an entirely new set of function names. Also, many functions in previous versions of the LTE System Toolbox product returned row vectors for output arguments. In version 1.0, many of the new equivalent functions return column vectors for output arguments.

## Compatibility Considerations

If you wrote scripts using any of the old function names used in previous versions, you must modify the scripts to use the new function names in the LTE System Toolbox

product, version 1.0. Also, you must modify many of the scripts to expect column vectors for output arguments where row vectors were previously returned. Refer to the following table for a mapping of the previous function names to their new equivalent function names.

In R2014a, by default, all the functions listed in the **Previous Function Name** column are on the MATLAB path. To remove these functions from the path, call the `rmLTEobsolete` function. To add these functions to the path again, call the `addLTEobsolete` function.

Previous Function Name	New Function Name
LteACKDecode	lteACKDecode
LteACKEncode	lteACKEncode
LteBCH	lteBCH
LteBCHDecode	lteBCHDecode
LteCFI	lteCFI
LteCFIDecode	lteCFIDecode
LteCQIDecode	lteCQIDecode
LteCQIEncode	lteCQIEncode
LteCRC	lteCRCEncode
LteCRCDecode	lteCRCDecode
LteCSICodebook	lteCSICodebook
LteCSIRS	lteCSIRS
LteCSIRSIndices	lteCSIRSIndices
LteCellRS	lteCellRS
LteCellRSIndices	lteCellRSIndices
LteCellSearch	lteCellSearch
LteCodeBlkDeseg	lteCodeBlockDesegment
LteCodeBlkSeg	lteCodeBlockSegment
LteConvCode	lteConvolutionalEncode
LteConvDecode	lteConvolutionalDecode
LteDCI	lteDCI

Previous Function Name	New Function Name
LteDCIDecode	lteDCIDecode
LteDCIDims	lteDCIInfo
LteDCIEncode	lteDCIEncode
LteDLChannelEstimation	lteDLChannelEstimate
LteDLConformanceTestBench	lteDLConformanceTestTool
LteDLDeprecoder	lteDLDeprecode
LteDLFrameOffset	lteDLFrameOffset
LteDLPerfectChannelEstimation	lteDLPerfectChannelEstimate
LteDLPrecoder	lteDLPrecode
LteDLResourceGrid	lteDLResourceGrid
LteDLResourceGridDims	lteDLResourceGridSize
LteDLSCH	lteDLSCH
LteDLSCHDecode	lteDLSCHDecode
LteDLSCHDims	lteDLSCHInfo
LteDMRS	lteDMRS
LteDMRSIndices	lteDMRSIndices
LteDuplexDims	lteDuplexingInfo
LteEVM	lteEVM
LteEqualizeMIMO	lteEqualizeMIMO
LteEqualizeMMSE	lteEqualizeMMSE
LteEqualizeULMIMO	lteEqualizeULMIMO
LteEqualizeZF	lteEqualizeZF
LteFadingChan	lteFadingChannel
LteFreqCorrect	lteFrequencyCorrect
LteFreqOffset	lteFrequencyOffset
LteHSTChan	lteHSTChannel
LteLayerDemapper	lteLayerDemap

<b>Previous Function Name</b>	<b>New Function Name</b>
LteLayerMapper	lteLayerMap
LteMIB	lteMIB
LteMovingChan	lteMovingChannel
LteOFDM	lteOFDMModulate
LteOFDMDemod	lteOFDMDemodulate
LteOFDMDims	lteOFDMInfo
LtePBCH	ltePBCH
LtePBCHDecode	ltePBCHDecode
LtePBCHIndices	ltePBCHIndices
LtePBCHPRBS	ltePBCHPRBS
LtePCFICH	ltePCFICH
LtePCFICHDecode	ltePCFICHDecode
LtePCFICHDims	ltePCFICHInfo
LtePCFICHIndices	ltePCFICHIndices
LtePCFICHPRBS	ltePCFICHPRBS
LtePDCCH	ltePDCCH
LtePDCCHDecode	ltePDCCHDecode
LtePDCCHDeinterleave	ltePDCCHDeinterleave
LtePDCCHDims	ltePDCCHInfo
LtePDCCHIndices	ltePDCCHIndices
LtePDCCHInterleave	ltePDCCHInterleave
LtePDCCHPRBS	ltePDCCHPRBS
LtePDCCHSearch	ltePDCCHSearch
LtePDCCHSpace	ltePDCCHSpace
LtePDSCH	ltePDSCH
LtePDSCHDecode	ltePDSCHDecode
LtePDSCHIndices	ltePDSCHIndices



<b>Previous Function Name</b>	<b>New Function Name</b>
LtePDSCHPRBS	ltePDSCHPRBS
LtePHICH	ltePHICH
LtePHICHDecode	ltePHICHDecode
LtePHICHDeprecoder	ltePHICHDeprecode
LtePHICHDims	ltePHICHInfo
LtePHICHIndices	ltePHICHIndices
LtePHICHPRBS	ltePHICHPRBS
LtePHICHPrecoder	ltePHICHPrecode
LtePHICHTxDivDecode	ltePHICHTransmitDiversityDecode
LtePMIDims	ltePMIInfo
LtePMISelection	ltePMISelect
LtePRACH	ltePRACH
LtePRACHDetect	ltePRACHDetect
LtePRACHDims	ltePRACHInfo
LtePRBFromDCI	lteDCIResourceAllocation
LtePRBS	ltePRBS
LtePRS	ltePRS
LtePRSIndices	ltePRSIndices
LtePSS	ltePSS
LtePSSIndices	ltePSSIndices
LtePUCCH1	ltePUCCH1
LtePUCCH1DRS	ltePUCCH1DRS
LtePUCCH1DRSIndices	ltePUCCH1DRSIndices
LtePUCCH1Decode	ltePUCCH1Decode
LtePUCCH1Indices	ltePUCCH1Indices
LtePUCCH2	ltePUCCH2
LtePUCCH2DRS	ltePUCCH2DRS

<b>Previous Function Name</b>	<b>New Function Name</b>
LtePUCCH2DRSDecode	ltePUCCH2DRSDecode
LtePUCCH2DRSIndices	ltePUCCH2DRSIndices
LtePUCCH2Decode	ltePUCCH2Decode
LtePUCCH2Indices	ltePUCCH2Indices
LtePUCCH2PRBS	ltePUCCH2PRBS
LtePUCCH3	ltePUCCH3
LtePUCCH3DRS	ltePUCCH3DRS
LtePUCCH3DRSIndices	ltePUCCH3DRSIndices
LtePUCCH3Decode	ltePUCCH3Decode
LtePUCCH3Indices	ltePUCCH3Indices
LtePUCCH3PRBS	ltePUCCH3PRBS
LtePUSCH	ltePUSCH
LtePUSCHDRS	ltePUSCHDRS
LtePUSCHDRSIndices	ltePUSCHDRSIndices
LtePUSCHDecode	ltePUSCHDecode
LtePUSCHDeprecoder	ltePUSCHDeprecode
LtePUSCHIndices	ltePUSCHIndices
LtePUSCHPrecoder	ltePUSCHPrecode
LteRIDecode	lteRIDecode
LteRIEncode	lteRIEncode
LteRMCDL	lteRMCDL
LteRMCDLTool	lteRMCDLTool
LteRMCUL	lteRMCUL
LteRMCULTool	lteRMCULTool
LteRateMatchConv	lteRateMatchConvolutional
LteRateMatchTurbo	lteRateMatchTurbo
LteRateRecoverConv	lteRateRecoverConvolutional

Previous Function Name	New Function Name
LteRateRecoverTurbo	lteRateRecoverTurbo
LteResourceGrid	lteResourceGrid
LteResourceGridDims	lteResourceGridSize
LteSCFDMA	lteSCFDMAModulate
LteSCFDMADemod	lteSCFDMADemodulate
LteSCFDMADims	lteSCFDMAInfo
LteSRS	lteSRS
LteSRSDims	lteSRSInfo
LteSRSIndices	lteSRSIndices
LteSSS	lteSSS
LteSSSIndices	lteSSSIndices
LteSymbolDemod	lteSymbolDemodulate
LteSymbolMod	lteSymbolModulate
LteTBS	lteTBS
LteTestModel	lteTestModel
LteTestModelTool	lteTestModelTool
LteTurboCode	lteTurboEncode
LteTurboDecode	lteTurboDecode
LteTxDiversityDecode	lteTransmitDiversityDecode
LteUCI3Decode	lteUCI3Decode
LteUCI3Encode	lteUCI3Encode
LteUCIDecode	lteUCIDecode
LteUCIEncode	lteUCIEncode
LteUeRS	Removed. Use lteDMRS instead.
LteUeRSIndices	Removed. Use lteDMRSIndices instead.
LteULChannelEstimation	lteULChannelEstimate
LteULChannelEstimationPUCCH1	lteULChannelEstimatePUCCH1

Previous Function Name	New Function Name
LteULChannelEstimationPUCCH2	lteULChannelEstimatePUCCH2
LteULChannelEstimationPUCCH3	lteULChannelEstimatePUCCH3
LteULDeprecoder	lteULDeprecode
LteULDescrambler	lteULDescramble
LteULFrameOffset	lteULFrameOffset
LteULFrameOffsetPUCCH1	lteULFrameOffsetPUCCH1
LteULFrameOffsetPUCCH2	lteULFrameOffsetPUCCH2
LteULFrameOffsetPUCCH3	lteULFrameOffsetPUCCH3
LteULPMIDims	lteULPMIInfo
LteULPMISelection	lteULPMISelect
LteULPerfectChannelEstimation	lteULPerfectChannelEstimate
LteULPrecoder	lteULPrecode
LteULResourceGrid	lteULResourceGrid
LteULResourceGridDims	lteULResourceGridSize
LteULSCH	lteULSCH
LteULSCHDecode	lteULSCHDecode
LteULSCHDeinterleave	lteULSCHDeinterleave
LteULSCHDims	lteULSCHInfo
LteULSCHInterleave	lteULSCHInterleave
LteULScrambler	lteULScramble
LteVersion	Removed. Use the MATLAB version function instead.
LteWarning	lteWarning
LteZadoffChu	Removed. Use lteZadoffChuSeq in the Communications System Toolbox™ product instead.