RF Blockset™ Release Notes

MATLAB&SIMULINK®

MathWorks®

How to Contact MathWorks

	Latest news:	www.mathworks.com
	Sales and services:	www.mathworks.com/sales_and_services
	User community:	www.mathworks.com/matlabcentral
	Technical support:	www.mathworks.com/support/contact_us
	Phone:	508-647-7000

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

Contents

R2021b

R2021a

R2020b

R2017a

R2016b

R2012b

R2012a

R2011b

R2011a

Bug Fixes

R2010bSP1

Bug Fixes

R2010b

R2010a

No New Features or Changes

R2009b

R2009a

R2006b

No New Features or Changes

R2006a

R14SP3

R14SP2

R2022b

Version: 8.4

New Features

Compatibility Considerations

Amplifier Block: Visualize amplifier power characteristics

The Amplifier block now supports visualizing the nonlinear power curve of an amplifier.

Data source in S-parameters and Amplifier Blocks: Use network parameter and rational objects as data source

The S-Parameters and the Amplifier blocks now support using network parameter and the rational objects created at the MATLAB® command line as a data source to model S-parameters and amplifier gain in the S-parameters and the Amplifier blocks, respectively.

Inport Block: Modulate input signal onto square carrier wave in circuit envelope simulation environment

The Inport block now supports modulating an input signal onto a square carrier wave in the RF Blockset circuit envelope simulation environment.

Impulse Response Duration: Estimate impulse response duration using phase noise offset frequencies

These blocks now estimate the impulse response duration using phase noise offset frequencies and visualize the phase noise characteristics:

- Continuous Wave
- IQ Demodulator
- IQ Modulator
- Modulator
- Demodulator

Divider Block: Model Wilkinson power divider with up to 65 ports

The Divider block now supports modeling a Wilkinson power divider with up to 65 ports.

S-parameter Block: Visualize single-frequency S-parameter data

The S-Parameters block now supports visualizing single-frequency S-parameter data.

Application-Based Examples

- "Modulate Input Signal Onto Square Carrier Wave"
- "Model Wilkinson Power Divider"

Functionality being removed or changed

Outport block icon updated
Behavior change

Starting in R2022b, the block icon for the Outport block have been updated.

Compatibility Considerations

When you open a model created before R2022b containing the Outport block, the software replaces the block icon with the R2022b version.

Parameters of Amplifier block renamed
Behavior change

The **Pick operation frequency at maximum S21 magnitude** and **Frequency data** parameters in the Amplifier block have been renamed to **Use operation frequency at maximum S21 magnitude** and **Source of frequency data**, respectively .

Compatibility Considerations

When you open a model created before R2022b containing the Amplifier block, the software replaces the **Pick operation frequency at maximum S21 magnitude** parameter with the **Use operation frequency at maximum S21 magnitude** parameter and **Frequency data** parameter with the **Source of frequency data** parameter.

Parameters of S-parameters block renamed
Behavior change

The **Frequency data** parameter in the S-Parameters block have been renamed to **Source of frequency data**.

Compatibility Considerations

When you open a model created before R2022b containing the S-parameter block, the software replaces the **Frequency data** parameter with the **Source of frequency data** parameter.

R2022a

Version: 8.3

New Features

Compatibility Considerations

Idealized Power Amplifier Block: Model narrowband power amplifier with memory

Use the idealized Power Amplifier block to model a narrowband power amplifier with memory using the memory polynomial or the cross-term memory model types.

Antenna Block: Use antenna array object to model transmit and receive antenna array

Input an antenna array object to the Antenna block to model a transmit and receive antenna array.

Amplifier Block: Use AM/AM-AM/PM table to specify amplifier power characteristics and model frequency-dependent gain in nonlinear amplifier

The Amplifier block now supports:

- Using AM/AM-AM/PM table to specify amplifier power characteristics.
- Modeling frequency-dependent gain (S21) when operating in a nonlinear region.

Transmission Line Block: Model transmission lines

The Transmission Line block now allows you to model:

- Embedded, inverted, and suspended microstrip transmission lines
- Conductor-backed coplanar waveguide transmission lines
- Stripline transmission lines

Connection Label Block: Create virtual connection between circuit envelope ports

Use the Connection Label block in the Circuit Envelope Utilities sublibrary to create a virtual connection between circuit envelope ports.

IMT Mixer Block: Extract reference input power and nominal output power from data file

The IMT Mixer block now supports extracting reference input power and nominal output power from a data file.

Overview Topics: RF system and transceiver design

Learn about RF system and transceiver design from these overview topics:

- RF System Design for Radar and Wireless Communications
- RF Transceiver Design

- RF Noise and Nonlinearity Simulations

Application-Based Examples

- Power Amplifier and DPD Modeling for Dynamic EVM Measurement of 5G Waveforms
- RF Impairments for 5G NR Downlink Waveforms
- Massive MIMO Hybrid Beamforming with RF Impairments
- 100 Watt TR Module for S-Band Applications
- Model RF Systems with Antenna Arrays Using RF Blockset Antenna Block
- Speed Up PA and DPD simulation

Functionality being removed or changed

Noise modeling in nonlinear circuit envelope amplifier
Behavior change

Before R2022a, frequency-dependent noise in the Circuit Envelope library Amplifier block operating in a nonlinear region was modeled as white noise. This release, the Amplifier block allows you to model frequency-dependent noise as colored noise when your amplifier is operates in a nonlinear region.

Compatibility Considerations

When you open a model created before R2022a containing the Amplifier block operating in nonlinear region with frequency-depended noise, the software will model noise as specified in the block.

Transmission Line block parameters renamed
Behavior change

The **Substrate height**, **Relative permittivity constant** and, **Relative permeability constant** parameters in the Transmission Line block have been renamed to **Dielectric thickness**, **Relative permittivity of dielectric**, and **Relative permeability of dielectric**, respectively.

Compatibility Considerations

When you open a model created before R2022a containing the Transmission Line block, the software replaces the **Substrate height**, **Relative permittivity constant**, and **Relative permeability constant** parameters with the **Dielectric thickness**, **Relative permittivity of dielectric**, and **Relative permeability of dielectric** parameters, respectively.

Mutual Inductor, Three-Winding Transformer, and Ideal Transformer block icons updated
Behavior change

Starting in R2022a, the block icons for the Mutual Inductor, Three-Winding Transformer, and Ideal Transformer blocks have been updated.

Compatibility Considerations

When you open a model created before R2022a containing the Mutual Inductor, Three-Winding Transformer, or Ideal Transformer blocks, the software replaces the block icons with the R2022a version.

R2021b

Version: 8.2

New Features

Bug Fixes

Compatibility Considerations

N-Port S-Parameters block: Model S-Parameter objects with up to 65 ports

Use the N-Port S-Parameters block from the Circuit Envelope library to model S-Parameter objects with up to 65 ports for massive multiple-input and multiple-output (MIMO) array modeling.

Functionality being removed or changed

S-parameter network data construction in S-parameter block
Behavior change

Starting in R2021b, the Circuit Envelope library S-Parameters block uses the `rational` method to perform rational fitting to complex frequency-dependent data. The `rational` method improves fitting speed. The block also has a new parameter, **Maximum number of poles**, to provide additional control over the fitting procedure. This parameter allows you to specify `99` poles.

Compatibility Considerations

When you open a model created before R2021b containing the Circuit Envelope library S-parameter block, the software updates the extraction method to perform rational fit with the new **Maximum number of poles** parameter. The output of the model gets refitted and the refitted output might be different from the output in the previous releases.

Block icons in Circuit Envelope sublibraries updated and now show noise support
Behavior change

Starting in R2021b, the block icons for the blocks from the Circuit Envelope Elements, Sources, Systems, and Utilities sublibraries have updated. If the block supports noise and you enable it in the block, the block icon includes additional gray coloration.

Compatibility Considerations

When you open a model created before R2021b containing a block from the Circuit Envelope Elements, Sources, Systems, and Utilities sublibraries, the software replaces the block icons with the R2021b version. If you enable noise in these blocks, the block icon includes additional gray coloration.

R2021a

Version: 8.1

New Features

Bug Fixes

Compatibility Considerations

Model Compilation Speeds: Compilation speed of RF Blockset™ models improved

Due to enhancements made to RF Blockset™ in this release, RF Blockset models compile noticeably faster when you repeat model compilations. Performance can vary based on model complexity, but most RF Blockset models compile faster compared to the previous release.

Functionality being removed or changed

Mixer models and noise supported for Mixer block in Idealized Baseband library changed
Behavior change

Starting this release, the Mixer block from the Idealized Baseband library supports modulator, demodulator, IQ modulator, and IQ demodulator mixers with impairments and noise. The new Mixer block includes pre- R2021b functionality when the **Mixer type** parameter is set to `Modulator`.

Compatibility Considerations

When you open a model from a previous release containing the Mixer block from the Idealized Baseband library, the pre- R2021a version of this block is automatically replaced with the R2021a version of this block with impairments and noise.

Port positions of Wilkinson power divider component in Divider block changed
Behavior change

Starting this release, the port positions in the Divider block when you select the `Wilkinson power divider` component have changed. Prior to this release, Ports 1 and 3 were on the same side opposite that of Port 2. This release, Ports 2 and 3 appear on one side together opposite the side of Port 1.

Compatibility Considerations

Existing models using the Divider block with the `Wilkinson power divider` component might need to be updated to ensure that there are no broken connections. Use the RF Blockset check in the Simulink® Upgrade Advisor to identify and rewire the broken port connections in your existing models. For more information, see Check model for RF Blockset Divider blocks using Wilkinson power divider component with broken connections.

R2020b

Version: 8.0

New Features

Compatibility Considerations

Antenna block: Model transmitting and receiving antennas with frequency-dependent impedance and radiation pattern

Use the Antenna block from the Circuit Envelope library to model transmitting and receiving antennas with frequency-dependent impedance and radiation pattern.

N-Port S-Parameters block: Model S-Parameter objects with more than eight ports

Use the N-Port S-Parameters block from the Circuit Envelope library to model S-Parameter objects with up to 32 ports for massive MIMO array modeling.

Functionality being removed or changed

Default averaging method in Spectrum Analyzer block changed
Behavior change

Starting in R2020b, the Spectrum Analyzer block uses the exponential averaging as the default averaging method. The default value of the **Averaging method** parameter in the block is now `Exponential`.

Compatibility Considerations

For existing models with a Spectrum Analyzer, the averaging method has not been changed. For new visualizations with the Spectrum Analyzer block, you may see some changes in the output because of the averaging method. If you want to use the previous default, set the **Averaging method** to `Running`.

R2020a

Version: 7.4

New Features

Amplifier block: Model a nonlinear amplifier with noise using one of four methods

Use the Amplifier block from the Idealized Baseband library to model an amplifier using the Cubic polynomial, AM/AM-AM/PM, Modified Rapp, or Saleh model.

R2019b

Version: 7.3

New Features

Intermodulation Table (IMT) Mixer Block: Simulate mixer spurs using IMT

Use the IMT Mixer block to simulate a mixer specified using an IMT.

S-Parameter Testbench Block: Measure S-parameters of arbitrary networks using circuit envelope

Use the S-Parameter Testbench block to connect to a general circuit build using RF Blockset circuit envelope and measure the S-parameter data.

Vector Signals in Circuit Envelope: Support of frame-based processing in Inport and Outport blocks

Use the Configuration block for frame-based processing and to interface with blocks used in baseband system modeling.

Updated Filter Block: Design method for inverse Chebyshev added to filter block

Use the Filter block to design and simulate an inverse Chebyshev filter.

R2019a

Version: 7.2

New Features

Small Signal Analysis: Run faster simulations for small transient signals with suppressed mixing harmonics

Use the Configuration block for small signal analysis to capture the behaviors of small signals affected by large constant signals.

Improved Coupler Block: Extended operation range for directional coupler

The `Directional coupler` option in the Coupler block now has increased passive range operation.

Junction Blocks: New junction components in Circulator, Divider, and Coupler blocks

- Coupler Block: The Coupler block now includes the Magic Tee.
- Circulator Block: The Circulator block now includes the Tee H-plane (S11 = 0) and the Reciprocal phase shifter.
- Divider Block: The Divider block now includes the Tee H-plane (S33 = 0) and the Tee E-plane.

Spectrum Analyzer improvements for exponential averaging, mixed-complexity inputs

The Spectrum Analyzer block now allows exponential averaging and mixed-complexity inputs.

Smooth data with exponential averaging

The Spectrum Analyzer block now has two averaging modes for smoothing input samples: running averages (existing) and exponential averages (new). To specify the smoothing options for your input data, use these properties:

- **Averaging method** (`AveragingMethod`) — Choose `Running` or `Exponential`.
- **Averages** (`SpectralAverages`) — For running averages, choose the number of spectrum estimates to include in the running average.
- **Forgetting factor** (`ForgettingFactor`) — For exponential averaging, weigh previous spectrum estimates with a forgetting factor in the range (0,1].

For more details about the averaging methods, see Spectrum Analyzer Algorithms.

Display block inputs with different complexity

In the Spectrum Analyzer block, you can now visualize frequencies of inputs with different complexities. The signals must have the same sample rate and frame size, but can have both real and complex values.

9

R2018b

Version: 7.1

New Features

Automatic Sample-Time Interpolation at Input Port: Directly use baseband communication signals using a lower sample rate in wider-band circuit envelope simulation

You can now use **Enable input interpolation filter** in the Configuration block to up sample the input signal rates to fit the sample rates of the RF solver. To understand more see, Automatic Sample-Time Interpolation at Input Port.

New Application Examples: Learn how to model the RF architecture of MIMO receivers, Hybrid beamforming transmitters, ZigBee, and DVB wireless systems

Use the following examples to learn how to model RF architectures of:

- MIMO receiver: Modeling and Simulation of MIMO RF Receiver Including Beamforming
- ZigBee®: Top-Down Design of Spread Spectrum Receiver for ZigBee
- Hybrid beamforming transmitters: Modeling an RF mmWave Transmitter with Hybrid Beamforming
- DVB wireless systems: Wireless Digital Video Broadcasting with RF Beamforming

R2018a

Version: 7.0

New Features

Generalized Power Amplifier Model: Increase the accuracy of amplifier models using leading and lagging memory cross-terms

Improve the accuracy of Power Amplifier model by including leading and lagging memory cross-terms:

- Cross-Term Hammerstein
- Cross-Term Memory Polynomial

Testbench Measurement Library: Measure gain, noise figure, IP2, and IP3 characteristics of an RF network

Use the Testbench Measurement library blocks to measure gain, noise figure, and IP data of RF systems. The current library consists of the following blocks:

- Transducer Gain Testbench
- Noise Figure Testbench
- IIP2 Testbench
- OIP2 Testbench
- IIP3 Testbench
- OIP3 Testbench

RF Modulator and Demodulator Systems: Model RF modulators and demodulators for homodyne and heterodyne systems, including RF impairments, image rejection, and channel selection filters

Use the Modulator and Demodulator blocks to simulate homodyne and heterodyne upconversion or downconversion. You can also model common RF impairments, image reject, and channel select filters using these blocks.

'Edit System' Button for System Library Blocks: Edit and customize system models of modulators and demodulators

Use the **Edit System** button in Modulator, Demodulator, IQ Demodulator, and IQ Modulator blocks to break the block library links in the RF circuit and replace internal variables with appropriate values.

SPnT Switch: Model single pole multiple throw switching networks

Use the SPnT block to simulate single pole multiple throw ($2<=n<=8$) switch, where n is the number of outputs of the switch. This block supports both reflective and absorptive switches.

Circuit Envelope Concepts: Understand basic circuit envelope concepts and explore additional application examples in expanded documentation

Use RF Simulation Glossary and Circuit Envelope Basics to understand basic RF simulation vocabulary and circuit envelope concepts.

New examples of applications using circuit envelope simulation include:

- Power Amplifier Characterization with DPD for Reduced Signal Distortion
- Modeling RF Front End in Radar System Simulation
- RF Receiver Modeling for LTE Reception
- Communications System with Embedded RF Receiver

R2017b

Version: 6.1

New Features

Amplifier Block: Model the effects of finite reverse isolation and frequency-dependent noise with data source option

Use the Amplifier block to simulate advanced noise concepts, such as `Spot Noise` and `Phase Noise`. You can use the **Noise** pane to define a frequency-dependent noise figure and generally define noise using `Spot noise data`. If there is nonlinearity, you can define an operation frequency to determine the constant S21 and noise data used for simulation.

Power Amplifier Model: Model wideband and narrowband power amplifiers capturing nonlinearity and memory effects based on input/output device characteristics

Use the Power Amplifier block to simulate a two-terminal power amplifier. This block allows for modeling nonlinearity and memory effects using narrowband and wideband models extracted from input/output measurements. The block supports two types of power amplifier models:

- Generalized Hammerstein for wideband amplifiers characterized by real coefficients
- Memory Polynomial for narrowband amplifiers characterized by complex coefficients

S-parameter Block: Model causal responses for amplitude data using the frequency response domain option

When using scattering data to specify S-Parameters block in the Circuit Envelope library of RF Blockset, you are expected to provide data including phase information that corresponds to realistic devices. However, if you are interested in shaping the spectral content by including the effect of filters described by magnitude, then such filters represent noncausal transfer functions. RF solver incorrectly interprets these transfer functions as causal, which in turn causes distortion in the transfer function behavior. To avoid this distortion and allow simulation of magnitude-based filters, you can delay the impulse response by half its length. As the solver internal impulse response length somewhat differs from that defined, you implement delay,internally.

To achieve this select **Use only S-parameter magnitude with appropriate delay** in the **Modeling** pane of the s-parameter block. The check box appears only for s-parameter defined data modeled in the time-domain.

S-parameter Block: Simulate and visualize up to 8-port data

You can now use the s-parameter block for time and frequency modeling of 8-port data.

CW Source: Model frequency-dependent phase noise

Phase noise is created in nonideal oscillators as a result of jitter and other types of colored noise. The noise is defined compared to the oscillator signal amplitude over an offset frequency range around the oscillator frequency. You can now use the Continuous Wave source block to add phase noise and define **Phase noise offset (Hz)** and **Phase noise level (db/Hz)**.

Variable Resistor Block: Build tunable RF systems by varying the resistance at run time

Use the Variable Resistor block to control the resistance of an RF system during a simulation.

12

R2017a

Version: 6.0

New Features

SimRF Renamed to RF Blockset

The SimRF™ product is now named RF Blockset. The product library is located in the Simulink® library browser.

RF Blockset Software does not require Simscape license

RF Blockset requires only MATLAB, Simulink, and RF Toolbox™ licenses.

IQ Modulator and Demodulator Blocks: Simplify quadrature transmitter and receiver design

Use the IQ Modulator and IQ Demodulator system blocks to retain and augment the parameters used in mixers as well as implement RF impairments. The system blocks are in the RF Systems library of RF Blockset.

Specify Tolerances for Circuit Envelope Solver: Improved accuracy control for mildly nonlinear conditions

The optimized Configuration block now includes Newton solver parameters. You can use the Newton solver parameters to affect the solution of nonlinear RF Systems.

Analog Devices AD9361 Models: Fast attack mode added to the receiver model

In RF Blockset AD9361 models, you can now achieve gain control by enabling pre-programmed fast attack mode in the internal AGC.

Analog Devices AD9371 Models: Simulate transmitter, receiver, observer, and sniffer

Simulate system-level models of Analog Devices® AD9371 transceivers, observer, and sniffer. For full access to features and documentation, download models using the Add-on Explorer.

R2016b

Version: 5.1

New Features

Frequency-Dependent Noise Figure for Amplifiers: Specify the noise figure of an amplifier using Touchstone files

Use the Amplifier block to specify and plot noise figure using Touchstone files.

Random Seed for Noise Simulation: Reproduce thermal noise Circuit Envelope simulation results by specifying random seed

Use the Configuration block to specify the noise seed to study noise properties of complex RF systems.

Attenuator Block: Model RF attenuators that generate thermal noise

Use the Attenuator block to attenuate signal power by a given factor in dB.

Variable Attenuator Block: Build tunable RF systems by varying the attenuation at run time

Use the Variable Attenuator block to control the attenuation of the signal power during simulation.

Variable Phase Shifter Block: Build tunable RF systems by varying the phase shift at run time

Use the Variable Phase Shift block to control the phase shift of an RF system during simulation.

Variable LC Blocks: Build tunable RF networks by varying the capacitance and inductance of lumped components at run time

Use the Variable Inductor and Variable Capacitor blocks to control the values of inductance and capacitance in an RF circuit during simulation.

R2016a

Version: 5.0

New Features

Automatic Testbench Generation: Validate Circuit Envelope simulation results of gain, noise figure and IP3 of cascaded RF components

You can use SimRF Testbench simulation to verify the gain, noise figure, and third intercept point (IP3) of a system created using the **RF Budget Analyzer** app.

To understand how to use the SimRF testbench, see Using SimRF Testbench.

Analog Devices RF Transceivers Models: Faster implementation for AD9361 transmitter and receiver

The optimized RF Transceiver models enable faster implementation and analysis of the Analog Devices AD9361 transmitter and receiver.

R2015b

Version: 4.5

New Features

VGA Block: Tune the gain, IP2, and IP3 of a variable gain amplifier at run time

Use the VGA block to model a variable gain amplifier using standard industry terminology. The VGA block can also incorporate nonlinear characteristics common to real world amplifiers.

RF Switch Blocks: Build dynamically configurable networks with potentiometer, single-pole single-throw (SPST), and single-pole double-throw (SPDT) switches

You now use the:

- Potentiometer block — Model a Simulink signal controlled switch with three taper styles: Linear, Logarithmic and Antilog.
- SPST or SPDT blocks — Model reflective or absorptive Simulink signal controlled switch.
- Switch block — Model 2–terminal Simulink signal controlled switch.

Noise Option in S-Parameters Block: Simulate the passive noise calculated from S-parameter data

Simulate thermal noise by using **Simulate Noise** option in the S-parameters block.

R2015a

Version: 4.4

New Features

Colored noise option in Noise Source block: simulate frequency dependent noise profiles

You now use the noise source block to simulate correlated noise in SimRF models.

R2014b

Version: 4.3

New Features

Bug Fixes

Impulse response option for modeling S-parameters in Circuit Envelope

You can now use frequency domain modeling from S-Parameters, Amplifier and Transmission line blocks to specify impulse response duration.

Analog filter block that includes lumped component implementations for Circuit Envelope

You can now model `Butterworth` and `Chebyshev` analog filters using the Filter block. You can also specify the filter type (`LC Tee`, `LC Pi`, or `rational model`) in this block.

Models for Analog Devices RF Transceivers

Simulate system level models of Analog Devices AD9361 transceivers. For full access to features and documentation, use the function `simrfSupportPackages` to download the models. For MathWorks® software requirements, see Analog Devices RF Transceivers Support from MATLAB and Simulink

R2014a

Version: 4.2

New Features

Bug Fixes

Circulator, Divider, and Coupler blocks for Circuit Envelope

SimRF Circuit Envelope now includes the following blocks in the new `Junctions` sublibrary:

- Circulator: 3-port clockwise or counterclockwise circulators
- Divider: 3-port power dividers (combiners) for splitting (combining) signals
- Coupler: 4-port directional couplers for monitoring or measuring signals

Ideal Delay-based Transmission Line block for Circuit Envelope

The Transmission Line block has new options to model delay-based transmission lines: `Delay-based and lossless` and `Delay-based and lossy`.

Automatic resampling of real passband signals in Outport block

The Outport block now includes an option to automatically choose time step to resample passband output signals.

R2013b

Version: 4.1

New Features

Bug Fixes

Configuration block option to normalize carrier power

The Configuration block now has a new option, Normalize Carrier Power. This default option allows unified power calculation for passband and baseband components of Circuit Envelope Library.

Faster simulation at passband frequency

Passband frequency options have been optimized. When you set Inport and Outport carrier frequencies to zero, there is significant improvement in the speed of solver calculation.

Faster simulation of S-parameters block for Circuit Envelope

The S-parameters block has been optimized resulting in faster analysis times and improved efficiency.

Enhanced Visualization pane in Circuit Envelope blocks

The **Visualization** pane in the Circuit Envelope blocks now supports:

- Simultaneous display of two or more plots of different blocks
- Frequency response plots displaying only the S-parameter plot

Additional Circuit Envelope Amplifier block options for data import

The Amplifier block now includes additional data import options:

- Network Parameters with S-parameters, Y-parameters, and Z-parameters
- Residues and poles to describe a rational model

Example for creating SimRF Circuit Envelope custom models

The new example, Create Custom SimRF Models, shows how to model a nonlinear SimRF model using Simscape™ language, build a custom library, and use the model in a Circuit Envelope simulation.

R2013a

Version: 4.0

New Features

Bug Fixes

Compatibility Considerations

Faster loading and simulation for Circuit Envelope models

Because of significant improvements in the SimRF simulation engine, models using SimRF Circuit Envelope library blocks load and simulate faster.

- SimRF 4.0 software supports envelope simulation on unlimited simulation frequencies. Additionally, the new local solver bins simulation frequencies by fundamental tones and harmonics. This change allows the software to simulate on a greater number of frequencies in less time.
- SimRF blocks no longer require a compiler. In particular, Amplifier and Mixer blocks no longer create compiled files at update time.
- S-parameters blocks load faster because of improvements in the RF Toolbox `rationalfit` function.

Compatibility Considerations

- In previous releases, the **Use local solver** check box in the Solver Configuration block controls whether SimRF uses a local solver. In this release, SimRF only supports local-solver simulation. Use the **Solver** parameter in the new Configuration block to select a local solver.

Automatic solver selection

The `Auto` setting for the **Solver** parameter in the Configuration block dialog enables automatic solver selection for the SimRF environment.

Compatibility Considerations

- The Configuration block replaces the SimRF Parameters and Solver Configuration block from previous releases. These two blocks no longer appear in the SimRF library. When you open a model with either of these blocks connected to the SimRF environment, the parameter settings are transferred to the Configuration block, and the blocks are removed.
- If your model created in a previous release does not use a local solver at all, you may need to change the default settings in the Configuration block to reproduce the same results you received in previous releases. In particular, if you were using a Simulink variable-step solver such as `ode23t` without a local solver, the latest release of SimRF software does not retain this setting. Use the **Step size** parameter in the Configuration block dialog to set a step size.

Envelope frequency selection by fundamental tones and harmonics

The Configuration block supports automatic and manual simulation frequency selection.

Compatibility Considerations

When you open a model created in a previous release, SimRF software automatically selects fundamental tones and harmonics that include your simulation frequencies. The selection algorithm prioritizes covering the entire set of frequencies rather than finding the smallest set. Simulation time scales with the total simulation frequencies, so it may be possible to manually set fundamental tones and harmonics to further reduce simulation time.

Nonlinear amplification model enhancements for Amplifier and Mixer blocks

Amplifier and Mixer blocks support nonlinear amplification models using a third-order or 9th-odd-order polynomial.

RF beamforming and radar examples

R2013a introduces Radar System Modeling and Wireless Digital Video Broadcasting with RF Beamforming examples.

LC Ladder block for implementing common analog filter architectures

This release adds the LC Ladder block. The new block provides circuit envelope equivalent models of the filter architectures available in the Equivalent Baseband Ladder Filters library.

Transmission line specification from physical parameters

You can now specify Transmission Line block parameters to model a large class of physical transmission lines. These new options parallel the specifications available in the Equivalent Baseband Transmission Lines library.

Compatibility Considerations

Delay-based transmission lines are not supported in this release.

Ideal Transformer block

R2013a introduces the Ideal Transformer block.

Automatic model transition to an expanded set of Circuit Envelope library blocks

If you open a model created in a previous release, SimRF 4.0 software automatically transitions each old block to a new block that supports the new SimRF solver.

Renaming of SimRF Inport to Inport and SimRF Outport to Outport

In the SimRF 4.0 Circuit Envelope library, the old **SimRF Inport** block is now named **Inport**, and the old **SimRF Outport** block is now named **Outport**.

Merging of the SimRF Parameters and Solver Configuration blocks into one simpler block

In the SimRF 4.0 Circuit Envelope library, the old **SimRF Parameters** and **Solver Configuration** blocks have been merged into one **Configuration** block. This block has a simpler interface to support automatic solver selection and envelope frequency selection by fundamental tones and harmonics.

Code generation support

The SimRF Circuit Envelope library no longer supports Simulink Coder™. The Circuit Envelope library used to behave as Simscape did, but in this release, we have implemented a new design. In this design, C code generation with Simulink Coder and Rapid Accelerator mode are not supported, but Accelerator mode is.

R2012b

Version: 3.3

New Features

Bug Fixes

Speed and accuracy example showing a comparison of equivalent-baseband and circuit envelope simulation technologies

The featured example, `Compare Equivalent Baseband and Circuit Envelope Simulations`, shows two models of the same transmission-line filter in different SimRF simulation environments. Speed and accuracy results are compared. You can use this example to inform your own choice of simulation environment for your application.

Display enhancement of achieved accuracy in S-parameter fit

The Visualization pane in the S-Parameters block allows you to plot the S-parameter data and the corresponding time- or frequency-domain model on the same axis. This enhancement helps you:

- Check whether a time-domain model accurately reproduces the behavior of the data, when **S-parameter modeling** is set to `Time domain (rationalfit)`.
- Verify that a frequency-domain model captures the steady-state response of your data, when **S-parameter modeling** is set to `Frequency domain`.

R2012a

Version: 3.2

New Features

New Transmission Line Block

The Transmission Line block is available in this release for modeling delay-based and lumped-element transmission lines.

Expanded S-Parameter Modeling

A new frequency-domain-based S-parameter simulation feature is available in this release. You can specify frequency-domain S-parameter modeling for Amplifier and S-Parameters blocks. See the new demo, `Comparing Time- and Frequency-Domain Simulation Options for S-parameters`, to learn more about choosing between the two simulation options.

R2011b

Version: 3.1

New Features

Bug Fixes

Compatibility Considerations

New Real-Passband Output Support

The SimRF Outport block now supports output of real-passband signals from the SimRF environment. See the Reduce Computations by Using RF Simulation Techniques example in the *Getting Started* documentation for a comparison SimRF and Simulink techniques for modeling real passband signals.

New Product Dependencies

To run models with SimRF Equivalent Baseband library blocks, you no longer need to install DSP System Toolbox™ software. In this release, you must install DSP System Toolbox software only if you want to use:

- SimRF Idealized Baseband library blocks.
- DSP System Toolbox features, such as frames and DSP System Toolbox library blocks.

Enhanced Model Compilation

To run models with S-Parameters blocks, SimRF software no longer generates support files. In this release, SimRF models require compilation only when they contain an Amplifier or Mixer block.

Compatibility Considerations

Models from previous releases that contain Amplifier or Mixer do not run in this release unless you recompile them. To run this type of model in the new release, perform one of the following procedures.

- Copy your model, rename it, and run the renamed model in the new release. This action causes SimRF to generate new support files with different file names, leaving the original model and support files intact. This procedure guarantees that the original model continues to run in the old release.
- Run the model in the new release, and follow the instructions on the error message to delete the old support files. Next, run the model again to generate new support files. The recompiled model does not run in previous releases.

Enhanced S-Parameter Visualization

The S-Parameters block now displays rational fitting results alongside data in the Visualization pane. You can use this feature to validate simulation of S-parameter data in SimRF software.

Enhanced Noise Modeling

- The SimRF Parameters block now supports noise temperature modeling from a single parameter. Set the **Temperature** parameter to model a global noise temperature for each Amplifier and Mixer block in the SimRF environment.
- The Noise block now supports noise modeling on a subset of carrier frequencies. Set the **Carrier frequencies** parameter to a vector of frequencies to model noise on only those carriers.

Conversion of Error and Warning Message Identifiers

For R2011b, error and warning messages identifiers have changed in SimRF software.

Compatibility Considerations

If you have scripts or functions that use message identifiers that changed, you must update the code to use the new identifiers. Typically, message identifiers are used to turn off specific warning messages.

For example, the `SimRF:InvalidString` identifier has changed to `simrf:simrf_restring:InvalidString`. If your code checks for `SimRF:InvalidString`, you must update it to check for `simrf:simrf_restring:InvalidString` instead.

To determine the identifier for a warning, run the following command just after you see the warning:

```
[MSG,MSGID] = lastwarn;
```

This command saves the message identifier to the variable `MSGID`.

Note Warning messages indicate a potential issue with your code. While you can turn off a warning, a suggested alternative is to change your code so it runs warning-free.

R2011a

Version: 3.0.2

Bug Fixes

R2010bSP1

Version: 3.0.1

Bug Fixes

R2010b

Version: 3.0

New Features

Compatibility Considerations

New Circuit Envelope Library

SimRF 3.0 software introduces Circuit Envelope Elements, Sources, and Utilities libraries, which contain:

- Capacitor, Inductor, Resistor, and Impedance blocks that can connect in any configuration.
- A 2-port Amplifier block and a 3-port Mixer block, which support second-order and third-order nonlinearity modeling.
- An S-Parameters block for modeling black-box elements with up to four ports.
- Continuous Wave, Sinusoid, and Noise current and voltage sources that can model signals at multiple carrier frequencies simultaneously.
- A SimRF Outport block for probing signals from any location in an RF network.

For a full list of SimRF Circuit Envelope library blocks, see the *SimRF Reference* documentation.

New Circuit Envelope Simulation Environment

SimRF 3.0 software introduces circuit envelope simulation of RF systems into the Simulink environment. SimRF circuit envelope simulation technology is built on the Simscape platform. All blocks in the SimRF Circuit Envelope library support the features available in the SimRF environment. For an introduction to circuit envelope simulation, see the *SimRF Getting Started Guide*.

Compatibility Considerations

SimRF circuit envelope simulation software diverges from the baseband-equivalent simulation technology of RF Blockset release 2.5.1 and earlier. In SimRF release 3.0, RF Blockset software is part of SimRF software. RF Blockset Mathematical and Physical libraries have been renamed SimRF Equivalent Baseband and Idealized Baseband libraries.

- SimRF Circuit Envelope library blocks have different product dependencies than Equivalent Baseband and Idealized Baseband library blocks. To run models with Equivalent Baseband or Idealized Baseband library blocks, you must install DSP System Toolbox software. See Working with SimRF Software for more information on SimRF product dependencies.
- SimRF Equivalent Baseband library and Idealized Baseband library blocks do not support features of the SimRF environment, such as multi-carrier simulation, signal probing, or general network topologies.
- Blocks in the SimRF Circuit Envelope library do not connect to blocks in the Equivalent Baseband library or Idealized Baseband library. To pass data between these blocks, convert signals from SimRF Circuit Envelope and Equivalent Baseband library blocks to Simulink signals using:
  - Circuit Envelope library SimRF Inport and SimRF Outport blocks.
  - Equivalent Baseband library Input Port and Output Port blocks.
- If you have Signal Processing Blockset™ installed, models built in RF Blockset release 2.5.1 run in SimRF release 3.0.
- RF Blockset release 2.5.1 documentation is contained within the SimRF documentation.

New RF System Demos

SimRF release 3.0 introduces eight new demos:

- AC Analysis of an RF System
- Architectural Design of a Low-IF Receiver System
- Executable Specification of a Direct Conversion Receiver
- Frequency Response of an RF Transmit/Receive Duplex Filter
- Impact of an RF Receiver on Communication System Performance
- Measuring Image Rejection Ratio in Receivers
- Two-Tone Envelope Analysis Using Real Signals
- Validating IP2/IP3 Using Complex Signals

R2010a

Version: 2.5.1

No New Features or Changes

R2009b

Version: 2.5

New Features

Compatibility Considerations

Enhanced Frequency-Dependent Noise Modeling for Amplifier and Mixer Blocks

The RF Blockset amplifier and mixer blocks from the Physical library now support more advanced calculations of nonlinear effects. In particular, this enhances the behavior of the following blocks:

- General Amplifier and General Mixer
- S-Parameters Amplifier and S-Parameters Mixer
- Y-Parameters Amplifier and Y-Parameters Mixer
- Z-Parameters Amplifier and Z-Parameters Mixer

Compatibility Considerations

For each of the physical Amplifier and Mixer blocks, a new field, **Gain compression at saturation**, appears under the **Nonlinearity Data** tab in the block dialog boxes. The various parameters specified under this tab control the method by which these blocks handle nonlinear effects. See the related documentation for more information.

New Demo for Radar Systems

The new `Radar Tracking System` demo is relevant to aerospace defense applications. The demo contains two RF subsystems: an RF transmitter and an RF receiver, both of which use RF Blockset components. This demo requires Communications Toolbox™.

R2009a

Version: 2.4

New Features

Compatibility Considerations

New Option for Interpreting the Simulink Signal as the Incident Power Wave

The Input Port block now provides the option to interpret the input Simulink signal as the incident power wave. This is the most common RF modeling interpretation. To select this option, use the new **Treat Simulink signal as** parameter.

Enhanced Dielectric Loss Model in Three Transmission Line Blocks

The following blocks now provide a more realistic model for dielectric loss:

- Coaxial Transmission Line
- Two-Wire Transmission Line
- Parallel-Plate Transmission Line

To specify dielectric loss, you use a new parameter, **Loss tangent**. This parameter replaces the **Conductivity in dielectric** parameter.

Compatibility Considerations

Your existing models that include blocks with a nonzero value for the **Conductivity in dielectric** parameter no longer model dielectric loss. Instead, the models issue a warning message and use the default value of zero for the **Loss tangent** parameter when you run the model.

R2008b

Version: 2.3

New Features

Compatibility Considerations

New Plot Options Added to the Output Port Block

You can plot the following new parameters from the **Visualization** tab of the Output Port block:

- OIP3 for the XY Plot
- OIP3, NFactor, and NTemp for the Budget Plot

For the definition of each parameter, see Types of Plots.

Enhanced Noise Factor and Noise Temperature Visualization

You can now plot Noise Factor and Noise Temperature on an XY plot from the **Visualization** tab of all blocks in the Physical library.

Physical Amplifier and Mixer Blocks Now Support Frequency-Dependent, Nonlinear Data

You can now specify frequency-dependent nonlinear data on the **Nonlinearity Data** tab of all physical amplifier and mixer blocks. For more information about how to do this specification, see Modeling Nonlinearity.

Enhanced Downconverter Mixers

Mixer blocks now model spectral inversion for down-converter physical mixers. As a result, blocks from the Mixers library no longer error out when you set the **Mixer type** parameter to `Downconverter` and the local oscillator frequency (LO) is greater than the input RF frequency.

Removed GammaMS and GammaML Polar Plot Options

You can no longer display GammaMS and GammaML on a Polar Plot from the **Visualization** tab of the Output Port block. These parameters are useful for detailed RF analysis, but not for the system-level RF analysis that RF Blockset software supports. In some cases, using RF Blockset software to plot these parameters can lead to incorrect results.

Compatibility Considerations

Your existing models that plot GammaMS and GammaML will not longer plot these parameters. Instead, the models will plot the default parameter for the Polar Plot when you run the model and click the **Plot** button in the **Visualization** tab of the Output Port block. Use RF Toolbox software to perform detailed RF analysis.

R2008a

Version: 2.2

New Features

Baseband-Equivalent Modeling Enhanced

Two new Input Port block parameters provide better control of baseband-equivalent modeling:

- **Fractional bandwidth of guard bands** lets you specify Tukey windowing to reduce ringing and other artifacts in the baseband-equivalent model.
- **Modeling delay (samples)** lets you specify a delay to ensure that the baseband-equivalent model has a causal response.

For more information about these parameters and how to use them, see the Input Port block reference page and Create a Complex Baseband-Equivalent Model.

Note If you create a model using RF Blockset Version 2.2 and run it in previous versions of the software, two things happen:

- The blockset issues warnings indicating that the Input Port block does not have these two parameters.
- The blockset ignores the values of these two parameters, and uses their default values.

To avoid these warnings, use the Simulink **Save As** option to save the model in an earlier format, as described in Saving a Model in an Earlier Simulink Version in the Simulink documentation.

Demos Updated

The `Touchstone Data File for 2-Port Bandpass Filter` demo now uses more realistic data.

The following demos now show how to display passband frequency values on the Spectrum Scope block:

- `Data File for Amplifier`
- `Intermodulation Analysis of Physical Amplifier`

R2007b

Version: 2.1

New Features

Series/Shunt RLC Library Added

The Series/Shunt RLC library contains series and shunt RLC blocks for designing lumped element cascades such as filters and matching networks. The library contains these new blocks:

- Series R
- Series L
- Series C
- Shunt R
- Shunt L
- Shunt C

These blocks used to be part of the Ladder Filters library and are now part of the Series/Shunt RLC library:

- Series RLC
- Shunt RLC

Physical Mixer Block Icons Updated

The icons for the blocks in the Mixer library now show the local oscillator that these blocks models. The following blocks have new icons:

- General Mixer
- S-Parameters Mixer
- Y-Parameters Mixer
- Z-Parameters Mixer

Demos Added and Updated

`User-Defined Models: Nonlinear Amplifier` uses a nonlinear amplifier example to show how to create custom (user-defined) models.

`An Executable Specification for System Design` now uses a more realistic model for the front-end filter and provides better instructions for validating the specification.

R2007a

Version: 2.0

New Features

Agilent P2D and S2D System-Level Verification Model Support Added

The General Amplifier and General Mixer blocks now let you import system-level verification models of amplifiers and mixers, respectively, using data from Agilent® P2D and S2D files.

Use P2D files to specify the following data for multiple operating conditions, such as temperature and bias values:

- Small-signal network parameters
- Power-dependent network parameters
- Noise data
- Intermodulation tables

Use S2D files to specify the following data for multiple operating conditions:

- Small-signal network parameters
- Gain compression (1 dB)
- Third-order intercept point (IP3)
- Power-dependent S_{21} parameters
- Noise data
- Intermodulation tables

For more information on specifying operating conditions, see Specifying Operating Conditions.

Dialog Boxes for Physical Blocks Reorganized

The block dialog boxes of the Physical blocks are now organized by tab. All physical block dialog boxes now contain the following tabs:

- **Main** — Specify basic block parameters.
- **Visualization** — Specify plot parameters.

In addition, all physical amplifier and mixer blocks contain the following tabs:

- **Noise data** — Specify thermal noise data.
- **Nonlinearity Data** — Specify third-order intercept or power data.

The General Amplifier and General Mixer block dialog boxes also contain an **Operating Conditions** tab for specifying operating condition information after you import a P2D or S2D file into a block.

For information about the parameters available for a particular block, see the reference page for that block.

Data File Import Improved

For blocks that accept data from a file, the new **Data file** parameter lets you specify the name of the file to import. A new **Browse** button helps you find the file. Previous versions required you to use the RF Toolbox `read` function to import the file into the **RFCKT object** parameter.

Noise Specification Options Added

For physical amplifier and mixer blocks, the following noise specification options are now available:

- Spot noise data imported into the block
- Spot noise data in the block dialog box
- Noise figure, noise factor, or noise temperature value in the block dialog box

For more information on the new noise specification options, see Modeling Noise.

Nonlinearity Specification Options Added

For physical amplifier and mixer blocks, the following nonlinearity specification options are now available:

- Power data, which consists of output power as a function of input power, imported into the block.
- Third-order intercept data, with or without one or more power parameters, in the block dialog box. The power parameters are gain compression power and output saturation power.

For more information on the new nonlinearity specification options, see Modeling Nonlinearity.

Plotting Options Added

For the X-Y plane plot, the following options are now available in the **Visualization** tab:

- You can specify the scale of the *x*- and *y*-axes. The scale of each axis can be linear or logarithmic.
- You can create a plot that contains data on both the left and right *y*-axes.

For more information on the new plotting options, see Plotting Model Data.

Connection Port Block Added

Use the Connection Port block in a subsystem composed of RF Blockset blocks to add an RF Blockset physical modeling connector port to the subsystem.

Demos Added

`Power in Simulink Sources and Signals` uses several Simulink and models to show how to set the amplitude of a source to achieve the desired power level and how to display the power and power spectrum of a Simulink signal.

`An Executable Specification for System Design` shows how to use the Model-Based Design methodology with the blockset to build an executable specification that helps to tightly couple interactions between the various design teams that are involved in the system-level design.

R2006b

Version: 1.3.1

No New Features or Changes

R2006a

Version: 1.3

New Features

Upper and Lower Power Limit Parameters Added to the Mathematical Amplifier Block

Two parameters have been added to the Amplifier block in the Mathematical sublibrary. The **Upper input power limit for AM/PM conversion (dBm)** and **Lower input power limit for AM/PM conversion (dBm)** specify the maximum and minimum input power for which AM/PM conversion scales linearly with input power value. Beyond these limits, AM/PM conversion is constant at the values corresponding to the upper and lower input power limits

R14SP3

Version: 1.2

New Features

RLCG Transmission Line Block Added

An RLCG Transmission Line block has been added to the Transmission Lines sublibrary of the Physical library. This block lets you model RLCG transmission lines.

Frequency-Dependent Parameters Now Supported for the Transmission Line Block

The Transmission Line block's **Characteristic impedance**, **Phase velocity (m/s)**, and **Loss (dB/m)** parameters can now be frequency-dependent.

Budget Plots Now Supported for the Output Port Block

You can now create system budget plots from the Output Port block.

Consistency Checking Added for Pin/Pout Data

The blockset checks that the small signal gain calculated from the Pin/Pout data is the same as the gain (S_{21}) calculated from the S-parameters. If it is not, the blockset adjusts the Pin/Pout curve so that the small signal gain is the same as S_{21}.

Parameter Specifying the Impulse Response Length Renamed

The **Max length of impulse response** parameter has been renamed to **Finite impulse response filter length**. This change affects the Input Port, Lowpass RF Filter, Highpass RF Filter, Bandpass RF Filter, and Bandstop RF Filter blocks. The block behavior remains the same.

Error Messages Improved

The error and warning messages issued by the blockset are more descriptive.

Demos Improved

The demos have new documentation and can be accessed using an improved interface.

R14SP2

Version: 1.1

New Features

Series RLC Block Added

A Series RLC block has been added to the Ladder Filters sublibrary of the Physical library. This block lets you model a series RLC network.

Shunt RLC Block Added

A Shunt RLC block has been added to the Ladder Filters sublibrary of the Physical library. This block lets you model a shunt RLC network.

Output for Generic Real-Time (GRT) Targets Now Supported

You can use Real-Time Workshop® code generation software to generate standalone executables for GRT targets.

Nonlinear Modeling of Physical Mixers and Amplifiers Improved

Previously, the nonlinear algorithm that was used by the physical mixer and amplifier blocks was appropriate only for high-powered amplifiers (HPAs), which operate close to the saturation point. The new nonlinear algorithm can also be used for mixers and amplifiers that operate far below the saturation point and yield very weak intermodulation products.

As with the old algorithm, the saturated output power of the new algorithm is 8.3 dB below the third-order output intercept point (OIP3).

Where the previous algorithm was piecewise linear, the new nonlinear algorithm uses a linear plus cubic curve of amplitude-in versus amplitude-out to simulate the behavior of systems that operate far below the saturation point. Where the previous algorithm assumed a third-order intercept point (IP3) reference impedance of 50 ohm that was irrespective of the S-parameter reference impedance, the new algorithm assumes that the S-parameter reference impedance is the same as the IP3 reference impedance used to convert from IP3 to the amplitude-related constants in the model.

Note The corresponding Z and Y algorithms still assume a fixed 50-ohm conversion factor from specified power to modeled amplitude.