Agilent Technologies

Advanced Design System 2011.01

Feburary 2011
TD-SCDMA Wireless Test Benches

Errata The ADS product may contain references to "HP" or "HPEESOF" such as in file names and directory names. The business entity formerly known as "HP EEsof" is now part of Agilent Technologies and is known as "Agilent EEsof". To avoid broken functionality and to maintain backward compatibility for our customers, we did not change all the names and labels that contain "HP" or "HPEESOF" references.

Downlink Multicarrier Transmitter Test

Introduction

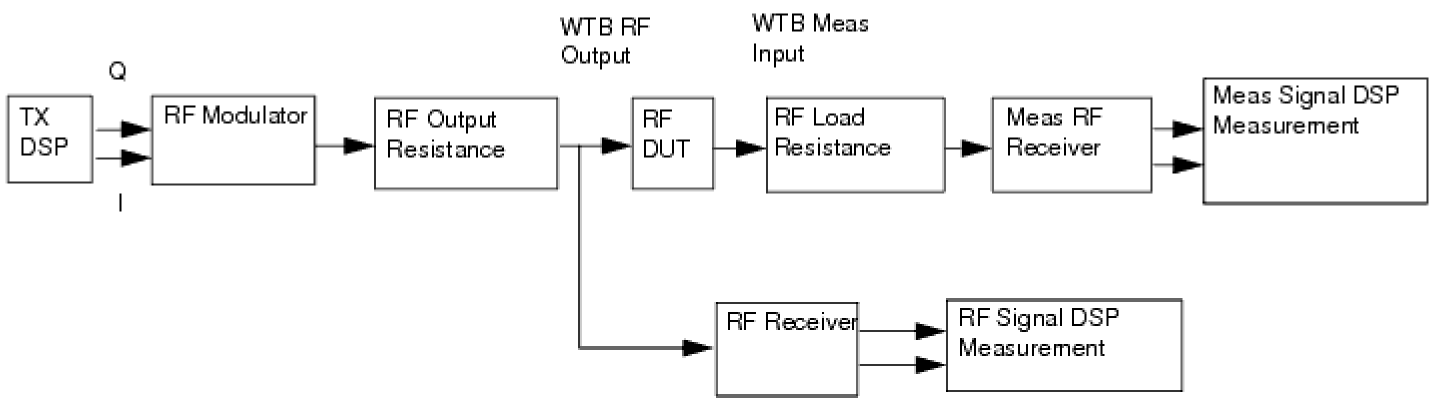
TDSCDMA_DnLnk_MultiCarrier_TX test bench for TD-SCDMA downlink (base station to user equipment) transmitter testing provides a way for users to connect to an RF circuit device under test (RF DUT) and determine its performance by activating various measurements. This test bench provides signal measurements for power (including CCDF) and spectrum.

The signal is designed according to 3GPP TS 25 (Release 4).

This TD-SCDMA signal source is compatible with Agilent Signal Studio signal source software option 411. Details regarding Signal Studio for TD-SCDMA are included at the website http://www.agilent.com/find/signalstudio .

The RF DUT output signal can be sent to an Agilent ESG RF signal generator.

This test bench includes a DSP section, an RF modulator, RF output source resistance, RF DUT connection, RF receivers, and DSP measurement blocks, as illustrated in Transmitter Wireless Test Bench Block Diagram. The generated test signal is sent to the DUT.

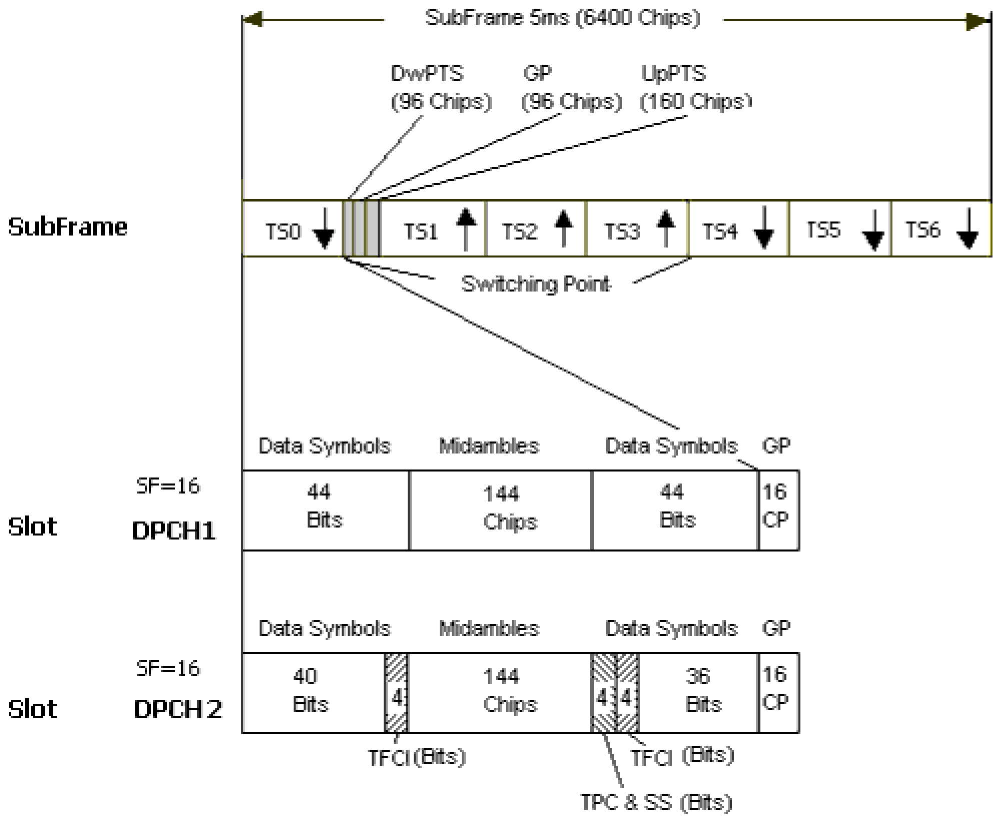


Transmitter Wireless Test Bench Block Diagram

The downlink channel subframe structure is illustrated in 12.2 kbps Downlink Channel Subframe Structure. One frame consists of two subframes. Each subframe consists of 7 time slots (TS), and one downlink pilot time slot (DwPTS), one guard period (GP) and one uplink pilot time slot (UpPTS). Each time slot can transmit DPCH signals. One subframe consists of 6400 chips. Because the chip rate is 1.28 MHz, the subframe has a 5msec duration.

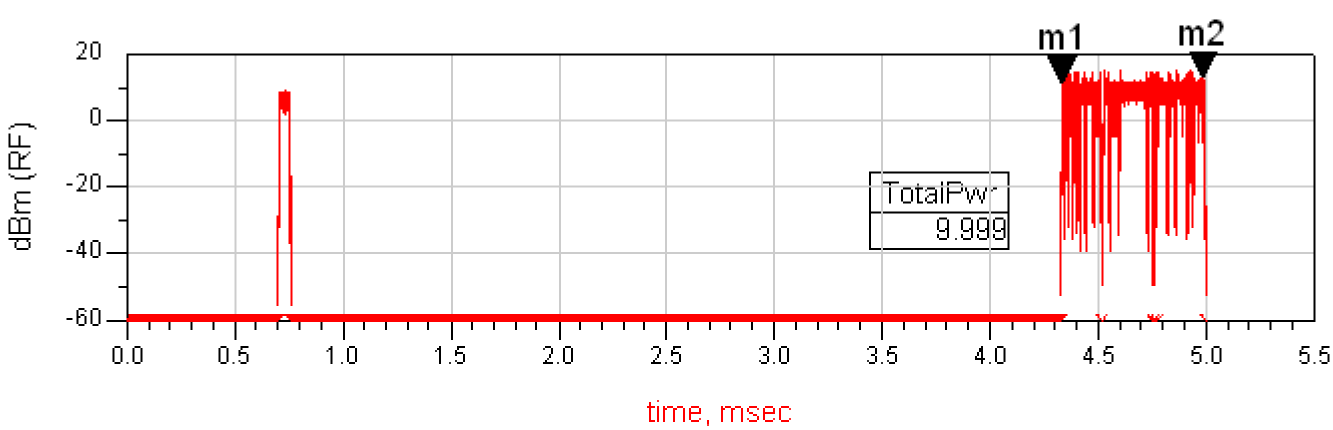
In the example in 12.2 kbps Downlink Channel Subframe Structure, two DPCH signals in DPCH1 and DPCH2 are transmitted in TS0. The first DPCH bits are modulated by QPSK and spread by Walsh code of length 16 then transmitted in the slot. The DPCH1 signal is composed of 88 coded information bits (88 × 16/2 chips) and 144 chips for midamble sequence plus 16 chips for GP. The DPCH2 signal, with the same modulation and spread scheme as DPCH1, is composed of 76 coded information bits (76 × 16/2 chips), 8 bits

(8 × 16/2 chips) for transport format combination indicator (TFCI), 144 chips for midamble sequence, 4 bits (4 × 16/2 chips) for transmitter power control and synchronization shift (TPC and SS) plus 16 chips for GP. The total chips for the subframe is composed of 7 time slots plus 96 chips for DwPTS, 96 chips for GP and 160 chips for UpPTS and summarized as (88 × 8+144+16) × 7+160+96 × 2=6400 chips.



12.2 kbps Downlink Channel Subframe Structure

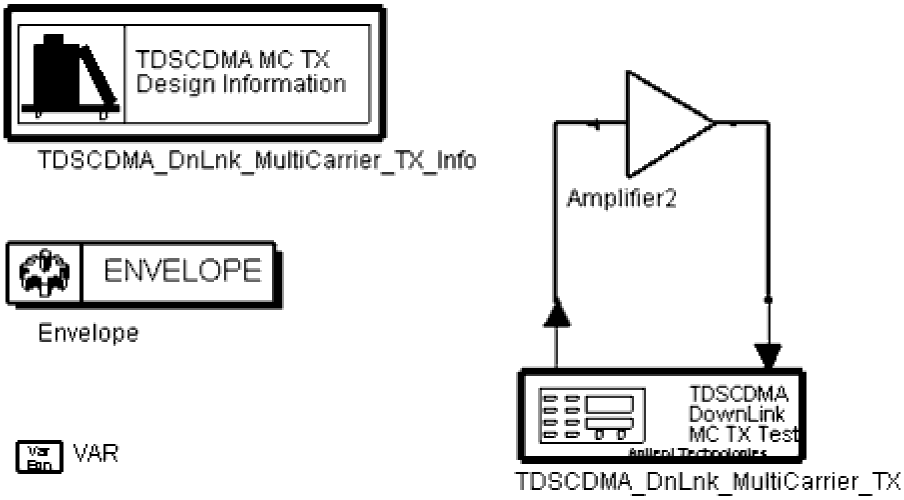
TD-SCDMA RF power delivered into a matched load is the average power delivered in the selected time slot TS6 in the TD-SCDMA subframe. RF Signal Downlink Envelope shows the RF envelope for an output signal with 10 dBm power.



RF Signal Downlink Envelope

Test Bench Basics

A template is provided for this test bench.



TDSCDMA Downlink MultiCarrier Transmitter Test Bench

To access the template:

1. In an Analog/RF schematic window select *Insert* > *Template.*
2. In the *Insert* > *Template* dialog box, choose *TDSCDMA_DnLnk_MultiCarrier_TX_test* , click *OK* ; click left to place the template in the schematic window.
   An example design using this template is available; from the ADS Main window click *File* > Open > Example > TDSCDMA > TDSCDMA_RF_Verification_wrk > *TDSCDMA_DnLnk_MultiCarrier_TX* _test.
   The basics for using the test bench are:
   - Replace the DUT (Amplifier2 is provided with this template) with an RF DUT that is suitable for this test bench.
   - CE_TimeStep, FSource, SourcePower, and FMeasurement parameter default values are typically accepted; otherwise, set values based on your requirements.
   - Activate/deactivate measurements based on your requirements.
   - Run the simulation and view Data Display page(s) for your measurement(s).

For details, refer to Test Bench Details.

Test Bench Details

The following sections provide details for setting up a test bench, setting measurement parameters for more control of the test bench, simulation measurement displays, and baseline performance.

Open and use the *TDSCDMA_DnLnk_MultiCarrier_TX_test* template:

1. In an Analog/RF schematic window select *Insert > Template.*
2. In the *Insert > Template* dialog box, choose *TDSCDMA_DnLnk_MultiCarrier_TX_test* , click *OK* ; click left to place the template in the schematic window.

The test bench setup is detailed here.

1. Replace the DUT (Amplifier2 is provided with this template) with an RF DUT that is suitable for this test bench.
   For information regarding using certain types of DUTs, see *RF DUT Limitations for TD-SCDMA Wireless Test Benches* (adswtbtds).
2. Set the *Required Parameters*

   > **Note**
   > Refer to *TDSCDMA_DnLnk_MultiCarrier_TX* (adswtbtds) for a complete list of parameters for this test bench.

   Generally, default values can be accepted; otherwise, values can be changed by the user as needed.

   - Set CE_TimeStep.
     Cosimulation occurs between the test bench (using ADS Ptolemy Data Flow simulation technology) and the DUT (using Circuit Envelope simulation technology). Each technology requires its own simulation time step with time-step coordination occurring in the interface between the technologies.
     CE_TimeStep defines the Circuit Envelope simulation time step to be used with this DUT. The CE_TimeStep must be set to a value equal to or a submultiple of (less than) WTB_TimeStep; otherwise, simulation will stop and an error message will be displayed.
     Note that WTB_TimeStep is not user-settable. Its value is derived from other test bench parameter values; with default settings WTB_TimeStep= 48.828125 nsec. The value is displayed in the Data Display pages as TimeStep.
     WTB_TimeStep = 1/(ChipRate × SamplesPerChip)
     where
     ChipRate is 1.28MHz
     SamplesPerChip is the number of samples per chip
   - Set FSource, SourcePower, and FMeasurement.
     - FSource defines the RF frequency for the TD-SCDMA signal input to the RF DUT.
     - SourcePower defines the power level for FSource. SourcePower is defined as the average power during the non-idle time of the TD-SCDMA signal segment.
     - FMeasurement defines the TDSCDMA RF frequency output from the RF DUT

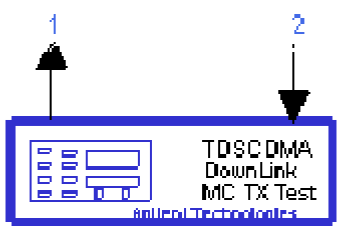
to be measured.

3. Activate/deactivate (*YES* / *NO*) test bench measurements (refer to *TDSCDMA_DnLnk_MultiCarrier_TX* (adswtbtds)). At least one measurement must be enabled from the measurement list:
   - PowerMeasurement
   - SpectrumMeasurement
4. More control of the test bench can be achieved by setting parameters on the *Basic Parameters* , *Signal Parameters* , and measurement categories for each activated measurement. For details, refer to *Setting Parameters* (adswtbtds).
5. The RF modulator (shown in the block diagram in Transmitter Wireless Test Bench Block Diagram) uses FSource, SourcePower (*Required Parameters*), MirrorSourceSpectrum (*Basic Parameters)* , GainImbalance, PhaseImbalance, I_OriginOffset, Q_OriginOffset, and IQ_Rotation (*Signal Parameters*).
   The RF output resistance uses SourceR, SourceTemp, and EnableSourceNoise (*Basic Parameters*). The RF output signal source has a 50-ohm (default) output resistance defined by SourceR.
   RF output (and input to the RF DUT) is at the frequency specified (FSource), with the specified source resistance (SourceR) and with power (SourcePower) delivered into a matched load of resistance SourceR. The RF signal has additive Gaussian noise power set by resistor temperature (SourceTemp) (when EnableSourceNoise=YES).
   Note that the Meas_in point of the test bench provides a resistive load to the RF DUT set by the MeasR value (50-ohm default) (*Basic Parameters*).
   The Meas signal contains linear and nonlinear signal distortions and time delays associated with the RF DUT input to output characteristics.
   The TX DSP block (shown in the block diagram in Transmitter Wireless Test Bench Block Diagram) uses other *Signal Parameters* .
6. More control of Circuit Envelope analysis can be achieved by setting Envelope controller parameters. These settings include Enable Fast Cosim, which may speed the RF DUT simulation more than 10×. Setting these simulation options is described in *Setting Fast Comsimulation Parameters* and *Setting Circuit Envelope Analysis Parameters* in the *Wireless Test Bench Simulation* documentation.
7. After running a simulation, results will appear in a Data Display window for the measurement. *Simulation Measurement Displays* (adswtbtds) describes results for each measurement. For general WTB Data Display details refer to *Viewing WTB Analysis Results* (adswtbsim).

TDSCDMA_DnLnk_MultiCarrier_TX

This section provides parameter information for *Required Parameters, Basic Parameters, Signal Parameters,* and parameters for the various measurements.

Symbol



Description TD-SCDMA downlink multi-carrier TX test
Library WTB
Class TSDFTDSCDMA_DnLnk_MultiCarrier_TX
Derived From baseWTB_TX

Parameters

Name	Description	Default	Sym	Unit	Type	Range
RequiredParameters						
CE_TimeStep	Circuit envelope simulation time step	1/1.28 MHz/16		sec	real	(0, ∞)
WTB_TimeStep	Set CE_TimeStep < = 1/1.28e6/SamplesPerChip.					
FSource	Source carrier frequency	1900 MHz		Hz	real	(0, ∞)
SourcePower	Source power	dbmtow(-20.0)		W	real	[0, ∞)
FMeasurement	Measurement carrier frequency	1900 MHz		Hz	real	(0, ∞)
MeasurementInfo	Available Measurements					
PowerMeasurement	Enable power measurements? NO, YES	YES			enum	
SpectrumMeasurement	Enable spectrum measurement? NO, YES	NO			enum	
BasicParameters						
SourceR	Source resistance	50 Ohm		Ohm	real	(0, ∞)
SourceTemp	Source resistor temperature	-273.15		Celsius	real	[-273.15, ∞)
EnableSourceNoise	Enable source thermal noise? NO, YES	NO			enum	
MeasR	Measurement resistance	50 Ohm		Ohm	real	[10,

						1.0e6]
MirrorSourceSpectrum	Mirror source spectrum about carrier? NO, YES	NO			enum	
MirrorMeasSpectrum	Mirror meas spectrum about carrier? NO, YES	NO			enum	
RF_MirrorFreq	Mirror source frequency for spectrum/envelope measurement? NO, YES	NO			enum	
MeasMirrorFreq	Mirror meas frequency for spectrum/envelope measurement? NO, YES	NO			enum	
TestBenchSeed	Random number generator seed	1234567			int	[0, ∞)
SignalParameters						
GainImbalance	Gain imbalance, Q vs I	0.0		dB	real	(-∞, ∞)
PhaseImbalance	Phase imbalance, Q vs I	0.0		deg	real	(-∞, ∞)
I_OriginOffset	I origin offset (percent)	0.0			real	(-∞, ∞)
Q_OriginOffset	Q origin offset (percent)	0.0			real	(-∞, ∞)
IQ_Rotation	IQ rotation	0.0		deg	real	(-∞, ∞)
SamplesPerChip	Samples per chip	16	S		int	[8, 32]
RRC_FilterLength	RRC filter length (chips)	16			int	[2, 128]
ActiveTimeslot	Active Timeslot: TS0, TS2, TS3, TS4, TS5, TS6	TS6			enum	
PowerMeasurementParameters						
PowerDisplayPages	Power measurement display pages:					
PowerSubframes	Number of subframes averaged	1			int	[0, ∞)
SpectrumMeasurementParameters						
SpecMeasDisplayPages	Spectrum measurement display pages:					
SpecMeasStart	Spectrum measurement start	0.0		sec	real	[0, ∞)
SpecMeasStop	Spectrum measurement stop	5.0 msec		sec	real	[0, ∞)
SpecMeasSubframes	Spectrum measurement subframes	3			int	[0, 100]
SpecMeasResBW	Spectrum resolution bandwidth	30 kHz		Hz	real	[0, ∞)
SpecMeasWindow	Window type: none, Hamming 0.54, Hanning 0.50, Gaussian 0.75, Kaiser 7.865, _8510 6.0, Blackman, Blackman-Harris	none			enum	

Pin Inputs

Pin	Name	Description	Signal Type
2	Meas_In	Test bench measurement RF input from RF circuit	timed

Pin Outputs

Pin	Name	Description	Signal Type
1	RF_Out	Test bench RF output to RF circuit	timed

Setting Parameters

More control of the test bench can be achieved by setting parameters in the Basic Parameters, Signal Parameters, and measurement categories for the activated measurements.

> **Note**
> For *required* parameter information, see *Set the Required Parameters* (adswtbtds).

Basic Parameters

1. SourceR is the RF output source resistance.
2. SourceTemp is the RF output source resistance temperature (oC) and sets noise density in the RF output signal to (k(SourceTemp+273.15)) Watts/Hz, where k is Boltzmann's constant.
3. EnableSourceNoise, when set to NO disables the SourceTemp and effectively sets it to -273.15oC (0 Kelvin). When set to YES, the noise density due to SourceTemp is enabled.
4. MeasR defines the load resistance for the RF DUT output Meas signal into the test bench. This resistance loads the RF DUT output; it is also the reference resistance for Meas signal power measurements.
5. MirrorSourceSpectrum is used to invert the polarity of the Q envelope of the generated RF signal before it is sent to the RF DUT. Depending on the configuration and number of mixers in an RF transmitter, the signal at the input of the DUT may need to be mirrored. If such an RF signal is desired, set this parameter to YES.
6. MirrorMeasSpectrum is used to invert the polarity of the Q envelope in the Meas_in RF signal input to the test bench (and output from the RF DUT). Depending on the configuration and number of mixers in the RF DUT, the signal at its output may be mirrored compared to the signal generated by the signal source (before any mirroring is done because of the MirrorSourceSpectrum setting). Proper demodulation and measurement of the RF DUT output signal requires that its RF envelope is not mirrored compared to the signal generated by the signal source (before any mirroring is done because of the MirrorSourceSpectrum setting). If the Meas_in RF signal is mirrored, set this parameter to YES. Proper setting of this parameter is required for measurements on the Meas_in signal in TX test benches (EVM, Constellation, CDP, PCDE) and results in measurement on a signal with no spectrum mirroring.
7. TestBenchSeed is an integer used to seed the random number generator used with the test bench. This value is used by all test bench random number generators, except those RF DUT components that use their own specific seed parameter. TestBenchSeed initializes the random number generation. The same seed value produces the same *random* results, thereby giving you predictable simulation results. To generate repeatable *random* output from simulation to simulation, use any positive seed value. If you want the output to be truly random, enter the seed value of 0.
8. RF_MirrorFreq is used to invert the polarity of the Q envelope in the RF_out RF signal for RF envelope, ppectrum, ACLR, and occupied bandwidth measurements.

RF_MirrorFreq is typically set by the user to NO when MirrorSourceSpectrum = NO; RF_MirrorFreq is typically set by the user to YES when MirrorSourceSpectrum = YES. Both settings result in viewing the RF_out signal with no spectrum mirroring. Other settings by the user result in RF_out signal for RF_Envelope and Spectrum measurements with spectrum mirroring.

9. MeasMirrorFreq is used to invert the polarity of the Q envelope in the Meas_in RF signal for the RF envelope, spectrum, ACLR, and occupied bandwidth measurements. MeasMirrorFreq is typically set to NO by the user when the combination of the MirrorSourceSpectrum value and any signal mirroring in the users RF DUT results in no spectrum mirroring in the Meas_in signal. MeasMirrorFreq is typically set to YES by the user when the combination of the MirrorSourceSpectrum and RF DUT results in spectrum mirroring in the Meas_in signal.
   Other settings result in Meas_in signal for RF_Envelope and Spectrum measurements with spectrum mirroring. The MirrorMeasSpectrum parameter setting has no impact on the setting or use of the MeasMirrorFreq parameter.

Signal Parameters

1. GainImbalance, PhaseImbalance, I_OriginOffset, Q_OriginOffset, and IQ_Rotation are used to add certain impairments to the ideal output RF signal. Impairments are added in the order described here.
   The unimpaired RF I and Q envelope voltages have gain and phase imbalance applied. The RF is given by:
   $$V_{RF}(t) = A\left(V_I(t)\cos(\omega_c t) - gV_Q(t)\sin\left(\omega_c t + \frac{\phi\pi}{180}\right)\right)$$
   where *A* is a scaling factor that depends on the SourcePower and SourceR parameters specified by the user, $V_I(t)$ is the in-phase RF envelope, $V_Q(t)$ is the quadrature phase RF envelope, *g* is the gain imbalance
   $$g = 10^{\frac{GainImbalance}{20}}$$
   and, φ (in degrees) is the phase imbalance.
   Next, the signal $V_{RF}(t)$ is rotated by IQ_Rotation degrees. The I_OriginOffset and Q_OriginOffset are then applied to the rotated signal. Note that the amounts specified are percentages with respect to the output rms voltage. The output rms voltage is given by sqrt(2 × SourceR × SourcePower).
2. SamplesPerChip sets the number of samples in a chip.
   The default value is set to 16 to display settings according to the 3GPP NTDD. It can be set to a larger value for a simulation frequency bandwidth wider than 16 × 1.28 MHz. It can be set to a smaller value for faster simulation; however, this will result in lower signal fidelity. If SamplesPerChip = 8, the simulation RF bandwidth is larger than the signal bandwidth by a factor of 8 (e.g., simulation RF bandwidth = 8 × 1.28 MHz).
3. RRC_FilterLength sets root raised-cosine (RRC) filter length in chips.
   The default value is set to 16 to transmit TD-SCDMA downlink signals in time and frequency domains based on the 3GPP NTDD standard. It can be set to a smaller value for faster simulation; however, this will result in lower signal fidelity.

4. ActiveTimeslot specifies which slot signal in the subframe will be transmitted. Referring to *12.2 kbps Downlink Channel Subframe Structure* (adswtbtds), when ActiveTimeslot=0, TS0 is used.

Power Measurement Parameters

1. PowerDisplayPages provides Data Display page information for this measurement. It cannot be changed by the user.
2. PowerSubframes sets the number of subframes over which data will be collected.
3. The measurement start time is the time when the first subframe is detected in the measured RF signal. Automatic synchronization by the measurement model avoids any start-up transient in the Constellation plots. The measurement stop time is this start time plus PowerSubframes × SubframeTime. SubframeTime is described in Test Bench Variables for Data Displays.

Spectrum Measurement Parameters

The Spectrum measurement calculates the spectrum of the input signal. Averaging the spectrum over multiple subframes can be enabled as described in this section.

This measurement is not affected by the MirrorMeasSpectrum parameter. To apply spectrum mirroring to the measured RF_out signal, set RF_MirrorFreq = YES; to apply spectrum mirroring to the measured Meas_in signal, set MeasMirrorFreq = YES.

In the following, TimeStep denotes the simulation time step and FMeasurement denotes the measured RF signal characterization frequency.

1. The measurement outputs the complex amplitude voltage values at the frequencies of the spectral tones. It does not output the power at the frequencies of the spectral tones. However, one can calculate and display the power spectrum as well as the magnitude and phase spectrum by using the dBm, mag, and phase functions of the data display window.
   Note that the dBm function assumes a 50-ohm reference resistance; if a different measurement was used in the test bench, its value can be specified as a second argument to the dBm function, for example, dBm(SpecMeas, Meas_RefR) where SpecMeas is the instance name of the spectrum measurement and Meas_RefR is the resistive load used.
   By default, the displayed spectrum extends from FMeasurement - 1/(2×TimeStep) Hz to FMeasurement + 1/(2×TimeStep) Hz. When FMeasurement < 1/(2×TimeStep), the default spectrum extends to negative frequencies. The spectral content at these negative frequencies is conjugated, mirrored, and added to the spectral content of the closest positive frequency. The negative frequency tones are then displayed on the positive frequency axis as would happen in an RF spectrum analyzer measurement instrument. This process may introduce an error in the displayed frequency for the mirrored tones. The absolute error introduced is less than

(spectrum frequency step) / 2 (see Effect of Values for SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW for the definition of spectrum frequency step).
The basis of the algorithm used by the spectrum measurement is the chirp-Z transform. The algorithm can use multiple subframes and average the results to achieve video averaging (see *note 6*).

2. SpecMeasDisplayPages provides information regarding Data Display pages for this measurement. It cannot be changed by the user.
3. SpecMeasStart sets the start time for collecting input data.
4. SpecMeasStop sets the stop time for collecting input data when SpecMeasSubframes = 0 and SpecMeasResBW = 0.
5. SpecMeasSubframes sets the number of segments over which data will be collected.
6. SpecMeasResBW sets the resolution bandwidth of the spectrum.
   Depending on the values of SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW, the stop time may be adjusted or spectrum video averaging may occur (or both). The different cases are described in Effect of Values for SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW.
   Referring to Effect of Values for SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW, let
   Start = TimeStep × int((SpecMeasStart/TimeStep) + 0.5)
   Stop = TimeStep × int((SpecMeasStop/TimeStep) + 0.5)
   (This means Start and Stop are forced to be an integer number of time step intervals.)
   X = normalized equivalent noise bandwidth of the window
   Start and Stop times are used for RF_out and Meas_in signal spectrum analyses. The Meas_in signal is delayed in time from the RF_out signal by the value of the RF DUT time delay. Therefore, for RF DUT time delay >0, the RF_out and Meas_in signals are inherently different and spectrum display differences can be expected.
   TimeStep and SubframeTime are defined in the *Test Bench Variables for Data Displays* section.
   Equivalent noise bandwidth (ENBW) compares the window to an ideal, rectangular filter. It is the equivalent width of a rectangular filter that passes the same amount of white noise as the window. Normalized ENBW (NENBW) is ENBW multiplied by the duration of the signal being windowed. (Refer to *note 7* regarding the various window options and *Window Options and Normalized Equivalent Noise Bandwidth* regarding NENBW for the various windows.)

Effect of Values for SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW

Case 1	SpecMeasSubframes = 0 SpecMeasResBW = 0 Resultant stop time = Stop Resultant resolution BW = X/(Stop - Start) Resultant spectrum frequency step = 1/(Stop-Start) Video averaging status = None
Case 2	SpecMeasSubframes > 0 SpecMeasResBW = 0 Resultant stop time = Start + SpecMeasSubframes x SubframeTime For SpecMeasSubframes > 0 and SpecMeasResBW = 0 Video averaging occurs over all segment time intervals Resultant resolution BW = X /SubframeTime Resultant spectrum frequency step = 1/SubframeTime Video averaging status = Yes, when SpecMeasSubframes > 1
Case 3	SpecMeasSubframes = 0 SpecMeasResBW > 0 Resultant stop time = Start + N x SubframeTimeInterval where N = int((Stop -Start)/SubframeTimeInterval) + 1 For SpecMeasSubframes = 0 and SpecMeasResBW > 0 Define SubframeTimeInterval = TimeStep x int((X/SpecMeasResBW/TimeStep) + 0.5) This means SubframeTimeInterval is forced to a value that is an integer number of time step intervals. (Stop-Start) time is forced to be an integer number (N) of SubframeTimeIntervals N has a minimum value of 1 Video averaging occurs over all SubframeTimeIntervals Resolution bandwidth achieved is ResBW = X / SubframeTimeInterval, which is very close to SpecMeasResBW but may not be exactly the same if X/SpecMeasResBW/TimeStep is not an exact integer. Resultant resolution BW = ResBW Resultant spectrum frequency step = ResBW Video averaging status = Yes when N > 1
Case 4	SpecMeasSubframes > 0 SpecMeasResBW > 0 Resultant stop time = Start + M x SubframeTimeInterval where M = int((SpecMeasSubframes x SubframeTime)/SubframeTimeInterval) + 1 For SpecMeasSubframes > 0 and SpecMeasResBW > 0 Define SubframeTimeInterval = TimeStep x int((X /SpecMeasResBW/TimeStep) + 0.5) This means SubframeTimeInterval is forced to a value that is an integer number of time step intervals. (Stop-Start) time is forced to be an integer number (M) of the SubframeTimeIntervals M has a minimum value of 1 Video averaging occurs over all SubframeTimeIntervals Resolution bandwidth achieved is ResBW = X / SubframeTimeInterval, which is very close to SpecMeasResBW but may not be exactly the same if X/SpecMeasResBW/TimeStep is not an exact integer. Resultant resolution BW = ResBW Resultant spectrum frequency step = ResBW Video averaging status = Yes, when M > 1

7. SpecMeasWindow specifies the window that will be applied to each segment before its spectrum is calculated. Different windows have different properties, affect the resolution bandwidth achieved, and affect the spectral shape. Windowing is often necessary in transform-based (chirp-Z, FFT) spectrum estimation in order to reduce spectral distortion due to discontinuous or non-harmonic signal over the measurement time interval. Without windowing, the estimated spectrum may suffer

from spectral leakage that can cause misleading measurements or masking of weak signal spectral detail by spurious artifacts.
The windowing of a signal in time has the effect of changing its power. The spectrum measurement compensates for this and the spectrum is normalized so that the power contained in it is the same as the power of the input signal.
Window Type Definitions:

- none

$$w(kT_s) = \begin{cases} 1.0 & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size
- Hamming 0.54

$$w(kT_s) = \begin{cases} 0.54 - 0.46\cos\left(\frac{2\pi k}{N}\right) & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size
- Hanning 0.50

$$w(kT_s) = \begin{cases} 0.5 - 0.5\cos\left(\frac{2\pi k}{N}\right) & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size
- Gaussian 0.75

$$w(kT_s) = \begin{cases} exp\left(-\frac{1}{2}\left(0.75\frac{(2k-N)}{N}\right)^2\right) & 0 \le \left|k - \frac{N}{2}\right| \le \frac{N}{2} \\ 0.0 & otherwise \end{cases}$$

  where N is the window size
- Kaiser 7.865

$$w(kT_s) = \begin{cases} \frac{I_0\left(7.865\left[1-\left(\frac{k-\alpha}{\alpha}\right)^2\right]^{1/2}\right)}{I_0(7.865)} & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size, $\alpha = N / 2$, and $I_0(.)$ is the 0th order modified Bessel function of the first kind
- 8510 6.0 (Kaiser 6.0)

$$w(kT_s) = \begin{cases} \frac{I_0\left(6.0\left[1-\left(\frac{k-\alpha}{\alpha}\right)^2\right]^{1/2}\right)}{I_0(6.0)} & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size, $\alpha = N / 2$, and $I_0(.)$ is the 0th order modified Bessel function of the first kind

- Blackman

$$w(kT_s) = \begin{cases} 0.42 - 0.5\cos\left(\frac{2\pi k}{N}\right) + 0.08\cos\left(\frac{4\pi k}{N}\right) & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

where N is the window size

- Blackman-Harris

$$w(kT_s) = \begin{cases} 0.35875 - 0.48829\cos\left(\frac{2\pi k}{N}\right) + 0.14128\cos\left(\frac{4\pi k}{N}\right) - 0.01168\cos\left(\frac{6\pi k}{N}\right) & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

where N is the window size.

Window Options and Normalized Equivalent Noise Bandwidth

Window and Default Constant	NENBW
none	1
Hamming 0.54	1.363
Hanning 0.50	1.5
Gaussian 0.75	1.883
Kaiser 7.865	1.653
8510 6.0	1.467
Blackman	1.727
Blackman-Harris	2.021

Simulation Measurement Displays

After running the simulation, results are displayed in the Data Display pages for each measurement activated.

> **Note**
> Measurement results from a wireless test bench have associated names that can be used in Data Display Expressions. For more information, refer to *Measurement Results for Expressions for TD-SCDMA Wireless Test Benches* (adswtbtds).

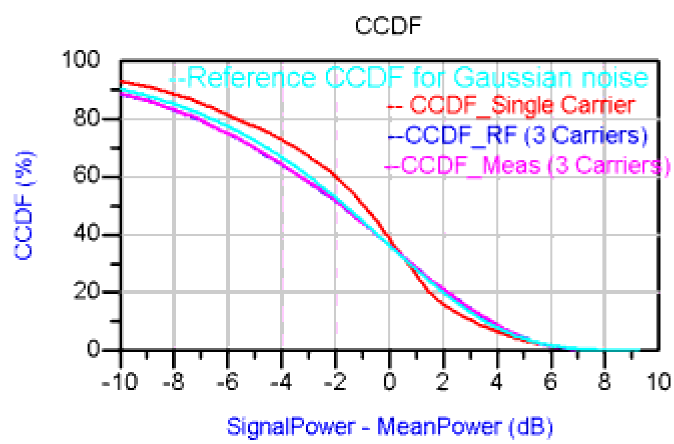
Power Measurement

The power measurement shows CCDF curves (not defined in 3GPP standards) for single carrier and multicarrier before and after DUT signals. Mean and peak power, and peak-to-average power ratios before and after the DUT are given as shown in Power Measurement Results.

RF_Power.MeanPower_dBm	RF_Power.PeakPower_dBm	PeakToAverageRF_dB
29.986	38.465	8.479

Meas_Power.MeanPower_dBm	Meas_Power.PeakPower_dBm	PeakToAverageMeas_dB
29.988	38.378	8.390

real(NumCarriers)	real(NumChannelsPerCarrier)
3.000	16.000



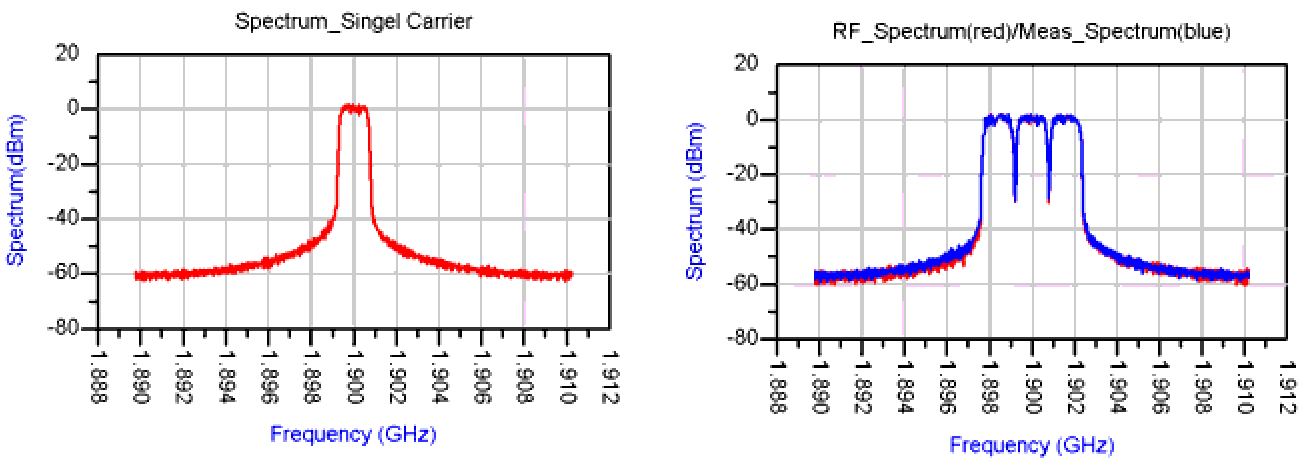
real(TimeStep)/(1usec)	real(FrameTime)/(1msec)	real(ActiveSlot)
0.049	5.000	6.000

Power Measurement Results

Spectrum Measurement

The spectrum measurement (not defined in 3GPP standards) shows spectrums for single- and multi-carrier signals before and after the DUT. The spectrum analyzer output contains complex amplitude voltage values and the dBm(<meas_name>, <ref_r>) expressions can be used to convert to dBm values. Spectrum for the RF and Meas signals are shown in Spectrum Measurement Results.

real(FCarrier1)/(1GHz)	real(FCarrier2)/(1GHz)	real(FCarrier3)/(1GHz)
1.8984	1.9000	1.9016



Eqn FCarrier1=RF_FSource-1.6e6 Eqn FCarrier2=RF_FSource Eqn FCarrier3=RF_FSource+1.6e6

Spectrum Measurement Results

Test Bench Variables for Data Displays

Reference variables used to set up this test bench are listed in Test Bench Equations Derived from Test Bench Parameters and Exported to Data Display.

Test Bench Equations Derived from Test Bench Parameters and Exported to Data Display

Data Display Parameter	Equation with Test Bench Parameters
RF_FSource	FSource
RF_Power_dBm	10*log10(SourcePower)+30
RF_R	SourceR
TimeStep	1/(ChipRate*SamplesPerChip)
SubframeTime	5 msec
ActiveSlot	ActiveSlotIndex
NumCarriers	3
NumChannelsPerCarrier	16
Meas_FMeasurement	FMeasurement
Meas_R	MeasR

Baseline Performance

- Test Computer Configuration
  - Pentium IV 2.4 GHz, 512 MB RAM, Red Hat Linux 7.3
- Conditions
  - Measurements made with default test bench settings.
  - RF DUT is an RF system behavior component.
  - The number of time points in one TD-SCDMA downlink subframe is a function of SamplesPerChip and ChipRate.
  - SamplesPerChip = 16
  - ChipRate = 1.28 Mb/s
  - Resultant WTB_TimeStep = 48.828125 nsec; SubframeTime = 5 msec; time points per subframe = 102400

TDSCDMA_DnLnk_MultiCarrier_TX Measurement	Bursts Measured	Simulation Time (sec)	ADS Processes (MB)
Power	1	144	139
Spectrum	1	301	272

Expected ADS Performance

Expected ADS performance is the combined performance of the baseline test bench and the RF DUT Circuit Envelope simulation with the same signal and number of time points. For example, if the RF DUT performance with Circuit Envelope simulation alone takes 2 hours and consumes 200 MB of memory (excluding the memory consumed by the core ADS product), then add these numbers to the Baseline Performance numbers to determine the expected ADS performance. This is valid only if the full memory consumed is from RAM. If RAM is less, larger simulation times may result due to increased disk access time for swap memory usage.

References

1. 3GPP TS 25.221, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Physical channels and mapping of transport channels onto physical channels (TDD) (Release 4)," version 4.5.0, June, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25221-450.zip]
2. 3GPP TS 25.223, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Spreading and modulation (TDD) (Release 4)," version 4.4.0, March, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25223-440.zip]

Setting up a Wireless Test Bench Analysis in the *Wireless Test Bench Simulation* documentation explains how to use test bench windows and dialogs to perform analysis tasks.
Setting Circuit Envelope Analysis Parameters in the *Wireless Test Bench Simulation* documentation explains how to set up circuit envelope analysis parameters such as convergence criteria, solver selection, and initial guess.
Setting Automatic Verification Modeling Parameters in the *Wireless Test Bench Simulation* documentation explains how to improve simulation speed.

Downlink Receiver Adjacent Channel Selectivity Test

Introduction

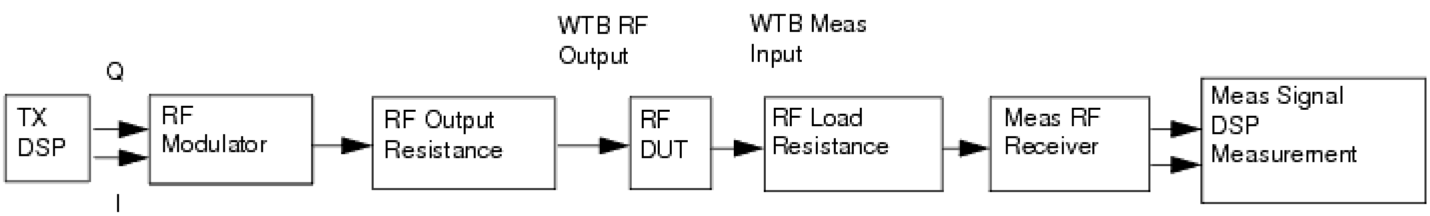
TDSCDMA_DnLnk_RX_ACS test bench for TD-SCDMA downlink (base station to user equipment) receiver adjacent channel selectivity testing provides a way for users to connect to an RF circuit device under test (RF DUT) and determine its ACS performance by BER measurements.

ACS is a measure of a receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an adjacent channel signal. ACS is the ratio of the receiver filter attenuation on the assigned channel frequency to the receiver filter attenuation on the adjacent channel frequency.

The signal and measurements in this test bench are designed according to 3GPP TS 34.122 section 6.4.

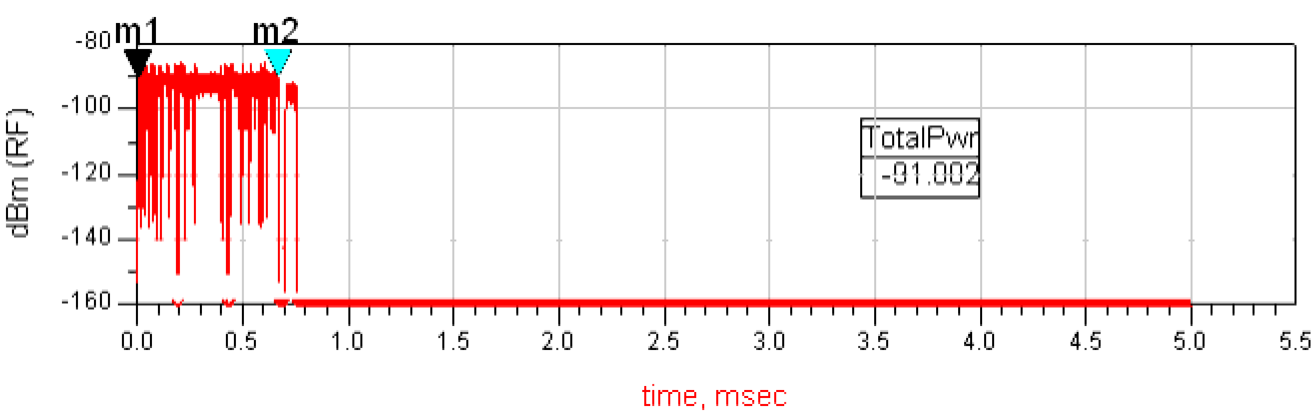
This TD-SCDMA signal source model is compatible with Agilent Signal Studio software option 411. Details regarding Signal Studio for TD-SCDMA are included at the website http://www.agilent.com/find/signalstudio .

This test bench includes a TX DSP section, an RF modulator, RF output source resistance, an RF DUT connection, RF receivers, and DSP measurement blocks as illustrated in Receiver Wireless Test Bench Block Diagram. The generated test signal is sent to the DUT.



Receiver Wireless Test Bench Block Diagram

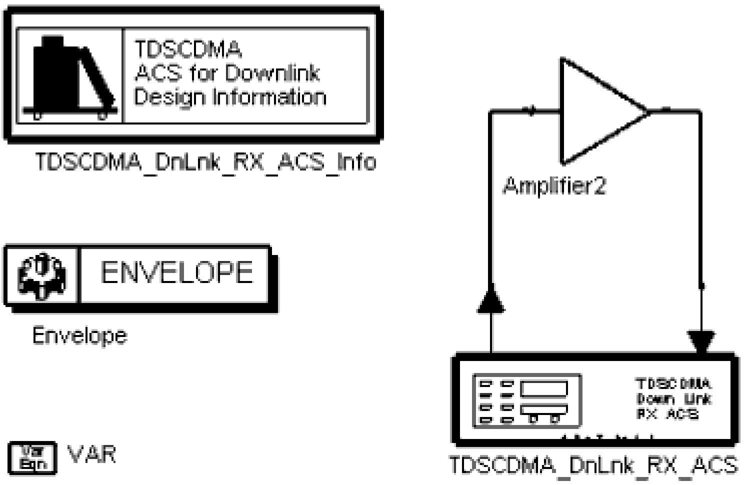
The TD-SCDMA RF power delivered into a matched load is the average power delivered in the selected time slot TS0 in the TD-SCDMA subframe. TD-SCDMA Downlink Envelope for RF Signal shows the RF envelope for an output signal with -91 dBm power.



TD-SCDMA Downlink Envelope for RF Signal

Test Bench Basics

A template is provided for this test bench.



TDSCDMA Downlink Receiver ACS Test Bench

To access the template:

1. In an Analog/RF schematic window select *Insert* > *Template.*
2. In the *Insert* > *Template* dialog box, choose *TDSCDMA_DnLnk_RX_ACS_test* , click *OK* ; click left to place the template in the schematic window.

An example design using this template is available; from the ADS Main window click *File* > *Open* > *Example* > TDSCDMA > TDSCDMA_RF_Verification_wrk > *TDSCDMA_DnLnk_RX_ACS* _test.

The basics for using the test bench are:

- Replace the DUT (Amplifier2 is provided with this template) with an RF DUT that is suitable for this test bench.
- CE_TimeStep, FSource, SourcePower, and FMeasurement parameter default values are typically accepted; otherwise, set values based on your requirements.
- Run the simulation and view Data Display page(s) for your measurement(s).

For details, refer to Test Bench Details.

Test Bench Details

The following sections provide details for setting up a test bench, setting measurement parameters for more control of the test bench, simulation measurement displays, and baseline performance.
Open and use the *TDSCDMA_DnLnk_RX_ACS_test* template:

1. In an Analog/RF schematic window select *Insert* > *Template.*
2. In the *Insert* > *Template* dialog box, choose *TDSCDMA_DnLnk_RX_ACS_test* , click *OK* ; click left to place the template in the schematic window.

The test bench setup is detailed here.

1. Replace the DUT (Amplifier2 is provided with this template) with an RF DUT that is suitable for this test bench.
   For information regarding using certain types of DUTs, see *RF DUT Limitations for TD-SCDMA Wireless Test Benches* (adswtbtds).
2. Set the *Required Parameters* .

   > **Note**
   > Refer to *TDSCDMA_DnLnk_RX_ACS* (adswtbtds) for a complete list of parameters for this test bench.

   Generally, default values can be accepted; otherwise, values can be changed by the user as needed.

- Set CE_TimeStep.
  Cosimulation occurs between the test bench (using ADS Ptolemy Data Flow simulation technology) and the DUT (using Circuit Envelope simulation technology). Each technology requires its own simulation time step with time-step coordination occurring in the interface between the technologies.
  CE_TimeStep defines the Circuit Envelope simulation time step to be used with this DUT. The CE_TimeStep must be set to a value equal to or a submultiple of (less than) WTB_TimeStep; otherwise, simulation will stop and an error message will be displayed.
  Note that WTB_TimeStep is not user-settable. Its value is derived from other test bench parameter values; with default settings WTB_TimeStep= 97.65625 nsec. The value is displayed in the Data Display pages as TimeStep.
  WTB_TimeStep = 1/(ChipRate × SamplesPerChip)
  where
  ChipRate is 1.28MHz
  SamplesPerChip is the number of samples per chip
  - Set FSource, SourcePower, and FMeasurement.
    - FSource defines the RF frequency for the TD-SCDMA signal input to the RF DUT.
    - SourcePower defines the power level for FSource. SourcePower is defined as the average power during the non-idle time of the TD-SCDMA signal segment.
    - FMeasurement defines the RF frequency output from the RF DUT to be measured.

1. More control of the test bench can be achieved by setting parameters on the *Basic Parameters* , *Signal Parameters* , and the *measurement* categories. For details, refer to *Setting Parameters* (adswtbtds).
2. The RF modulator (shown in the block diagram in Receiver Wireless Test Bench Block Diagram) uses FSource, SourcePower (*Required Parameters*), MirrorSourceSpectrum (*Basic Parameters)* , GainImbalance, PhaseImbalance, I_OriginOffset, Q_OriginOffset, and IQ_Rotation (*Signal Parameters*).
   The RF output resistance uses SourceR and SourceTemp (*Basic Parameters*). The RF output signal source has a 50-ohm (default) output resistance defined by SourceR.
   RF output (and input to the RF DUT) is at the frequency specified (FSource), with the specified source resistance (SourceR) and with power (SourcePower) delivered into a matched load of resistance SourceR. The RF signal has additive Gaussian noise power set by resistor temperature (SourceTemp).
   Note that the Meas_in point of the test bench provides a resistive load to the RF DUT set by the MeasR value (50-ohm default) (*Basic Parameters*).
   The Meas signal contains linear and nonlinear signal distortions and time delays associated with the RF DUT input to output characteristics.
   The DSP block (shown in the block diagram in Receiver Wireless Test Bench Block Diagram) uses other *Signal Parameters* .
3. More control of Circuit Envelope analysis can be achieved by setting Envelope controller parameters. These settings include Enable Fast Cosim, which may speed the RF DUT simulation more than 10×. Setting these simulation options is described in *Setting Fast Cosimulation Parameters* and *Setting Circuit Envelope Analysis Parameters* in the *Wireless Test Bench Simulation* documentation.
4. After running a simulation, results will appear in a Data Display window for the measurement. *Simulation Measurement Displays* (adswtbtds) describes results for each measurement. For general WTB Data Display details refer to *Viewing WTB Analysis Results* (adswtbsim).

TDSCDMA_DnLnk_RX_ACS

This section provides parameter information for *Required Parameters, Basic Parameters, Signal Parameters,* and measurement parameters.

Symbol

Description TD-SCDMA downlink RX ACS
Library WTB
Class TSDFTDSCDMA_DnLnk_RX_ACS
Derived From baseWTB_RX

Parameters

Name	Description	Default	Sym	Unit	Type	Range
RequiredParameters						
CE_TimeStep	Circuit envelope simulation time step	1/1.28 MHz/8		sec	real	(0, ∞)
WTB_TimeStep	Set CE_TimeStep < = 1/1.28e6/SamplesPerChip.					
FSource	Source carrier frequency	1900 MHz		Hz	real	(0, ∞)
SourcePower	Source power	dbmtow(-91.0)		W	real	[0, ∞)
FMeasurement	Measurement carrier frequency	1900 MHz		Hz	real	(0, ∞)
BasicParameters						
SourceR	Source resistance	50 Ohm		Ohm	real	(0, ∞)
SourceTemp	Source resistor temperature	16.85		Celsius	real	[-273.15, ∞)
MeasR	Measurement resistance	50 Ohm		Ohm	real	[10, 1.0e6]
MirrorSourceSpectrum	Mirror source spectrum about carrier? NO, YES	NO			enum	
MirrorMeasSpectrum	Mirror meas spectrum about carrier? NO, YES	NO			enum	
TestBenchSeed	Random number generator seed	1234567			int	[0, ∞)
SignalParameters						
GainImbalance	Gain imbalance, Q vs I	0.0		dB	real	(-∞, ∞)

PhaseImbalance	Phase imbalance, Q vs I	0.0		deg	real	(-∞, ∞)
I_OriginOffset	I origin offset (percent)	0.0			real	(-∞, ∞)
Q_OriginOffset	Q origin offset (percent)	0.0			real	(-∞, ∞)
IQ_Rotation	IQ rotation	0.0		deg	real	(-∞, ∞)
SamplesPerChip	Samples per chip	8	S		int	[2, 32]
ActiveTimeslot	Active Timeslot: TS0, TS2, TS3, TS4, TS5, TS6	TS0			enum	
RRC_FilterLength	RRC filter length (chips)	12			int	[2, 128]
BasicMidambleID	Basic midamble index	0			int	[0, 127]
MidambleID	Midamble index	1			int	[1, K]
MaxMidambleShift	Max midamble shift	16	K		int	{2, 4,6,8,10,12,14,16}
MinSF	Minimum spreading factor	16			int	{1, 2,4,8,16}
SpreadCode1	Spread code index for first channel	1			int	[0, 15]
SpreadCode2	Spread code index for second channel	2			int	[0, 15]
AdjChSignalParameters						
AdjChFSourceOffset	Adjacent channel carrier frequency offset	1.6 MHz		Hz	real	[0, ∞)
AdjChPower	Adjacent channel power	dbmtow(-54.0)		W	real	[0, ∞)
MeasurementParameters						
DisplayPages	RX downlink ACS measurement display pages:					
StartBlock	Start block	1			int	[0, 1000]
StopBlock	Stop block	50			int	[1, 1000]

Pin Inputs

Pin	Name	Description	Signal Type
2	Meas_In	Test bench measurement RF input from RF circuit	timed

Pin Outputs

Pin	Name	Description	Signal Type
1	RF_Out	Test bench RF output to RF circuit	timed

Setting Parameters

More control of the test bench can be achieved by setting parameters on the Basic Parameters, Signal Parameters, Adjacent Channel Selectivity, and measurement categories.

Basic Parameters

1. SourceR is the RF output source resistance.
2. SourceTemp is the RF output source resistance temperature (oC) and sets noise density in the RF output signal to (k(SourceTemp+273.15)) Watts/Hz, where k is Boltzmann's constant.
3. MeasR defines the load resistance for the RF DUT output Meas signal into the test bench. This resistance loads the RF DUT output; it is also the reference resistance for Meas signal power measurements.
4. MirrorSourceSpectrum is used to invert the polarity of the Q envelope of the generated RF signal before it is sent to the RF DUT. Depending on the configuration and number of mixers in an RF transmitter, the signal at the input of the DUT may need to be mirrored. If such an RF signal is desired, set this parameter to YES.
5. MirrorMeasSpectrum is used to invert the polarity of the Q envelope in the Meas_in RF signal input to the test bench (and output from the RF DUT). Depending on the configuration and number of mixers in the RF DUT, the signal at its output may be mirrored compared to the signal generated by the signal source (before any mirroring is done because of the MirrorSourceSpectrum setting). Proper demodulation and measurement of the RF DUT output signal requires that its RF envelope is not mirrored compared to the signal generated by the signal source (before any mirroring is done because of the MirrorSourceSpectrum setting). If the Meas_in RF signal is mirrored, set this parameter to YES. Proper setting of this parameter is required for measurements on the Meas_in signal in RX text benches and results in measurement on a signal with no spectrum mirroring.
6. TestBenchSeed is an integer used to seed the random number generator used with the test bench. This value is used by all test bench random number generators, except those RF DUT components that use their own specific seed parameter. TestBenchSeed initializes the random number generation. The same seed value produces the same *random* results, thereby giving you predictable simulation results. To generate repeatable *random* output from simulation to simulation, use any positive seed value. If you want the output to be truly random, enter the seed value of 0.

Signal Parameters

1. GainImbalance, PhaseImbalance, I_OriginOffset, Q_OriginOffset, and IQ_Rotation are used to add certain impairments to the ideal output RF signal. Impairments are added in the order described here.

The unimpaired RF I and Q envelope voltages have gain and phase imbalance applied. The RF is given by:

$$V_{RF}(t) = A\left(V_I(t)\cos(\omega_c t) - gV_Q(t)\sin\left(\omega_c t + \frac{\phi\pi}{180}\right)\right)$$

where *A* is a scaling factor that depends on the SourcePower and SourceR parameters specified by the user, $V_I(t)$ is the in-phase RF envelope, $V_Q(t)$ is the quadrature phase RF envelope, *g* is the gain imbalance

$$g = 10^{\frac{GainImbalance}{20}}$$

and, φ (in degrees) is the phase imbalance.
Next, the signal $V_{RF}(t)$ is rotated by IQ_Rotation degrees. The I_OriginOffset and Q_OriginOffset are then applied to the rotated signal. Note that the amounts specified are percentages with respect to the output rms voltage. The output rms voltage is given by sqrt(2 × SourceR × SourcePower).

2. SamplesPerChip sets the number of samples in a chip.
The default value is set to 8 to display settings according to the 3GPP NTDD. It can be set to a larger value for a simulation frequency bandwidth wider than 8 × 1.28 MHz. It can be set to a smaller value for faster simulation; however, this will result in lower signal fidelity. If SamplesPerChip = 8, the simulation RF bandwidth is larger than the signal bandwidth by a factor of 8 (e.g., simulation RF bandwidth = 8 × 1.28 MHz).
3. ActiveTimeslot specifies which timeslot is active. The ACS measurement is based on this active timeslot.
4. RRC_FilterLength shows root raised-cosine (RRC) filter length in chips.
The default value is set to 12 to transmit TD-SCDMA downlink signals in time and frequency domains based on the 3GPP NTDD standard. It can be set to a smaller value for faster simulation; however, this will result in lower signal fidelity.
5. BasicMidambleID sets the basic midamble code ID. The basic midamble code is used for training sequences for uplink and downlink channel estimation, power measurements and maintaining uplink synchronization. There are 128 different sequences; the BasicMidambleID range is 0 to 127. In Signal Studio, Basic Midamble ID code has the same meaning as this parameter.
6. MidambleID is the midamble index which specifies which midamble is used in the physical channel.
7. MaxMidambleShift is the maximum number of different midamble shifts in a cell that can be determined by maximum users in the cell for the current time slot.
8. MinSF is the minimum spreading factor which can be used by the physical channel.
9. SpreadCode1 and SpreadCode2 set spread code indices for the first and second DPCH, respectively. For this signal source, the spreading factor is 16.

Adjacent Channel Selectivity Parameters

1. AdjChFSourceOffset is the adjacent channel carrier frequency offset.
2. AdjChPower is the transmit power of the adjacent channel.

Measurement Parameters

This measurement requires setting the MirrorMeasSpectrum parameter such that there is an even number of spectrum mirrorings from the combined test bench source and RF DUT. For example, if MirrorSourceSpectrum = NO and the RF DUT causes its output RF signal to have spectrum mirroring relative to its input signal, then set MirrorMeasSpectrum = YES.

1. DisplayPages provides Data Display page information for this test bench. It cannot be changed by the user.
2. StartBlock sets the start block. The block is the unit set of TD-SCDMA subframes for processing channel coding. One block contains four subframes. A value of 0 is the first block.
3. StopBlock sets the stop block. For example, StopBlock=50 results in a measurement of 51 blocks.

Simulation Measurement Displays

After running the simulation, results will be displayed in the Data Display page as shown in Simulation Results.

> **Note**
> Measurement results from a wireless test bench have associated names that can be used in Data Display Expressions. For more information, refer to *Measurement Results for Expressions for TD-SCDMA Wireless Test Benches* (adswtbtds).

The BER must be less than 0.001 for a desired input level of -91 dBm with a -54 dBm adjacent interference as specified for a TD-SCDMA signal with a 12.2 k reference channel.

RF Source Power

real(RF_FSource)/1MHz	real(RF_SourcePower_dBm)
1900.00	-91.00

Adjacent Channel Power

real(RF_AdjChFSourceOffset)/1MHz	real(RF_AdjChPower_dBm)
1.60	-54.00

RF BER & Meas BER

Meas_BER
0.0000

Simulation Results

Test Bench Variables for Data Displays

Reference variables used to set up this test bench are listed in Test Bench Parameters Exported to the Data Display.

Test Bench Parameters Exported to the Data Display

Data Display Parameter	Equation with Test Bench Parameters
RF_FSource	FSource
RF_SourcePower_dBm	10*log10(SourcePower)+30
RF_SourceTemp	SourceTemp in degrees Celcius

Baseline Performance

- Test Computer Configuration
  - Pentium IV 2.4 GHz, 512 MB RAM, Red Hat Linux 7.3
- Conditions
  - Measurements made with default test bench settings.
  - RF DUT is an RF system behavior component.
  - The number of time points in one TD-SCDMA downlink subframe is a function of SamplesPerChip and ChipRate.
    SamplesPerChip = 8
    ChipRate = 1.28 Mb/s
  - Resultant WTB_TimeStep = 97.65625 nsec; SubframeTime = 5 msec; time points per subframe = 51200
- Simulation time and memory requirements:

TDSCDMA_DnLnk_RX Measurement*	Bursts Measured	Simulation Time (sec)	ADS Processes (MB)
ACS	50	513	112

Expected ADS Performance

Expected ADS performance is the combined performance of the baseline test bench and the RF DUT Circuit Envelope simulation with the same signal and number of time points. For example, if the RF DUT performance with Circuit Envelope simulation alone takes 2 hours and consumes 200 MB of memory (excluding the memory consumed by the core ADS product), then add these numbers to the Baseline Performance numbers to determine the expected ADS performance. This is valid only if the full memory consumed is from RAM. If RAM is less, larger simulation times may result due to increased disk access time for swap memory usage.

References

1. 3GPP TS 25.221, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Physical channels and mapping of transport channels onto physical channels (TDD) (Release 4)," version 4.5.0, June, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25221-450.zip]
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http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25223-440.zip]
3. 3GPP TS 25.102, "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UE Radio Transmission and Reception (TDD) (Release 4)," version 4.5.0, June, 2002.
http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25102-450.zip]
4. 3GPP TS 34.122, "3rd Generation Partnership Project; Technical Specification Group Terminal; Terminal Conformance Specification; Radio Transmission and Reception (TDD) (Release 4)," version 4.4.0, June, 2002.
http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/34_series/34122-440.zip]

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Setting Circuit Envelope Analysis Parameters in the *Wireless Test Bench Simulation* documentation explains how to set up circuit envelope analysis parameters such as convergence criteria, solver selection, and initial guess.

Setting Automatic Verification Modeling Parameters in the *Wireless Test Bench Simulation* documentation explains how to improve simulation speed.

Downlink Transmitter Test

Introduction

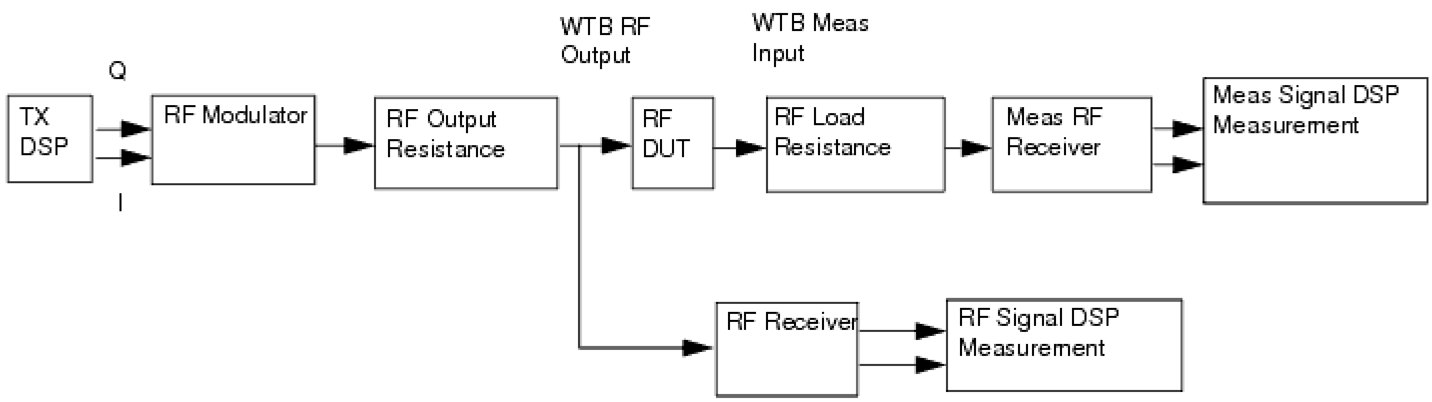
TDSCDMA_DnLnk_TX text bench for TDSCDMA downlink (base station to user equipment) transmitter testing provides a way for users to connect to an RF circuit device under test (RF DUT) and determine its performance by activating various measurements. This test bench provides signal measurements for RF envelope, constellation, power (including power vs. time and CCDF), spectrum, and EVM.

The signal and most of the measurements are designed according to 3GPP TS 25 (Release 4).

This TD-SCDMA signal source model is compatible with Agilent Signal Studio software option 411. Details regarding Signal Studio for TD-SCDMA are included at the website http://www.agilent.com/find/signalstudio .

The DUT output signal can be sent to an Agilent ESG RF signal generator.

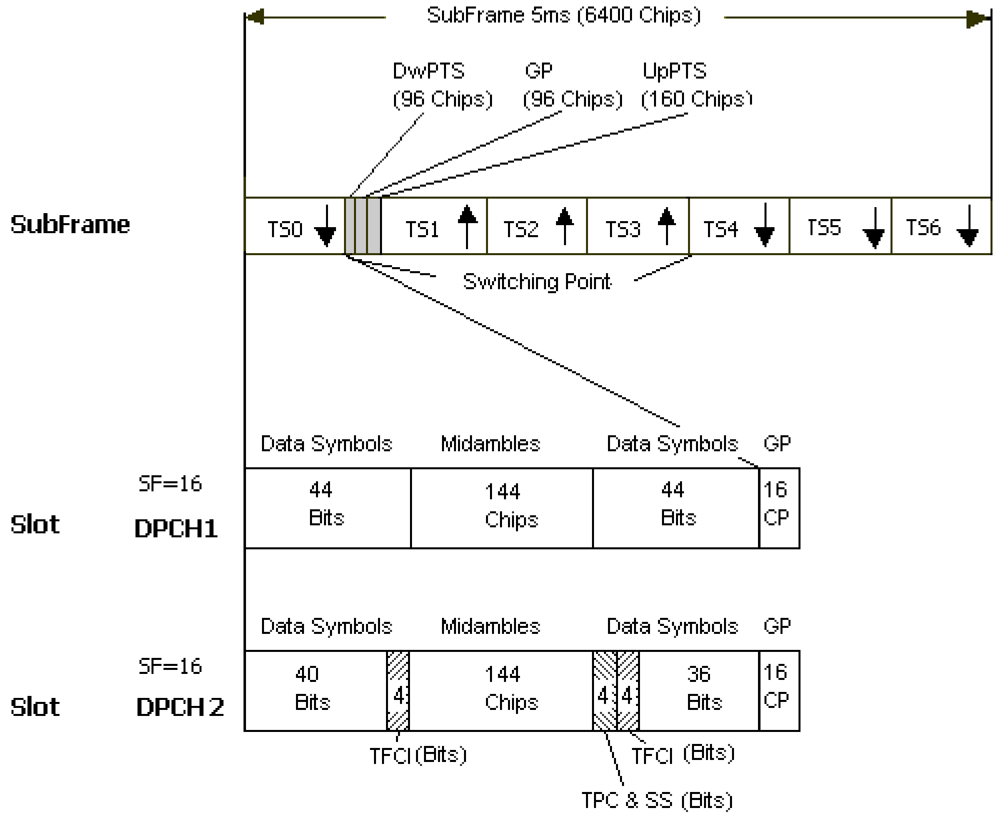
This test bench includes a DSP section, an RF modulator, RF output source resistance, RF DUT connection, RF receivers, and DSP measurement blocks, as illustrated in Transmitter Wireless Test Bench Block Diagram. The generated test signal is sent to the DUT.



Transmitter Wireless Test Bench Block Diagram

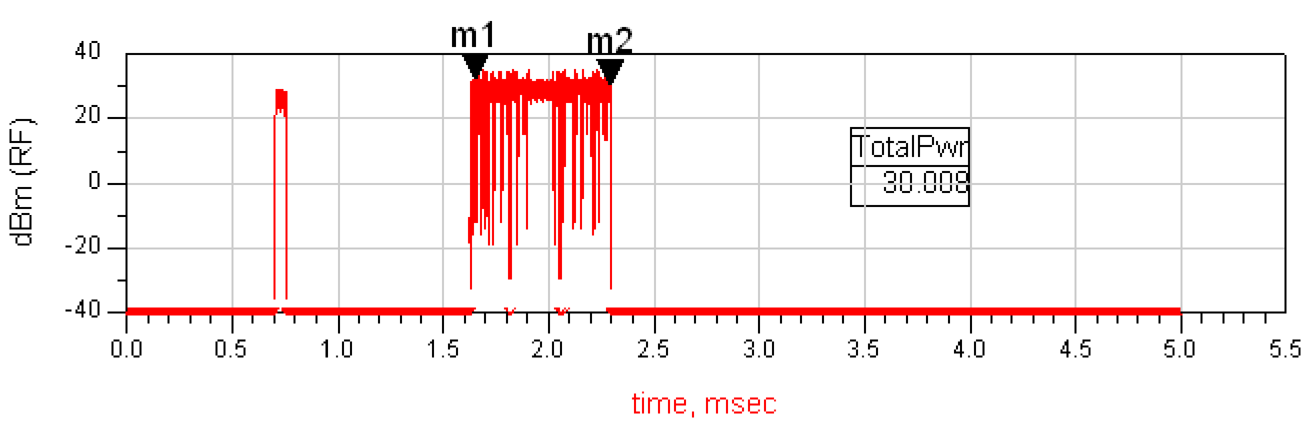
The downlink channel subframe structure is illustrated in 12.2 kbps Downlink Channel Subframe Structure. One frame consists of two subframes. Each subframe consists of 7 time slots (TS), and one downlink pilot time slot (DwPTS), one guard period (GP) and one uplink pilot time slot (UpPTS). Each time slot can transmit DPCH signals. One subframe consists of 6400 chips. Because the chip rate is 1.28 MHz, the subframe has a 5 msec duration.

In the example in 12.2 kbps Downlink Channel Subframe Structure, two DPCH signals in DPCH1 and DPCH2 are transmitted in TS0. The first DPCH bits are modulated by QPSK and spread by Walsh code of length 16 then transmitted in the slot. The DPCH1 signal is composed of 88 coded information bits (88 × 16/2 chips) and 144 chips for midamble sequence plus 16 chips for GP. The DPCH2 signal, with the same modulation and spread scheme as DPCH1, is composed of 76 coded information bits (76 × 16/2 chips), 8 bits (8 × 16/2 chips) for transport format combination indicator (TFCI), 144 chips for midamble sequence, 4 bits (4 × 16/2 chips) for transmitter power control and synchronization shift (TPC and SS) plus 16 chips for GP. The total chips for the subframe is composed of 7 time slots plus 96 chips for DwPTS, 96 chips for GP and 160 chips for UpPTS and summarized as (88 × 8+144+16) × 7+160+96 × 2=6400 chips.



12.2 kbps Downlink Channel Subframe Structure

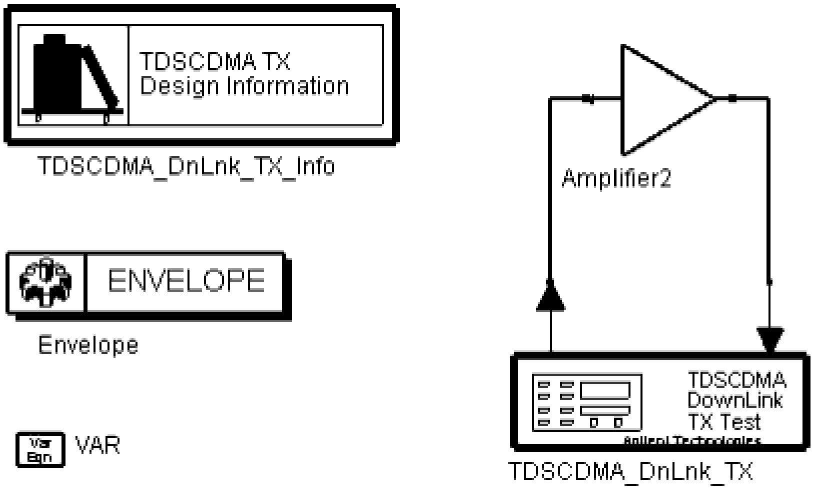
TD-SCDMA RF power delivered into a matched load is the average power delivered in the selected time slot TS2 in the TD-SCDMA subframe. RF Signal Downlink Envelope shows the RF envelope for an output signal with 30 dBm power.



RF Signal Downlink Envelope

Test Bench Basics

A template is provided for this test bench.



TDSCDMA Downlink Transmitter Test Bench

To access the template:

1. In an Analog/RF schematic window select *Insert* > *Template.*
2. In the *Insert* > *Template* dialog box, choose *TDSCDMA_DnLnk_TX_test* , click *OK* ; click left to place the template in the schematic window.

An example design using this template is available; from the ADS Main window click *File* > *Open* > *Example* > TDSCDMA > TDSCDMA_RF_Verification_wrk > TDSCDMA_DnLnk_TX_test.

The basics for using the test bench are:

- Replace the DUT (Amplifier2 is provided with this template) with an RF DUT that is suitable for this test bench.
- CE_TimeStep, FSource, SourcePower, and FMeasurement parameter default values are typically accepted; otherwise, set values based on your requirements.
- Activate/deactivate measurements based on your requirements.
- Run the simulation and view Data Display page(s) for your measurement(s).

For details, refer to Test Bench Details.

Test Bench Details

The following sections provide details for setting up a test bench, setting measurement parameters for more control of the test bench, simulation measurement displays, and baseline performance.
Open and use the *TDSCDMA_DnLnk_TX* template:

1. In an Analog/RF schematic window select *Insert > Template.*
2. In the *Insert > Template* dialog box, choose *TDSCDMA_DnLnk_TX_test* , click *OK* ; click left to place the template in the schematic window.

Test bench setup is detailed here.

1. Replace the DUT (Amplifier2 is provided with this template) with an RF DUT that is suitable for this test bench.
   For information regarding using certain types of DUTs, see *RF DUT Limitations for TD-SCDMA Wireless Test Benches* (adswtbtds).
2. Set the *Required Parameters*

   > **Note**
   > Refer to *TDSCDMA_DnLnk_TX* (adswtbtds) for a complete list of parameters for this test bench.

   Generally, default values can be accepted; otherwise, values can be changed by the user as needed.

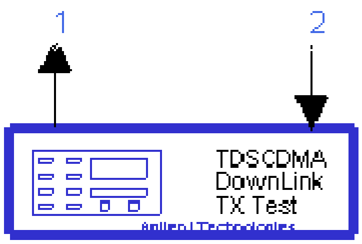
   - Set CE_TimeStep.
     Cosimulation occurs between the test bench (using ADS Ptolemy Data Flow simulation technology) and the DUT (using Circuit Envelope simulation technology). Each technology requires its own simulation time step with time-step coordination occurring in the interface between the technologies.
     CE_TimeStep defines the Circuit Envelope simulation time step to be used with this DUT. The CE_TimeStep must be set to a value equal to or a submultiple of (less than) WTB_TimeStep; otherwise, simulation will stop and an error message will be displayed.
     Note that WTB_TimeStep is not user-settable. Its value is derived from other test bench parameter values; with default settings WTB_TimeStep= 97.65625 nsec. The value is displayed in the Data Display pages as TimeStep.
     WTB_TimeStep = 1/(ChipRate × SamplesPerChip)
     where
     ChipRate is 1.28MHz
     SamplesPerChip is the number of samples per chip
   - Set FSource, SourcePower, and FMeasurement.
     - FSource defines the RF frequency for the TD-SCDMA signal input to the RF DUT.
     - SourcePower defines the power level for FSource. SourcePower is defined as the average power during the non-idle time of the TD-SCDMA signal segment.
     - FMeasurement defines the RF frequency output from the RF DUT to be measured.
3. Activate/deactivate (*YES* / *NO*) test bench measurements (refer to

TDSCDMA_DnLnk_TX (adswtbtds)). At least one measurement must be enabled:
   - RF_EnvelopeMeasurement
   - Constellation
   - PowerMeasurement
   - SpectrumMeasurement
   - EVM_Measurement
4. More control of the test bench can be achieved by setting parameters in the *Basic Parameters* , *Signal Parameters* , and measurement categories for each activated measurement. For details, refer to *Setting Parameters* (adswtbtds). The RF modulator (shown in the block diagram in Transmitter Wireless Test Bench Block Diagram) uses FSource, SourcePower (*Required Parameters*), MirrorSourceSpectrum (*Basic Parameters)* , GainImbalance, PhaseImbalance, I_OriginOffset, Q_OriginOffset, and IQ_Rotation (*Signal Parameters*).
   The RF output resistance uses SourceR, SourceTemp, and EnableSourceNoise (*Basic Parameters*). The RF output signal source has a 50-ohm (default) output resistance defined by SourceR.
   RF output (and input to the RF DUT) is at the frequency specified (FSource), with the specified source resistance (SourceR) and with power (SourcePower) delivered into a matched load of resistance SourceR. The RF signal has additive Gaussian noise power set by resistor temperature (SourceTemp) (when EnableSourceNoise=YES).
   Note that the Meas_in point of the test bench provides a resistive load to the RF DUT set by the MeasR value (50-ohm default) (*Basic Parameters*).
   The Meas signal contains linear and nonlinear signal distortions and time delays associated with the RF DUT input to output characteristics.
   The TX DSP block (shown in the block diagram in Transmitter Wireless Test Bench Block Diagram) uses other *Signal Parameters* .
5. More control of Circuit Envelope analysis can be achieved by setting Envelope controller parameters. These settings include Enable Fast Cosim, which may speed the RF DUT simulation more than 10×. Setting these simulation options is described in *Setting Fast Cosimulation Parameters* and *Setting Circuit Envelope Analysis Parameters* in the *Wireless Test Bench Simulation* documentation.
6. To send the RF DUT output signal to an Agilent ESG RF signal generator, set parameters on the *Signal to ESG* category.
   For details, refer to *Signal to ESG Parameters* (adswtbtds).
7. After running a simulation, results will appear in a Data Display window for the measurement. *Simulation Measurement Displays* (adswtbtds) describes results for each measurement. For general WTB Data Display details refer to *Viewing WTB Analysis Results* (adswtbsim).

TDSCDMA_DnLnk_TX

This section provides parameter information for *Required Parameters, Basic Parameters, Signal Parameters,* and parameters for the various measurements.

Symbol



Description TD-SCDMA downlink TX test
Library WTB
Class TSDFTDSCDMA_DnLnk_TX
Derived From baseWTB_TX

Parameters

Name	Description	Default	Sym	Unit	Type	Range
Required Parameters						
CE_TimeStep	Circuit envelope simulation time step	1/1.28 MHz/8		sec	real	(0, ∞)
WTB_TimeStep	Set CE_TimeStep < = 1/1.28e6/ SamplesPerChip.					
FSource	Source carrier frequency	1900 MHz		Hz	real	(0, ∞)
SourcePower	Source power	dbmtow(-20.0)		W	real	[0, ∞)
FMeasurement	Measurement carrier frequency	1900 MHz		Hz	real	(0, ∞)
MeasurementInfo	Available Measurements					
RF_Envelope Measurement	Enable RF envelope measurement? NO, YES	YES			enum	
Constellation	Enable constellation measurement? NO, YES	NO			enum	
PowerMeasurement	Enable power measurement? NO, YES	NO			enum	
SpectrumMeasurement	Enable spectrum measurement? NO, YES	NO			enum	

EVM_Measurement	Enable EVM measurement? NO, YES	NO			enum	
Basic Parameters						
SourceR	Source resistance	50 Ohm		Ohm	real	(0, ∞)
SourceTemp	Source resistor temperature	-273.15		Celsius	real	[-273.15, ∞)
EnableSourceNoise	Enable source thermal noise? NO, YES	NO			enum	
MeasR	Measurement resistance	50 Ohm		Ohm	real	[10, 1.0e6]
MirrorSourceSpectrum	Mirror source spectrum about carrier? NO, YES	NO			enum	
MirrorMeasSpectrum	Mirror meas spectrum about carrier? NO, YES	NO			enum	
RF_MirrorFreq	Mirror source frequency for spectrum/envelope measurement? NO, YES	NO			enum	
MeasMirrorFreq	Mirror meas frequency for spectrum/envelope measurement? NO, YES	NO			enum	
TestBenchSeed	Random number generator seed	1234567			int	[0, ∞)
SignalParameters						
GainImbalance	Gain imbalance, Q vs I	0.0		dB	real	(-∞, ∞)
PhaseImbalance	Phase imbalance, Q vs I	0.0		deg	real	(-∞, ∞)
I_OriginOffset	I origin offset (percent)	0.0			real	(-∞, ∞)
Q_OriginOffset	Q origin offset (percent)	0.0			real	(-∞, ∞)
IQ_Rotation	IQ rotation	0.0		deg	real	(-∞, ∞)
SamplesPerChip	Samples per chip	8	S		int	[2, 32]
RRC_FilterLength	RRC filter length (chips)	8			int	[2, 128]
MidambleAllocScheme	Midamble allocation scheme: UE_Specific, Common, Default	Common			enum	
BasicMidambleID	Basic midamble index	0			int	[0, 127]
MidambleID1	1st DPCH midamble index	1			int	[1, K]
MidambleID2	2nd DPCH midamble index	2			int	[1, K]
MaxMidambleShift	Max midamble shift	16	K		int	[1, 16]
ActiveTimeslot	Active Timeslot: TS0, TS2, TS3, TS4, TS5, TS6	TS2			enum	
SpreadCode1	1st DPCH spread code index	1			int	[1, 16]
SpreadCode2	2nd DPCH spread code index	2			int	[1, 16]
DownlinkPilotCode	Downlink pilot code index	0			int	[0, 31]
ModPhase	Modulation phase quadruples: S1, S2	S1			enum	
DwPCH_Gain	DwPCH gain	1			int	(0, ∞)
RF_Envelope Measurement Parameters						

RF_EnvelopeDisplayPages	RF envelope measurement display pages:					
RF_EnvelopeStart	RF envelope measurement start	0.0		sec	real	[0, ∞)
RF_EnvelopeStop	RF envelope measurement stop	5.0 msec		sec	real	[0, ∞)
RF_EnvelopeSubframes	RF envelope measurement subframes	1			int	[0, 100]
Constellation Parameters						
ConstellationDisplayPages	Constellation measurement display pages:					
ConstellationSubframes	Constellation measurement subframes	3			int	[1, 100]
PowerMeasurement Parameters						
PowerDisplayPages	Power measurement display pages:					
PowerSubframeMeasured	Subframes measured	3			int	[1, ∞)
SpectrumMeasurement Parameters						
SpecMeasDisplayPages	Spectrum measurement display pages:					
SpecMeasStart	Spectrum measurement start	0.0		sec	real	[0, ∞)
SpecMeasStop	Spectrum measurement stop	5.0 msec		sec	real	[0, ∞)
SpecMeasSubframes	Spectrum measurement subframes	3			int	[0, 100]
SpecMeasResBW	Spectrum resolution bandwidth	0		Hz	real	[0, ∞)
SpecMeasWindow	Window type: none, Hamming 0.54, Hanning 0.50, Gaussian 0.75, Kaiser 7.865, _8510 6.0, Blackman, Blackman-Harris	none			enum	
EVM_Measurement Parameters						
EVM_DisplayPages	EVM measurement display pages:					
EVM_StartTime	EVM measurement start	0.0		sec	real	[0, ∞)
EVM_AverageType	Average type: Off, RMS (Video)	RMS (Video)			enum	
EVM_SubframesToAverage	Subframes used for RMS averaging	3			int	[1, ∞)
EVM_ActiveSlotThreshold	Active slot threshold (dBc)	-30.0			real	[-120, 0]
SignalToESG _Parameters						
EnableESG	Enable signal to ESG? NO, YES	NO			enum	

ESG_Instrument	ESG instrument address	[GPIB0::19::INSTR][localhost][4790]			instrument	
ESG_Start	Signal start	0.0		sec	real	[0, ∞)
ESG_Stop	Signal stop	5.0 msec		sec	real	[(ESG_Start+60/1.28e6/S), (ESG_Start+32/1.28/S)]
ESG_Subframes	Subframes to ESG	3			int	[0, 1000]
ESG_Power	ESG RF ouput power (dBm)	-20			real	(-∞, ∞)
ESG_ClkRef	Waveform clock reference: Internal, External	Internal			enum	
ESG_ExtClkRefFreq	External clock reference freq	10 MHz		Hz	real	(0, ∞)
ESG_IQFilter	IQ filter: through, filter_2100kHz, filter_40MHz	through			enum	
ESG_SampleClkRate	Sequencer sample clock rate	10.24 MHz		Hz	real	(0, ∞)
ESG_Filename	ESG waveform storage filename	TDSCDMA_DL			string	
ESG_AutoScaling	Activate auto scaling? NO, YES	YES			enum	
ESG_ArbOn	Select waveform and turn ArbOn after download? NO, YES	YES			enum	
ESG_RFPowOn	Turn RF ON after download? NO, YES	YES			enum	
ESG_EventMarkerType	Event marker type: Neither, Event1, Event2, Both	Event1			enum	
ESG_MarkerLength	ESG marker length	10			int	[1, 60]

Pin Inputs

Pin	Name	Description	Signal Type
2	Meas_In	Test bench measurement RF input from RF circuit	timed

Pin Outputs

Pin	Name	Description	Signal Type
1	RF_Out	Test bench RF output to RF circuit	timed

Setting Parameters

More control of the test bench can be achieved by setting parameters on the Basic Parameters, Signal Parameters, and measurement categories for the activated measurements.

> **Note**
> For *required* parameter information, see TDSCDMA_DnLnk_TX.

Basic Parameters

1. SourceR is the RF output source resistance.
2. SourceTemp is the RF output source resistance temperature (oC) and sets noise density in the RF output signal to (k(SourceTemp+273.15)) Watts/Hz, where k is Boltzmann's constant.
3. EnableSourceNoise, when set to NO disables the SourceTemp and effectively sets it to -273.15oC (0 Kelvin). When set to YES, the noise density due to SourceTemp is enabled.
4. MeasR defines the load resistance for the RF DUT output Meas signal into the test bench. This resistance loads the RF DUT output; it is also the reference resistance for Meas signal power measurements.
5. MirrorSourceSpectrum is used to invert the polarity of the Q envelope of the generated RF signal before it is sent to the RF DUT. Depending on the configuration and number of mixers in an RF transmitter, the signal at the input of the DUT may need to be mirrored. If such an RF signal is desired, set this parameter to YES.
6. MirrorMeasSpectrum is used to invert the polarity of the Q envelope in the Meas_in RF signal input to the test bench (and output from the RF DUT). Depending on the configuration and number of mixers in the RF DUT, the signal at its output may be mirrored compared to the signal generated by the signal source (before any mirroring is done because of the MirrorSourceSpectrum setting). Proper demodulation and measurement of the RF DUT output signal requires that its RF envelope is not mirrored compared to the signal generated by the signal source (before any mirroring is done because of the MirrorSourceSpectrum setting). If the Meas_in RF signal is mirrored, set this parameter to YES. Proper setting of this parameter is required for measurements on the Meas_in signal in TX test benches (EVM, Constellation, CDP, PCDE) and results in measurement on a signal with no spectrum mirroring.
7. TestBenchSeed is an integer used to seed the random number generator used with the test bench. This value is used by all test bench random number generators, except those RF DUT components that use their own specific seed parameter. TestBenchSeed initializes the random number generation. The same seed value produces the same *random* results, thereby giving you predictable simulation results. To generate repeatable *random* output from simulation to simulation, use any positive seed value. If you want the output to be truly random, enter the seed value of 0.
8. RF_MirrorFreq is used to invert the polarity of the Q envelope in the RF_out RF signal for RF envelope, ppectrum, ACLR, and occupied bandwidth measurements.

RF_MirrorFreq is typically set by the user to NO when MirrorSourceSpectrum = NO; RF_MirrorFreq is typically set by the user to YES when MirrorSourceSpectrum = YES. Both settings result in viewing the RF_out signal with no spectrum mirroring. Other settings by the user result in RF_out signal for RF_Envelope and Spectrum measurements with spectrum mirroring.

9. MeasMirrorFreq is used to invert the polarity of the Q envelope in the Meas_in RF signal for the RF envelope, spectrum, ACLR, and occupied bandwidth measurements. MeasMirrorFreq is typically set to NO by the user when the combination of the MirrorSourceSpectrum value and any signal mirroring in the users RF DUT results in no spectrum mirroring in the Meas_in signal. MeasMirrorFreq is typically set to YES by the user when the combination of the MirrorSourceSpectrum and RF DUT results in spectrum mirroring in the Meas_in signal.
Other settings result in Meas_in signal for RF_Envelope and Spectrum measurements with spectrum mirroring. The MirrorMeasSpectrum parameter setting has no impact on the setting or use of the MeasMirrorFreq parameter.

Signal Parameters

1. GainImbalance, PhaseImbalance, I_OriginOffset, Q_OriginOffset, and IQ_Rotation are used to add certain impairments to the ideal output RF signal. Impairments are added in the order described here.
The unimpaired RF I and Q envelope voltages have gain and phase imbalance applied. The RF is given by:
$$V_{RF}(t) = A\left(V_I(t)\cos(\omega_c t) - gV_Q(t)\sin\left(\omega_c t + \frac{\phi\pi}{180}\right)\right)$$
where A is a scaling factor that depends on the SourcePower and SourceR parameters specified by the user, $V_I(t)$ is the in-phase RF envelope, $V_Q(t)$ is the quadrature phase RF envelope, g is the gain imbalance
$$g = 10^{\frac{GainImbalance}{20}}$$
and, φ (in degrees) is the phase imbalance.
Next, the signal $V_{RF}(t)$ is rotated by IQ_Rotation degrees. The I_OriginOffset and Q_OriginOffset are then applied to the rotated signal. Note that the amounts specified are percentages with respect to the output rms voltage. The output rms voltage is given by sqrt(2 × SourceR × SourcePower).
2. SamplesPerChip sets the number of samples in a chip.
The default value is set to 8 to display settings according to the 3GPP NTDD. It can be set to a larger value for a simulation frequency bandwidth wider than 8 × 1.28 MHz. It can be set to a smaller value for faster simulation; however, this will result in lower signal fidelity. If SamplesPerChip = 8, the simulation RF bandwidth is larger than the signal bandwidth by a factor of 8 (e.g., simulation RF bandwidth = 8 × 1.28 MHz).
3. RRC_FilterLength sets root raised-cosine (RRC) filter length in chips.
The default value is set to 8 to transmit TD-SCDMA downlink signals in time and frequency domains based on the 3GPP NTDD standard [1]-[3]. It can be set to a smaller value for faster simulation; however, this will result in lower signal fidelity.
4. MidambleAllocScheme is used to select the midamble allocation scheme. There are

three midamble allocation schemes based on the 3GPP NTDD standard [1], [2]. To set the MidambleAllocScheme parameter based on the 3GPP NTDD standard [1], related parameters must be set as stated here.

- **UE specific midamble allocation** : a UE specific midamble for uplink and downlink is explicitly assigned by higher layers.
  if MidambleAllocScheme=UE_Specific, BasicMidambleID, MaxMidambleShift, and MidambleID are used to specify which midamble is exported.
- **Common midamble allocation** : the midamble for downlink is allocated by layer 1 depending on the number of channelization codes currently present in the downlink time slot.
  if MidambleAllocScheme=Common, only BasicMidambleID and MaxMidambleShift are used to specify which midamble is exported; the MidambleID parameter is ignored.
- **Default midamble allocation** : the midamble for uplink and downlink is assigned by layer 1 depending on the associated channelization code.
  if MidambleAllocScheme=Default, only BasicMidambleID and MaxMidambleShift are used to specify which midamble is exported; the MidambleID parameter is ignored.

5. BasicMidambleID sets the basic midamble code ID. The basic midamble code is used for training sequences for uplink and downlink channel estimation, power measurements and maintaining uplink synchronization. There are 128 different sequences; the BasicMidambleID range is 0 to 127. In Signal Studio, Basic Midamble ID code has the same meaning as this parameter.
6. MidambleID1 and MidambleID2 set the midamble indices for the first and second DPCH, respectively. Midambles of different users active in the same cell and the same time slot are cyclically shifted versions of one basic midamble code.
   Let P = 128, the length of basic midamble and K=MaxMidambleShift, then
   $W = \left\lfloor \frac{P}{K} \right\rfloor$, is the shift between midambles and $\lfloor x \rfloor$
   denotes the largest number less than or equal to x. The MidambleID range is from 1 to MaxMidambleShift.
   MidambleID and MaxMidambleShift together correspond to the Midamble Offset parameter in Signal Studio for Timeslot setup. Midamble Offset = MidambleID × W.
7. MaxMidambleShift is the maximum number of different midamble shifts in a cell that can be determined by maximum users in the cell for the current time slot.
8. ActiveTimeslot specifies which slot signal in the subframe will be transmitted. Referring to *12.2 kbps Downlink Channel Subframe Structure* (adswtbtds), when ActiveTimeslot=2, TS2 is used.
9. SpreadCode1 and SpreadCode2 set spread code indices for the first and second DPCH, respectively. For this signal source, the spreading factor is 16.
   In Signal Studio, channelization code for time slot setup has the same meaning as SpreadCode1 and SpreadCode2.
10. DownlinkPilotCode sets the downlink pilot synchronization sequence (SYNC-DL). Downlink pilot synchronization is used for DL synchronization and cell initial search. 32 different SYNC-DL code groups are used to distinguish base stations.
    DwPTS has 64 chips of a complex SYNC_DL sequence
    $\underline{s} = (\underline{s}_1, \underline{s}_2, \ldots, \underline{s}_{64})$
    and 32 chips of guard period. To generate the complex SYNC_DL code, the basic SYNC_DL code $s = s_1, s_2, \ldots, s_{64}$ is used. There are 32 different basic SYNC_DL

codes for the entire system. The relation between s and s-is given by:

$$\underline{s}_i = (j)^i s_i \text{ where } v_i \in \{1, -1\}, i = 1, \ldots, 64$$

Therefore, the elements $\underline{s}_i$ of $\underline{s}$ are alternating real and imaginary.
In Signal Studio, SYNC Code is used to set the downlink pilot code.

11. ModPhase is used to select the phase quadruples of DwPTS for various phase rotation patterns. In Signal Studio, the Rotation Phase parameter is used to select the phase quadruples.
Two different phase quadruples S1 and S2 are specified by 3GPP NTDD standard [3] and described in the following table. A quadruple always starts with an even signal frame number.

Name	Phase Quadruple	Description
S1	135, 45, 225, 135	A P-CCPCH is present in the next 4 sub-frames
S2	315, 225, 315, 45	A P-CCPCH is not present in the next 4 sub-frames

12. DwPCH_Gain sets the gain of DwPCH relative to DPCH. In Signal Studio, there are dialog boxes with dB unit for each DwPCH to set the gain of DwPCH relative to DPCH.

RF Envelope Measurement Parameters

The RF Envelope measurement is not affected by the MirrorMeasSpectrum parameter. To apply spectrum mirroring to the measured RF_out signal, set RF_MirrorFreq=YES. To apply spectrum mirroring to the measured Meas_in signal, set MeasMirrorFreq=YES.

- RF_EnvelopeDisplayPages provides Data Display page information for this measurement. It cannot be changed by the user.
- RF_EnvelopeStart sets the start time for collecting input data.
- RF_EnvelopeStop sets the stop time for collecting input data when RF_EnvelopeSubframes=0.
- RF_EnvelopeSubframes (when > 0) sets the number of bursts over which data will be collected.
Depending on the values of RF_EnvelopeStart, RF_EnvelopeStop, and RF_EnvelopeSubframes, the stop time may be adjusted.
For RF envelope measurement for the RF_out and Meas_in signals:
Let:
Start = TimeStep× (int(RF_EnvelopeStart/TimeStep) + 0.5)
Stop = TimeStep × (int(RF_EnvelopeStop/TimeStep) + 0.5)
This means Start and Stop are forced to be an integer number of time-step intervals.

RF_EnvelopeSubframes	Resultant Stop Time
0	Stop
> 0	Start + RF_EnvelopeSubframes x SubframeTime

For the RF envelope of Meas_in to contain at least one complete Subframe, the Stop value must be set to a minimum of SubframeTime + (RF DUT time delay).
For information about TimeStep and SubframeTime, see Test Bench Variables for Data Displays.

Constellation Parameters

The Constellation measurement requires setting the MirrorMeasSpectrum parameter such that there is an even number of spectrum mirrorings from the combined test bench source and RF DUT. For example, if MirrorSourceSpectrum=NO and the RF DUT causes its output RF signal to have spectrum mirroring relative to its input signal, then set MirrorMeasSpectrum=YES.

1. ConstellationDisplayPages provides Data Display page information for this measurement. It cannot be changed by the user.
2. ConstellationSubframes sets the number of subframes over which data will be collected.
3. The measurement start time is the time when the first subframe is detected in the measured RF signal. Automatic synchronization by the measurement model avoids any start-up transient in the Constellation plots.

Power Measurement Parameters

1. PowerDisplayPages provides Data Display page information for this measurement. It cannot be changed by the user.
2. PowerSubframeMeasured sets the number of subframes over which data will be collected.
3. The measurement start time is the time when the first subframe is detected in the measured RF signal. Automatic synchronization by the measurement model avoids any start-up transient in the Constellation plots. The measurement stop time is this start time plus PowerSubframeMeasured × SubframeTime. SubframeTime is described in Test Bench Variables for Data Displays.

Spectrum Measurement Parameters

The Spectrum measurement calculates the spectrum of the input signal. Averaging the spectrum over multiple subframes can be enabled as described in this section.
This measurement is not affected by the MirrorMeasSpectrum parameter. To apply spectrum mirroring to the measured RF_out signal, set RF_MirrorFreq = YES; to apply spectrum mirroring to the measured Meas_in signal, set MeasMirrorFreq = YES.
In the following, TimeStep denotes the simulation time step and FMeasurement denotes the measured RF signal characterization frequency.

1. The measurement outputs the complex amplitude voltage values at the frequencies of the spectral tones. It does not output the power at the frequencies of the spectral tones. However, one can calculate and display the power spectrum as well as the magnitude and phase spectrum by using the dBm, mag, and phase functions of the data display window.
   Note that the dBm function assumes a 50-ohm reference resistance; if a different measurement was used in the test bench, its value can be specified as a second

argument to the dBm function, for example, dBm(SpecMeas, Meas_RefR) where SpecMeas is the instance name of the spectrum measurement and Meas_RefR is the resistive load used.
By default, the displayed spectrum extends from FMeasurement - 1/(2×TimeStep) Hz to FMeasurement + 1/(2×TimeStep) Hz. When FMeasurement < 1/(2×TimeStep), the default spectrum extends to negative frequencies. The spectral content at these negative frequencies is conjugated, mirrored, and added to the spectral content of the closest positive frequency. The negative frequency tones are then displayed on the positive frequency axis as would happen in an RF spectrum analyzer measurement instrument. This process may introduce an error in the displayed frequency for the mirrored tones. The absolute error introduced is less than (spectrum frequency step) / 2 (see Effect of Values for SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW for the definition of spectrum frequency step).
The basis of the algorithm used by the spectrum measurement is the chirp-Z transform. The algorithm can use multiple subframes and average the results to achieve video averaging (see *note 6*).

2. SpecMeasDisplayPages provides information regarding Data Display pages for this measurement. It cannot be changed by the user.
3. SpecMeasStart sets the start time for collecting input data.
4. SpecMeasStop sets the stop time for collecting input data when SpecMeasSubframes = 0 and SpecMeasResBW = 0.
5. SpecMeasSubframes sets the number of segments over which data will be collected.
6. SpecMeasResBW sets the resolution bandwidth of the spectrum.
   Depending on the values of SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW, the stop time may be adjusted or spectrum video averaging may occur (or both). The different cases are described in Effect of Values for SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW.
   Referring to Effect of Values for SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW, let
   Start = TimeStep × int((SpecMeasStart/TimeStep) + 0.5)
   Stop = TimeStep × int((SpecMeasStop/TimeStep) + 0.5)
   (This means Start and Stop are forced to be an integer number of time step intervals.)
   X = normalized equivalent noise bandwidth of the window
   Start and Stop times are used for RF_out and Meas_in signal spectrum analyses. The Meas_in signal is delayed in time from the RF_out signal by the value of the RF DUT time delay. Therefore, for RF DUT time delay >0, the RF_out and Meas_in signals are inherently different and spectrum display differences can be expected.
   TimeStep and SubframeTime are defined in the *Test Bench Variables for Data Displays* section.
   Equivalent noise bandwidth (ENBW) compares the window to an ideal, rectangular filter. It is the equivalent width of a rectangular filter that passes the same amount of white noise as the window. Normalized ENBW (NENBW) is ENBW multiplied by the duration of the signal being windowed. (Refer to *note 7* regarding the various window options and *Window Options and Normalized Equivalent Noise Bandwidth* regarding NENBW for the various windows.)

Effect of Values for SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW

Case 1	SpecMeasSubframes = 0 SpecMeasResBW = 0 Resultant stop time = Stop Resultant resolution BW = X/(Stop - Start) Resultant spectrum frequency step = 1/(Stop-Start) Video averaging status = None
Case 2	SpecMeasSubframes > 0 SpecMeasResBW = 0 Resultant stop time = Start + SpecMeasSubframes x SubframeTime For SpecMeasSubframes > 0 and SpecMeasResBW = 0 Video averaging occurs over all segment time intervals Resultant resolution BW = X /SubframeTime Resultant spectrum frequency step = 1/SubframeTime Video averaging status = Yes, when SpecMeasSubframes > 1
Case 3	SpecMeasSubframes = 0 SpecMeasResBW > 0 Resultant stop time = Start + N x SubframeTimeInterval where N = int((Stop -Start)/SubframeTimeInterval) + 1 For SpecMeasSubframes = 0 and SpecMeasResBW > 0 Define SubframeTimeInterval = TimeStep x int((X/SpecMeasResBW/TimeStep) + 0.5) This means SubframeTimeInterval is forced to a value that is an integer number of time step intervals. (Stop-Start) time is forced to be an integer number (N) of SubframeTimeIntervals N has a minimum value of 1 Video averaging occurs over all SubframeTimeIntervals Resolution bandwidth achieved is ResBW = X / SubframeTimeInterval, which is very close to SpecMeasResBW but may not be exactly the same if X/SpecMeasResBW/TimeStep is not an exact integer. Resultant resolution BW = ResBW Resultant spectrum frequency step = ResBW Video averaging status = Yes when N > 1
Case 4	SpecMeasSubframes > 0 SpecMeasResBW > 0 Resultant stop time = Start + M x SubframeTimeInterval where M = int((SpecMeasSubframes x SubframeTime)/SubframeTimeInterval) + 1 For SpecMeasSubframes > 0 and SpecMeasResBW > 0 Define SubframeTimeInterval = TimeStep x int((X /SpecMeasResBW/TimeStep) + 0.5) This means SubframeTimeInterval is forced to a value that is an integer number of time step intervals. (Stop-Start) time is forced to be an integer number (M) of the SubframeTimeIntervals M has a minimum value of 1 Video averaging occurs over all SubframeTimeIntervals Resolution bandwidth achieved is ResBW = X / SubframeTimeInterval, which is very close to SpecMeasResBW but may not be exactly the same if X/SpecMeasResBW/TimeStep is not an exact integer. Resultant resolution BW = ResBW Resultant spectrum frequency step = ResBW Video averaging status = Yes, when M > 1

7. SpecMeasWindow specifies the window that will be applied to each segment before its spectrum is calculated. Different windows have different properties, affect the resolution bandwidth achieved, and affect the spectral shape. Windowing is often necessary in transform-based (chirp-Z, FFT) spectrum estimation in order to reduce spectral distortion due to discontinuous or non-harmonic signal over the

measurement time interval. Without windowing, the estimated spectrum may suffer from spectral leakage that can cause misleading measurements or masking of weak signal spectral detail by spurious artifacts.
The windowing of a signal in time has the effect of changing its power. The spectrum measurement compensates for this and the spectrum is normalized so that the power contained in it is the same as the power of the input signal.
Window Type Definitions:

- none

$$w(kT_s) = \begin{cases} 1.0 & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size
- Hamming 0.54

$$w(kT_s) = \begin{cases} 0.54 - 0.46\cos\left(\frac{2\pi k}{N}\right) & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size
- Hanning 0.50

$$w(kT_s) = \begin{cases} 0.5 - 0.5\cos\left(\frac{2\pi k}{N}\right) & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size
- Gaussian 0.75

$$w(kT_s) = \begin{cases} exp\left(-\frac{1}{2}\left(0.75\frac{(2k-N)}{N}\right)^2\right) & 0 \le \left|k - \frac{N}{2}\right| \le \frac{N}{2} \\ 0.0 & otherwise \end{cases}$$

  where N is the window size
- Kaiser 7.865

$$w(kT_s) = \begin{cases} \dfrac{I_0\left(7.865\left[1 - \left(\frac{k-\alpha}{\alpha}\right)^2\right]^{1/2}\right)}{I_0(7.865)} & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size, $\alpha = N / 2$, and $I_0(.)$ is the 0th order modified Bessel function of the first kind
- 8510 6.0 (Kaiser 6.0)

$$w(kT_s) = \begin{cases} \dfrac{I_0\left(6.0\left[1 - \left(\frac{k-\alpha}{\alpha}\right)^2\right]^{1/2}\right)}{I_0(6.0)} & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size, $\alpha = N / 2$, and $I_0(.)$ is the 0th order modified

Bessel function of the first kind

- Blackman

$$w(kT_s) = \begin{cases} 0.42 - 0.5\cos\left(\frac{2\pi k}{N}\right) + 0.08\cos\left(\frac{4\pi k}{N}\right) & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

where N is the window size

- Blackman-Harris

$$w(kT_s) = \begin{cases} 0.35875 - 0.48829\cos\left(\frac{2\pi k}{N}\right) + 0.14128\cos\left(\frac{4\pi k}{N}\right) - 0.01168\cos\left(\frac{6\pi k}{N}\right) & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

where N is the window size.

Window Options and Normalized Equivalent Noise Bandwidth

Window and Default Constant	NENBW
none	1
Hamming 0.54	1.363
Hanning 0.50	1.5
Gaussian 0.75	1.883
Kaiser 7.865	1.653
8510 6.0	1.467
Blackman	1.727
Blackman-Harris	2.021

EVM Measurement Parameters

The EVM measurement requires setting the MirrorMeasSpectrum parameter such that there is an even number of spectrum mirrorings from the combined test bench source and RF DUT. For example, if MirrorSourceSpectrum=NO and the RF DUT causes its output RF signal to have spectrum mirroring relative to its input signal, then set MirrorMeasSpectrum=YES.
The EVM measurement provides results for EVM, magnitude error, phase error for one code channel and for the composite signal. It also provides rho, frequency error, IQ offset, and gain imbalance.

1. EVM_DisplayPages provides information regarding Data Display pages for this measurement. It cannot be changed by the user.
2. Starting at the time instant specified by EVM_StartTime, a signal segment of 10msec is captured and the beginning of a subframe is detected (a 10msec signal segment is guaranteed to contain a whole subframe). After the subframe is detected, the I and Q envelopes of the input signal are extracted. The I and Q envelopes are then passed to a complex algorithm that performs synchronization, demodulation, and EVM

analysis (this algorithm is the same as the one used in the Agilent 89600 VSA).
3. If EVM_AverageType is set to Off, only one subframe is detected, demodulated, and analyzed.
If EVM_AverageType is set to RMS (Video), after the first subframe is analyzed the signal segment corresponding to it is discarded and new signal samples are collected from the input to fill in the 10msec signal buffer. When the buffer is full again a new subframe is detected, demodulated, and analyzed. These steps are repeated until EVM_SubframesToAverage subframes are processed.
If a subframe is mis-detected for any reason, results from its analysis are discarded. EVM results obtained from all the successfully detected, demodulated, and analyzed subframes are averaged to give the final averaged results. EVM results from each successfully analyzed subframe are also recorded (in the variables without the *Avg_* prefix in their name).
4. EVM_ActiveSlotThreshold sets the active slot detection threshold; that is the power level (in dB with respect to the power level of the slot with the largest measured power) below which a slot will be considered as inactive.

Signal to ESG Parameters

The EVM measurement collects data from the Meas_in signal and downloads it to an Agilent E4438C Vector Signal Generator. This measurement uses Connection Manager architecture to communicate with the instrument; parameters specify how data is interpreted.
Prerequisites for using the Signal to ESG option are:

- ESG Vector Signal Generator E4438C; for information, visit the web site http://www.agilent.com/find/esg .
- PC workstation running an instance of the connection manager server.
- Supported method of connecting the instrument to your computer through the Connection Manager architecture; for information, see *Connection Manager* .

Parameter Information

1. EnableESG specifies if the signal is downloaded to the ESG instrument. If set to NO, no attempt will be made to communicate with the instrument.
2. ESG_Instrument specifies a triplet that identifies the VSA resource of the instrument to be used in the simulation, the connection manager server hostname (defaults to *localhost*), and the port at which the connection manager server listens for incoming requests (defaults to 4790). To ensure that this field is populated correctly, click *Select Instrument* , enter the server hostname and port, click *OK* to see the Remote Instrument Explorer dialog, select a VSA resource identifier, and click *OK* . For details about selecting instruments, see *Instrument Discovery* in the *Wireless Test Bench Simulation* documentation.
3. ESG_Start and ESG_Stop (when ESG_Subframes=0) specify when to start and stop data collection. The number of samples collected, ESG_Stop - ESG_Start + 1, must

be in the range 60 samples to 64 Msamples, where 1 Msample = 1,048,576 samples. The ESG requires an even number of samples; the last sample will be discarded if ESG_Stop - ESG_Start + 1 is odd.

4. ESG_Subframes sets the number of subframes over which data will be collected. If ESG_Subframes is greater than zero, then ESG_Stop is forced to ESG_Start + ESG_Subframes x SubframeTime where SubframeTime is 5 msec.
5. ESG_ClkRef specifies an internal or external reference for the ESG clock generator. If set to External, the ESG_ExtClkRefFreq parameter sets the frequency of this clock.
6. ESG_IQFilter specifies the cutoff frequency for the reconstruction filter that lies between the DAC output and the Dual Arbitrary Waveform Generator output inside the ESG.
7. ESG_SampleClkRate sets the sample clock rate for the DAC output.
8. ESG_Filename sets the name of the waveform inside the ESG that will hold the downloaded data.
9. The ESG driver expects data in the range {-1, 1}. The ESG_AutoScaling parameter specifies whether to scale inputs to fit this range. If set to YES, inputs are scaled to the range {-1, 1}; if set to NO, raw simulation data is downloaded to the ESG without any scaling, but data outside the range {-1, 1} is clipped to -1 or 1. If set to YES, scaling is also applied to data written to the local file (ESG_Filename setting).
10. If ESG_ArbOn is set to YES, the ESG will start generating the signal immediately after simulation data is downloaded; if set to NO, waveform generation must be turned on at the ESG front panel.
11. If ESG_RFPowOn is set to YES, the ESG will turn RF power on immediately after simulation data is downloaded. If ESG_RFPowOn is set to NO (default), RF power must be turned on at the ESG front panel.
12. ESG_EventMarkerType specifies which ESG Event markers are enabled: Event1, Event2, Both, or Neither. Event markers are used for synchronizing other instruments to the ESG. When event markers are enabled, Event1 or Event2 (or both) is set beginning from the first sample of the downloaded Arb waveform over the range of points specified by the ESG_MarkerLength parameter. This is equivalent to setting the corresponding event from the front panel of the ESG.
13. ESG_MarkerLength specifies the range of points over which the markers must be set starting from the first point of the waveform. Depending on the ESG_EventMarkerType setting, the trigger length of Event1 or Event2 (or both) is set to a multiple of the pulsewidth that, in turn, is determined by the sample clock rate of the DAC output.

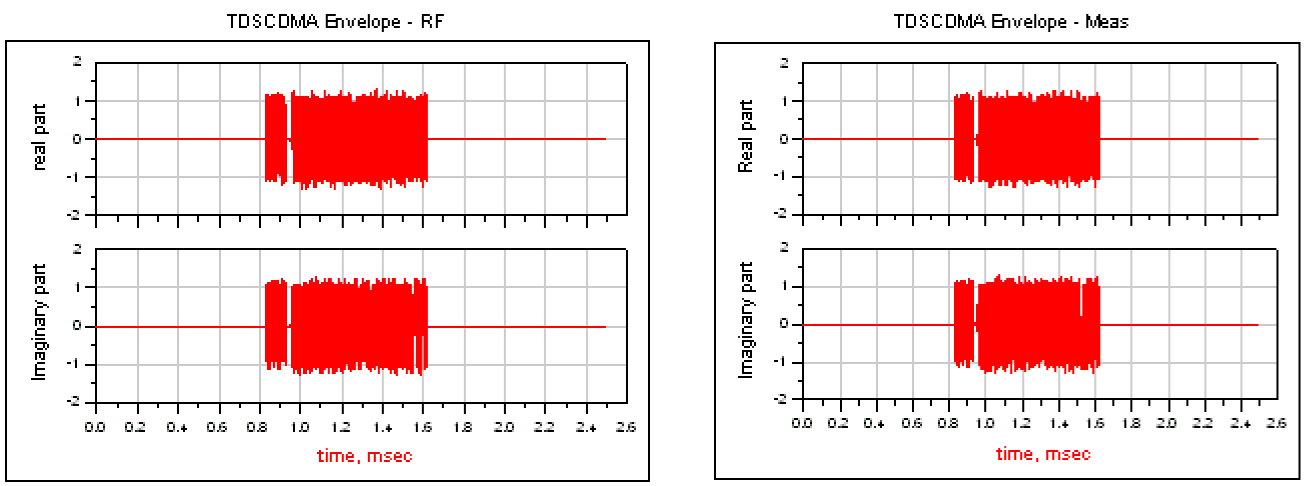
Simulation Measurement Displays

After running the simulation, results are displayed in Data Display pages for each measurement activated.

> **Note**
> Measurement results from a wireless test bench have associated names that can be used in Data Display Expressions. For more information, refer to *Measurement Results for Expressions for TD-SCDMA Wireless Test Benches* (adswtbtds).

RF Envelope Measurement

The RF Envelope measurement (not defined in 3GPP TS 25) shows the envelope of a TD-SCDMA uplink signal. Measurements for the RF signal at the input of the RF DUT and the Meas signal at the output of the RF DUT are implemented.
The real and imaginary parts of the RF and Meas signals are shown in RF Envelope Simulation Results. There are two active parts because ActiveTimeslot is set to TS1 and uplink pilot is transmitted. Only 2.6msec of data is stored to save disk space; the stop time can be changed by setting RF_EnvelopeMeasurement parameters.



...l(RF_FSource)/(1MHz)	real(RF_Power_dBm)	real(RF_R)	...l(Meas_FMeasurement)/(1MHz)	real(Meas_R)
1900.000	10.000	50.000	1900.000	50.000

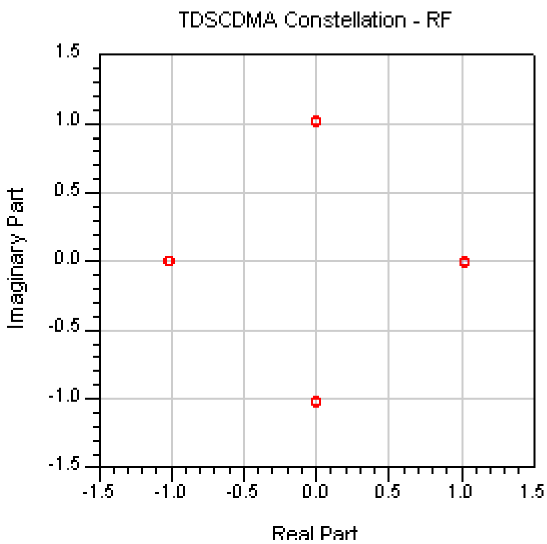
real(FrameTime)/(1msec)	int(ActiveSlot)	int(FilterLength)/(1_chip)	real(TimeStep)/(1usec)
5.000	1	12.000	0.098

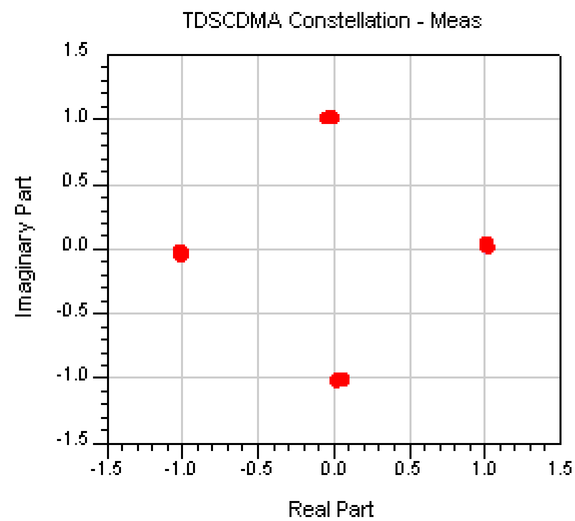
RF Envelope Simulation Results

Constellation Measurement

The constellation measurement (not defined in 3GPP TS 25) shows the constellation of one code channel of the TD-SCDMA uplink signal. The constellation for the RF and Meas signals are shown in Signal Constellations. Through the constellation measurement, distortion caused by carrier phase shift, IQ imbalance, and phase noise can be observed. Comparing the RF and the Meas signals, the constellation of the Meas signal rotates a fixed angle due to the delay introduced by the DUT.

QPSK demodulation is implemented in the TD-SCDMA uplink. Symbol mapping is shown in *Symbol Mapping*.





Signal Constellations

Symbol Mapping

***Input**	**<th**
$b_{l,n}^{(k,i)} b_{2,n}^{(k,i)}$	$\underline{d}^{(k,i)}$
00	+j
01	+1
10	-1
11	-j

Power Measurement

The power measurement includes: power vs. time (defined in 3GPP TS 25.105 [3] and TS 25.142 [4]); and, CCDF (not defined in 3GPP standards).

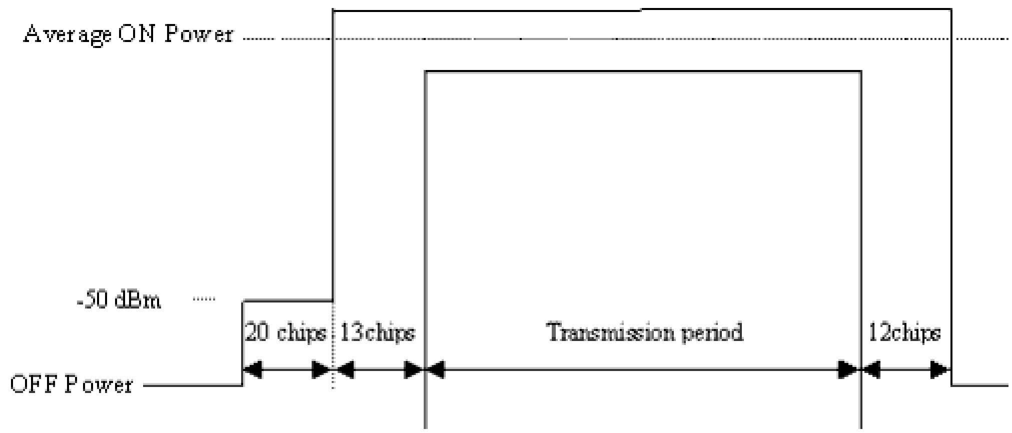
Power vs. time is the instant power of chips in the subframe (when

PowerSubframeMeasured = 1) and average power of chips at the same position in all measured subframes (when PowerSubframeMeasured > 1). CCDF fully characterizes the power statistics of a signal and provides characterization of peak-to-average power ratio versus probability.
The on/off mask template for power vs. time is illustrated in Downlink Transmit On/Off Mask Template.

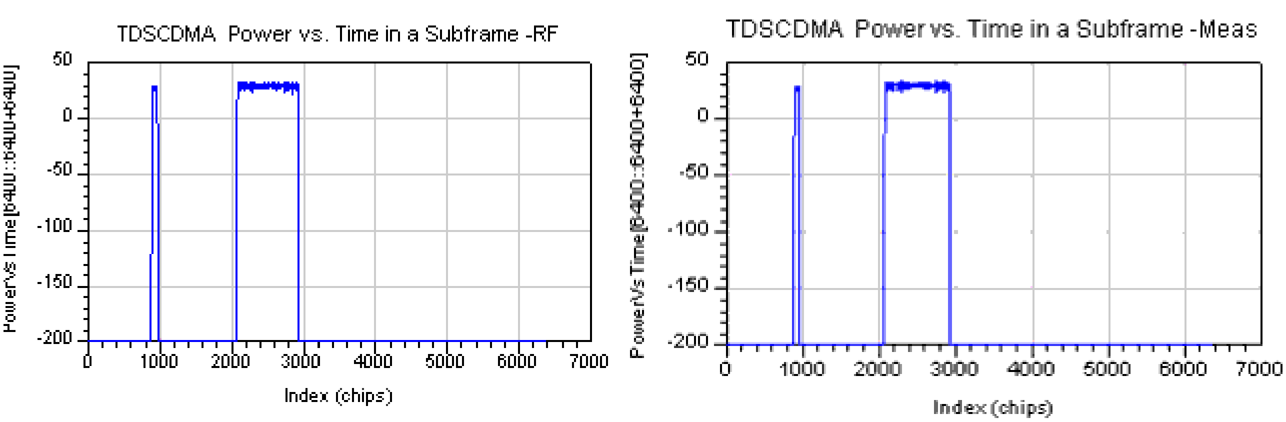
Results of power vs. time for the RF and Meas signals are shown in Power vs. Time in One Subframe; results of power vs. time with masks are shown in RF and Signal Power vs. Time with Masks.

To show the power vs. time on/off masks more clearly, zoomed-in RF and Meas signals are shown in RF Signal Power vs. Time with Masks Off and On and Meas Signal Power vs. Time with Masks Off and On.

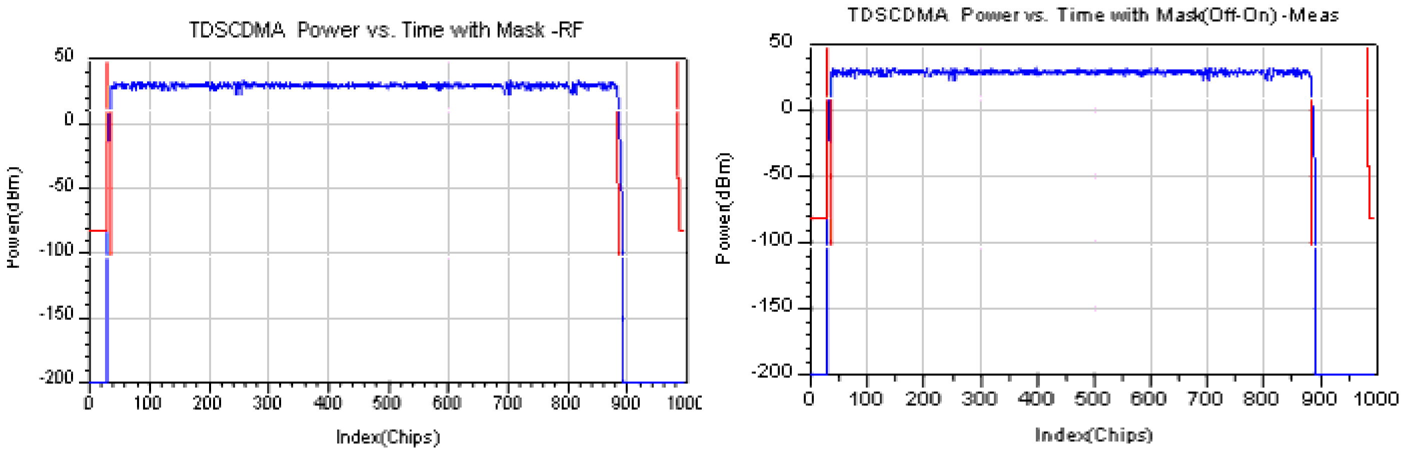
If the curves meet the masks, *Pass* will show in the Data Display window; otherwise, *Failure* will show.



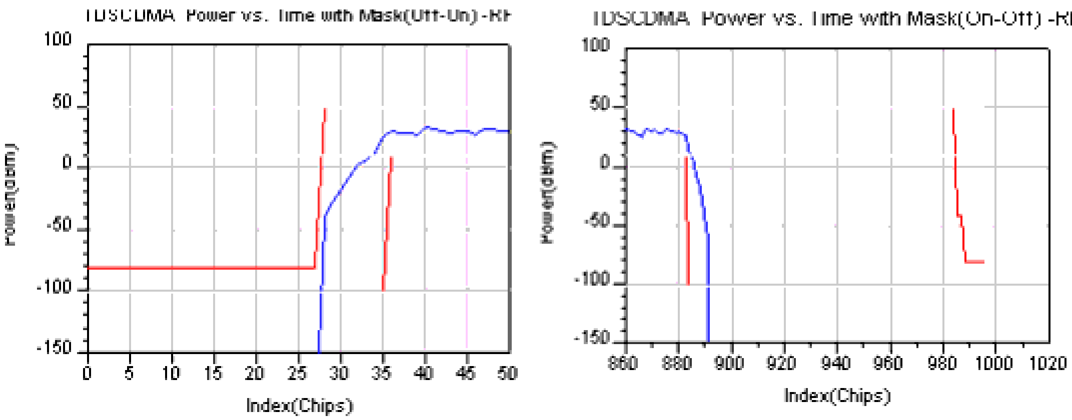
Downlink Transmit On/Off Mask Template



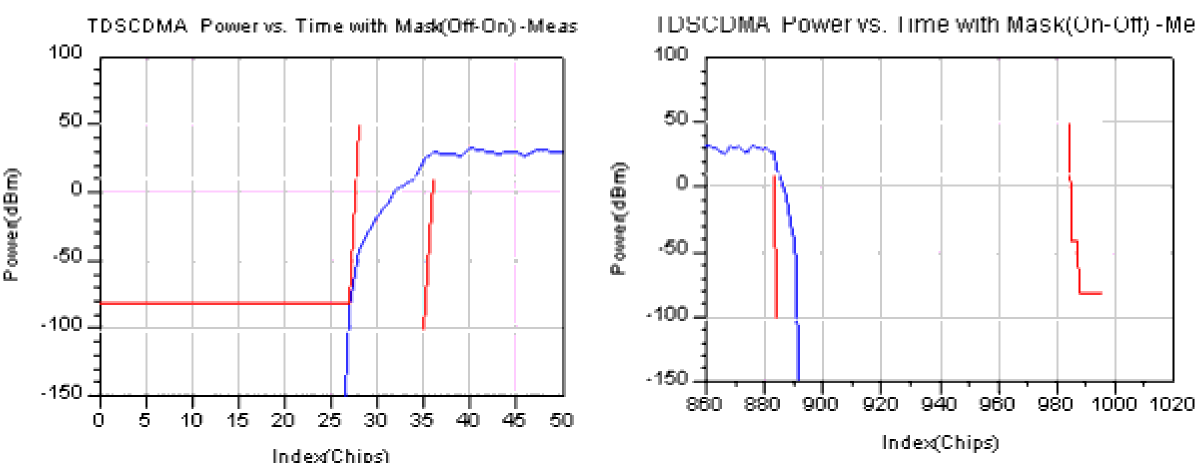
Power vs. Time in One Subframe



RF and Signal Power vs. Time with Masks



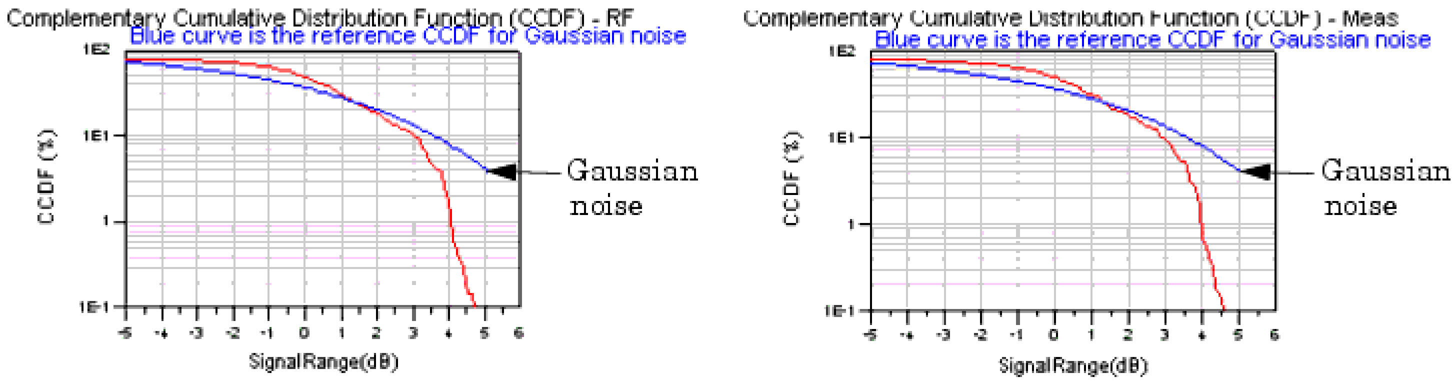
RF Signal Power vs. Time with Masks Off and On



Meas Signal Power vs. Time with Masks Off and On

The CCDF for the RF and the Meas signals are shown in Complementary Cumulative Distribution Function.

The peak-to-average power ratios of the RF and Meas signals are shown in Peak-to-Average Power Ratios.



Complementary Cumulative Distribution Function

Peak to average power ratio -RF

Peak_to_MeanRF	PowerRF.CCDF.PeakPower_dBm	PowerRF.CCDF.MeanPower_dBm
4.815	34.818	30.003

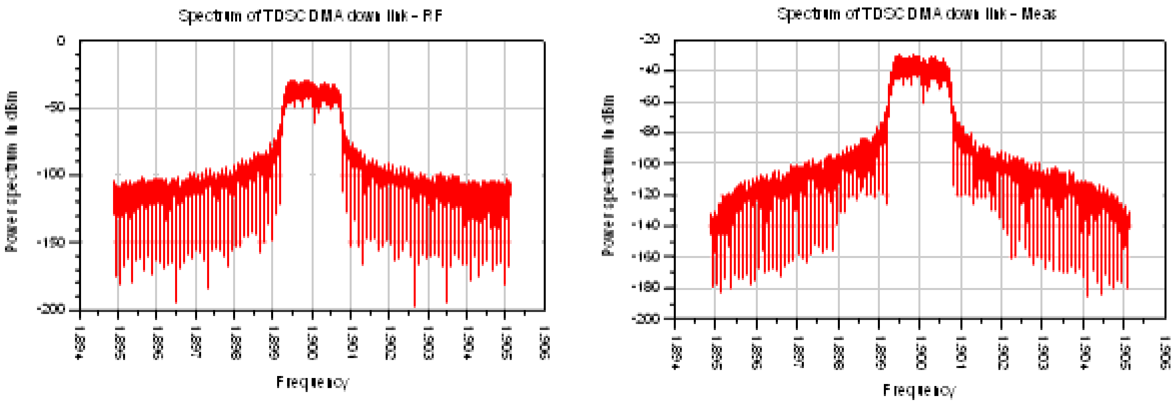
Peak to average power ratio -Meas

Peak_to_MeanMeas	PowerMeas.CCDF.PeakPower_dBm	PowerMeas.CCDF.MeanPower_dBm
4.680	34.573	29.894

Peak-to-Average Power Ratios

Spectrum Measurement

The spectrum measurement (not defined in 3GPP standards) shows the spectrum of the TD-SCDMA downlink signal. The spectrum analyzer output contains complex amplitude voltage values and the dBm(<meas_name>, <ref_r>) expressions can be used to convert to dBm values. Spectrums for the RF and the Meas signals are shown in TD-SCDMA Signal Spectrums.



TD-SCDMA Signal Spectrums

EVM Measurement

The EVM measurement (defined in 3GPP TS 25.102 and TS 34.122) demonstrates the uplink EVM measurement. EVM is a measure of the difference between the reference and the measured waveform; this difference is called the error vector. Both waveforms pass through a matched root raised-cosine filter with bandwidth corresponding to the considered chip rate and roll-off a=0.22. Both waveforms are further modified by selecting the frequency, absolute phase, absolute amplitude, and chip clock timing so as to minimize the error vector. The EVM result is defined as the square root of the ratio of the mean error vector power to the mean reference power expressed as a percent. The measurement interval is one timeslot. The EVM must not exceed 12.5%. The requirement is valid over the total power dynamic range as specified in subclause 6.4.3 of TS 25.102.

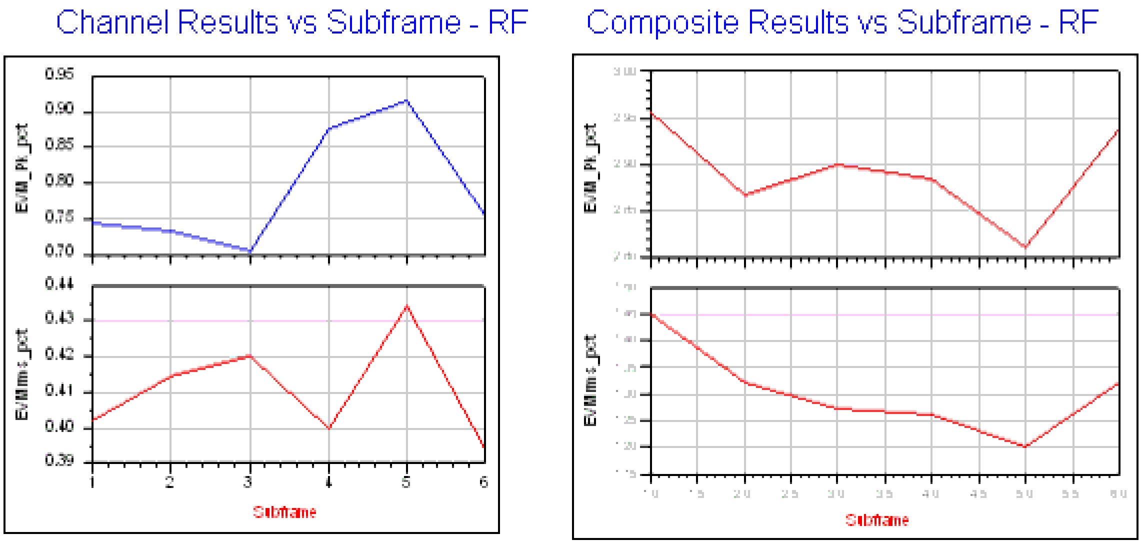
The results from this measurement are described in the following table.

EVM Measurement Results

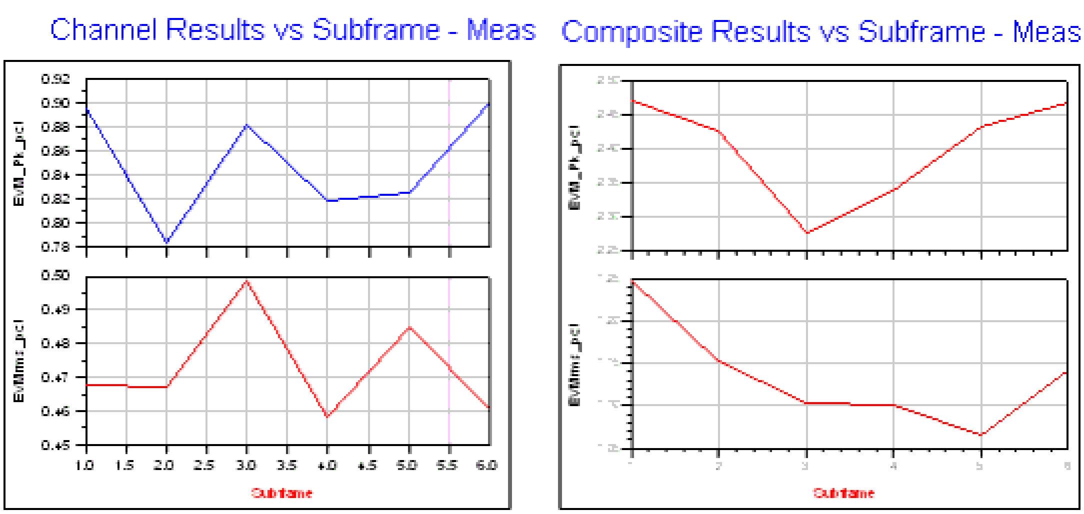
Result	Description
Avg_ChEVMrms_pct	average channel EVM rms in %
ChEVMrms_pct	channel EVM rms in % versus subframe
ChEVM_Pk_pct	channel peak EVM in % versus subframe
ChEVM_Pk_symbol_idx	channel peak EVM symbol index versus subframe
Avg_ChMagErr_rms_pct	average channel magnitude error rms in %
ChMagErr_rms_pct	channel magnitude error rms in % versus subframe
ChMagErr_Pk_pct	channel peak magnitude error in % versus subframe
ChMagErr_Pk_symbol_idx	channel peak magnitude error symbol index versus subframe
Avg_ChPhaseErr_deg	average channel phase error in degrees
ChPhaseErr_deg	channel phase error in degrees versus subframe
ChPhaseErr_Pk_deg	channel peak phase error in degrees versus subframe
ChPhaseErr_Pk_symbol_idx	channel peak phase error symbol index versus subframe
ChCodePhase_deg	channel code phase (phase of the channel code with respect to the pilot) versus subframe
Avg_CompEVMrms_pct	average composite EVM rms in %
CompEVMrms_pct	composite EVM rms in % versus subframe
CompEVM_Pk_pct	composite peak EVM in % versus subframe
CompEVM_Pk_chip_idx	composite peak EVM chip index versus subframe
Avg_CompMagErr_rms_pct	average composite magnitude error rms in %
CompMagErr_rms_pct	composite magnitude error rms in % versus subframe
CompMagErr_Pk_pct	composite peak magnitude error in % versus subframe
CompMagErr_Pk_chip_idx	composite peak magnitude error chip index versus subframe
Avg_CompPhaseErr_deg	average composite phase error in degrees
CompPhaseErr_deg	composite phase error in degrees versus subframe
CompPhaseErr_Pk_deg	composite peak phase error in degrees versus subframe
CompPhaseErr_Pk_chip_idx	composite peak phase error chip index versus subframe
Avg_Rho	average rho
Rho	rho versus subframe
Avg_FreqError_Hz	average frequency error in Hz
FreqError_Hz	frequency error in Hz versus subframe
Avg_IQ_Offset_dB	average IQ offset in dB
IQ_Offset_dB	IQ offset in dB versus subframe
Avg_QuadErr_deg	average quadrature error in degrees
QuadErr_deg	quadrature error in degrees versus subframe
Avg_GainImb_dB	average IQ gain imbalance in dB
IQ_GainImb_dB	IQ gain imbalance in dB versus subframe

If EVM_AverageType is set to RMS (Video), EVM will be measured in EVM_SubframesToAverage subframes. If EVM_AverageType is set to Off, EVM will be measured in the first subframe detected. Results named with the *Avg_* prefix are results averaged over the number of subframes specified by the user in EVM_SubframesToAverage (when EVM_AverageType is set to RMS (Video)). Results that are not named *Avg_* are results versus subframe. RF signal results are shown in RF Signal Average and Peak EVM; Meas signal results are shown in Meas Signal Average and Peak

EVM.



RF Signal Average and Peak EVM



Meas Signal Average and Peak EVM

RF signal results for averaged EVM, magnitude error, and phase error of one code channel and composite channel are shown in RF Signal EVM, Magnitude Error, and Phase Error Results; Meas signal results are shown in Meas Signal EVM, Magnitude Error, and Phase Error Results. According to the 3GPP standard, the EVM must not exceed 12.5%; EVM results for the RF and the Meas signals meet specification requirements.

Average Channel Results - RF

EVM_RF.Avg_ChEVMrms_pct
0.411

EVM_RF.Avg_ChMagErr_rms_pct
0.289

EVM_RF.Avg_ChPhaseErr_deg
0.165

Average Composite Results - RF

EVM_RF.Avg_Rho	EVM_RF.Avg_FreqError_Hz
1.000	-0.042

EVM_RF.Avg_IQ_Offset_dB	EVM_RF.Avg_QuadErr_deg	EVM_RF.Avg_GainImb_dB
-65.772	-0.011	-4.107E-4

EVM_RF.Avg_CompEVMrms_pct	EVM_RF.Avg_CompMagErr_rms_pct	EVM_RF.Avg_CompPhaseErr_deg
1.304	0.882	47.500

RF Signal EVM, Magnitude Error, and Phase Error Results

Average Channel Results - Meas

EVM_Meas.Avg_ChEVMrms_pct
0.473

EVM_Meas.Avg_ChMagErr_rms_pct
0.410

EVM_Meas.Avg_ChPhaseErr_deg
0.134

Average Composite Results - Meas

EVM_Meas.Avg_Rho	EVM_Meas.Avg_FreqError_Hz
1.000	-0.151

EVM_Meas.Avg_IQ_Offset_dB	EVM_Meas.Avg_QuadErr_deg	EVM_Meas.Avg_GainImb_dB
-66.800	-0.010	4.404E-4

EVM_Meas.Avg_CompEVMrms_pct	..._Meas.Avg_CompMagErr_rms_pct	...M_Meas.Avg_CompPhaseErr_deg
1.135	0.834	44.483

Meas Signal EVM, Magnitude Error, and Phase Error Results

Test Bench Variables for Data Displays

Reference variables used to set up this test bench are listed in Test Bench Equations Derived from Test Bench Parameters and Exported to Data Display.

Test Bench Equations Derived from Test Bench Parameters and Exported to Data Display

Data Display Parameter	Equation with Test Bench Parameters
RF_FSource	FSource
RF_Power_dBm	10 × log10(SourcePower)+30
RF_R	SourceR
TimeStep	1/(ChipRate × SamplesPerChip)
ActiveSlot	ActiveTimeslot
SubframeTime	5 msec
FilterLength	RRC_FilterLength
Meas_FMeasurement	FMeasurement
Meas_R	MeasR

Baseline Performance

- Test Computer Configuration
    - Pentium IV 2.4 GHz, 512 MB RAM, Red Hat Linux 7.3
- Conditions
    - Measurements made with default test bench settings.
    - RF DUT is an RF system behavior component.
    - The number of time points in one TD-SCDMA downlink subframe is a function of SamplesPerChip and ChipRate.
      SamplesPerChip = 8
      ChipRate = 1.28 Mb/s
    - Resultant WTB_TimeStep = 97.65625 nsec; SubframeTime = 5msec; time points per subframe = 51200.
- Simulation times and memory requirements:

TDSCDMA_DnLnk_TX Measurement	**Bursts Measured**	**Simulation Time (sec)**	**ADS Processes (MB)**
RF_Envelope	1	14	125
Constellation	3	17	124
Power	3	175	122
Spectrum	3	24	142
EVM	3	13	108

Expected ADS Performance

Expected ADS performance is the combined performance of the baseline test bench and the RF DUT Circuit Envelope simulation with the same signal and number of time points. For example, if the RF DUT performance with Circuit Envelope simulation alone takes 2 hours and consumes 200 MB of memory (excluding the memory consumed by the core ADS product), then add these numbers to the Baseline Performance numbers to determine the expected ADS performance. This is valid only if the full memory consumed is from RAM. If RAM is less, larger simulation times may result due to increased disk access time for swap memory usage.

References for Downlink Transmitter Test

1. 3GPP TS 25.221, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Physical channels and mapping of transport channels onto physical channels (TDD) (Release 4)," version 4.5.0, June, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25221-450.zip]
2. 3GPP TS 25.223, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Spreading and modulation (TDD) (Release 4)," version 4.4.0, March, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25223-440.zip]
3. 3GPP TS 25.105, "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; BS Radio transmission and Reception (TDD) (Release 4)," version 4.5.0, June, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25105-450.zip]
4. 3GPP TS 25.142 V4.5.0 "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; Base station conformance testing (TDD) (Release 4)," version 4.5.0, June, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25142-450.zip]

Setting up a Wireless Test Bench Analysis in the *Wireless Test Bench Simulation* documentation explains how to use test bench windows and dialogs to perform analysis tasks.
Setting Circuit Envelope Analysis Parameters in the *Wireless Test Bench Simulation* documentation explains how to set up circuit envelope analysis parameters such as convergence criteria, solver selection, and initial guess.
Setting Automatic Verification Modeling Parameters in the *Wireless Test Bench Simulation* documentation explains how to improve simulation speed.

Measurement Results for Expressions for TD-SCDMA Wireless Test Benches

Measurement results from a wireless test bench have associated names that can be used in Expressions. Those expressions can further be used in specifying goals for Optimization and Monte Carlo/Yield analysis. For details on using expressions, see *Measurement Expressions* (expmeas). For details on setting analysis goals using Optimization and Monte Carlo/Yield analysis, see *Tuning, Optimization, and Statistical Design* (optstat).

You can use an expression to determine the measurement result independent variable name and its minimum and maximum values. The following example expressions show how to obtain these measurement details where MeasResults is the name of the measurement result of interest:

- The *Independent Variable Name* for this measurement result is obtained by using the expression
  `indep(MeasResults)`
- The *Minimum Independent Variable Value* for this measurement result is obtained by using the expression
  `min(indep(MeasResults))`
- The *Maximum Independent Variable Value* for this measurement result is obtained by using the expression
  `max(indep(MeasResults))`
  TDSCDMA_UpLnk_TX Measurement Results (adswtb3g) through *TDSCDMA_DnLnk_RX_ACS Measurement Results* (adswtb3g) list the measurement result names and independent variable name for each test bench measurement. Expressions defined in a MeasEqn block must use the full *Measurement Results Name* listed. Expressions used in the Data Display may omit the leading test bench name. You can also locate details on the measurement result minimum and maximum independent variable values by

- Referring to the measurement parameter descriptions when they are available (not all measurement parameter descriptions identify these minimum and maximum values).
- Observing the minimum and maximum independent variable values in the Data Display for the measurement.

TDSCDMA_UpLnk_TX Measurement Results

Measurement Results Name	Independent Variable Name
Envelope	
TDSCDMA_UpLnk_TX.RF_V	time
TDSCDMA_UpLnk_TX.Meas_V	time
Constellation	

TDSCDMA_UpLnk_TX.ConstellationRF.Constellation	Index
TDSCDMA_UpLnk_TX.ConstellationMeas.Constellation	Index
Power	
TDSCDMA_UpLnk_TX.PowerRF.CCDF.CCDF	Index
TDSCDMA_UpLnk_TX.PowerRF.CCDF.MeanPower_dBm	Index
TDSCDMA_UpLnk_TX.PowerRF.CCDF.PeakPower_dBm	Index
TDSCDMA_UpLnk_TX.PowerRF.CCDF.SignalRange_dB	Index
TDSCDMA_UpLnk_TX.PowerRF.Power.AverageTotalPower	Index
TDSCDMA_UpLnk_TX.PowerRF.Power.PowerVsTime	Index
TDSCDMA_UpLnk_TX.PowerMeas.CCDF.CCDF	Index
TDSCDMA_UpLnk_TX.PowerMeas.CCDF.MeanPower_dBm	Index
TDSCDMA_UpLnk_TX.PowerMeas.CCDF.PeakPower_dBm	Index
TDSCDMA_UpLnk_TX.PowerMeas.CCDF.SignalRange_dB	Index
TDSCDMA_UpLnk_TX.PowerMeas.Power.AverageTotalPower	Index
TDSCDMA_UpLnk_TX.PowerMeas.Power.PowerVsTime	Index
Spectrum	
TDSCDMA_UpLnk_TX.SpecRF	freq
TDSCDMA_UpLnk_TX.SpecMeas	freq
EVM	
TDSCDMA_UpLnk_TX.EVM_RF.Avg_ChEVMrms_pct	Index
TDSCDMA_UpLnk_TX.EVM_RF.Avg_ChMagErr_rms_pct	Index
TDSCDMA_UpLnk_TX.EVM_RF.Avg_ChPhaseErr_deg	Index
TDSCDMA_UpLnk_TX.EVM_RF.Avg_CompEVMrms_pct	Index
TDSCDMA_UpLnk_TX.EVM_RF.Avg_CompMagErr_rms_pct	Index
TDSCDMA_UpLnk_TX.EVM_RF.Avg_CompPhaseErr_deg	Index
TDSCDMA_UpLnk_TX.EVM_RF.Avg_FreqError_Hz	Index
TDSCDMA_UpLnk_TX.EVM_RF.Avg_GainImb_dB	Index
TDSCDMA_UpLnk_TX.EVM_RF.Avg_IQ_Offset_db	Index
TDSCDMA_UpLnk_TX.EVM_RF.Avg_QuadErr_deg	Index
TDSCDMA_UpLnk_TX.EVM_RF.Avg_Rho	Index
TDSCDMA_UpLnk_TX.EVM_RF.ChCodePhase_deg	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.ChEVMrms_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.ChEVM_Pk_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.ChEVM_Pk_symbols_idx	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.ChMagErr_Pk_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.ChMagErr_Pk_symbols_idx	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.ChMagErr_rms_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.ChPhaseErr_deg	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.ChPhaseErr_Pk_deg	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.ChPhaseErr_Pk_Symbols_idx	Subframe

TDSCDMA_UpLnk_TX.EVM_RF.CompEVMrm_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.CompEVM_Pk_chip_idx	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.CompEVM_Pk_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.CompMagErr_Pk_chip_idx	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.CompMagErr_Pk_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.CompMagErr_rms_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.CompPhaseErr_deg	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.CompPhaseErr_Pk_chip_idx	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.CompPhaseErr_Pk_deg	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.FreqError_Hz	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.GainImb_dB	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.IQ_Offset_dB	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.QuadErr_deg	Subframe
TDSCDMA_UpLnk_TX.EVM_RF.Rho	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.Avg_ChEVMrms_pct	Index
TDSCDMA_UpLnk_TX.EVM_Meas.Avg_ChMagErr_rms_pct	Index
TDSCDMA_UpLnk_TX.EVM_Meas.Avg_ChPhaseErr_deg	Index
TDSCDMA_UpLnk_TX.EVM_Meas.Avg_CompEVMrms_pct	Index
TDSCDMA_UpLnk_TX.EVM_Meas.Avg_CompMagErr_rms_pct	Index
TDSCDMA_UpLnk_TX.EVM_Meas.Avg_CompPhaseErr_deg	Index
TDSCDMA_UpLnk_TX.EVM_Meas.Avg_FreqError_Hz	Index
TDSCDMA_UpLnk_TX.EVM_Meas.Avg_GainImb_dB	Index
TDSCDMA_UpLnk_TX.EVM_Meas.Avg_IQ_Offset_db	Index
TDSCDMA_UpLnk_TX.EVM_Meas.Avg_QuadErr_deg	Index
TDSCDMA_UpLnk_TX.EVM_Meas.Avg_Rho	Index
TDSCDMA_UpLnk_TX.EVM_Meas.ChCodePhase_deg	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.ChEVMrms_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.ChEVM_Pk_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.ChEVM_Pk_symbols_idx	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.ChMagErr_Pk_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.ChMagErr_Pk_symbols_idx	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.ChMagErr_rms_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.ChPhaseErr_deg	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.ChPhaseErr_Pk_deg	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.ChPhaseErr_Pk_Symbols_idx	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.CompEVMrm_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.CompEVM_Pk_chip_idx	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.CompEVM_Pk_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.CompMagErr_Pk_chip_idx	Subframe

TDSCDMA_UpLnk_TX.EVM_Meas.CompMagErr_Pk_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.CompMagErr_rms_pct	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.CompPhaseErr_deg	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.CompPhaseErr_Pk_chip_idx	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.CompPhaseErr_Pk_deg	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.FreqError_Hz	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.GainImb_dB	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.IQ_Offset_dB	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.QuadErr_deg	Subframe
TDSCDMA_UpLnk_TX.EVM_Meas.Rho	Subframe

TDSCDMA_DnLnk_TX Measurement Results

Measurement Results Name	Independent Variable Name
Envelope	
TDSCDMA_DnLnk_TX.RF_V	time
TDSCDMA_DnLnk_TX.Meas_V	time
Constellation	
TDSCDMA_DnLnk_TX.ConstellationRF.Constellation	Index
TDSCDMA_DnLnk_TX.ConstellationMeas.Constellation	Index
Power	
TDSCDMA_DnLnk_TX.PowerRF.CCDF.CCDF	Index
TDSCDMA_DnLnk_TX.PowerRF.CCDF.MeanPower_dBm	Index
TDSCDMA_DnLnk_TX.PowerRF.CCDF.PeakPower_dBm	Index
TDSCDMA_DnLnk_TX.PowerRF.CCDF.SignalRange_dB	Index
TDSCDMA_DnLnk_TX.PowerRF.Power.AverageTotalPower	Index
TDSCDMA_DnLnk_TX.PowerRF.Power.PowerVsTime	Index
TDSCDMA_DnLnk_TX.PowerMeas.CCDF.CCDF	Index
TDSCDMA_DnLnk_TX.PowerMeas.CCDF.MeanPower_dBm	Index
TDSCDMA_DnLnk_TX.PowerMeas.CCDF.PeakPower_dBm	Index
TDSCDMA_DnLnk_TX.PowerMeas.CCDF.SignalRange_dB	Index
TDSCDMA_DnLnk_TX.PowerMeas.Power.AverageTotalPower	Index
TDSCDMA_DnLnk_TX.PowerMeas.Power.PowerVsTime	Index
Spectrum	
TDSCDMA_DnLnk_TX.SpecRF	freq
TDSCDMA_DnLnk_TX.SpecMeas	freq
EVM	
TDSCDMA_DnLnk_TX.EVM_RF.Avg_ChEVMrms_pct	Index
TDSCDMA_DnLnk_TX.EVM_RF.Avg_ChMagErr_rms_pct	Index

TDSCDMA_DnLnk_TX.EVM_RF.Avg_ChPhaseErr_deg	Index
TDSCDMA_DnLnk_TX.EVM_RF.Avg_CompEVMrms_pct	Index
TDSCDMA_DnLnk_TX.EVM_RF.Avg_CompMagErr_rms_pct	Index
TDSCDMA_DnLnk_TX.EVM_RF.Avg_CompPhaseErr_deg	Index
TDSCDMA_DnLnk_TX.EVM_RF.Avg_FreqError_Hz	Index
TDSCDMA_DnLnk_TX.EVM_RF.Avg_GainImb_dB	Index
TDSCDMA_DnLnk_TX.EVM_RF.Avg_IQ_Offset_db	Index
TDSCDMA_DnLnk_TX.EVM_RF.Avg_QuadErr_deg	Index
TDSCDMA_DnLnk_TX.EVM_RF.Avg_Rho	Index
TDSCDMA_DnLnk_TX.EVM_RF.ChCodePhase_deg	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.ChEVMrms_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.ChEVM_Pk_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.ChEVM_Pk_symbols_idx	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.ChMagErr_Pk_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.ChMagErr_Pk_symbols_idx	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.ChMagErr_rms_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.ChPhaseErr_deg	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.ChPhaseErr_Pk_deg	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.ChPhaseErr_Pk_Symbols_idx	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.CompEVMrm_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.CompEVM_Pk_chip_idx	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.CompEVM_Pk_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.CompMagErr_Pk_chip_idx	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.CompMagErr_Pk_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.CompMagErr_rms_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.CompPhaseErr_deg	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.CompPhaseErr_Pk_chip_idx	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.CompPhaseErr_Pk_deg	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.FreqError_Hz	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.GainImb_dB	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.IQ_Offset_dB	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.QuadErr_deg	Subframe
TDSCDMA_DnLnk_TX.EVM_RF.Rho	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.Avg_ChEVMrms_pct	Index
TDSCDMA_DnLnk_TX.EVM_Meas.Avg_ChMagErr_rms_pct	Index
TDSCDMA_DnLnk_TX.EVM_Meas.Avg_ChPhaseErr_deg	Index
TDSCDMA_DnLnk_TX.EVM_Meas.Avg_CompEVMrms_pct	Index
TDSCDMA_DnLnk_TX.EVM_Meas.Avg_CompMagErr_rms_pct	Index
TDSCDMA_DnLnk_TX.EVM_Meas.Avg_CompPhaseErr_deg	Index
TDSCDMA_DnLnk_TX.EVM_Meas.Avg_FreqError_Hz	Index

TDSCDMA_DnLnk_TX.EVM_Meas.Avg_GainImb_dB	Index
TDSCDMA_DnLnk_TX.EVM_Meas.Avg_IQ_Offset_db	Index
TDSCDMA_DnLnk_TX.EVM_Meas.Avg_QuadErr_deg	Index
TDSCDMA_DnLnk_TX.EVM_Meas.Avg_Rho	Index
TDSCDMA_DnLnk_TX.EVM_Meas.ChCodePhase_deg	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.ChEVMrms_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.ChEVM_Pk_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.ChEVM_Pk_symbols_idx	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.ChMagErr_Pk_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.ChMagErr_Pk_symbols_idx	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.ChMagErr_rms_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.ChPhaseErr_deg	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.ChPhaseErr_Pk_deg	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.ChPhaseErr_Pk_Symbols_idx	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.CompEVMrm_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.CompEVM_Pk_chip_idx	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.CompEVM_Pk_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.CompMagErr_Pk_chip_idx	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.CompMagErr_Pk_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.CompMagErr_rms_pct	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.CompPhaseErr_deg	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.CompPhaseErr_Pk_chip_idx	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.CompPhaseErr_Pk_deg	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.FreqError_Hz	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.GainImb_dB	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.IQ_Offset_dB	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.QuadErr_deg	Subframe
TDSCDMA_DnLnk_TX.EVM_Meas.Rho	Subframe

TDSCDMA_DnLnk_MultiCarrier_TX Measurement Result

Measurement Results Name	Independent Variable Name
Power	
TDSCDMA_DnLnk_MultiCarrier_TX.RF_Power.CCDF	Index
TDSCDMA_DnLnk_MultiCarrier_TX.RF_Power.MeanPower_dBm	Index
TDSCDMA_DnLnk_MultiCarrier_TX.RF_Power.PeakPower_dBm	Index
TDSCDMA_DnLnk_MultiCarrier_TX.RF_Power.SignalRange_dB	Index
TDSCDMA_DnLnk_MultiCarrier_TX.Meas_Power.CCDF	Index
TDSCDMA_DnLnk_MultiCarrier_TX.Meas_Power.MeanPower_dBm	Index
TDSCDMA_DnLnk_MultiCarrier_TX.Meas_Power.PeakPower_dBm	Index
TDSCDMA_DnLnk_MultiCarrier_TX.Meas_Power.SignalRange_dB	Index
TDSCDMA_DnLnk_MultiCarrier_TX.SC_Power.CCDF	Index
TDSCDMA_DnLnk_MultiCarrier_TX.SC_Power.MeanPower_dBm	Index
TDSCDMA_DnLnk_MultiCarrier_TX.SC_Power.PeakPower_dBm	Index
TDSCDMA_DnLnk_MultiCarrier_TX.SC_Power.SignalRange_dB	Index
Spectrum	
TDSCDMA_DnLnk_MultiCarrier_TX.RF_Spectrum	freq
TDSCDMA_DnLnk_MultiCarrier_TX.Meas_Spectrum	freq
TDSCDMA_DnLnk_MultiCarrier_TX.SC_Spectrum	freq

TDSCDMA_UpLnk_RX_Sensitivity Measurement Results

Measurement Results Name	Independent Variable Name
RX Sensitivity	
TDSCDMA_UpLnk_RX_Sensitivity.Meas_BER	Index

TDSCDMA_DnLnk_RX_ACS Measurement Results

Measurement Results Name	Independent Variable Name
RX ACR	
TDSCDMA_DnLnk_RX_ACS.Meas_BER	Index

RF DUT Limitations for TD-SCDMA Wireless Test Benches

This section describes test bench use with typical RF DUTs, improving test bench performance when certain RF DUT types are used, and improving simulation fidelity. Two sections regarding special attention for Spectum and EVM transmission measurements is also included.

The RF DUT, in general, may be a circuit design with any combination and quantity of analog and RF components, transistors, resistors, capacitors, etc. suitable for simulation with the Circuit Envelope simulator. More complex RF circuits will take more time to simulate and will consume more memory.

Test bench simulation time and memory requirements can be considered to be the combination of the requirements for the baseline test bench measurement with the simplest RF circuit plus the requirements for a Circuit Envelope simulation for the RF DUT of interest.

An RF DUT connected to a wireless test bench can generally be used with the test bench to perform default measurements by setting the test bench *Required Parameters* . Default measurement parameter settings can be used (exceptions described below), for a typical RF DUT that:

- Requires an input (RF) signal with constant RF carrier frequency.
  The test bench RF signal source output does not produce an RF signal whose RF carrier frequency varies with time. However, the test bench will support an output (RF) signal that contains RF carrier phase and frequency modulation as can be represented with suitable I and Q envelope variations on a constant RF carrier frequency.
- Produces an output (Meas) signal with constant RF carrier frequency.
  The test bench input (Meas) signal must not contain a carrier frequency whose frequency varies with time. However, the test bench will support an input (Meas) signal that contains RF carrier phase noise or contains time varying Doppler shifts of the RF carrier. These signal perturbations are expected to be represented with suitable I and Q envelope variations on a constant RF carrier frequency.
- Requires an input (RF) signal from a signal generator with a 50-ohm source resistance. Otherwise, set the SourceR parameter value in the *Basic Parameters* tab.
- Requires an input (RF) signal with no additive thermal noise (TX test benches) or source resistor temperature set to 16.85^{o} C (RX test benches). Otherwise, set the SourceTemp (TX and RX test benches) and EnableSourceNoise (TX test benches) parameters in the *Basic Parameters* tab.
- Requires an input (RF) signal with no spectrum mirroring. Otherwise, set the MirrorSourceSpectrum parameter value in the *Basic Parameters* tab.
- Produces an output (Meas) signal that requires a 50-ohm external load resistance. Otherwise, set the MeasR parameter value in the *Basic Parameters* tab.
- Produces an output (Meas) signal with no spectrum mirroring. Otherwise, set the MirrorMeasSpectrum parameter value in the *Basic Parameters* tab.

- Relies on the test bench for any measurement-related bandpass signal filtering of the RF DUT output (Meas) signal.
    - When the RF DUT contains a bandpass filter with bandwidth that is on the order of the test bench receiver system (~1 times the test bench receiver bandwidth) and the user wants a complete characterization of the RF DUT filter, the default time CE_TimeStep must be set smaller.
    - When the RF DUT bandpass filter is much wider than the test bench receiver system (>2 times the test bench receiver bandwidth), the user may not want to use the smaller CE_TimeStep time step to fully characterize it because the user knows the RF DUT bandpass filter has little or no effect in the modulation bandwidth in this case.

Improving Test Bench Performance

This section provides information regarding improving test bench performance when certain RF DUT types are used.

- Analog/RF models (TimeDelay and all transmission line models) used with Circuit Envelope simulation that perform linear interpolation on time domain waveforms for modeling time delay characteristics that are not an integer number of CE_TimeStep units. Degradation is likely in some measurements, especially EVM.
  This limitation is due to the linear interpolation between two successive simulation time points, which degrades waveform quality and adversely affects EVM measurements.
  To avoid this kind of simulator-induced waveform quality degradation: avoid use of Analog/RF models that rely on linear interpolation on time domain characteristics; or, reduce the test bench CE_TimeStep time step by a factor of 4 below the default CE_TimeStep (simulation time will be 4 times longer).

- Analog/RF lumped components (R, L, C) used to provide bandpass filtering with a bandwidth as small as the wireless signal RF information bandwidth are likely to cause degradation in some measurements, especially Spectrum. These circuit filters require much smaller CE_TimeStep values than would otherwise be required for RF DUT circuits with broader bandwidths.
  This limitation is due to the smaller Circuit Envelope simulation time steps required to resolve the differential equations for the L, C components when narrow RF bandwidths are involved. Larger time steps degrade the resolution of the simulated bandpass filtering effects and do not result in accurate frequency domain measurements, especially Spectrum and EVM measurements (when the wireless technology is sensitive to frequency domain distortions).
  To determine that your lumped component bandwidth filter requires smaller CE_TimeStep, first characterize your filter with Harmonic Balance simulations over the modulation bandwidth of interest centered at the carrier frequency of interest. Though it is difficult to identify an exact guideline on the Circuit Envelope time step required for good filter resolution, a reasonable rule is to set the CE_TimeStep to 1/(double-sided 3dB bandwidth)/32.
  To avoid this kind of simulator-induced waveform quality degradation, avoid the use of R, L, C lumped filters with bandwidths as narrow as the RF signal information

bandwidth, or reduce the CE_TimeStep.

- Analog/RF data-based models (such as S-parameters and noise parameters in S2P data files) used to provide RF bandpass filtering with a bandwidth as small as 1.5 times the wireless signal RF information bandwidth are likely to cause degradation in some measurements, especially EVM.
  This limitation is due to causal S-parameter data about the signal carrier frequency requiring a sufficient number of frequency points within the modulation bandwidth; otherwise, the simulated data may cause degraded signal waveform quality. In general, there should be more than 20 frequency points in the modulation bandwidth; more is required if the filter that the S-parameter data represents has fine-grain variations at small frequency steps.
  To avoid this kind of simulator-induced waveform quality degradation, avoid the use of data-based models with bandwidths as narrow as the RF signal information bandwidth, or increase the number of frequency points in the data file within the modulation bandwidth and possibly also reduce the CE_TimeStep simulation time step.

- An additional limitation exists when noise data is included in the data file. Circuit Envelope simulation technology does not provide frequency-dependent noise within the modulation bandwidth for this specific case when noise is from a frequency domain data file. This may result in output noise power that is larger than expected; if the noise power is large enough, it may cause degraded signal waveform quality. To avoid this kind of simulator-induced waveform quality degradation avoid the use of noise data in the data-based models or use an alternate noise model.

Improving Simulation Fidelity

Some RF circuits will provide better Circuit Envelope simulation fidelity if the CE_TimeStep is reduced.

- In general, the default setting of the test bench SamplesPerChip provides adequate wireless signal definition and provides the WTB_TimeStep default value.
- Set CE_TimeStep = 1/(1.28e6×SamplesPerChip×N)
  where N is an integer ≥ 1
- When CE_TimeStep is less than the WTB_TimeStep (i.e., N>1), the RF signal to the RF DUT is automatically upsampled from the WTB_TimeStep and the RF DUT output signal is automatically downsampled back to the WTB_TimeStep. This sampling introduces a time delay to the RF DUT of 10×WTB_TimeStep and a time delay of the measured RF DUT output signal of 20×WTB_TimeStep relative to the measured RF signal sent to the RF DUT prior to its upsampling.

Special Attention for Spectrum Measurements

The Spectrum Measurement spectrum may have a mask against which the spectrum must be lower in order to pass the wireless specification. The Spectrum measurement itself is based on DSP algorithms that result in as much as 15 dB low-level spectrum variation at frequencies far from the carrier.

To reduce this low-level spectrum variation, a moving average can be applied to the spectrum using the moving_average(<data>, 20) measurement expression for a 20-point moving average. This will give a better indication of whether the measured signal meets the low-level spectrum mask specification at frequencies far from the carrier.

Special Attention for EVM Measurements

For the EVM measurement, the user can specify a start time. The EVM for the initial wireless segment may be unusually high (due to signal startup transient effects or other reasons) that cause a mis-detected first frame that the user does not want included in the RF DUT EVM measurement.

To remove the degraded initial burst EVM values from the RF DUT EVM measurement, set the EVM_Start to a value greater than or equal to the RF DUT time delay characteristic.

Uplink Receiver Sensitivity Test

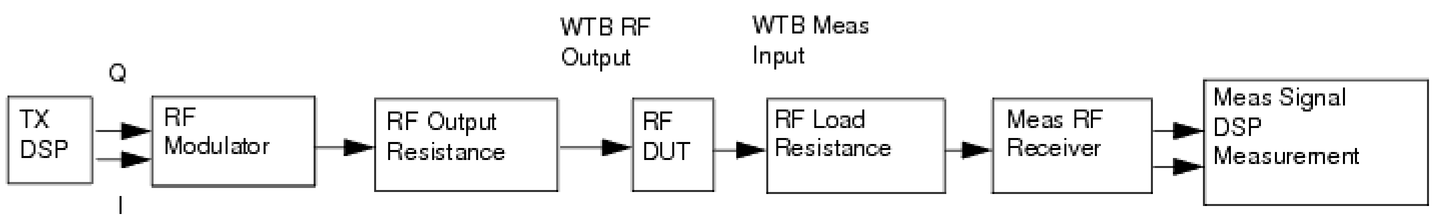
Introduction

TDSCDMA_UpLnk_RX_Sensitivity test bench for TD-SCDMA uplink (user equipment to base station) receiver reference sensitivity testing provides a way for users to connect to an RF circuit device under test (RF DUT) and determine its sensitivity performance by BER measurements. Reference sensitivity is the minimum input power at the receiver antenna connector at which the BER does exceed a specified value.

The signal and measurements in this test bench are designed according to 3GPP TS 25.142 section 7.2.

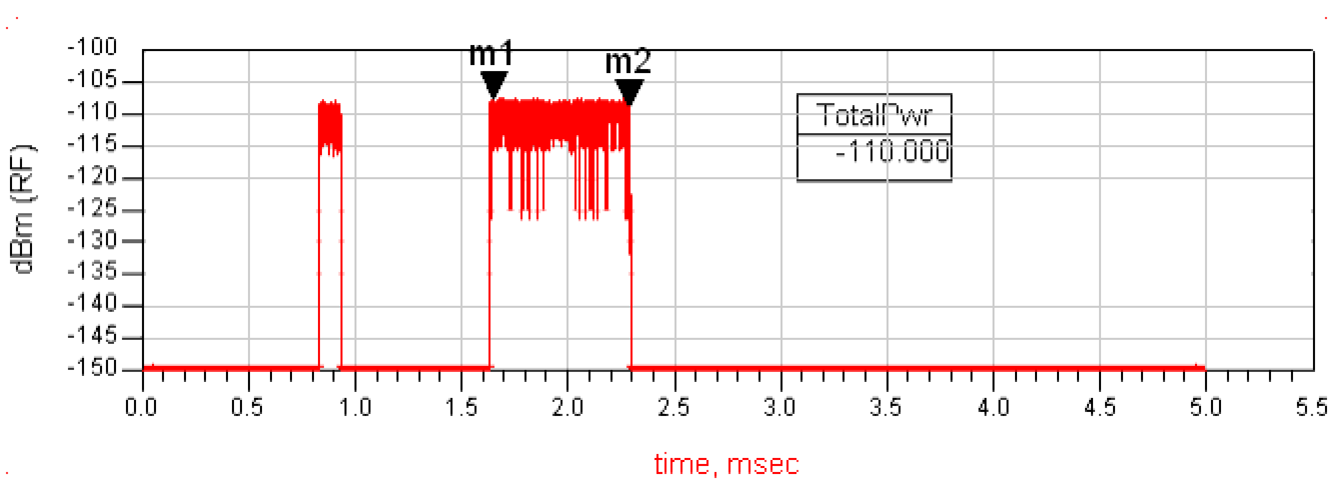
This TD-SCDMA signal source model is compatible with Agilent Signal Studio software option 411. Details regarding Signal Studio for TD-SCDMA are included at the website http://www.agilent.com/find/signalstudio .

This test bench includes a TX DSP section, an RF modulator, RF output source resistance, an RF DUT connection, RF receivers, and DSP measurement blocks as illustrated in Receiver Wireless Test Bench Block Diagram. The generated test signal is sent to the DUT.



Receiver Wireless Test Bench Block Diagram

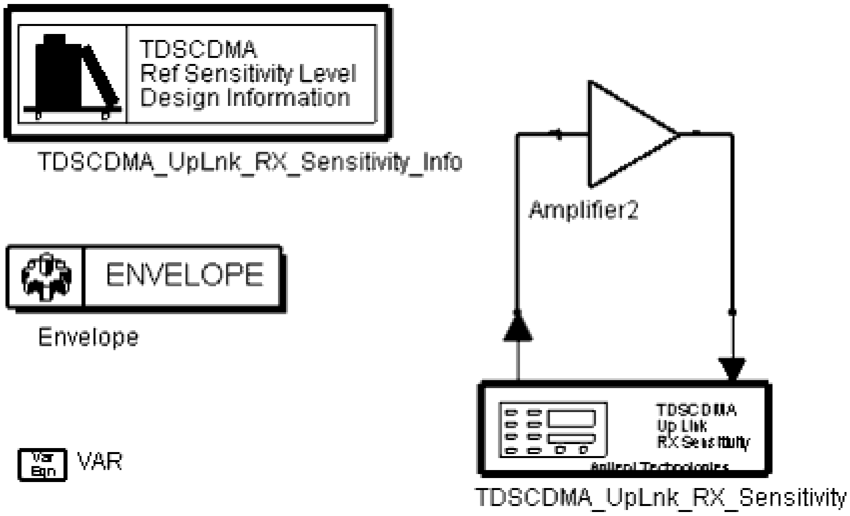
TD-SCDMA RF power delivered into a matched load is the average power delivered in the selected time slot TS2 in the TD-SCDMA subframe. RF Signal Uplink Envelope shows the RF envelope for an output signal with -110 dBm power.



RF Signal Uplink Envelope

Test Bench Basics

A template is provided for this test bench.



TDSCDMA Uplink Receiver Sensitivity Test Bench

To access the template:

1. In an Analog/RF schematic window select *Insert* > *Template.*
2. In the *Insert* > *Template* dialog box, choose *TDSCDMA_UpLnk_RX_Sensitivity_test* , click *OK* ; click left to place the template in the schematic window.

An example design using this template is available; from the ADS Main window click *File* > *Open* > *Example* > TDSCDMA > TDSCDMA_RF_Verification_wrk > *TDSCDMA_UpLnk_RX_Sensitivity* _test.

The basics for using the test bench are:

- Replace the DUT (Amplifier2 is provided with this template) with an RF DUT that is suitable for this test bench.
- CE_TimeStep, FSource, SourcePower, and FMeasurement parameter default values are typically accepted; otherwise, set values based on your requirements.
- Run the simulation and view Data Display page(s) for your measurement(s).

For details, refer to Test Bench Details.

Test Bench Details

The following sections provide details for setting up a test bench, setting measurement parameters for more control of the test bench, simulation measurement displays, and baseline performance.
Open and use the *TDSCDMA_UpLnk_RX_Sensitivity_test* template:

1. In an Analog/RF schematic window select *Insert > Template.*
2. In the *Insert > Template* dialog box, choose *TDSCDMA_UpLnk_RX_Sensitivity_test* , click *OK* ; click left to place the template in the schematic window.

Test bench setup is detailed here.

1. Replace the DUT (Amplifier2 is provided with this template) with an RF DUT that is suitable for this test bench.
   For information regarding using certain types of DUTs, see *RF DUT Limitations for TD-SCDMA Wireless Test Benches* (adswtbtds).
2. Set the *Required Parameters*

   > **Note**
   > Refer to *TDSCDMA_UpLnk_RX_Sensitivity* (adswtbtds) for a complete list of parameters for this test bench.

   Generally, default values can be accepted; otherwise, values can be changed by the user as needed.

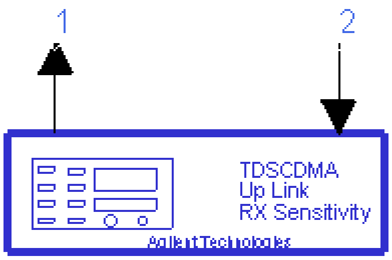
   - Set CE_TimeStep.
     Cosimulation occurs between the test bench (using ADS Ptolemy Data Flow simulation technology) and the DUT (using Circuit Envelope simulation technology). Each technology requires its own simulation time step with time-step coordination occurring in the interface between the technologies.
     CE_TimeStep defines the Circuit Envelope simulation time step to be used with this DUT. The CE_TimeStep must be set to a value equal to or a submultiple of (less than) WTB_TimeStep; otherwise, simulation will stop and an error message will be displayed.
     Note that WTB_TimeStep is not user-settable. Its value is derived from other test bench parameter values; with default settings WTB_TimeStep= 97.65625 nsec. The value is displayed in the Data Display pages as TimeStep.
     WTB_TimeStep = 1/(ChipRate × SamplesPerChip)
     where
     ChipRate is 1.28MHz
     SamplesPerChip is the number of samples per chip
   - Set FSource, SourcePower, and FMeasurement.
     - FSource defines the RF frequency for the TD-SCDMA signal input to the RF DUT.
     - SourcePower defines the power level for FSource. SourcePower is defined as the average power during the non-idle time of the TD-SCDMA signal segment.
     - FMeasurement defines the RF frequency output from the RF DUT to be measured.

3. More control of the test bench can be achieved by setting parameters on the *Basic Parameters* , *Signal Parameters* , and measurement categories for each activated measurement. For details, refer to *Setting Parameters* (adswtbtds).
4. The RF modulator (shown in the block diagram in Receiver Wireless Test Bench Block Diagram) uses FSource, SourcePower (*Required Parameters*), MirrorSourceSpectrum (*Basic Parameters)* , GainImbalance, PhaseImbalance, I OriginOffset, Q OriginOffset, and IQ Rotation (*Signal Parameters*).
   The RF output resistance uses SourceR and SourceTemp (*Basic Parameters*). The RF output signal source has a 50-ohm (default) output resistance defined by SourceR.
   RF output (and input to the RF DUT) is at the frequency specified (FSource), with the specified source resistance (SourceR) and with power (SourcePower) delivered into a matched load of resistance SourceR. The RF signal has additive Gaussian noise power set by resistor temperature (SourceTemp).
   Note that the Meas_in point of the test bench provides a resistive load to the RF DUT set by the MeasR value (50-ohm default) (*Basic Parameters*).
   The Meas signal contains linear and nonlinear signal distortions and time delays associated with the RF DUT input to output characteristics.
   The DSP block (shown in the block diagram in Receiver Wireless Test Bench Block Diagram) uses other *Signal Parameters* .
5. More control of Circuit Envelope analysis can be achieved by setting Envelope controller parameters. These settings include Enable Fast Cosim, which may speed the RF DUT simulation more than 10×. Setting these simulation options is described in *Setting Fast Cosimulation Parameters and Setting Circuit Envelope Analysis Parameters* in the *Wireless Test Bench Simulation* documentation.
6. After running a simulation, results will appear in a Data Display window for the measurement. *Simulation Measurement Displays* (adswtbtds) describes results for each measurement. For general WTB Data Display details refer to *Viewing WTB Analysis Results* (adswtbsim).

TDSCDMA_UpLnk_RX_Sensitivity

This section provides parameter information for *Required Parameters, Basic Parameters, Signal Parameters,* and parameters for the various measurements.

Symbol



Description TD-SCDMA uplink RX sensitivity
Library WTB
Class TSDFTDSCDMA_UpLnk_RX_Sensitivity
Derived From baseWTB_RX

Parameters

Name	Description	Default	Sym	Unit	Type	Range
RequiredParameters						
CE_TimeStep	Circuit envelope simulation time step	1/1.28 MHz/8		sec	real	(0, ∞)
WTB_TimeStep	Set CE_TimeStep < = 1/1.28e6/SamplesPerChip.					
FSource	Source carrier frequency	1900 MHz		Hz	real	(0, ∞)
SourcePower	Source power	dbmtow(-110.0)		W	real	[0, ∞)
FMeasurement	Measurement carrier frequency	1900 MHz		Hz	real	(0, ∞)
BasicParameters						
SourceR	Source resistance	50 Ohm		Ohm	real	(0, ∞)
SourceTemp	Source resistor temperature	16.85		Celsius	real	[-273.15, ∞)
MeasR	Measurement resistance	50 Ohm		Ohm	real	[10, 1.0e6]
MirrorSourceSpectrum	Mirror source spectrum about carrier? NO, YES	NO			enum	
MirrorMeasSpectrum	Mirror meas spectrum about carrier? NO, YES	NO			enum	
TestBenchSeed	Random number generator seed	1234567			int	[0, ∞)
SignalParameters						
GainImbalance	Gain imbalance, Q vs I	0.0		dB	real	(-∞, ∞)
PhaseImbalance	Phase imbalance, Q vs I	0.0		deg	real	(-∞, ∞)
I_OriginOffset	I origin offset (percent)	0.0			real	(-∞, ∞)
Q_OriginOffset	Q origin offset (percent)	0.0			real	(-∞, ∞)
IQ_Rotation	IQ rotation	0.0		deg	real	(-∞, ∞)
SamplesPerChip	Samples per chip	8	S		int	[2, 32]
ActiveTimeslot	Active Timeslot: TS1, TS2, TS3, TS4, TS5, TS6	TS1			enum	
RRC_FilterLength	RRC filter length (chips)	12			int	[2, 128]
BasicMidambleID	Basic midamble index	0			int	[0, 127]
MidambleID	Midamble index	1			int	[1, K]
MaxMidambleShift	Max midamble shift	16	K		int	{2, 4,6,8,10,12,14,16}
MinSF	Minimum spreading factor	8			int	{1, 2,4,8,16}
SpreadCode	Spread code index	1			int	[0, 15]
MeasurementParameters						
DisplayPages	RX uplink sensitivity measurement display pages:					
StartBlock	Start block	1			int	[0, 1000]
StopBlock	Stop block	50			int	[1, 1000]

Pin Inputs

Pin	Name	Description	Signal Type
2	Meas_In	Test bench measurement RF input from RF circuit	timed

Pin Outputs

Pin	Name	Description	Signal Type
1	RF_Out	Test bench RF output to RF circuit	timed

Setting Parameters

More control of the test bench can be achieved by setting parameters on the Basic Parameters, Signal Parameters, and measurement categories.

> **Note**
> For *required* parameter information, see *Set the Required Parameters* (adswtbtds).

Basic Parameters

1. SourceR is the RF output source resistance.
2. SourceTemp is the RF output source resistance temperature (oC) and sets noise density in the RF output signal to (k(SourceTemp+273.15)) Watts/Hz, where k is Boltzmann's constant.
3. MeasR defines the load resistance for the RF DUT output Meas signal into the test bench. This resistance loads the RF DUT output; it is also the reference resistance for Meas signal power measurements.
4. MirrorSourceSpectrum is used to invert the polarity of the Q envelope of the generated RF signal before it is sent to the RF DUT. Depending on the configuration and number of mixers in an RF transmitter, the signal at the input of the DUT may need to be mirrored. If such an RF signal is desired, set this parameter to YES.
5. MirrorMeasSpectrum is used to invert the polarity of the Q envelope in the Meas_in RF signal input to the test bench (and output from the RF DUT). Depending on the configuration and number of mixers in the RF DUT, the signal at its output may be mirrored compared to the signal generated by the signal source (before any mirroring is done because of the MirrorSourceSpectrum setting). Proper demodulation and measurement of the RF DUT output signal requires that its RF envelope is not mirrored compared to the signal generated by the signal source (before any mirroring is done because of the MirrorSourceSpectrum setting). If the Meas_in RF signal is mirrored, set this parameter to YES. Proper setting of this parameter is required for measurements on the Meas_in signal in RX text benches and results in measurement on a signal with no spectrum mirroring.
6. TestBenchSeed is an integer used to seed the random number generator used with the test bench. This value is used by all test bench random number generators, except those RF DUT components that use their own specific seed parameter. TestBenchSeed initializes the random number generation. The same seed value produces the same *random* results, thereby giving you predictable simulation results. To generate repeatable *random* output from simulation to simulation, use any positive seed value. If you want the output to be truly random, enter the seed value of 0.

Signal Parameters

1. GainImbalance, PhaseImbalance, I_OriginOffset, Q_OriginOffset, and IQ_Rotation are

used to add certain impairments to the ideal output RF signal. Impairments are added in the order described here.
The unimpaired RF I and Q envelope voltages have gain and phase imbalance applied. The RF is given by:

$$V_{RF}(t) = A\left(V_I(t)\cos(\omega_c t) - gV_Q(t)\sin\left(\omega_c t + \frac{\phi\pi}{180}\right)\right)$$

where *A* is a scaling factor that depends on the SourcePower and SourceR parameters specified by the user, $V_I(t)$ is the in-phase RF envelope, $V_Q(t)$ is the quadrature phase RF envelope, *g* is the gain imbalance

$$g = 10^{\frac{GainImbalance}{20}}$$

and, φ (in degrees) is the phase imbalance.
Next, the signal $V_{RF}(t)$ is rotated by IQ_Rotation degrees. The I_OriginOffset and Q_OriginOffset are then applied to the rotated signal. Note that the amounts specified are percentages with respect to the output rms voltage. The output rms voltage is given by sqrt(2 × SourceR × SourcePower).

2. SamplesPerChip sets the number of samples in a chip.
   The default value is set to 8 to display settings according to the 3GPP NTDD. It can be set to a larger value for a simulation frequency bandwidth wider than 8 × 1.28 MHz. It can be set to a smaller value for faster simulation; however, this will result in lower signal fidelity. If SamplesPerChip = 8, the simulation RF bandwidth is larger than the signal bandwidth by a factor of 8 (e.g., simulation RF bandwidth = 8 × 1.28 MHz).
3. ActiveTimeslot specifies which timeslot is active for the sensitivity measurement. For this uplink test bench, set ActiveTimeslot>0.
4. RRC_FilterLength sets the root raised-cosine (RRC) filter length in chips.
   The default value is set to 12 to transmit TD-SCDMA downlink signals in time and frequency domains based on the 3GPP NTDD standard [1]-[3]. It can be set to a smaller value for faster simulation; however, this will result in lower signal fidelity.
5. BasicMidambleID sets the basic midamble code ID. The basic midamble code is used for training sequences for uplink and downlink channel estimation, power measurements and maintaining uplink synchronization. There are 128 different sequences; the BasicMidambleID range is 0 to 127. In Signal Studio, Basic Midamble ID code has the same meaning as this parameter.
6. MidambleID sets the index of midambles for DPCH. Midambles of different users active in the same cell and the same time slot are cyclically shifted versions of one basic midamble code.
7. MaxMidambleShift is the maximum number of different midamble shifts in a cell that can be determined by maximum users in the cell for the current time slot.
8. MinSF is the minimum spreading factor which can be used by the physical channel.
9. SpreadCode sets the spread code index for the DPCH. For this signal source, the spreading factor is 8.
   In Signal Studio, Channelization code for Time slot setup has the same meaning as SpreadCode.

Measurement Parameters

This measurement requires setting the MirrorMeasSpectrum parameter such that there is an even number of spectrum mirrorings from the combined test bench source and RF DUT. For example, if MirrorSourceSpectrum = NO and the RF DUT causes its output RF signal to have spectrum mirroring relative to its input signal, then set MirrorMeasSpectrum = YES.

1. DisplayPages provides Data Display page information for this test bench; it is not user-editable.
2. StartBlock sets the start block. The block is the unit set of TD-SCDMA subframes for processing channel coding. One block contains four subframes. A value of 0 is the first block.
3. StopBlock sets the stop block. For example, StopBlock=50 results in a measurement of 51 blocks.

Simulation Measurement Displays

After simulation, BER results are displayed in the Data Display pages as shown in Simulation Results.

> **Note**
> Measurement results from a wireless test bench have associated names that can be used in Data Display Expressions. For more information, refer to *Measurement Results for Expressions for TD-SCDMA Wireless Test Benches* (adswtbtds).

The BER must be less than 0.001 for an input level of -110dBm, as specified for a TD-SCDMA signal with a 12.2k reference channel.

ReceivedPower_dBm	EbN0_RF_dB
-110.00	11.93

BER

Meas_BER
0.0000

Simulation Results

Parameters used in the Data Display are described in Test Bench Parameters Exported to Data Display. The EbN0_RF_dB is the local Eb/N0 measured at the input of the RF DUT and calculated by the following equations:

T = real(RF_SourceTemp) + 273.15
k = Boltzmann's constant
N0_dBm = 10*log10(k * T) + 30
EbN0_RF_dB = real(RF_Power_dBm) - N0_dBm - 10*log10(1280000*2/(2*8))
Local and system Eb/N0 are described in *Receiver Eb/No Definitions* in the Wirele *ss Test Bench Simulation* documentation.

Test Bench Variables for Data Displays

Test Bench Parameters Exported to Data Display identifies the variables exported to the data display set in this test bench:

Test Bench Parameters Exported to Data Display

Data Display Parameter	Equation with Test Bench Parameters
RF_FSource	FSource
RF_SourcePower_dBm	10*log10(SourcePower)+30
RF_SourceTemp	SourceTemp in degrees Celcius

Baseline Performance

- Test Computer Configuration
  - Pentium IV 2.4 GHz, 512 MB RAM, Red Hat Linux 7.3
- Conditions
  - Measurements made with default test bench settings.
  - RF DUT is an RF system behavior component.
  - The number of time points in one TD-SCDMA uplink subframe is a function of SamplesPerChip and ChipRate.
    SamplesPerChip = 8
    ChipRate = 1.28 Mb/s
  - Resultant WTB_TimeStep = 97.65625 nsec; SubframeTime = 5msec; time points per subframe = 51200.
- Simulation times and memory requirements:

TDSCDMA_UpLnk_Rx	Bursts Measured	Simulation Time (sec)	ADS Processes (MB)
Sensitivity	50	412	99

Expected ADS Performance

Expected ADS performance is the combined performance of the baseline test bench and the RF DUT Circuit Envelope simulation with the same signal and number of time points. For example, if the RF DUT performance with Circuit Envelope simulation alone takes 2 hours and consumes 200 MB of memory (excluding the memory consumed by the core ADS product), then add these numbers to the Baseline Performance numbers to determine the expected ADS performance. This is valid only if the full memory consumed is from RAM. If RAM is less, larger simulation times may result due to increased disk access time for swap memory usage.

References

1. 3GPP Technical Specification TS 25.142 V4.5.0 "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; Base station Conformance (TDD) (Release 4)," June, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25142-450.zip]
2. 3GPP TS 25.221, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Physical channels and mapping of transport channels onto physical channels (TDD) (Release 4)," version 4.5.0, June, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25221-450.zip]
3. 3GPP TS 25.223, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Spreading and modulation (TDD) (Release 4)," version 4.4.0, March, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25223-440.zip]
4. 3GPP TS 25.102, "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UE Radio Transmission and Reception (TDD) (Release 4)," version 4.5.0, June, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25102-450.zip]
5. 3GPP TS 34.122, "3rd Generation Partnership Project; Technical Specification Group Terminal; Terminal Conformance Specification; Radio Transmission and Reception (TDD) (Release 4)," version 4.4.0, June, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/34_series/34122-440.zip]

Setting up a Wireless Test Bench Analysis in the *Wireless Test Bench Simulation* documentation explains how to use test bench windows and dialogs to perform analysis tasks.
Setting Circuit Envelope Analysis Parameters in the *Wireless Test Bench Simulation* documentation explains how to set up circuit envelope analysis parameters such as convergence criteria, solver selection, and initial guess.
Setting Automatic Verification Modeling Parameters in the *Wireless Test Bench Simulation* documentation explains how to improve simulation speed.

Uplink Transmitter Test

Introduction

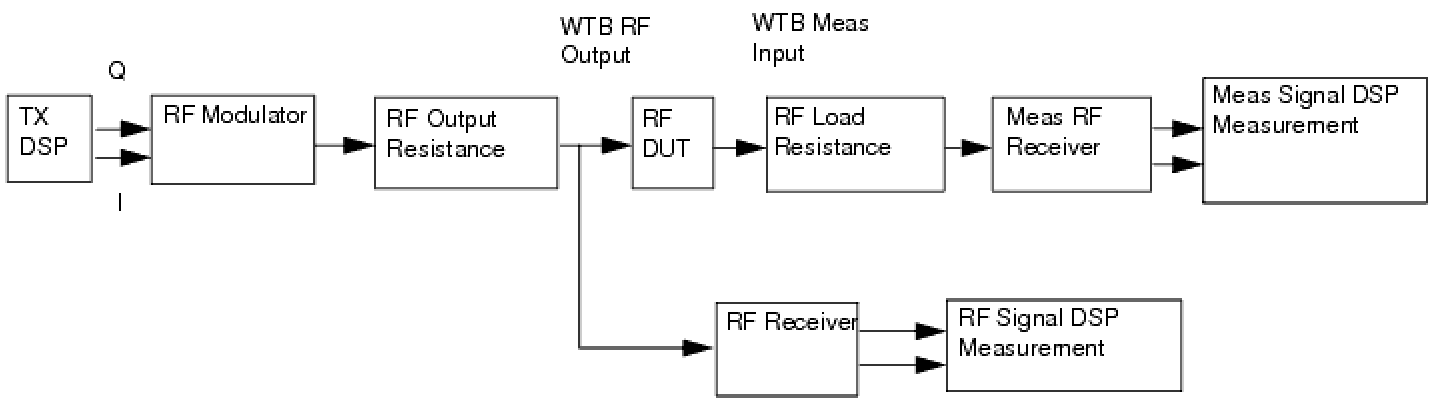
TDSCDMA_UpLnk_TX test bench for TD-SCDMA uplink (user equipment to base station) transmitter testing provides a way for users to connect to an RF circuit device under test (RF DUT) and determine its performance by activating various measurements. This test bench provides signal measurements for RF envelope, constellation, power (including power vs. time and CCDF), spectrum, and EVM.

The signal and most of the measurements are designed according to 3GPP TS 25 (Release 4).

This TD-SCDMA signal source model is compatible with Agilent Signal Studio software option 411. Details regarding Signal Studio for TD-SCDMA are included at the website http://www.agilent.com/find/signalstudio .

The DUT output signal can be sent to an Agilent ESG RF signal generator.

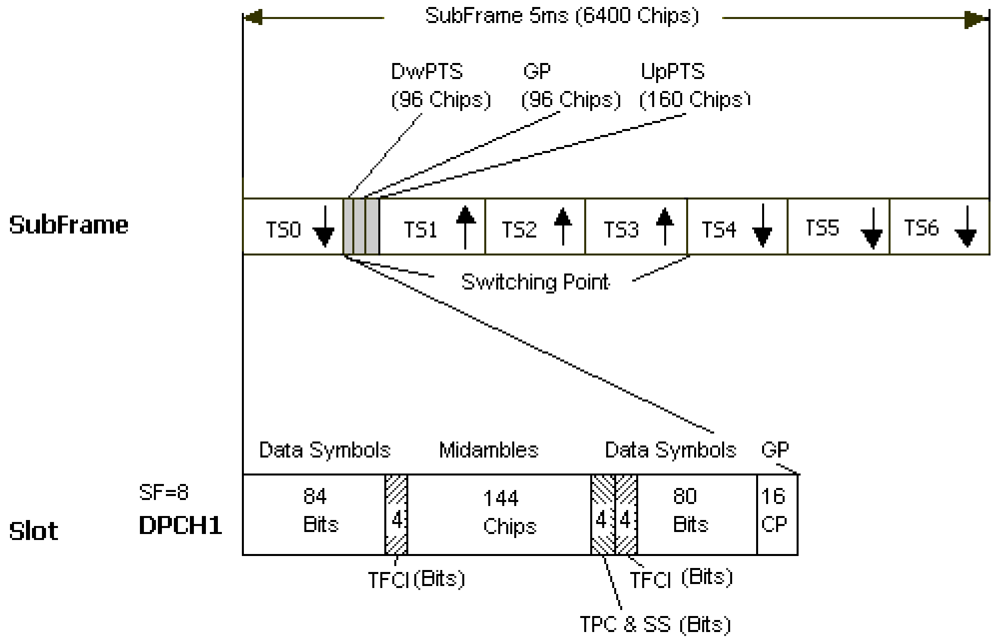
This test bench includes a DSP section, an RF modulator, RF output source resistance, RF DUT connection, RF receivers, and DSP measurement blocks, as illustrated in Transmitter Wireless Test Bench Block Diagram. The generated test signal is sent to the DUT.



Transmitter Wireless Test Bench Block Diagram

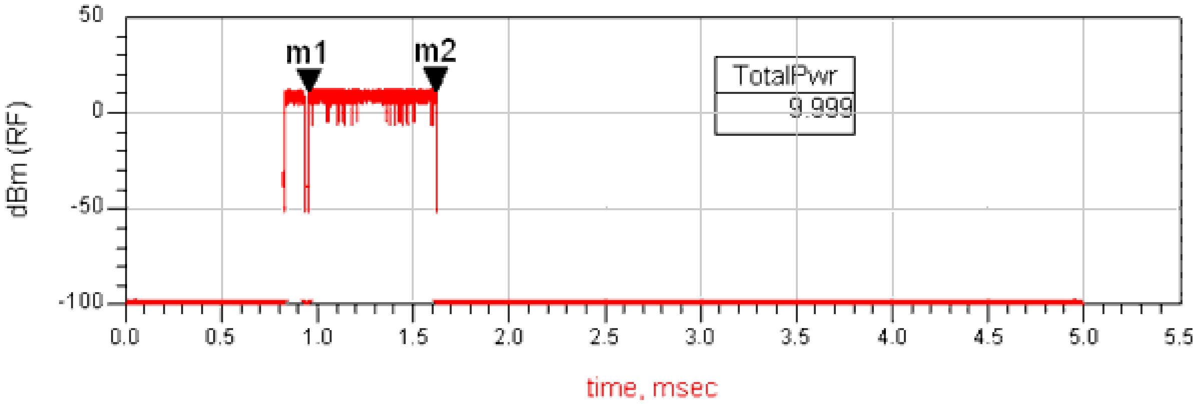
The uplink channel subframe structure is illustrated in 12.2 kbps Uplink Channel Subframe Structure. One frame consists of two subframes. Each subframe consists of 7 time slots (TS), and one downlink pilot time slot (DwPTS), one guard period (GP) and one uplink pilot time slot (UpPTS). Each time slot can transmit DPCH signals. One subframe consists of 6400 chips. Because the chip rate is 1.28 MHz, the subframe has a 5msec duration.

In the example in 12.2 kbps Uplink Channel Subframe Structure, one DPCH signal is transmitted in TS2. The DPCH bits are modulated by QPSK and spread by Walsh code of length 8 then transmitted in the slot. The DPCH signal is composed of 164 coded information bits (164 × 8/2 chips), 8 bits (8 × 8/2 chips) for transport format combination indicator (TFCI), 144 chips for midamble sequence, 2 bits (2 × 8/2 chips) for transmitter power control and 2 bits (2 × 8/2 chips) reserved (TPC and Reserved) plus 16 chips for GP. The total chips for the subframe is composed of 7 time slots plus 96 chips for DwPTS, 96 chips for GP and 160 chips for UpPTS and summarized as (164 × 4+8 × 4+144+2 × 4+2 × 4+16) × 7+160+96 × 2=6400 chips.



12.2 kbps Uplink Channel Subframe Structure

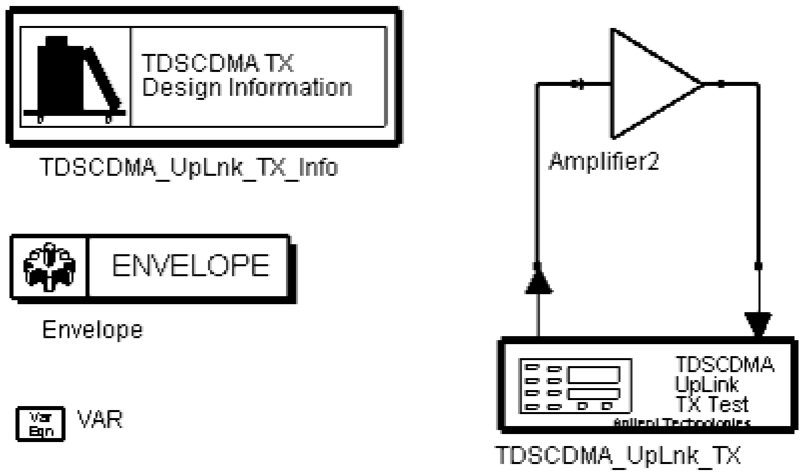
TD-SCDMA RF power delivered into a matched load is the average power delivered in the selected time slot in the TD-SCDMA subframe. RF Signal Uplink Envelope shows the RF envelope for an output signal with 10 dBm power.



RF Signal Uplink Envelope

Test Bench Basics

A template is provided for this test bench.



TDSCDMA Uplink Transmitter Test Bench

To access the template:

1. In an Analog/RF schematic window select *Insert* > *Template.*
2. In the *Insert* > *Template* dialog box, choose *TDSCDMA_UpLnk_TX_test* , click *OK* ; click left to place the template in the schematic window.

An example design using this template is available; from the ADS Main window click *File* > *Open* > *Example* > TDSCDMA > TDSCDMA_RF_Verification_wrk > TDSCDMA_UpLnk_TX_test.

The basics for using the test bench are:

- Replace the DUT (Amplifier2 is provided with this template) with an RF DUT that is suitable for this test bench.
- CE_TimeStep, FSource, SourcePower, and FMeasurement parameter default values are typically accepted; otherwise, set values based on your requirements.
- Activate/deactivate measurements based on your requirements.
- Run the simulation and view Data Display page(s) for your measurement(s).

For details, refer to Test Bench Details.

Test Bench Details

The following sections provide details for setting up a test bench, setting measurement parameters for more control of the test bench, simulation measurement displays, and baseline performance.
Open and use the *TDSCDMA_UpLnk_TX* template:

1. In an Analog/RF schematic window select *Insert > Template.*
2. In the *Insert > Template* dialog box, choose *TDSCDMA_UpLnk_TX_test* , click *OK* ; click left to place the template in the schematic window.

Test bench setup is detailed here.

1. Replace the DUT (Amplifier2 is provided with this template) with an RF DUT that is suitable for this test bench.
   For information regarding using certain types of DUTs, see *RF DUT Limitations for TD-SCDMA Wireless Test Benches* (adswtbtds).
2. Set the *Required Parameters*

   > **Note**
   > Refer to *TDSCDMA_UpLnk_TX* (adswtbtds) for a complete list of parameters for this test bench.

   Generally, default values can be accepted; otherwise, values can be changed by the user as needed.

   - Set CE_TimeStep.
     Cosimulation occurs between the test bench (using ADS Ptolemy Data Flow simulation technology) and the DUT (using Circuit Envelope simulation technology). Each technology requires its own simulation time step with time-step coordination occurring in the interface between the technologies.
     CE_TimeStep defines the Circuit Envelope simulation time step to be used with this DUT. The CE_TimeStep must be set to a value equal to or a submultiple of (less than) WTB_TimeStep; otherwise, simulation will stop and an error message will be displayed.
     Note that WTB_TimeStep is not user-settable. Its value is derived from other test bench parameter values; with default settings WTB_TimeStep= 97.65625 nsec. The value is displayed in the Data Display pages as TimeStep.
     WTB_TimeStep = 1/(ChipRate × SamplesPerChip)
     where
     ChipRate is 1.28MHz
     SamplesPerChip is the number of samples per chip
   - Set FSource, SourcePower, and FMeasurement.
   - FSource defines the RF frequency for the TD-SCDMA signal input to the RF DUT.
   - SourcePower defines the power level for FSource. SourcePower is defined as the average power during the non-idle time of the TD-SCDMA signal segment.
   - FMeasurement defines the RF frequency output from the RF DUT to be measured.
3. Activate/deactivate (*YES* / *NO*) test bench measurements (refer to *TDSCDMA_UpLnk_TX* (adswtbtds)). At least one measurement must be enabled:
   - RF_EnvelopeMeasurement

- Constellation
- PowerMeasurement
- SpectrumMeasurement
- EVM_Measurement

4. More control of the test bench can be achieved by setting *Basic Parameters* , *Signal Parameters* , and parameters for each activated measurement. For details, refer to *Setting Parameters* (adswtbtds).
5. The RF modulator (shown in the block diagram in Transmitter Wireless Test Bench Block Diagram) uses FSource, SourcePower (*Required Parameters*), MirrorSourceSpectrum (*Basic Parameters)* , GainImbalance, PhaseImbalance, I_OriginOffset, Q_OriginOffset, and IQ_Rotation (*Signal Parameters*).
   The RF output resistance uses SourceR, SourceTemp, and EnableSourceNoise (*Basic Parameters*). The RF output signal source has a 50-ohm (default) output resistance defined by SourceR.
   RF output (and input to the RF DUT) is at the frequency specified (FSource), with the specified source resistance (SourceR) and with power (SourcePower) delivered into a matched load of resistance SourceR. The RF signal has additive Gaussian noise power set by resistor temperature (SourceTemp) (when EnableSourceNoise=YES).
   Note that the Meas_in point of the test bench provides a resistive load to the RF DUT set by the MeasR value (50-ohm default) (*Basic Parameters*).
   The Meas signal contains linear and nonlinear signal distortions and time delays associated with the RF DUT input to output characteristics.
   The TX DSP block (shown in the block diagram in Transmitter Wireless Test Bench Block Diagram) uses other *Signal Parameters* .
6. More control of Circuit Envelope analysis can be achieved by setting Envelope controller parameters. These settings include Enable Fast Cosim, which may speed the RF DUT simulation more than 10×. Setting these simulation options is described in *Setting Fast Cosimulation Parameters* and *Setting Circuit Envelope Analysis Parameters* in the *Wireless Test Bench Simulation* documentation.
7. To send the RF DUT output signal to an Agilent ESG RF signal generator, set *Signal to ESG Parameters* .
   For details, refer to *Signal to ESG Parameters* (adswtbtds).
8. After running a simulation, results will appear in a Data Display window for the measurement. *Simulation Measurement Displays* (adswtbtds) describes results for each measurement. For general WTB Data Display details refer to *Viewing WTB Analysis Results* (adswtbsim).

TDSCDMA_UpLnk_TX

This section provides parameter information for *Required Parameters, Basic Parameters, Signal Parameters,* and parameters for the various measurements.

Symbol

Description TD-SCDMA uplink TX test
Library WTB
Class TSDFTDSCDMA_UpLnk_TX
Derived From baseWTB_TX

Parameters

Name	Description	Default	Sym	Unit	Type	Range
Required Parameters						
CE_TimeStep	Circuit envelope simulation time step	1/1.28 MHz/8		sec	real	(0, ∞)
WTB_TimeStep	Set CE_TimeStep < = 1/1.28e6/ SamplesPerChip.					
FSource	Source carrier frequency	1900 MHz		Hz	real	(0, ∞)
SourcePower	Source power	dbmtow(-20.0)		W	real	[0, ∞)
FMeasurement	Measurement carrier frequency	1900 MHz		Hz	real	(0, ∞)
MeasurementInfo	Available Measurements					
RF_Envelope Measurement	Enable RF envelope measurement? NO, YES	YES			enum	
Constellation	Enable constellation measurement? NO, YES	NO			enum	
PowerMeasurement	Enable power measurement? NO, YES	NO			enum	
SpectrumMeasurement	Enable spectrum measurement? NO, YES	NO			enum	
EVM_Measurement	Enable EVM measurement?	NO			enum	

	NO, YES					
BasicParameters						
SourceR	Source resistance	50 Ohm		Ohm	real	(0, ∞)
SourceTemp	Source resistor temperature	-273.15		Celsius	real	[-273.15, ∞)
EnableSourceNoise	Enable source thermal noise? NO, YES	NO			enum	
MeasR	Measurement resistance	50 Ohm		Ohm	real	[10, 1.0e6]
MirrorSourceSpectrum	Mirror source spectrum about carrier? NO, YES	NO			enum	
MirrorMeasSpectrum	Mirror meas spectrum about carrier? NO, YES	NO			enum	
RF_MirrorFreq	Mirror source frequency for spectrum/envelope measurement? NO, YES	NO			enum	
MeasMirrorFreq	Mirror meas frequency for spectrum/envelope measurement? NO, YES	NO			enum	
TestBenchSeed	Random number generator seed	1234567			int	[0, ∞)
SignalParameters						
GainImbalance	Gain imbalance, Q vs I	0.0		dB	real	(-∞, ∞)
PhaseImbalance	Phase imbalance, Q vs I	0.0		deg	real	(-∞, ∞)
I_OriginOffset	I origin offset (percent)	0.0			real	(-∞, ∞)
Q_OriginOffset	Q origin offset (percent)	0.0			real	(-∞, ∞)
IQ_Rotation	IQ rotation	0.0		deg	real	(-∞, ∞)
SamplesPerChip	Samples per chip	8	S		int	[2, 32]
RRC_FilterLength	RRC filter length (chips)	12			int	[2, 128]
MidambleAllocScheme	Midamble allocation scheme: UE_Specific, Common, Default	Common			enum	
BasicMidambleID	Basic midamble index	0			int	[0, 127]
MidambleID	Midamble index	1			int	[1, K]
MaxMidambleShift	Max midamble shift	16	K		int	[1, 16]
ActiveTimeslot	Active Timeslot: TS1, TS2, TS3, TS4, TS5, TS6	TS1			enum	
SpreadCode	Spread code index	1			int	[1, 8]
RF_Envelope MeasurementParameters						
RF_EnvelopeDisplayPages	RF envelope measurement display pages:					
RF_EnvelopeStart	RF envelope measurement start	0.0		sec	real	[0, ∞)
RF_EnvelopeStop	RF envelope measurement stop	5.0 msec		sec	real	[0, ∞)
RF_EnvelopeSubframes	RF envelope measurement subframes	1			int	[0, 100]
ConstellationParameters						

ConstellationDisplayPages	Constellation measurement display pages:					
ConstellationSubframes	Constellation measurement subframes	3			int	[1, 100]
PowerMeasurement Parameters						
PowerDisplayPages	Power measurement display pages:					
PowerSubframeMeasured	Subframes measured	3			int	[1, ∞)
SpectrumMeasurement Parameters						
SpecMeasDisplayPages	Spectrum measurement display pages:					
SpecMeasStart	Spectrum measurement start	0.0		sec	real	[0, ∞)
SpecMeasStop	Spectrum measurement stop	5.0 msec		sec	real	[0, ∞)
SpecMeasSubframes	Spectrum measurement subframes	3			int	[0, 100]
SpecMeasResBW	Spectrum resolution bandwidth	0		Hz	real	[0, ∞)
SpecMeasWindow	Window type: none, Hamming 0.54, Hanning 0.50, Gaussian 0.75, Kaiser 7.865, _8510 6.0, Blackman, Blackman-Harris	none			enum	
EVM_Measurement Parameters						
EVM_DisplayPages	EVM measurement display pages:					
EVM_StartTime	EVM measurement start	0.0		sec	real	[0, ∞)
EVM_AverageType	Average type: Off, RMS (Video)	RMS (Video)			enum	
EVM_SubframesToAverage	Subframes used for RMS averaging	3			int	[1, ∞)
EVM_ActiveSlotThreshold	Active slot threshold (dBc)	-30.0			real	[-120, 0]
SignalToESG_Parameters						
EnableESG	Enable signal to ESG? NO, YES	NO			enum	
ESG_Instrument	ESG instrument address	[GPIB0::19::INSTR][localhost][4790]			instrument	
ESG_Start	Signal start	0.0		sec	real	[0, ∞)
ESG_Stop	Signal stop	5.0 msec		sec	real	[(ESG_Start+60/1.28e6/S), (ESG_Start+32/1.28/S)]

ESG_Subframes	Subframes to ESG	3			int	[0, 1000]
ESG_Power	ESG RF ouput power (dBm)	-20			real	(-∞, ∞)
ESG_ClkRef	Waveform clock reference: Internal, External	Internal			enum	
ESG_ExtClkRefFreq	External clock reference freq	10 MHz		Hz	real	(0, ∞)
ESG_IQFilter	IQ filter: through, filter_2100kHz, filter_40MHz	through			enum	
ESG_SampleClkRate	Sequencer sample clock rate	10.24 MHz		Hz	real	(0, ∞)
ESG_Filename	ESG waveform storage filename	TDSCDMA_UL			string	
ESG_AutoScaling	Activate auto scaling? NO, YES	YES			enum	
ESG_ArbOn	Select waveform and turn ArbOn after download? NO, YES	YES			enum	
ESG_RFPowOn	Turn RF ON after download? NO, YES	YES			enum	
ESG_EventMarkerType	Event marker type: Neither, Event1, Event2, Both	Event1			enum	
ESG_MarkerLength	ESG marker length	10			int	[1, 60]

Pin Inputs

Pin	Name	Description	Signal Type
2	Meas_In	Test bench measurement RF input from RF circuit	timed

Pin Outputs

Pin	Name	Description	Signal Type
1	RF_Out	Test bench RF output to RF circuit	timed

Setting Parameters

More control of the test bench can be achieved by setting parameters in the *Basic Parameters* , *Signal Parameters* , and *measurement* categories for the activated measurements.

Note
For *required* parameter information, see *Set the Required Parameters* (adswtbtds).

Basic Parameters

1. SourceR is the RF output source resistance.
2. SourceTemp is the RF output source resistance temperature (oC) and sets noise density in the RF output signal to (k(SourceTemp+273.15)) Watts/Hz, where k is Boltzmann's constant.
3. EnableSourceNoise, when set to NO disables the SourceTemp and effectively sets it to -273.15oC (0 Kelvin). When set to YES, the noise density due to SourceTemp is enabled.
4. MeasR defines the load resistance for the RF DUT output Meas signal into the test bench. This resistance loads the RF DUT output; it is also the reference resistance for Meas signal power measurements.
5. MirrorSourceSpectrum is used to invert the polarity of the Q envelope of the generated RF signal before it is sent to the RF DUT. Depending on the configuration and number of mixers in an RF transmitter, the signal at the input of the DUT may need to be mirrored. If such an RF signal is desired, set this parameter to YES.
6. MirrorMeasSpectrum is used to invert the polarity of the Q envelope in the Meas_in RF signal input to the test bench (and output from the RF DUT). Depending on the configuration and number of mixers in the RF DUT, the signal at its output may be mirrored compared to the signal generated by the signal source (before any mirroring is done because of the MirrorSourceSpectrum setting). Proper demodulation and measurement of the RF DUT output signal requires that its RF envelope is not mirrored compared to the signal generated by the signal source (before any mirroring is done because of the MirrorSourceSpectrum setting). If the Meas_in RF signal is mirrored, set this parameter to YES. Proper setting of this parameter is required for measurements on the Meas_in signal in TX test benches (EVM, Constellation, CDP, PCDE) and results in measurement on a signal with no spectrum mirroring.
7. TestBenchSeed is an integer used to seed the random number generator used with the test bench. This value is used by all test bench random number generators, except those RF DUT components that use their own specific seed parameter. TestBenchSeed initializes the random number generation. The same seed value produces the same *random* results, thereby giving you predictable simulation results. To generate repeatable *random* output from simulation to simulation, use any positive seed value. If you want the output to be truly random, enter the seed value of 0.
8. RF_MirrorFreq is used to invert the polarity of the Q envelope in the RF_out RF signal for RF envelope, ppectrum, ACLR, and occupied bandwidth measurements.

RF_MirrorFreq is typically set by the user to NO when MirrorSourceSpectrum = NO; RF_MirrorFreq is typically set by the user to YES when MirrorSourceSpectrum = YES. Both settings result in viewing the RF_out signal with no spectrum mirroring. Other settings by the user result in RF_out signal for RF_Envelope and Spectrum measurements with spectrum mirroring.

9. MeasMirrorFreq is used to invert the polarity of the Q envelope in the Meas_in RF signal for the RF envelope, spectrum, ACLR, and occupied bandwidth measurements. MeasMirrorFreq is typically set to NO by the user when the combination of the MirrorSourceSpectrum value and any signal mirroring in the users RF DUT results in no spectrum mirroring in the Meas_in signal. MeasMirrorFreq is typically set to YES by the user when the combination of the MirrorSourceSpectrum and RF DUT results in spectrum mirroring in the Meas_in signal.
   Other settings result in Meas_in signal for RF_Envelope and Spectrum measurements with spectrum mirroring. The MirrorMeasSpectrum parameter setting has no impact on the setting or use of the MeasMirrorFreq parameter.

Signal Parameters

1. GainImbalance, PhaseImbalance, I_OriginOffset, Q_OriginOffset, and IQ_Rotation are used to add certain impairments to the ideal output RF signal. Impairments are added in the order described here.
   The unimpaired RF I and Q envelope voltages have gain and phase imbalance applied. The RF is given by:
   $$V_{RF}(t) = A\left(V_I(t)\cos(\omega_c t) - gV_Q(t)\sin\left(\omega_c t + \frac{\phi\pi}{180}\right)\right)$$
   where A is a scaling factor that depends on the SourcePower and SourceR parameters specified by the user, $V_I(t)$ is the in-phase RF envelope, $V_Q(t)$ is the quadrature phase RF envelope, g is the gain imbalance
   $$g = 10^{\frac{GainImbalance}{20}}$$
   and, φ (in degrees) is the phase imbalance.
   Next, the signal $V_{RF}(t)$ is rotated by IQ_Rotation degrees. The I_OriginOffset and Q_OriginOffset are then applied to the rotated signal. Note that the amounts specified are percentages with respect to the output rms voltage. The output rms voltage is given by sqrt(2 × SourceR × SourcePower).
2. SamplesPerChip sets the number of samples in a chip.
   The default value is set to 8 to display settings according to the 3GPP NTDD. It can be set to a larger value for a simulation frequency bandwidth wider than 8 × 1.28 MHz. It can be set to a smaller value for faster simulation; however, this will result in lower signal fidelity. If SamplesPerChip = 8, the simulation RF bandwidth is larger than the signal bandwidth by a factor of 8 (e.g., simulation RF bandwidth = 8 × 1.28 MHz).
3. RRC_FilterLength sets root raised-cosine (RRC) filter length in chips.
   The default value is set to 12 to transmit TD-SCDMA downlink signals in time and frequency domains based on the 3GPP NTDD standard. It can be set to a smaller value for faster simulation; however, this will result in lower signal fidelity.

4. MidambleAllocScheme is used to select the midamble allocation scheme. There are three midamble allocation schemes based on the 3GPP NTDD standard [1], [2]. To set the MidambleAllocScheme parameter based on the 3GPP NTDD standard [1], related parameters must be set as stated here.
   - **UE specific midamble allocation** : a UE specific midamble for uplink and downlink is explicitly assigned by higher layers.
     if MidambleAllocScheme=UE_Specific, BasicMidambleID, MaxMidambleShift, and MidambleID are used to specify which midamble is exported.
   - **Common midamble allocation** : the midamble for downlink is allocated by layer 1 depending on the number of channelization codes currently present in the downlink time slot.
     if MidambleAllocScheme=Common, only BasicMidambleID and MaxMidambleShift are used to specify which midamble is exported; the MidambleID parameter is ignored.
   - **Default midamble allocation** : the midamble for uplink and downlink is assigned by layer 1 depending on the associated channelization code.
     if MidambleAllocScheme=Default, only BasicMidambleID and MaxMidambleShift are used to specify which midamble is exported; the MidambleID parameter is ignored.
5. BasicMidambleID sets the basic midamble code ID. The basic midamble code is used for training sequences for uplink and downlink channel estimation, power measurements and maintaining uplink synchronization. There are 128 different sequences; the BasicMidambleID range is 0 to 127. In Signal Studio, Basic Midamble ID code has the same meaning as this parameter.
6. MidambleID sets the index of midambles for DPCH. Midambles of different users active in the same cell and the same time slot are cyclically shifted versions of one basic midamble code.
   Let P = 128, the length of basic midamble and K=MaxMidambleShift, then
   $W = \left\lfloor \frac{P}{K} \right\rfloor$, is the shift between midambles and $\lfloor x \rfloor$
   denotes the largest number less than or equal to x. MidambleID range is from 1 to MaxMidambleShift.
   MidambleID and MaxMidambleShift together correspond to the Midamble Offset parameter in Signal Studio for Timeslot setup. Midamble Offset = MidambleID × W.
7. MaxMidambleShift is the maximum number of different midamble shifts in a cell that can be determined by maximum users in the cell for the current time slot.
8. ActiveTimeSlot specifies which slot signal in the subframe will be transmitted. Referring to *12.2 kbps Uplink Channel Subframe Structure* (adswtbtds), when ActiveTimeSlot=2, TS2 is used.
9. SpreadCode sets the spread code index for the DPCH. For this test bench, the spreading factor is 8.
   In Signal Studio, Channelization code for Time slot setup has the same meaning as SpreadCode.

RF Envelope Measurement Parameters

The RF Envelope measurement is not affected by the MirrorMeasSpectrum parameter. To apply spectrum mirroring to the measured RF_out signal, set RF_MirrorFreq=YES. To apply spectrum mirroring to the measured Meas_in signal, set MeasMirrorFreq=YES.

- RF_EnvelopeDisplayPages provides Data Display page information for this measurement. It cannot be changed by the user.
- RF_EnvelopeStart sets the start time for collecting input data.
- RF_EnvelopeStop sets the stop time for collecting input data when RF_EnvelopeSubframes=0.
- RF_EnvelopeSubframes (when > 0) sets the number of bursts over which data will be collected.
  Depending on the values of RF_EnvelopeStart, RF_EnvelopeStop, and RF_EnvelopeSubframes, the stop time may be adjusted.
  For RF envelope measurement for the RF_out and Meas_in signals:
  Let:
  Start = TimeStep× (int(RF_EnvelopeStart/TimeStep) + 0.5)
  Stop = TimeStep × (int(RF_EnvelopeStop/TimeStep) + 0.5)
  This means Start and Stop are forced to be an integer number of time-step intervals.

RF_EnvelopeSubframes	Resultant Stop Time
0	Stop
> 0	Start + RF_EnvelopeSubframes x SubframeTime

  For the RF envelope of Meas_in to contain at least one complete Subframe, the Stop value must be set to a minimum of SubframeTime + (RF DUT time delay).
  For information about TimeStep and SubframeTime, see Test Bench Variables for Data Displays.

Constellation Parameters

The Constellation measurement requires setting the MirrorMeasSpectrum parameter such that there is an even number of spectrum mirrorings from the combined test bench source and RF DUT. For example, if MirrorSourceSpectrum=NO and the RF DUT causes its output RF signal to have spectrum mirroring relative to its input signal, then set MirrorMeasSpectrum=YES.

1. ConstellationDisplayPages provides Data Display page information for this measurement. It cannot be changed by the user.
2. ConstellationSubframes sets the number of subframes over which data will be collected.
3. The measurement start time is the time when the first subframe is detected in the measured RF signal. Automatic synchronization by the measurement model avoids any start-up transient in the Constellation plots.

Power Measurement Parameters

1. PowerDisplayPages provides Data Display page information for this measurement. It cannot be changed by the user.

2. PowerSubframeMeasured sets the number of subframes over which data will be collected.
3. The measurement start time is the time when the first subframe is detected in the measured RF signal. Automatic synchronization by the measurement model avoids any start-up transient in the Constellation plots. The measurement stop time is this start time plus PowerSubframeMeasured × SubframeTime. SubframeTime is described in Test Bench Variables for Data Displays.

Spectrum Measurement Parameters

The Spectrum measurement calculates the spectrum of the input signal. Averaging the spectrum over multiple subframes can be enabled as described in this section.

This measurement is not affected by the MirrorMeasSpectrum parameter. To apply spectrum mirroring to the measured RF_out signal, set RF_MirrorFreq = YES; to apply spectrum mirroring to the measured Meas_in signal, set MeasMirrorFreq = YES.

In the following, TimeStep denotes the simulation time step and FMeasurement denotes the measured RF signal characterization frequency.

1. The measurement outputs the complex amplitude voltage values at the frequencies of the spectral tones. It does not output the power at the frequencies of the spectral tones. However, one can calculate and display the power spectrum as well as the magnitude and phase spectrum by using the dBm, mag, and phase functions of the data display window.
   Note that the dBm function assumes a 50-ohm reference resistance; if a different measurement was used in the test bench, its value can be specified as a second argument to the dBm function, for example, dBm(SpecMeas, Meas_RefR) where SpecMeas is the instance name of the spectrum measurement and Meas_RefR is the resistive load used.
   By default, the displayed spectrum extends from FMeasurement - 1/(2×TimeStep) Hz to FMeasurement + 1/(2×TimeStep) Hz. When FMeasurement < 1/(2×TimeStep), the default spectrum extends to negative frequencies. The spectral content at these negative frequencies is conjugated, mirrored, and added to the spectral content of the closest positive frequency. The negative frequency tones are then displayed on the positive frequency axis as would happen in an RF spectrum analyzer measurement instrument. This process may introduce an error in the displayed frequency for the mirrored tones. The absolute error introduced is less than (spectrum frequency step) / 2 (see Effect of Values for SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW for the definition of spectrum frequency step).
   The basis of the algorithm used by the spectrum measurement is the chirp-Z transform. The algorithm can use multiple subframes and average the results to achieve video averaging (see *note 6*).
2. SpecMeasDisplayPages provides information regarding Data Display pages for this measurement. It cannot be changed by the user.
3. SpecMeasStart sets the start time for collecting input data.

4. SpecMeasStop sets the stop time for collecting input data when SpecMeasSubframes = 0 and SpecMeasResBW = 0.
5. SpecMeasSubframes sets the number of segments over which data will be collected.
6. SpecMeasResBW sets the resolution bandwidth of the spectrum.
   Depending on the values of SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW, the stop time may be adjusted or spectrum video averaging may occur (or both). The different cases are described in Effect of Values for SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW.
   Referring to Effect of Values for SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW, let
   Start = TimeStep × int((SpecMeasStart/TimeStep) + 0.5)
   Stop = TimeStep × int((SpecMeasStop/TimeStep) + 0.5)
   (This means Start and Stop are forced to be an integer number of time step intervals.)
   X = normalized equivalent noise bandwidth of the window
   Start and Stop times are used for RF_out and Meas_in signal spectrum analyses. The Meas_in signal is delayed in time from the RF_out signal by the value of the RF DUT time delay. Therefore, for RF DUT time delay >0, the RF_out and Meas_in signals are inherently different and spectrum display differences can be expected.
   TimeStep and SubframeTime are defined in the *Test Bench Variables for Data Displays* section.
   Equivalent noise bandwidth (ENBW) compares the window to an ideal, rectangular filter. It is the equivalent width of a rectangular filter that passes the same amount of white noise as the window. Normalized ENBW (NENBW) is ENBW multiplied by the duration of the signal being windowed. (Refer to *note 7* regarding the various window options and *Window Options and Normalized Equivalent Noise Bandwidth* regarding NENBW for the various windows.)

Effect of Values for SpecMeasStart, SpecMeasStop, SpecMeasSubframes, and SpecMeasResBW

Case 1	SpecMeasSubframes = 0 SpecMeasResBW = 0 Resultant stop time = Stop Resultant resolution BW = X/(Stop - Start) Resultant spectrum frequency step = 1/(Stop-Start) Video averaging status = None
Case 2	SpecMeasSubframes > 0 SpecMeasResBW = 0 Resultant stop time = Start + SpecMeasSubframes x SubframeTime For SpecMeasSubframes > 0 and SpecMeasResBW = 0 Video averaging occurs over all segment time intervals Resultant resolution BW = X /SubframeTime Resultant spectrum frequency step = 1/SubframeTime Video averaging status = Yes, when SpecMeasSubframes > 1
Case 3	SpecMeasSubframes = 0 SpecMeasResBW > 0 Resultant stop time = Start + N x SubframeTimeInterval where N = int((Stop -Start)/SubframeTimeInterval) + 1 For SpecMeasSubframes = 0 and SpecMeasResBW > 0 Define SubframeTimeInterval = TimeStep x int((X/SpecMeasResBW/TimeStep) + 0.5) This means SubframeTimeInterval is forced to a value that is an integer number of time step intervals. (Stop-Start) time is forced to be an integer number (N) of SubframeTimeIntervals N has a minimum value of 1 Video averaging occurs over all SubframeTimeIntervals Resolution bandwidth achieved is ResBW = X / SubframeTimeInterval, which is very close to SpecMeasResBW but may not be exactly the same if X/SpecMeasResBW/TimeStep is not an exact integer. Resultant resolution BW = ResBW Resultant spectrum frequency step = ResBW Video averaging status = Yes when N > 1
Case 4	SpecMeasSubframes > 0 SpecMeasResBW > 0 Resultant stop time = Start + M x SubframeTimeInterval where M = int((SpecMeasSubframes x SubframeTime)/SubframeTimeInterval) + 1 For SpecMeasSubframes > 0 and SpecMeasResBW > 0 Define SubframeTimeInterval = TimeStep x int((X /SpecMeasResBW/TimeStep) + 0.5) This means SubframeTimeInterval is forced to a value that is an integer number of time step intervals. (Stop-Start) time is forced to be an integer number (M) of the SubframeTimeIntervals M has a minimum value of 1 Video averaging occurs over all SubframeTimeIntervals Resolution bandwidth achieved is ResBW = X / SubframeTimeInterval, which is very close to SpecMeasResBW but may not be exactly the same if X/SpecMeasResBW/TimeStep is not an exact integer. Resultant resolution BW = ResBW Resultant spectrum frequency step = ResBW Video averaging status = Yes, when M > 1

7. SpecMeasWindow specifies the window that will be applied to each segment before its spectrum is calculated. Different windows have different properties, affect the resolution bandwidth achieved, and affect the spectral shape. Windowing is often necessary in transform-based (chirp-Z, FFT) spectrum estimation in order to reduce spectral distortion due to discontinuous or non-harmonic signal over the measurement time interval. Without windowing, the estimated spectrum may suffer

from spectral leakage that can cause misleading measurements or masking of weak signal spectral detail by spurious artifacts.
The windowing of a signal in time has the effect of changing its power. The spectrum measurement compensates for this and the spectrum is normalized so that the power contained in it is the same as the power of the input signal.
Window Type Definitions:

- none

$$w(kT_s) = \begin{cases} 1.0 & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size
- Hamming 0.54

$$w(kT_s) = \begin{cases} 0.54 - 0.46\cos\left(\frac{2\pi k}{N}\right) & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size
- Hanning 0.50

$$w(kT_s) = \begin{cases} 0.5 - 0.5\cos\left(\frac{2\pi k}{N}\right) & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size
- Gaussian 0.75

$$w(kT_s) = \begin{cases} exp\left(-\frac{1}{2}\left(0.75\frac{(2k-N)}{N}\right)^2\right) & 0 \le \left|k - \frac{N}{2}\right| \le \frac{N}{2} \\ 0.0 & otherwise \end{cases}$$

  where N is the window size
- Kaiser 7.865

$$w(kT_s) = \begin{cases} \dfrac{I_0\left(7.865\left[1 - \left(\frac{k-\alpha}{\alpha}\right)^2\right]^{1/2}\right)}{I_0(7.865)} & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size, $\alpha = N / 2$, and $I_0(.)$ is the 0th order modified Bessel function of the first kind
- 8510 6.0 (Kaiser 6.0)

$$w(kT_s) = \begin{cases} \dfrac{I_0\left(6.0\left[1 - \left(\frac{k-\alpha}{\alpha}\right)^2\right]^{1/2}\right)}{I_0(6.0)} & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

  where N is the window size, $\alpha = N / 2$, and $I_0(.)$ is the 0th order modified Bessel function of the first kind

- Blackman

$$w(kT_s) = \begin{cases} 0.42 - 0.5\cos\left(\frac{2\pi k}{N}\right) + 0.08\cos\left(\frac{4\pi k}{N}\right) & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

where N is the window size

- Blackman-Harris

$$w(kT_s) = \begin{cases} 0.35875 - 0.48829\cos\left(\frac{2\pi k}{N}\right) + 0.14128\cos\left(\frac{4\pi k}{N}\right) - 0.01168\cos\left(\frac{6\pi k}{N}\right) & 0 \le k \le N \\ 0.0 & otherwise \end{cases}$$

where N is the window size.

Window Options and Normalized Equivalent Noise Bandwidth

Window and Default Constant	NENBW
none	1
Hamming 0.54	1.363
Hanning 0.50	1.5
Gaussian 0.75	1.883
Kaiser 7.865	1.653
8510 6.0	1.467
Blackman	1.727
Blackman-Harris	2.021

EVM Measurement Parameters

The EVM measurement requires setting the MirrorMeasSpectrum parameter such that there is an even number of spectrum mirrorings from the combined test bench source and RF DUT. For example, if MirrorSourceSpectrum=NO and the RF DUT causes its output RF signal to have spectrum mirroring relative to its input signal, then set MirrorMeasSpectrum=YES.
The EVM measurement provides results for EVM, magnitude error, phase error for one code channel and for the composite signal. It also provides rho, frequency error, IQ offset, and gain imbalance.

1. EVM_DisplayPages provides information regarding Data Display pages for this measurement. It cannot be changed by the user.
2. Starting at the time instant specified by EVM_StartTime, a signal segment of 10msec is captured and the beginning of a subframe is detected (a 10msec signal segment is guaranteed to contain a whole subframe). After the subframe is detected, the I and Q envelopes of the input signal are extracted. The I and Q envelopes are then passed to a complex algorithm that performs synchronization, demodulation, and EVM analysis (this algorithm is the same as the one used in the Agilent 89600 VSA).

3. If EVM_AverageType is set to Off, only one subframe is detected, demodulated, and analyzed.
If EVM_AverageType is set to RMS (Video), after the first subframe is analyzed the signal segment corresponding to it is discarded and new signal samples are collected from the input to fill in the 10msec signal buffer. When the buffer is full again a new subframe is detected, demodulated, and analyzed. These steps are repeated until EVM_SubframesToAverage subframes are processed.
If a subframe is mis-detected for any reason, results from its analysis are discarded. EVM results obtained from all the successfully detected, demodulated, and analyzed subframes are averaged to give the final averaged results. EVM results from each successfully analyzed subframe are also recorded (in the variables without the *Avg_* prefix in their name).
4. EVM_ActiveSlotThreshold sets the active slot detection threshold; that is the power level (in dB with respect to the power level of the slot with the largest measured power) below which a slot will be considered as inactive.

Signal to ESG Parameters

The EVM measurement collects data from the Meas_in signal and downloads it to an Agilent E4438C Vector Signal Generator. This measurement uses Connection Manager architecture to communicate with the instrument; parameters specify how data is interpreted.
Prerequisites for using the Signal to ESG option are:

- ESG Vector Signal Generator E4438C; for information, visit the web site http://www.agilent.com/find/esg .
- PC workstation running an instance of the connection manager server.
- Supported method of connecting the instrument to your computer through the Connection Manager architecture; for information, see *Connection Manager* .

Parameter Information

1. EnableESG specifies if the signal is downloaded to the ESG instrument. If set to NO, no attempt will be made to communicate with the instrument.
2. ESG_Instrument specifies a triplet that identifies the VSA resource of the instrument to be used in the simulation, the connection manager server hostname (defaults to *localhost*), and the port at which the connection manager server listens for incoming requests (defaults to 4790). To ensure that this field is populated correctly, click *Select Instrument* , enter the server hostname and port, click *OK* to see the Remote Instrument Explorer dialog, select a VSA resource identifier, and click *OK* . For details about selecting instruments, see *Instrument Discovery* in the *Wireless Test Bench Simulation* documentation.
3. ESG_Start and ESG_Stop (when ESG_Subframes=0) specify when to start and stop data collection. The number of samples collected, ESG_Stop - ESG_Start + 1, must be in the range 60 samples to 64 Msamples, where 1 Msample = 1,048,576 samples.

The ESG requires an even number of samples; the last sample will be discarded if ESG_Stop - ESG_Start + 1 is odd.

4. ESG_Subframes sets the number of subframes over which data will be collected. If ESG_Subframes is greater than zero, then ESG_Stop is forced to ESG_Start + ESG_Subframes x SubframeTime where SubframeTime is 5 msec.
5. ESG_ClkRef specifies an internal or external reference for the ESG clock generator. If set to External, the ESG_ExtClkRefFreq parameter sets the frequency of this clock.
6. ESG_IQFilter specifies the cutoff frequency for the reconstruction filter that lies between the DAC output and the Dual Arbitrary Waveform Generator output inside the ESG.
7. ESG_SampleClkRate sets the sample clock rate for the DAC output.
8. ESG_Filename sets the name of the waveform inside the ESG that will hold the downloaded data.
9. The ESG driver expects data in the range {-1, 1}. The ESG_AutoScaling parameter specifies whether to scale inputs to fit this range. If set to YES, inputs are scaled to the range {-1, 1}; if set to NO, raw simulation data is downloaded to the ESG without any scaling, but data outside the range {-1, 1} is clipped to -1 or 1. If set to YES, scaling is also applied to data written to the local file (ESG_Filename setting).
10. If ESG_ArbOn is set to YES, the ESG will start generating the signal immediately after simulation data is downloaded; if set to NO, waveform generation must be turned on at the ESG front panel.
11. If ESG_RFPowOn is set to YES, the ESG will turn RF power on immediately after simulation data is downloaded. If ESG_RFPowOn is set to NO (default), RF power must be turned on at the ESG front panel.
12. ESG_EventMarkerType specifies which ESG Event markers are enabled: Event1, Event2, Both, or Neither. Event markers are used for synchronizing other instruments to the ESG. When event markers are enabled, Event1 or Event2 (or both) is set beginning from the first sample of the downloaded Arb waveform over the range of points specified by the ESG_MarkerLength parameter. This is equivalent to setting the corresponding event from the front panel of the ESG.
13. ESG_MarkerLength specifies the range of points over which the markers must be set starting from the first point of the waveform. Depending on the ESG_EventMarkerType setting, the trigger length of Event1 or Event2 (or both) is set to a multiple of the pulsewidth that, in turn, is determined by the sample clock rate of the DAC output.

Simulation Measurement Displays

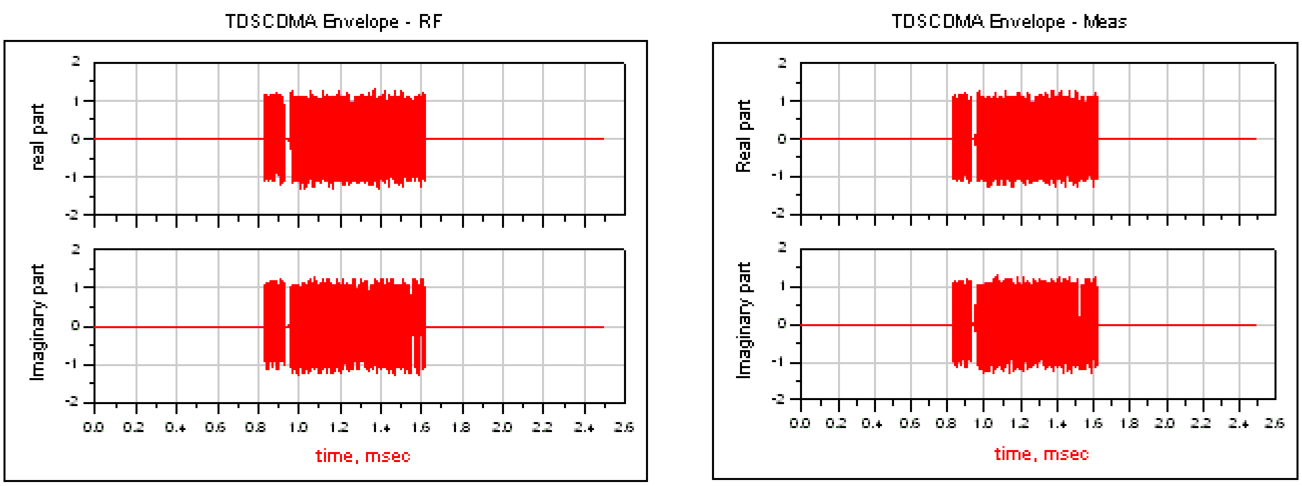
After running the simulation, results are displayed in Data Display pages for each measurement activated.

> **Note**
> Measurement results from a wireless test bench have associated names that can be used in Data Display Expressions. For more information, refer to *Measurement Results for Expressions for TD-SCDMA Wireless Test Benches* (adswtbtds).

RF Envelope Measurement

The RF Envelope measurement (not defined in 3GPP TS 25) shows the envelope of a TD-SCDMA uplink signal. Measurements for the RF signal at the input of the RF DUT and the Meas signal at the output of the RF DUT are implemented.

The real and imaginary parts of the RF and Meas signals are shown in RF Envelope Simulation Results. There are two active parts because ActiveTimeslot is set to TS1 and uplink pilot is transmitted. Only 2.6msec of data is stored to save disk space; the stop time can be changed by setting RF_EnvelopeMeasurement parameters.



...l(RF_FSource)/(1MHz)	real(RF_Power_dBm)	real(RF_R)	...l(Meas_FMeasurement)/(1MHz)	real(Meas_R)
1900.000	10.000	50.000	1900.000	50.000

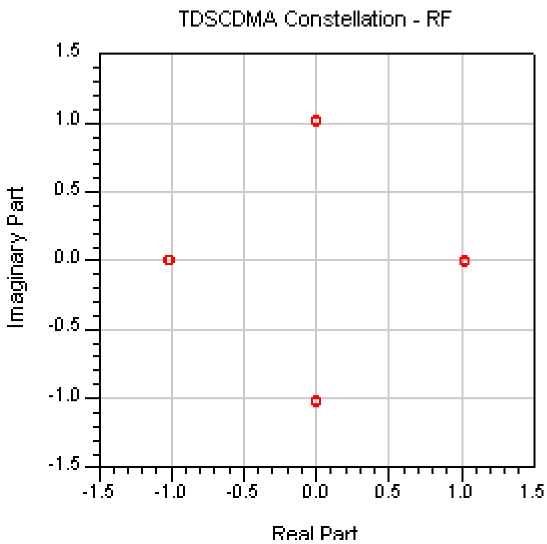
real(FrameTime)/(1msec)	int(ActiveSlot)	int(FilterLength)/(1_chip)	real(TimeStep)/(1usec)
5.000	1	12.000	0.098

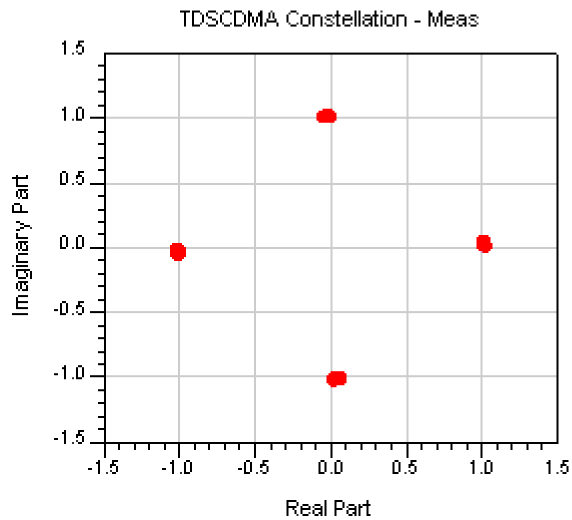
RF Envelope Simulation Results

Constellation Measurement

The constellation measurement (not defined in 3GPP TS 25) shows the constellation of one code channel of the TD-SCDMA uplink signal. The constellation for the RF and Meas signals are shown in Signal Constellations. Through the constellation measurement, distortion caused by carrier phase shift, IQ imbalance, and phase noise can be observed. Comparing the RF and the Meas signals, the constellation of the Meas signal rotates a fixed angle due to the delay introduced by the DUT.

QPSK demodulation is implemented in the TD-SCDMA uplink. Symbol mapping is shown in *Symbol Mapping*.





Signal Constellations

***Input**	**<th**
$b_{1,n}^{(k,i)} b_{2,n}^{(k,i)}$	$\underline{d}^{(k,i)}$
00	+j
01	+1
10	-1
11	-j

Power Measurement

The power measurement includes: power vs. time (defined in 3GPP TS 25.102 [3] and TS 34.122 [4]); and, CCDF (not defined in 3GPP standards).

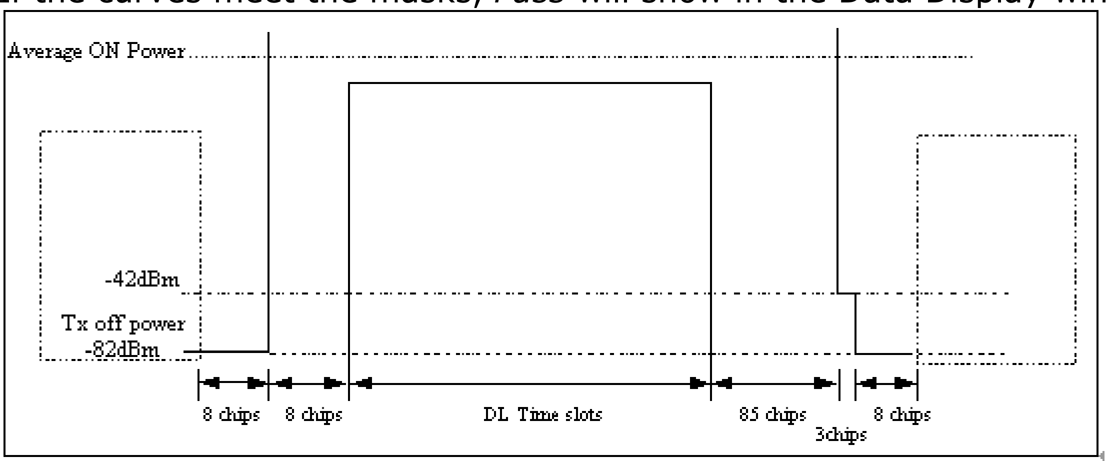
Power vs. time is the instant power of chips in the subframe (when PowerSubframeMeasured = 1) and average power of chips at the same position in all measured subframes (when PowerSubframeMeasured > 1). CCDF fully characterizes the power statistics of a signal and provides characterization of peak-to-average power ratio versus probability.

The on/off mask template for power vs. time is illustrated in Uplink Transmit On/Off Mask Template.

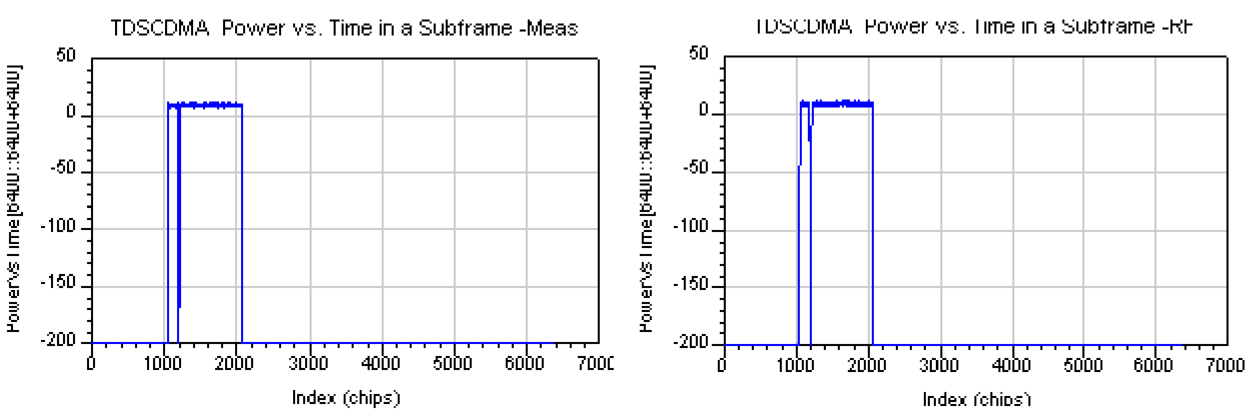
Results of power vs. time for the RF and Meas signals are shown in Power vs. Time in One Subframe; results of power vs. time with masks are shown in RF and Signal Power vs. Time with Masks.

To show the power vs. time on/off masks more clearly, zoomed-in RF and Meas signals are shown in RF Signal Power vs. Time with Masks Off and On and Meas Signal Power vs. Time with Masks Off and On.

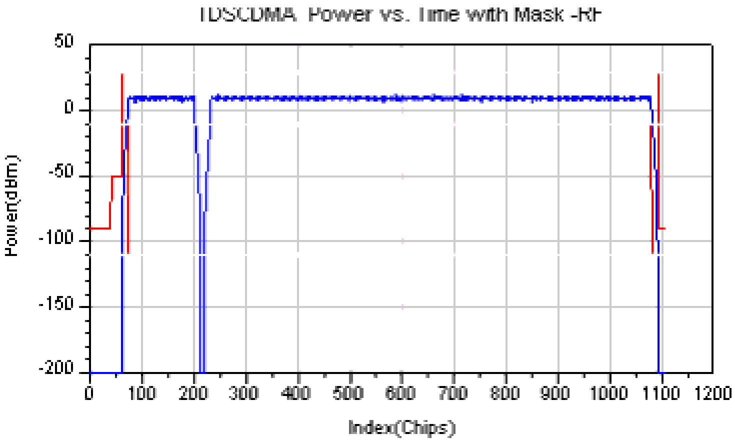
If the curves meet the masks, *Pass* will show in the Data Display window.

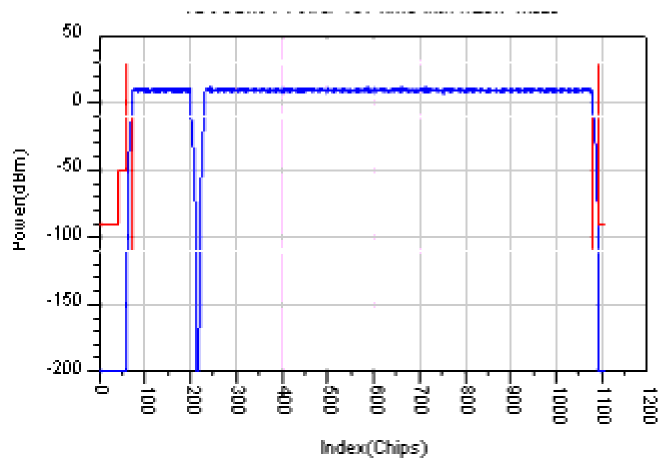


Uplink Transmit On/Off Mask Template

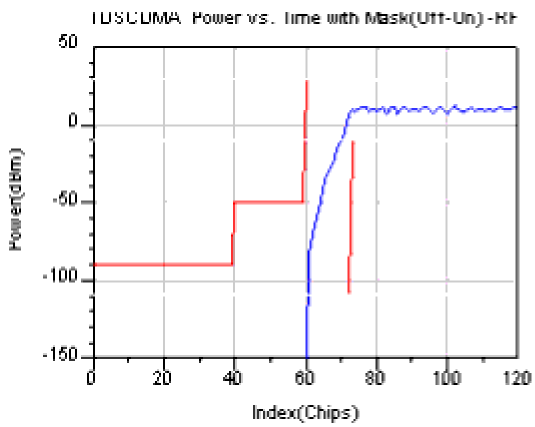


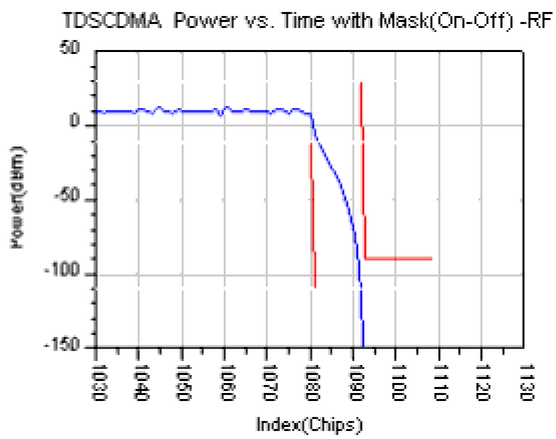
Power vs. Time in One Subframe



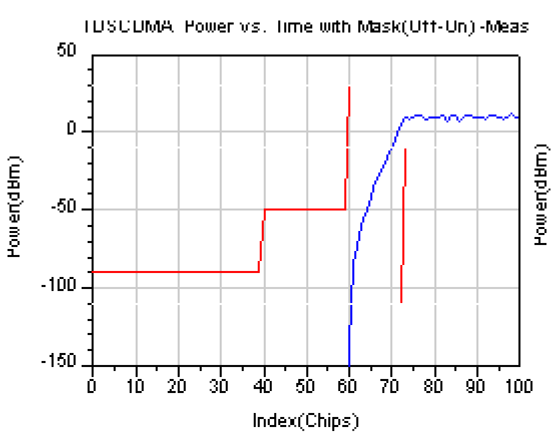


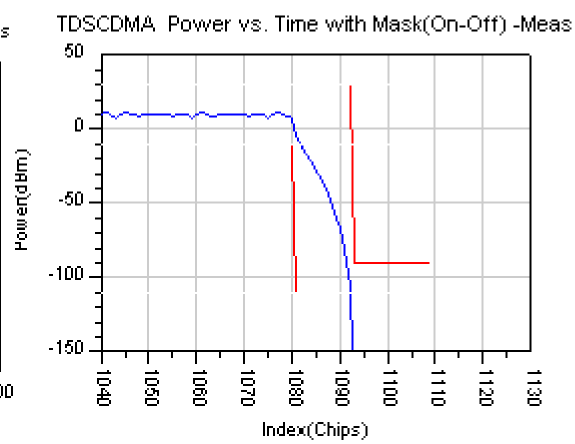
RF and Signal Power vs. Time with Masks





RF Signal Power vs. Time with Masks Off and On

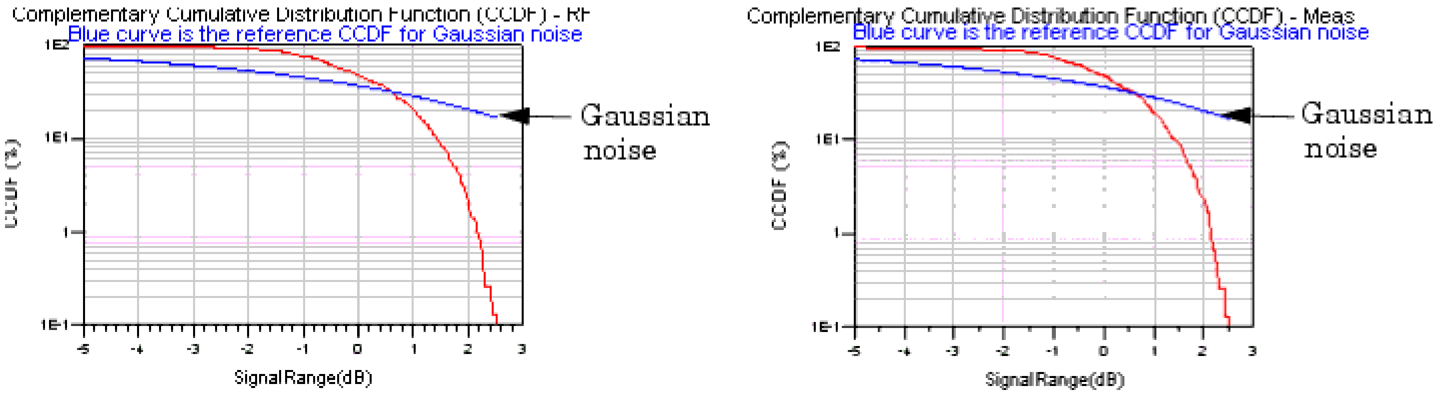




Meas Signal Power vs. Time with Masks Off and On

The CCDF for the RF and the Meas signals are shown in Complementary Cumulative Distribution Function.

The peak-to-average power ratios of the RF and Meas signals are shown in Peak-to-Average Power Ratios.



Complementary Cumulative Distribution Function

Peak to average power ratio -RF

Peak_to_MeanRF	PowerRF.CCDF.PeakPower_dBm	PowerRF.CCDF.MeanPower_dBm
2.531	12.528	9.997

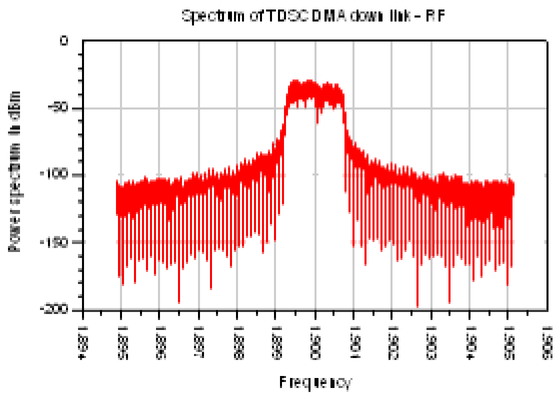
Peak to average power ratio -Meas

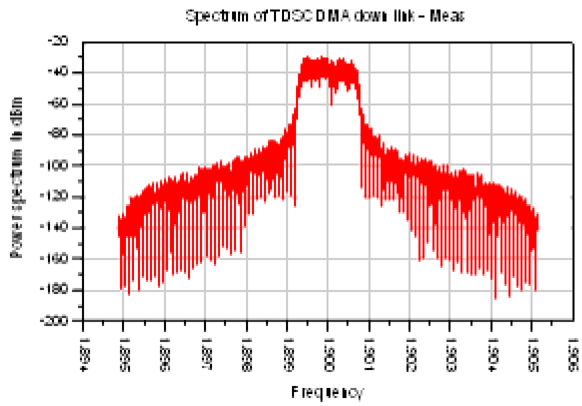
Peak_to_MeanMeas	PowerMeas.CCDF.PeakPower_dBm	PowerMeas.CCDF.MeanPower_dBm
2.521	12.515	9.994

Peak-to-Average Power Ratios

Spectrum Measurement

The spectrum measurement (not defined in 3GPP standards) shows the spectrum of the TD-SCDMA uplink signal. The spectrum analyzer output contain complex amplitude voltage values and the dBm(<meas_name>, <ref_r>) expressions can be used to convert to dBm values. Spectrums for the RF and the Meas signals are shown in TD-SCDMA Signal Spectrums.





TD-SCDMA Signal Spectrums

EVM Measurement

The EVM measurement (defined in 3GPP TS 25.102 and TS 34.122) demonstrates the uplink EVM measurement. EVM is a measure of the difference between the reference and the measured waveform; this difference is called the error vector. Both waveforms pass through a matched root raised-cosine filter with bandwidth corresponding to the considered chip rate and roll-off a=0.22. Both waveforms are further modified by selecting the frequency, absolute phase, absolute amplitude, and chip clock timing so as to minimize the error vector. The EVM result is defined as the square root of the ratio of the mean error vector power to the mean reference power expressed as a percent. The measurement interval is one timeslot.

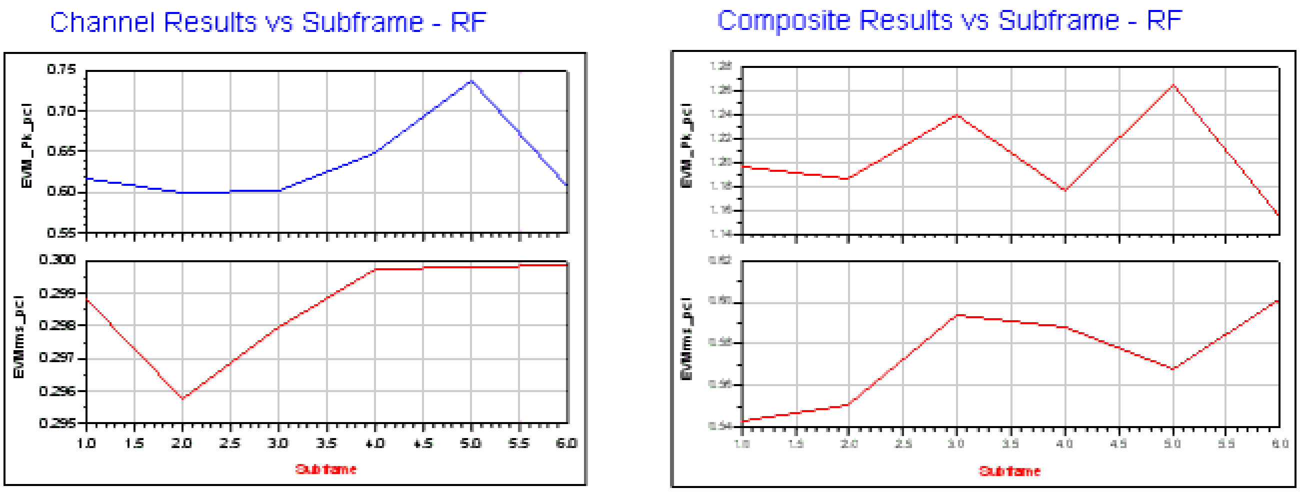
The EVM must not exceed 17.5%. The requirement is valid over the total power dynamic range as specified in subclause 6.4.3 of TS 25.102.

The results from this measurement are described in *EVM Measurement Results*.

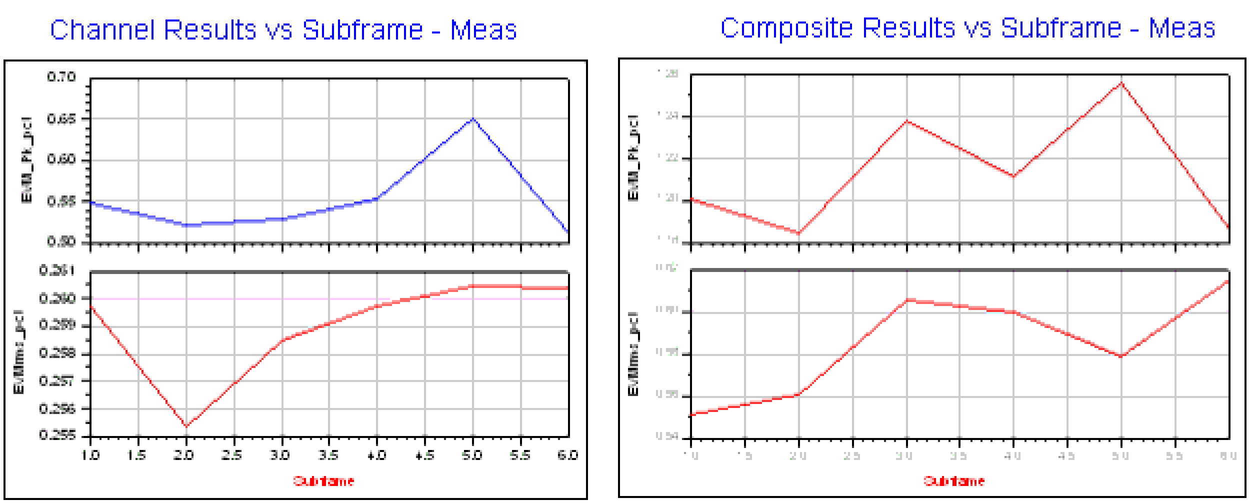
Result	Description
Avg_ChEVMrms_pct	average channel EVM rms in %
ChEVMrms_pct	channel EVM rms in % versus subframe
ChEVM_Pk_pct	channel peak EVM in % versus subframe
ChEVM_Pk_symbol_idx	channel peak EVM symbol index versus subframe
Avg_ChMagErr_rms_pct	average channel magnitude error rms in %
ChMagErr_rms_pct	channel magnitude error rms in % versus subframe
ChMagErr_Pk_pct	channel peak magnitude error in % versus subframe
ChMagErr_Pk_symbol_idx	channel peak magnitude error symbol index versus subframe
Avg_ChPhaseErr_deg	average channel phase error in degrees
ChPhaseErr_deg	channel phase error in degrees versus subframe
ChPhaseErr_Pk_deg	channel peak phase error in degrees versus subframe
ChPhaseErr_Pk_symbol_idx	channel peak phase error symbol index versus subframe
ChCodePhase_deg	channel code phase (phase of the channel code with respect to the pilot) versus subframe
Avg_CompEVMrms_pct	average composite EVM rms in %
CompEVMrms_pct	composite EVM rms in % versus subframe
CompEVM_Pk_pct	composite peak EVM in % versus subframe
CompEVM_Pk_chip_idx	composite peak EVM chip index versus subframe
Avg_CompMagErr_rms_pct	average composite magnitude error rms in %
CompMagErr_rms_pct	composite magnitude error rms in % versus subframe
CompMagErr_Pk_pct	composite peak magnitude error in % versus subframe
CompMagErr_Pk_chip_idx	composite peak magnitude error chip index versus subframe
Avg_CompPhaseErr_deg	average composite phase error in degrees
CompPhaseErr_deg	composite phase error in degrees versus subframe
CompPhaseErr_Pk_deg	composite peak phase error in degrees versus subframe
CompPhaseErr_Pk_chip_idx	composite peak phase error chip index versus subframe
Avg_Rho	average rho
Rho	rho versus subframe
Avg_FreqError_Hz	average frequency error in Hz
FreqError_Hz	frequency error in Hz versus subframe
Avg_IQ_Offset_dB	average IQ offset in dB
IQ_Offset_dB	IQ offset in dB versus subframe
Avg_QuadErr_deg	average quadrature error in degrees
QuadErr_deg	quadrature error in degrees versus subframe
Avg_GainImb_dB	average IQ gain imbalance in dB
IQ_GainImb_dB	IQ gain imbalance in dB versus subframe

If EVM_AverageType is set to RMS (Video), EVM will be measured in EVM_SubframesToAverage subframes. If EVM_AverageType is set to Off, EVM will be measured in the first subframe detected. Results named with the *Avg_* prefix are results averaged over the number of subframes specified by the user in EVM_SubframesToAverage (when EVM_AverageType is set to RMS (Video)). Results that are not named *Avg_* are results versus subframe. RF signal results are shown in RF Signal Average and Peak EVM; Meas signal results are shown in Meas Signal Average and Peak

EVM.



RF Signal Average and Peak EVM



Meas Signal Average and Peak EVM

RF signal results for averaged EVM, magnitude error, and phase error of one code channel and composite channel are shown in RF Signal EVM, Magnitude Error, and Phase Error Results; Meas signal results are shown in Meas Signal EVM, Magnitude Error, and Phase Error Results. According to the 3GPP standard, the EVM must not exceed 17.5%; EVM results for the RF and the Meas signals meet specification requirements.

Average Channel Results - RF

EVM_RF.Avg_ChEVMrms_pct
0.299

EVM_RF.Avg_ChMagErr_rms_pct
0.084

EVM_RF.Avg_ChPhaseErr_deg
0.164

Average Composite Results - RF

EVM_RF.Avg_Rho	EVM_RF.Avg_FreqError_Hz
1.000	-0.700

EVM_RF.Avg_IQ_Offset_dB	EVM_RF.Avg_QuadErr_deg	EVM_RF.Avg_GainImb_dB
-84.978	-0.009	-5.998E-5

EVM_RF.Avg_CompEVMrms_pct	EVM_RF.Avg_CompMagErr_rms_pct	EVM_RF.Avg_CompPhaseErr_deg
0.574	0.433	0.215

RF Signal EVM, Magnitude Error, and Phase Error Results

Average Channel Results - Meas

EVM_Meas.Avg_CompEVMrms_pct
0.585

EVM_Meas.Avg_CompMagErr_rms_pct
0.443

EVM_Meas.Avg_CompPhaseErr_deg
0.218

Average Composite Results - Meas

EVM_Meas.Avg_Rho	EVM_Meas.Avg_FreqError_Hz
1.000	-0.592

EVM_Meas.Avg_IQ_Offset_dB	EVM_Meas.Avg_QuadErr_deg	EVM_Meas.Avg_GainImb_dB
-83.784	-0.008	-2.125E-4

EVM_Meas.Avg_ChEVMrms_pct	EVM_Meas.Avg_ChMagErr_rms_pct	EVM_Meas.Avg_ChPhaseErr_deg
0.259	0.085	0.140

Meas Signal EVM, Magnitude Error, and Phase Error Results

Test Bench Variables for Data Displays

Reference variables used to set up this test bench are listed in *Test Bench Equations Derived from Test Bench Parameters and Exported to Data Display*.

Data Display Parameter	Equation with Test Bench Parameters
RF_FSource	FSource
RF_Power_dBm	10 × log10(SourcePower)+30
RF_R	SourceR
TimeStep	1/(ChipRate × SamplesPerChip)
ActiveSlot	ActiveTimeslot
SubframeTime	5 msec
FilterLength	RRC_FilterLength
Meas_FMeasurement	FMeasurement
Meas_R	MeasR

Baseline Performance

- Test Computer Configuration
  - Pentium IV 2.4 GHz, 512 MB RAM, Red Hat Linux 7.3
- Conditions
  - Measurements made with default test bench settings.
  - RF DUT is an RF system behavior component.
  - The number of time points in one TD-SCDMA uplink subframe is a function of SamplesPerChip and ChipRate.
    SamplesPerChip = 8
    ChipRate = 1.28 Mb/s
  - Resultant WTB_TimeStep = 97.65625 nsec; SubframeTime = 5msec; time points per subframe = 51200.
- Simulation times and memory requirements:

TDSCDMA_UpLnk_TX Measurement	**Bursts Measured**	**Simulation Time (sec)**	**ADS Processes (MB)**
RF_Envelope	1	19	91
Constellation	3	25	129
Power	3	197	122
Spectrum	3	24	140
EVM	3	11	104

Expected ADS Performance

Expected ADS performance is the combined performance of the baseline test bench and the RF DUT Circuit Envelope simulation with the same signal and number of time points. For example, if the RF DUT performance with Circuit Envelope simulation alone takes 2 hours and consumes 200 MB of memory (excluding the memory consumed by the core ADS product), then add these numbers to the Baseline Performance numbers to determine the expected ADS performance. This is valid only if the full memory consumed is from RAM. If RAM is less, larger simulation times may result due to increased disk access time for swap memory usage.

References for Uplink Transmitter Test

1. 3GPP TS 25.221, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Physical channels and mapping of transport channels onto physical channels (TDD) (Release 4)," version 4.5.0, June, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25221-450.zip]
2. 3GPP TS 25.223, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Spreading and modulation (TDD) (Release 4)," version 4.4.0, March, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25223-440.zip]
3. 3GPP TS 25.102, "3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UE Radio Transmission and Reception (TDD) (Release 4)," version 4.5.0, June, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/25_series/25102-450.zip]
4. 3GPP TS 34.122, "3rd Generation Partnership Project; Technical Specification Group Terminal; Terminal Conformance Specification; Radio Transmission and Reception (TDD) (Release 4)," version 4.4.0, June, 2002. http://www.3gpp.org/ftp/Specs/2002-06/Rel-4/34_series/34122-440.zip]

Setting up a Wireless Test Bench Analysis in the *Wireless Test Bench Simulation* documentation explains how to use test bench windows and dialogs to perform analysis tasks.

Setting Circuit Envelope Analysis Parameters in the Wireless Test Bench Simulation documentation explains how to set up circuit envelope analysis parameters such as convergence criteria, solver selection, and initial guess.

Setting Automatic Verification Modeling Parameters in the *Wireless Test Bench Simulation* documentation explains how to improve simulation speed.