Spatial_Channel_Model_SCM_5G

Where To Find This Example

AWR Version 14

Select Help > Open Examples... from the menus and type either the example name listed above or one of the keywords below.

Or you can open the project directly from this page using this button. Make sure to select the **Enable Guided Help** before clicking this button.

Open Install Example

AWR Version 13

This example is not available for AWR Version 13 or earlier.

Design Notes

Spatial Channel Model Example

This example illustrates the use of SPATIALCHANNEL block in a single-input single-output (SISO) configuration and it also applies to the related blocks, WINNER_II and 5G_CHANNEL. The SPATIALCHANNEL block implements the cluster delay line (CDL) model as described in WINNER II [1] and 3GPP channel model [2] documents. Using the secondary parameters of the model, a custom channel can be configured using the same parameters used to setup WINNER II and 3GPP channels.

The "SCM example" shows a single link with an OFDM transmitter and OFDM receiver. The simulation shows the channel input and output spectrums, time domain waveform magnitude at the output of the channel, and transmitted and received IQ constellations.

The spectrum plot shows the attenuation experienced through this channel. Note that the parameter PATHLOSS is left empty. When PATHLOSS is empty, the general pathloss equation is used which depends on four coefficients, carrier frequency, and distance. These parameters are specified in the secondary parameter. See the help file for details.

The time domain magnitude waveform shows the fading behavior of the channel output.

The IQ constellation plot shows the pathloss compensated (but no phase/rotation correction) OFDM receiver output. The rotation of the constellation due to Doppler and amplitude variation can be observed. Equations for calculating the necessary Doppler frequency from speed are shown on the diagram.

On antenna element radiation pattern:

The transmit and receive antenna element radiation pattern can be specified using the data file. In this example, DATA parameter is left empty thus omni directional 0dB gain pattern is used by default. Custom antenna pattern can be specified by selecting DATA = "Array_Config". The Array_Config file points to two files, one for TX and one for RX. The file format is the same as the one used in ANTENNA and PHARRAY_F block. Please see the help file for SPATIALCHANNELMODEL and related blocks for more information.

Simulating MIMO channel models:

SPATIALCHANNEL block supports the simulation of multiple-input multiple-output (MIMO) channels where multiple antennas are used at either or both at the transmitter or/and the receiver.

The antenna element radiation pattern in MIMO configuration uses the same radiation pattern for all transmit antennas and also for receive antennas. The radiation pattern of transmit side elements and receive side elements, however, can be different.

There are two modes of MIMO configuration, parallel mode and Serial mode, available for convenience of wiring on the system diagram. Parallel mode is where the number of input and output ports are expanded according to the selected number of antenna elements. This is convenient when the number of input and output are relatively small and it can be wired easily on the diagram.

Serial mode is where a single input and output ports are used regardless of the number of antenna elements. The input and output data are multiplexed in time, sample by sample, from the 0-th element to N-th element. Multiple input and output data can be managed with MUX and DMUX blocks. In PHARRAY block, this mode of operation is called the "MIMO mode".
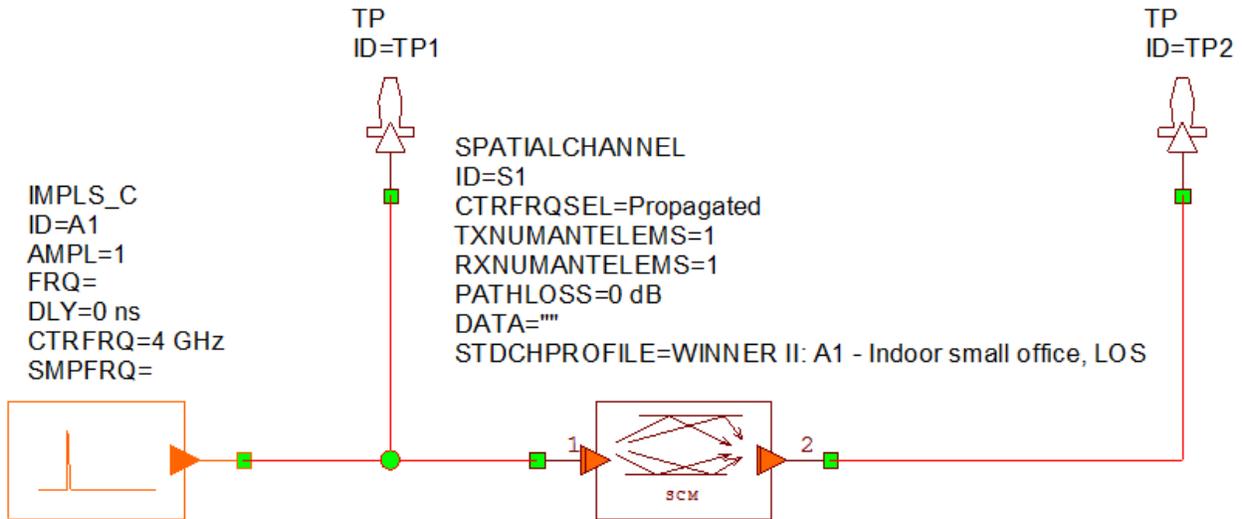
[1] IST-4-027756 WINNER II D1.1.2 V1.2 WINNER II Channel Models, available

<https://cept.org/files/8339/winner2%20-%20final%20report.pdf>

[2] 3GPP TR 38.900 v14.3.1 "Study on channel model for frequency spectrum above 6GHz (Release 14)" <http://www.3gpp.org/ftp//Specs/archive/38_series/38.900/38900-e31.zip>

System Diagram - SCM Delay Profile

Spatial Channel Model Impulse Response
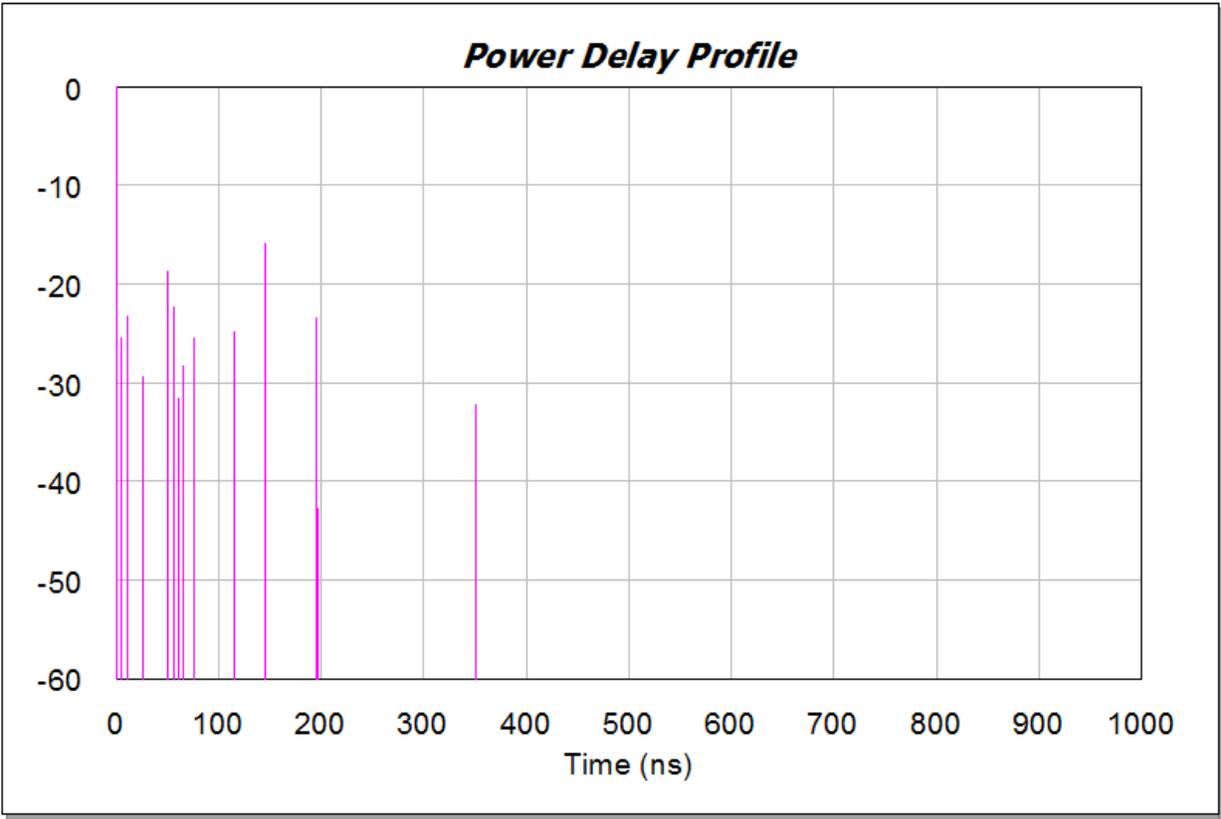
TP
ID=TP1

TP
ID=TP2
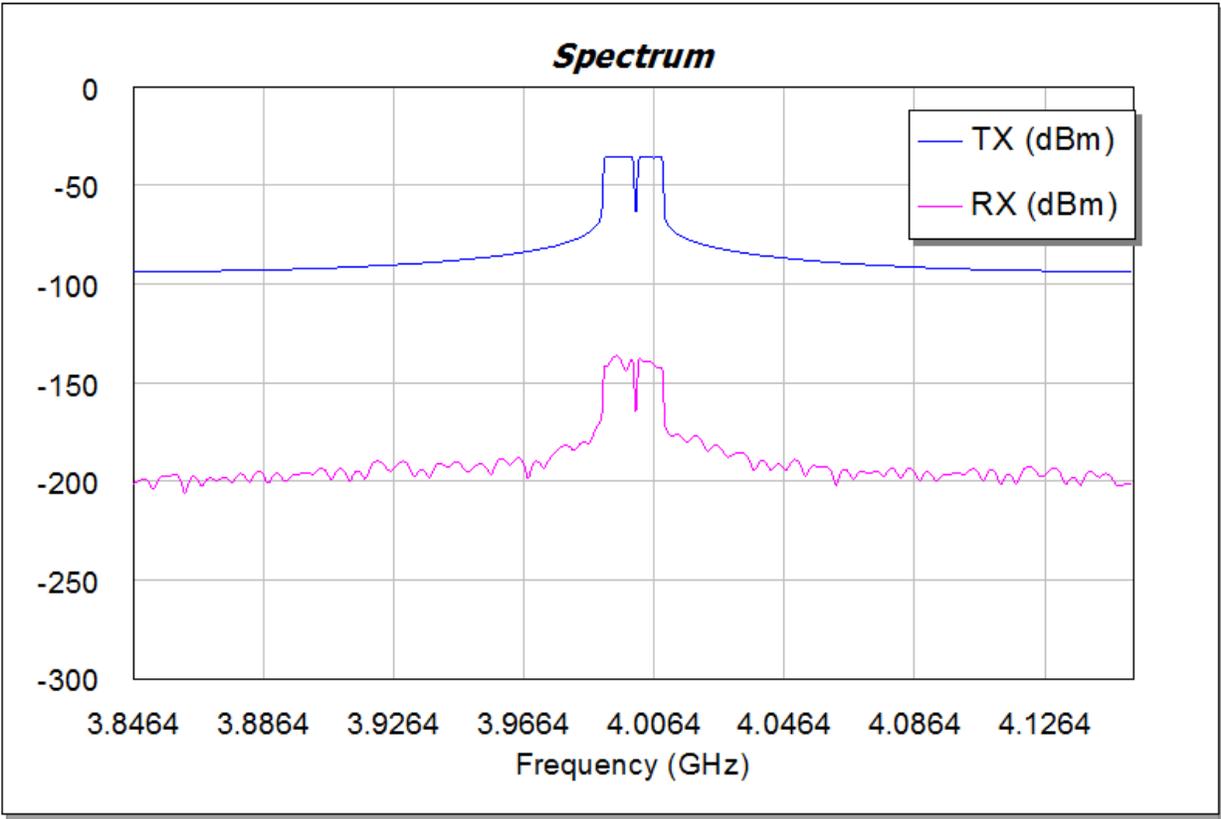
IMPLS_C
ID=A1
AMPL=1
FRQ=
DLY=0 ns
CTRFRQ=4 GHz
SMPFRQ=

SPATIALCHANNEL
ID=S1
CTRFRQSEL=Propagated
TXNUMANTELEMS=1
RXNUMANTELEMS=1
PATHLOSS=0 dB
DATA=""
STDCHPROFILE=WINNER II: A1 - Indoor small office, LOS

SCM

System Diagram - SCM Example

Spatial Channel Model Example

fc = 4e9
NC = 2048
MAP = {424,1023,1125,1624}

* Convert Doppler frequency to speed
fd = 741.3
Lambda = 299792458 / fc   Lambda: 0.07495
vd_ms = Lambda * fd / 2   vd_ms: 27.78   m/sec
vd_kmh = vd_ms * 3.6   vd_kmh: 100   km/h

* Convert speed (km/h) to Doppler frequency
vd = 100
vd_kmh_to_fd = 2 * (vd / 3.6) / Lambda   vd_kmh_to_fd: 741.3Hz

TP
ID=CH_In

TP
ID=CH_Out

TP
ID=Demod_Out

SUBCKT
ID=S2
NET="OFDM_Modulator"
OUTLVL=-20
OLVTYP=Avg. Total Power (dBm)
NC=NC
CS=15000
GI=1/8
CTRFRQ=fc
MAP=MAP
MOD=16

SPATIALCHANNEL
ID=S1
CTRFRQSEL=Propagated
MAXDOPPLER=fd
TXNUMANTELEMS=1
RXNUMANTELEMS=1
PATHLOSS=
DATA="Array_Config"
STDCHPROFILE=WINNER II: C1 - Urban macro-cell, NLOS

ALIGN
ID=A7
N=
REEVAL=
CORRDLY=
DLYCOMP=Align To Sample Boundaries
INTRPSPN=0
GAINCOMP=Power
PHSCOMP=No adjustments
NPOSTPHS=0
SMPLPTS=

SUBCKT
ID=S3
NET="OFDM_Demodulator"

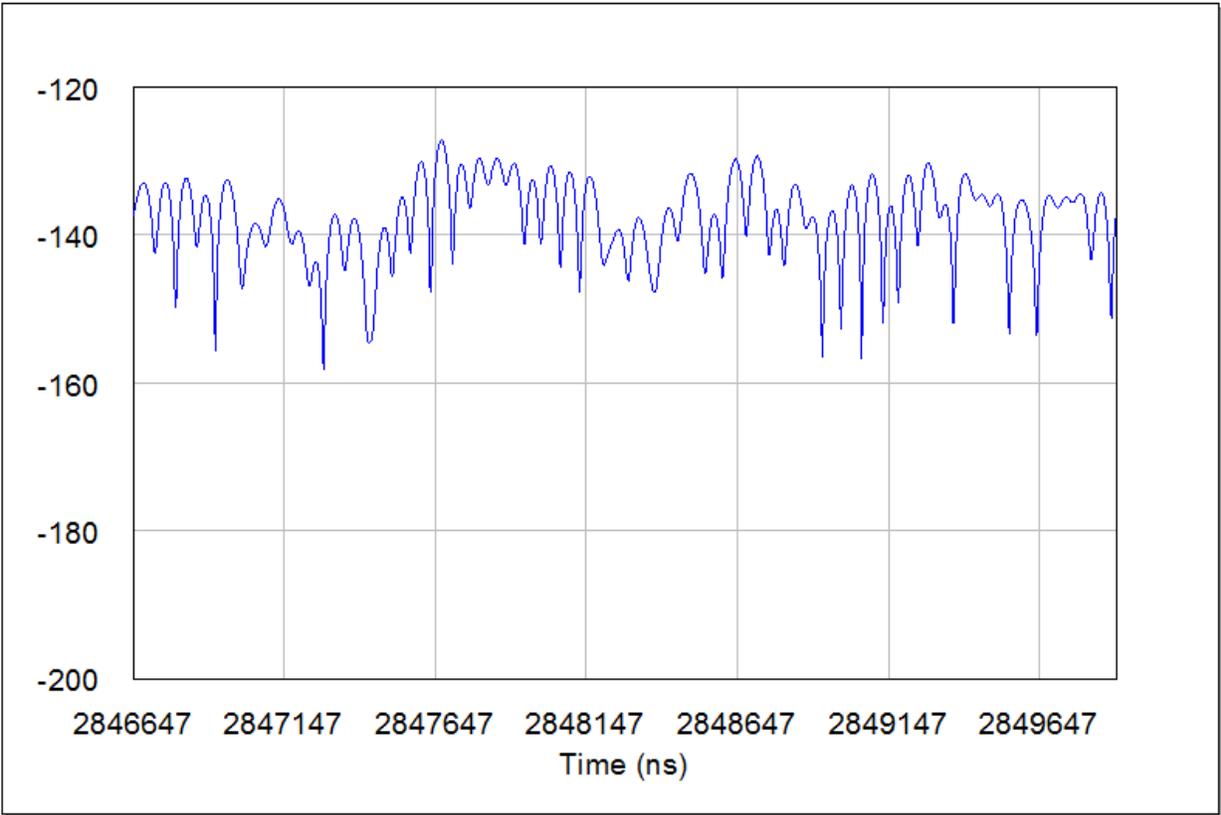**TP**
ID=OFDM_In

Graph - Power Delay Profile

Power Delay Profile

Graph - Spectrum

Graph - Time Domain

Graph - Pathloss Compensated Constellation

Pathloss Compensated Constellation