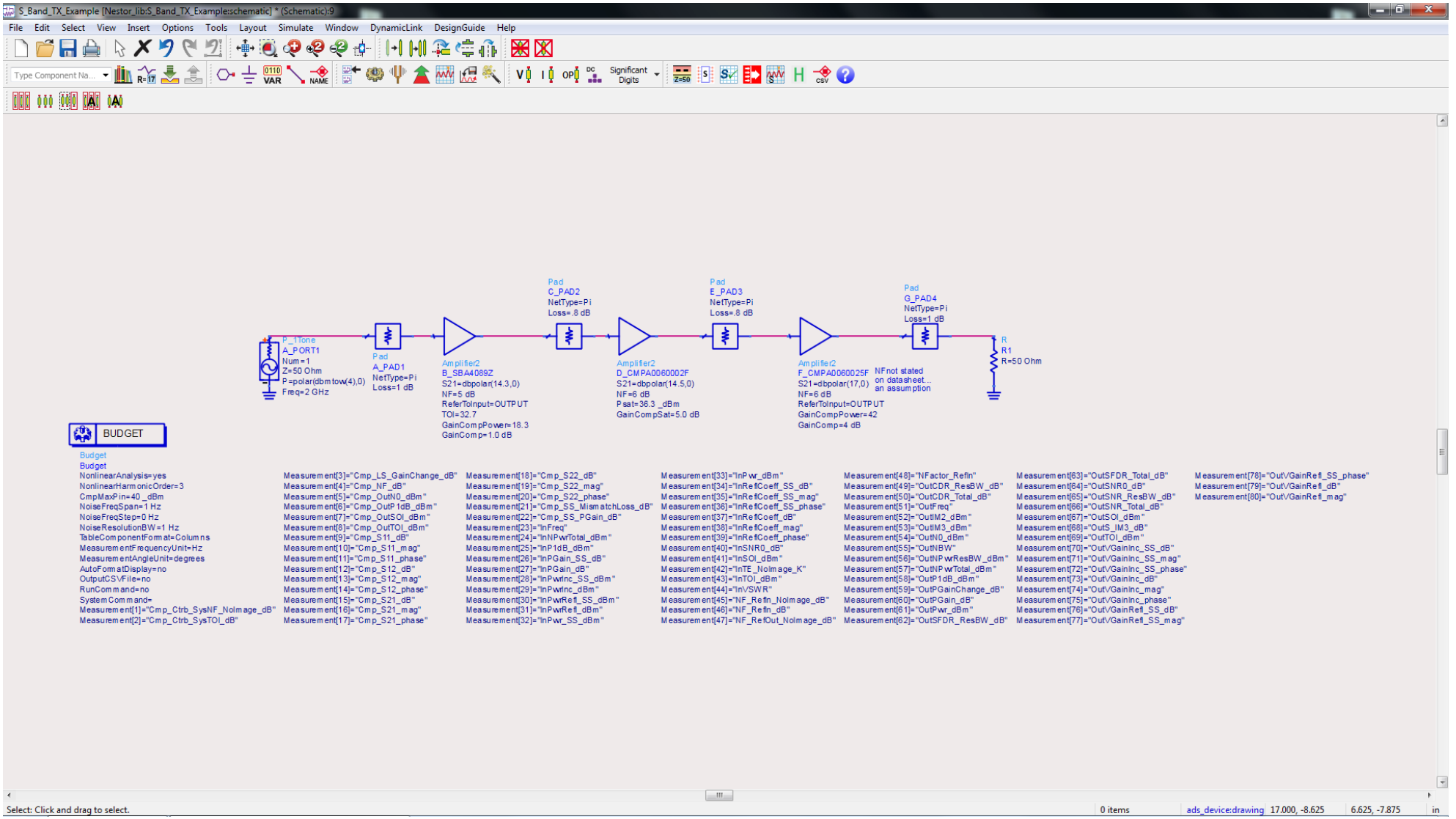
Two Examples Of Cascaded RF Analysis Using The RF Budget Simulator In The Advanced Design System (ADS) Simulator.

The RF Budget Simulator Is A Legacy Tool From Keysight Which Is No Longer Officially Supported, But It Still Yields Valuable Insight To Linear And Non-Linear Cascaded RF Signal Chains.

Other Advanced Design System Examples Can Be Found At: https://bbt-line.com/ads-examples/



S_Band_TX_Example* [page 1]:15

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Stage Parameters (NOT cascaded)

Cmp_Index	Cmp_RefDes	Gain [dB] Cmp_S21_dB	NF [dB] Cmp_NF_dB	Output P1dB Compression [dBm] Cmp_OutP1dB_dBm	Output TOI [dBm] Cmp_OutTOI_dBm
0	A_PAD1	-1.0	1.0	1000.0	1000.0
1	B_SBA4089Z	14.3	5.0	18.3	32.7
2	C_PAD2	-0.8	0.8	1000.0	1000.0
3	D_CMPA0060002F	14.5	6.0	32.3	42.7
4	E_PAD3	-0.8	0.8	1000.0	1000.0
5	F_CMPA0060025F	17.0	6.0	39.7	50.3
6	G_PAD4	-1.0	1.0	1000.0	1000.0

Stage Parameters, Small-Signal (cascaded)

Cmp_Index	Cmp_RefDes	Gain at Input to Stage [dB] InPGain_SS_dB	Gain at Output of Stage [dB] OutVGainInc_SS_dB	NF, moving forward in chain [dB] NF_RefIn_NoImage_dB	NF, moving backward in chain [dB] ..._RefOut_NoImage_dB	InTOI_dBm
0	A_PAD1	0.0	-1.0	1.0	6.2	6.3
1	B_SBA4089Z	-1.0	13.3	6.0	5.2	5.3
2	C_PAD2	13.3	12.5	6.0	6.9	19.9
3	D_CMPA0060002F	12.5	27.0	6.2	6.1	19.1
4	E_PAD3	27.0	26.2	6.2	6.8	34.1
5	F_CMPA0060025F	26.2	43.2	6.2	6.0	33.3
6	G_PAD4	43.2	42.2	6.2	1.0	1000.0

total cascaded small-signal gain

total cascaded NF

total Input TOI [dBm]

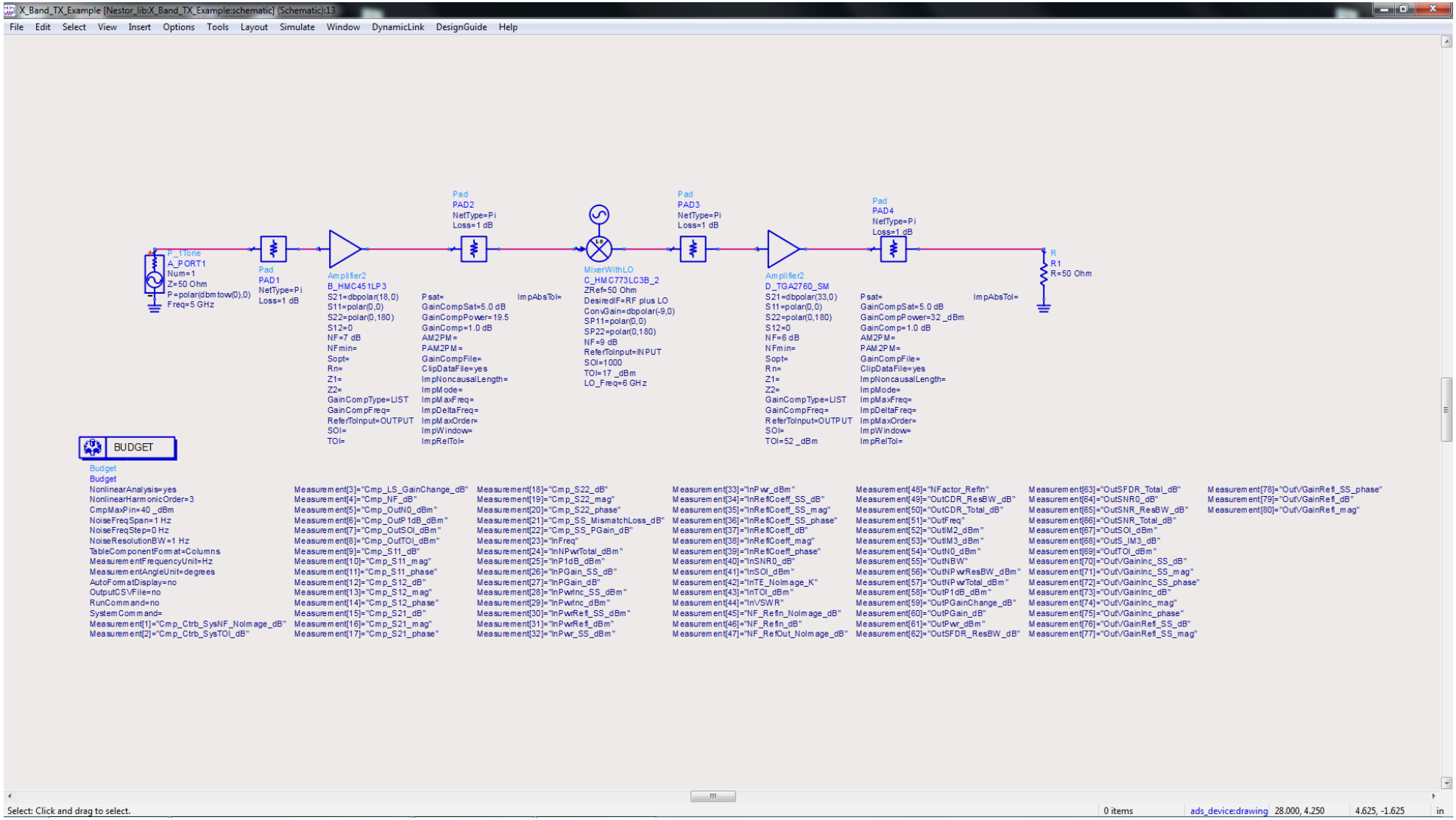
Single Tone Large Signal Analysis

Cmp_Index	Cmp_RefDes	Power at Input To Stage [dBm] InPwr_dBm	Power at Output of Stage [dBm] OutPwr_dBm	Freq at Input To Stage [GHz] InFreq/1e9	Freq at Output Of Stage [GHz] OutFreq/1e9	Gain at Input to Stage [dB] InPGain_dB	Gain at Output of Stage [dB] OutPGain_dB	Gain Deviation From Small Signal at Output of Stage [dB] ...tPGainChange_dB
0	A_PAD1	4.0	3.0	2.0	2.0	0.0	-1.0	0.0
1	B_SBA4089Z	3.0	16.8	2.0	2.0	-1.0	12.8	-0.5
2	C_PAD2	16.8	16.0	2.0	2.0	12.8	12.0	-0.5
3	D_CMPA0060002F	16.0	30.0	2.0	2.0	12.0	26.0	-1.0
4	E_PAD3	30.0	29.2	2.0	2.0	26.0	25.2	-1.0
5	F_CMPA0060025F	29.2	42.2	2.0	2.0	25.2	38.2	-5.0
6	G_PAD4	42.2	41.2	2.0	2.0	38.2	37.2	-5.0

Noise Power, SNR, SFDR

Cmp_Index	Cmp_RefDes	Noise Power, 1 Hz BW, Input of Stage InNPwrTotal_dBm	Noise Power, 1 Hz BW, Output of Stage OutNPwrTotal_dBm	SNR, Input of Stage, (difference between InPwr_dBm and InNPwrTotal_dBm) InSNR0_dB	SNR, Output of Stage, (difference between OutPwr_dBm and OutNPwrTotal_dBm) OutSNR0_dB	SFDR Output of Stage OutSFDR_Total_dB	Dynamic Range (difference between P1dB compression point and noisef floor), Output of Stage OutCDR_Total_dB	P1dB compression, Output of stage OutP1dB_dBm
0	A_PAD1	-173.9	-173.9	177.9	176.9	1000.0	1000.0	1000.0
1	B_SBA4089Z	-173.9	-154.6	176.9	171.5	124.9	172.9	18.3
2	C_PAD2	-154.6	-155.4	171.5	171.5	124.9	172.9	17.5
3	D_CMPA0060002F	-155.4	-140.8	171.5	170.7	121.3	170.7	30.0
4	E_PAD3	-140.8	-141.6	170.7	170.7	121.3	170.7	29.2
5	F_CMPA0060025F	-141.6	-124.5	170.7	166.8	116.1	163.6	39.1
6	G_PAD4	-124.5	-125.5	166.8	166.8	116.1	163.6	38.1

page 1


X_Band_TX_Example [Nestor_lib:X_Band_TX_Example:schematic] (Schematic):13
File Edit Select View Insert Options Tools Layout Simulate Window DynamicLink DesignGuide Help
P_1Tone
A_PORT1
Num=1
Z=50 Ohm
P=polar(dbmtow(0),0)
Freq=5 GHz
Pad
PAD1
NetType=Pi
Loss=1 dB
Amplifier2
B_HMC451LP3
S21=dbpolar(18,0)
S11=polar(0,0)
S22=polar(0,180)
S12=0
NF=7 dB
NFmin=
Sopt=
Rn=
Z1=
Z2=
GainCompType=LIST
GainCompFreq=
ReferToInput=OUTPUT
SOI=
TOI=
Psat=
GainCompSat=5.0 dB
GainCompPower=19.5
GainComp=1.0 dB
AM2PM=
PAM2PM=
GainCompFile=
ClipDataFile=yes
ImpNoncausalLength=
ImpMode=
ImpMaxFreq=
ImpDeltaFreq=
ImpMaxOrder=
ImpWindow=
ImpRelTol=
ImpAbsTol=
Pad
PAD2
NetType=Pi
Loss=1 dB
MixerWithLO
C_HMC773LC3B_2
ZRef=50 Ohm
DesiredIF=RF plus LO
ConvGain=dbpolar(-9,0)
SP11=polar(0,0)
SP22=polar(0,180)
NF=9 dB
ReferToInput=INPUT
SOI=1000
TOI=17 _dBm
LO_Freq=6 GHz
Pad
PAD3
NetType=Pi
Loss=1 dB
Amplifier2
D_TGA2760_SM
S21=dbpolar(33,0)
S11=polar(0,0)
S22=polar(0,180)
S12=0
NF=6 dB
NFmin=
Sopt=
Rn=
Z1=
Z2=
GainCompType=LIST
GainCompFreq=
ReferToInput=OUTPUT
SOI=
TOI=52 _dBm
Psat=
GainCompSat=5.0 dB
GainCompPower=32 _dBm
GainComp=1.0 dB
AM2PM=
PAM2PM=
GainCompFile=
ClipDataFile=yes
ImpNoncausalLength=
ImpMode=
ImpMaxFreq=
ImpDeltaFreq=
ImpMaxOrder=
ImpWindow=
ImpRelTol=
ImpAbsTol=
Pad
PAD4
NetType=Pi
Loss=1 dB
R
R1
R=50 Ohm
BUDGET
Budget
Budget
NonlinearAnalysis=yes
NonlinearHarmonicOrder=3
CmpMaxPin=40 _dBm
NoiseFreqSpan=1 Hz
NoiseFreqStep=0 Hz
NoiseResolutionBW=1 Hz
TableComponentFormat=Columns
MeasurementFrequencyUnit=Hz
MeasurementAngleUnit=degrees
AutoFormatDisplay=no
OutputCSVFile=no
RunCommand=no
SystemCommand=
Measurement[1]="Cmp_Ctrb_SysNF_NoImage_dB"
Measurement[2]="Cmp_Ctrb_SysTOI_dB"
Measurement[3]="Cmp_LS_GainChange_dB"
Measurement[4]="Cmp_NF_dB"
Measurement[5]="Cmp_OutN0_dBm"
Measurement[6]="Cmp_OutP1dB_dBm"
Measurement[7]="Cmp_OutSOI_dBm"
Measurement[8]="Cmp_OutTOI_dBm"
Measurement[9]="Cmp_S11_dB"
Measurement[10]="Cmp_S11_mag"
Measurement[11]="Cmp_S11_phase"
Measurement[12]="Cmp_S12_dB"
Measurement[13]="Cmp_S12_mag"
Measurement[14]="Cmp_S12_phase"
Measurement[15]="Cmp_S21_dB"
Measurement[16]="Cmp_S21_mag"
Measurement[17]="Cmp_S21_phase"
Measurement[18]="Cmp_S22_dB"
Measurement[19]="Cmp_S22_mag"
Measurement[20]="Cmp_S22_phase"
Measurement[21]="Cmp_SS_MismatchLoss_dB"
Measurement[22]="Cmp_SS_PGain_dB"
Measurement[23]="InFreq"
Measurement[24]="InNPwrTotal_dBm"
Measurement[25]="InP1dB_dBm"
Measurement[26]="InPGain_SS_dB"
Measurement[27]="InPGain_dB"
Measurement[28]="InPwrInc_SS_dBm"
Measurement[29]="InPwrInc_dBm"
Measurement[30]="InPwrRefl_SS_dBm"
Measurement[31]="InPwrRefl_dBm"
Measurement[32]="InPwr_SS_dBm"
Measurement[33]="InPwr_dBm"
Measurement[34]="InReflCoeff_SS_dB"
Measurement[35]="InReflCoeff_SS_mag"
Measurement[36]="InReflCoeff_SS_phase"
Measurement[37]="InReflCoeff_dB"
Measurement[38]="InReflCoeff_mag"
Measurement[39]="InReflCoeff_phase"
Measurement[40]="InSNR0_dB"
Measurement[41]="InSOI_dBm"
Measurement[42]="InTE_NoImage_K"
Measurement[43]="InTOI_dBm"
Measurement[44]="InVSWR"
Measurement[45]="NF_RefIn_NoImage_dB"
Measurement[46]="NF_RefIn_dB"
Measurement[47]="NF_RefOut_NoImage_dB"
Measurement[48]="NFactor_RefIn"
Measurement[49]="OutCDR_ResBW_dB"
Measurement[50]="OutCDR_Total_dB"
Measurement[51]="OutFreq"
Measurement[52]="OutIM2_dBm"
Measurement[53]="OutIM3_dBm"
Measurement[54]="OutN0_dBm"
Measurement[55]="OutNBW"
Measurement[56]="OutNPwrResBW_dBm"
Measurement[57]="OutNPwrTotal_dBm"
Measurement[58]="OutP1dB_dBm"
Measurement[59]="OutPGainChange_dB"
Measurement[60]="OutPGain_dB"
Measurement[61]="OutPwr_dBm"
Measurement[62]="OutSFDR_ResBW_dB"
Measurement[63]="OutSFDR_Total_dB"
Measurement[64]="OutSNR0_dB"
Measurement[65]="OutSNR_ResBW_dB"
Measurement[66]="OutSNR_Total_dB"
Measurement[67]="OutSOI_dBm"
Measurement[68]="OutS_IM3_dB"
Measurement[69]="OutTOI_dBm"
Measurement[70]="OutVGainInc_SS_dB"
Measurement[71]="OutVGainInc_SS_mag"
Measurement[72]="OutVGainInc_SS_phase"
Measurement[73]="OutVGainInc_dB"
Measurement[74]="OutVGainInc_mag"
Measurement[75]="OutVGainInc_phase"
Measurement[76]="OutVGainRefl_SS_dB"
Measurement[77]="OutVGainRefl_SS_mag"
Measurement[78]="OutVGainRefl_SS_phase"
Measurement[79]="OutVGainRefl_dB"
Measurement[80]="OutVGainRefl_mag"
Select: Click and drag to select.
0 items
ads_device:drawing
28.000, 4.250
4.625, -1.625
in

X_Band_TX_Example [page 1]:22

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Stage Parameters (NOT cascaded)

Cmp_Index	Cmp_RefDes	Gain [dB] Cmp_S21_dB	NF [dB] Cmp_NF_dB	Output P1dB Compression [dBm] Cmp_OutP1dB_dBm	Output TOI [dBm] Cmp_OutTOI_dBm
0	PAD1	-1.0	1.0	1000.0	* 1000.0
1	B_HMC451LP3	18.0	7.0	19.5	* 30.1
2	PAD2	-1.0	1.0	1000.0	1000.0
3	C_HMC773LC3B_2	-9.0	9.0	* -2.6	8.0
4	PAD3	-1.0	1.0	1000.0	1000.0
5	D_TGA2760_SM	33.0	6.0	32.0	52.0
6	PAD4	-1.0	1.0	1000.0	1000.0

* note: some of these numbers are not too accurate...this is a Budget Simulator limitation in the assumed relationship between P1dB compression and TOI

Stage Parameters, Small-Signal (cascaded)

Cmp_Index	Cmp_RefDes	Gain at Input to Stage [dB] InPGain_SS_dB	Gain at Output of Stage [dB] OutVGainInc_SS_dB	NF, moving forward in chain [dB] ...efIn_NoImage_dB	NF, moving forward in chain but no mixer image noise filtering [dB] NF_RefIn_dB	NF, moving backward in chain [dB] ...fOut_NoImage_dB	InTOI_dBm
0	PAD1	0.0	-1.0	1.0	1.0	8.6	0.5
1	B_HMC451LP3	-1.0	17.0	8.0	8.0	7.6	-0.5
2	PAD2	17.0	16.0	8.0	8.0	17.0	17.7
3	C_HMC773LC3B_2	16.0	7.0	8.1	11.1	16.0	16.7
4	PAD3	7.0	6.0	8.2	11.1	7.0	20.0
5	D_TGA2760_SM	6.0	39.0	8.6	11.4	6.0	19.0
6	PAD4	39.0	38.0	8.6	11.4	1.0	1000.0

total cascaded small-signal gain

total cascaded NF (with mixer image filtering)

total cascaded NF (without mixer image filtering)

total input TOI [dBm]

Single Tone Large Signal Analysis

Cmp_Index	Cmp_RefDes	Power at Input To Stage [dBm] InPwr_dBm	Power at Output of Stage [dBm] OutPwr_dBm	Freq at Input To Stage [GHz] InFreq/1e9	Freq at Output Of Stage [GHz] OutFreq/1e9	Gain at Input to Stage [dB] InPGain_dB	Gain at Output of Stage [dB] OutPGain_dB
0	PAD1	-0.0	-1.0	5.0	5.0	0.0	-1.0
1	B_HMC451LP3	-1.0	16.6	5.0	5.0	-1.0	16.6
2	PAD2	16.6	15.6	5.0	5.0	16.6	15.6
3	C_HMC773LC3B_2	15.6	-0.3	5.0	11.0	15.6	-0.3
4	PAD3	-0.3	-1.3	11.0	11.0	-0.3	-1.3
5	D_TGA2760_SM	-1.3	31.1	11.0	11.0	-1.3	31.1
6	PAD4	31.1	30.1	11.0	11.0	31.1	30.1

Noise Power, SNR, SFDR

Cmp_Index	Cmp_RefDes	InNPwrTotal_dBm	OutNPwrTotal_dBm	InSNR0_dB	OutSNR0_dB	OutSFDR_ResBW_dB	OutSFDR_Total_dB
0	PAD1	-173.9	-173.9	173.9	172.9	1000.0	1000.0
1	B_HMC451LP3	-173.9	-149.0	172.9	165.5	119.4	119.4
2	PAD2	-149.0	-150.0	165.5	165.5	119.4	119.4
3	C_HMC773LC3B_2	-150.0	-155.8	165.5	155.5	109.0	109.0
4	PAD3	-155.8	-156.8	155.5	155.5	109.0	109.0
5	D_TGA2760_SM	-156.8	-123.6	155.5	154.7	108.7	108.7
6	PAD4	-123.6	-124.6	154.7	154.7	108.7	108.7

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