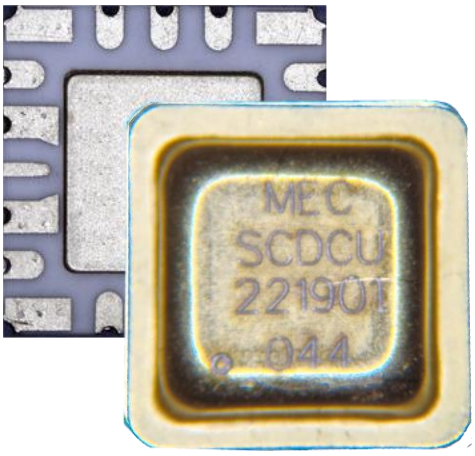
MECSCDCU

12 - 15 GHz to 1 – 5.5 GHz DownConverter



Main Features

- 0.25µm GaAs pHEMT space evaluated process
- Full performance in the frequency bands:
  - RF: 12.5 - 15 GHz
  - LO: 8.5 - 12.5 GHz
  - IF: 1 - 5.5 GHz
- -3 to +8 dB minimum Conversion Gain
- 11 dB Conversion Gain variation
- -7 to +2 dBm of LO input power with same conversion performance
- Fixed Bias: VDD = 3V, Idq = 105 mA
- Conversion Gain control: VC1 = -5 to 0 V
- LO power control: VC2 = -5 to 0 V
- Fully matched to 50 Ω, with integrated RF to DC decoupling
- Assembled in a hermetically sealed SMT ceramic package

Product Description

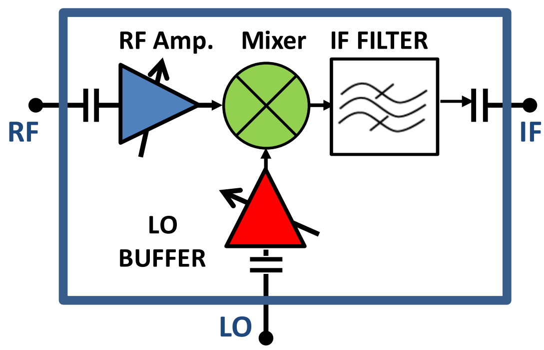
MECSCDCU is a Ku band to IF band frequency converter. It is based on a 0.25 µm GaAs pHEMT space evaluated process.

The MECSCDCU integrates in a single chip 11 dB of continuous gain variation in the conversion chain, as well as 9 dB of continuous gain variation of the LO buffer amplifier. They can be changed either statically or dynamically by means of two different control voltages. The gain variation features allow great flexibility in its integration within different systems requiring different conversion gain and LO input power.

The MECSCDCU offers a conversion gain in the range -3 dB to 8 dB, LOW-GAIN and HIGH-GAIN state respectively. Its performances remain quite uniform as a function of the LO input power from -7 to +2 dBm.

The MMIC is assembled in a hermetically sealed SMT ceramic package suitable for space applications.

Functional Block Diagram



Applications

- Radar
- Defence
- Space
- Itar-free

Nominal Operating Conditions

Parameter	Min	Typ.	Max	Units
Temperature Range	-40	+25	+85	°C
VD1		3		V
ID1		32		mA
VG1		-0.4		V
IG1		0		mA
VC1	-5		0	V
IC1		0		mA
VD2		3		V
ID2		73		mA
VG2		-0.4		V
IG2		0		mA
VC2	-4.25	-3	-1.25	V
IC2		0		mA
PDC_RF			96	mW
PDC_LO			219	mW
PDC			315	mW
P_RF_state1	-45		-35	dBm
P_RF_state2	-35		-25	dBm
P_LO	-7		+2	dBm

- When operates under these recommended conditions, the device is compliant with ESA space-derating rules.
- Electrical specifications are measured at specified test conditions.
- Control voltages configuration:
  - VC1 (RF gain control):
    -5 V for High Gain; 0 V for Low-Gain
  - VC2 (To equalize performance Vs. P_LO variation):
    -4.25 V @ P_LO [-7÷-4] dBm
    -3.0 V @ P_LO [-3÷-1] dBm
    -1.25 V @ P_LO [0÷-2] dBm
- The continuous gain variation features can be achieved by applying a continuous variation to VC1.

Absolute Maximum Rating

Parameter	Rating
VD	4 V
VG	-1.5 to 0 V
Channel temperature, T_J	175 °C
PDC (T = 85 °C; VD = 4V)	540 mW
RF Input Power @ High-Gain	8 dBm
RF Input Power @ Low-Gain	10 dBm
LO Input Power	10 dBm
Mounting Temperature (<30 sec)	260 °C
Storage Temperature	-55 to +150 °C

These parameters are carried out from specific stress test analysis.

Operation of this device outside of these ranges may cause permanent damage.

Thermal and Reliability Information

Conditions	Parameter	Value
Worst case operating conditions: VD1 = 3 V, ID1 = 32 mA VD2 = 3 V, ID2 = 73 mA VC1 = -1.0 V VC2 = -2.8 V P_RF = -25 dBm P_LO = +2 dBm Pdiss = 400 mW Tbase = 85°C	Equivalent Thermal Resistance	100 °C/W
	Channel Temperature	125 °C
	Mean Time Failure	**> 2E+7 hrs**

Electrical Characteristics

Test conditions unless otherwise noted: Tbase = 25°C, VD1 = 3 V, VG1 = - 0.4 V, ID1 =32 mA, VD2 = 3 V, VG2 = - 0.4 V, ID2 = 73 mA, VC2 = -4.25 V, P_LO = -4 dBm.

Parameter	Min.	Typ	Max	Units
Input Frequency Range (RF)	12.5		15	GHz
Output Frequency Range (IF)	1		5.5	GHz
LO Frequency Range (LO)	8.5		12.5	GHz
RF Input Power Range *High-Gain* *Low-Gain*	 -45 -35		 -35 -25	dBm
LO Input Power Range	-7	-3	+2	dBm
Conversion Gain *High-Gain* *Low-Gain*		 +8 -3		 dB dB
Conversion gain difference between states		11 ± 2		dB
Conversion Gain Flatness			2	dBpp
Conversion Gain Variation with LO Drive Level			1	dBpp
Noise Figure (SSB) *High-Gain* *Low-Gain*	 2.5 6.5		 3 8	 dB
Output P1dB *High-Gain* *Low-Gain*		 -6 -7		 dBm dBm
Output IP3 level *High-Gain* *Low-Gain*	 5 6		 11 15	 dBm dBm
LO to IF Isolation		40		dB
Input Return Loss	7		25	dB
Output Return Loss	10			dB
LO Input Return Loss	10			dBc
In-band Mixing Spurious Levels	50			dBc
Close to In-band Mixing Spurious Levels (IF bandwidth of 5.5 GHz to 7 GHz)	50			dBc
2LO x -RF Spurious	10			dBc
3LO x -RF Spurious	50			dBc
IF Spurious Harmonic Level	50			dBc
Power Consumption			0.315	W
Packaged Size Body Dimensions Package Height		 6 x 6 2.5		 mm^2 mm

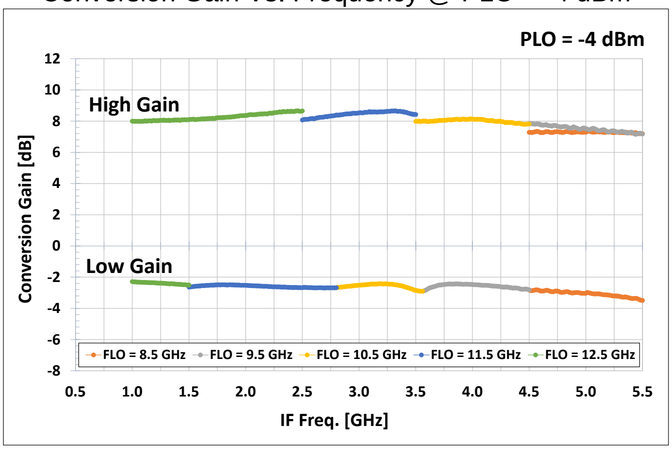
Main Performance – Conversion Gain

Test conditions unless otherwise noted: Tbase = 25°C, VD1 = 3 V, VG1 = - 0.4 V, ID1 = 32 mA, VD2 = 3 V, VG2 = - 0.4 V, ID2 = 73 mA. VC1 = -5 V (High-Gain) and 0 V (Low-Gain); VC2 = -4.25 V (P_LO = -4 dBm), -3 V (P_LO = -1 dBm) and -1.25 V (P_LO = 1 dBm)

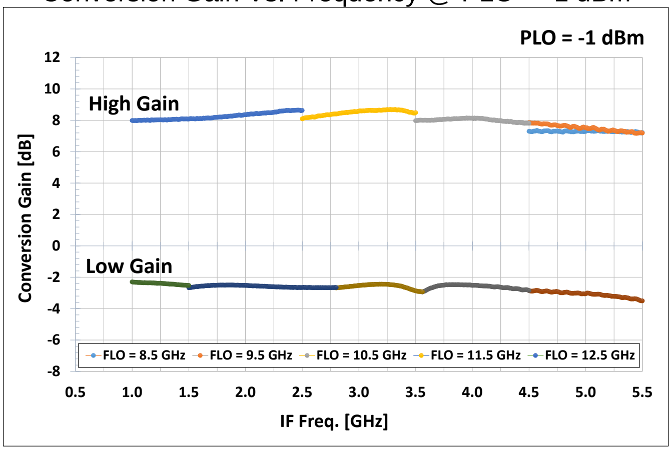
Specific Conversion Scheme

LO freq	8.5	9.5	10.5	11.5	12.5	GHz
Syn. #	1	2	3	4	5	
RF freq			IF freq			
12.5	4.0	3.0	2.0	1.0	0.0	
13.0	4.5	3.5	2.5	1.5	0.5	
13.5	5.0	4.0	3.0	2.0	1.0	
14.0	5.5	4.5	3.5	2.5	1.5	
14.5	6.0	5.0	4.0	3.0	2.0	
15.0	6.5	5.5	4.5	3.5	2.5	
GHz	GHz	GHz	GHz	GHz	GHz	

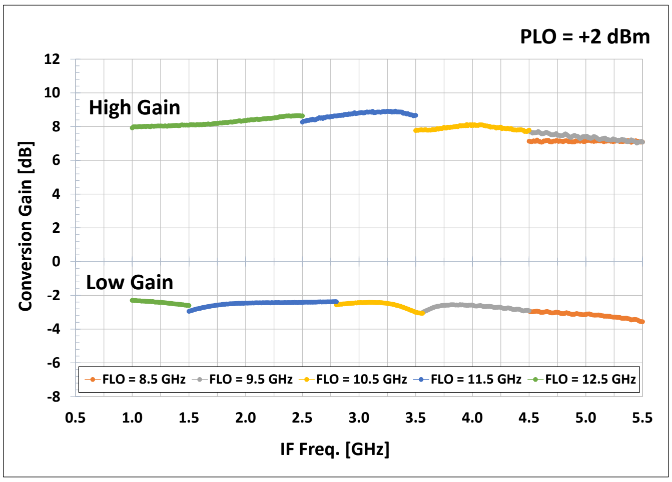
Conversion Gain Vs. Frequency @ PLO = -4 dBm



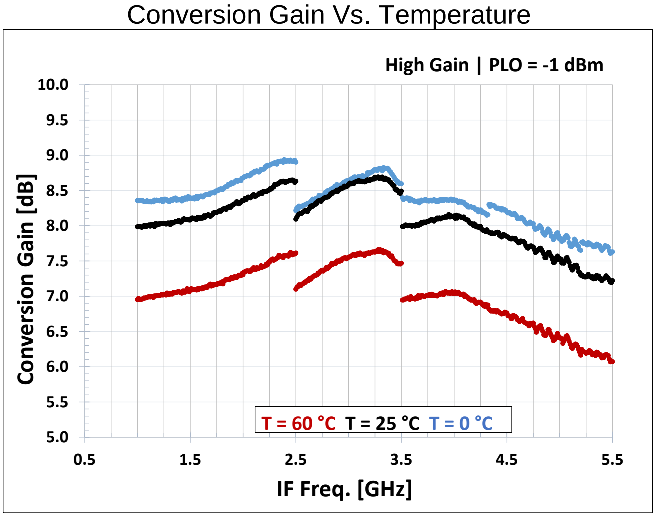
Conversion Gain Vs. Frequency @ PLO = -1 dBm



Conversion Gain Vs. Frequency @ PLO = 0 dBm



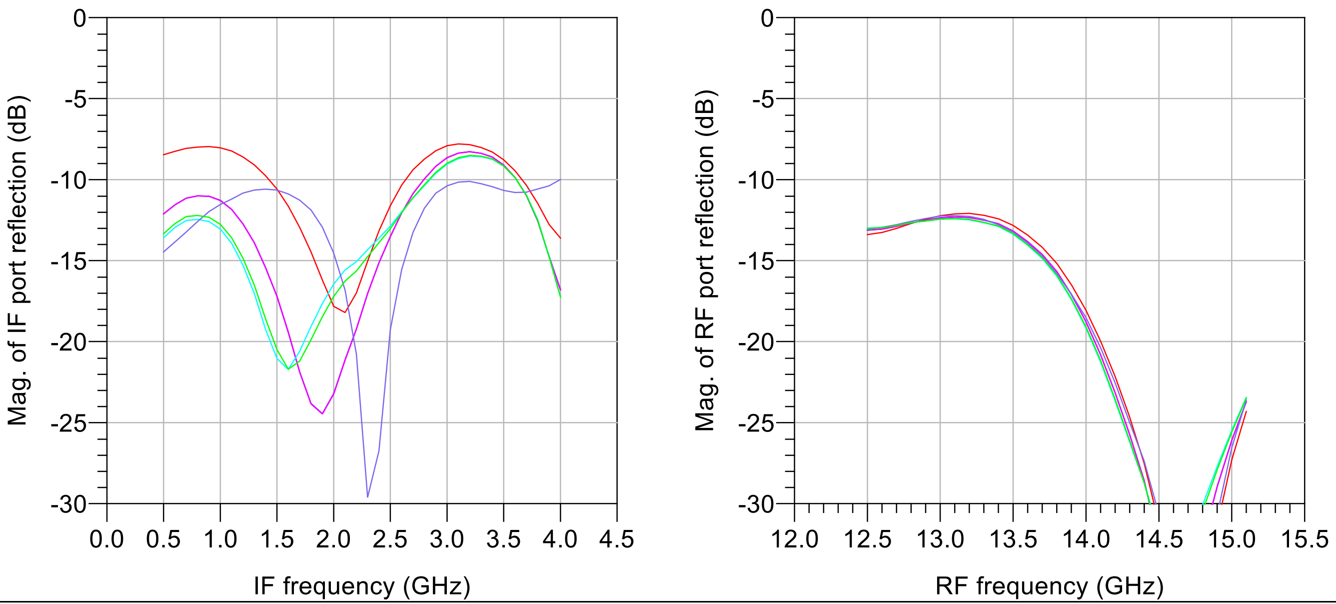
Conversion Gain Vs. Temperature



Main Performance – Return Loss

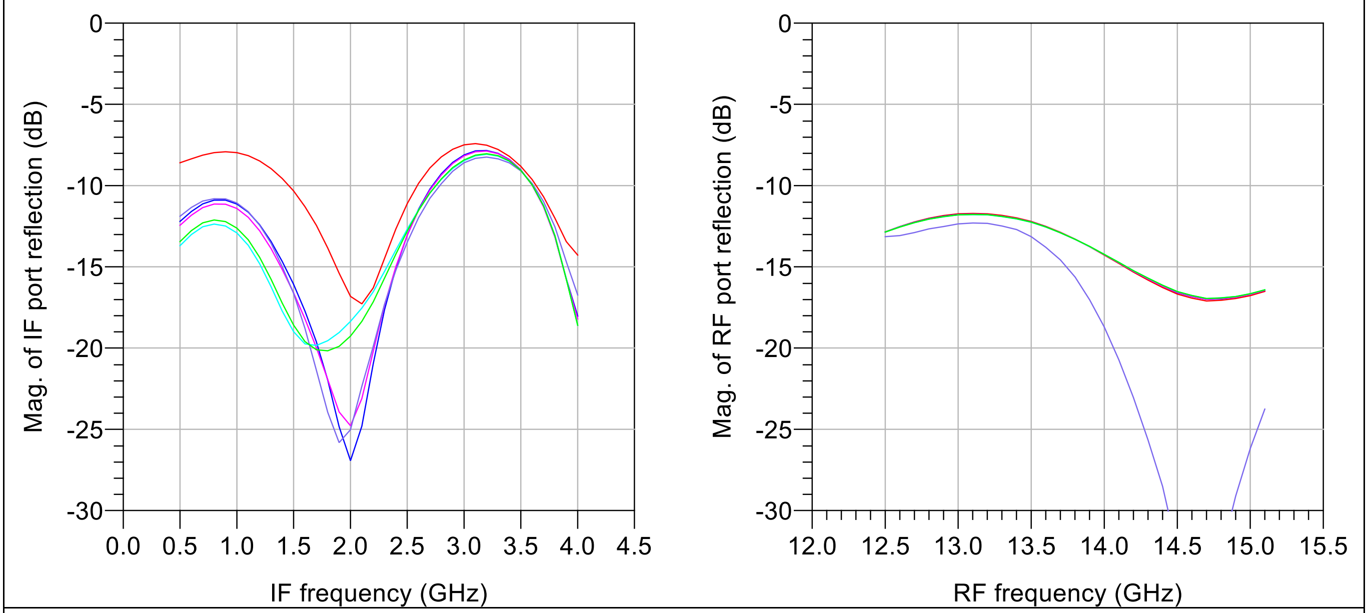
Test conditions unless otherwise noted: Tbase = 25°C, VD1 = 3 V, VG1 = - 0.4 V, ID1 = 32 mA, VD2 = 3 V, VG2 = - 0.4 V, ID2 = 73 mA. VC1 = -5 V (High-Gain) and 0 V (Low-Gain); VC2 = -4.25 V (P_LO = -7, -4 dBm), -3 V (P_LO = -3, -1 dBm) and 1.25 V (P_LO = 0, 2 dBm)

Retrun Loss Vs. Frequency @ LO = 11.4 GHz – ***High Gain state***



P_LO=-7dBm; P_LO=-4dBm; P_LO=-3dBm; P_LO=-1dBm; P_LO=0dBm; P_LO=2dBm

Retrun Loss Vs. Frequency @ LO = 11.4 GHz – ***Low Gain state***



P_LO=-7dBm; P_LO=-4dBm; P_LO=-3dBm; P_LO=-1dBm; P_LO=0dBm; P_LO=2dBm

Main Performance – IF harmonics and Spurious tones (F_LO = 9.4 GHz)

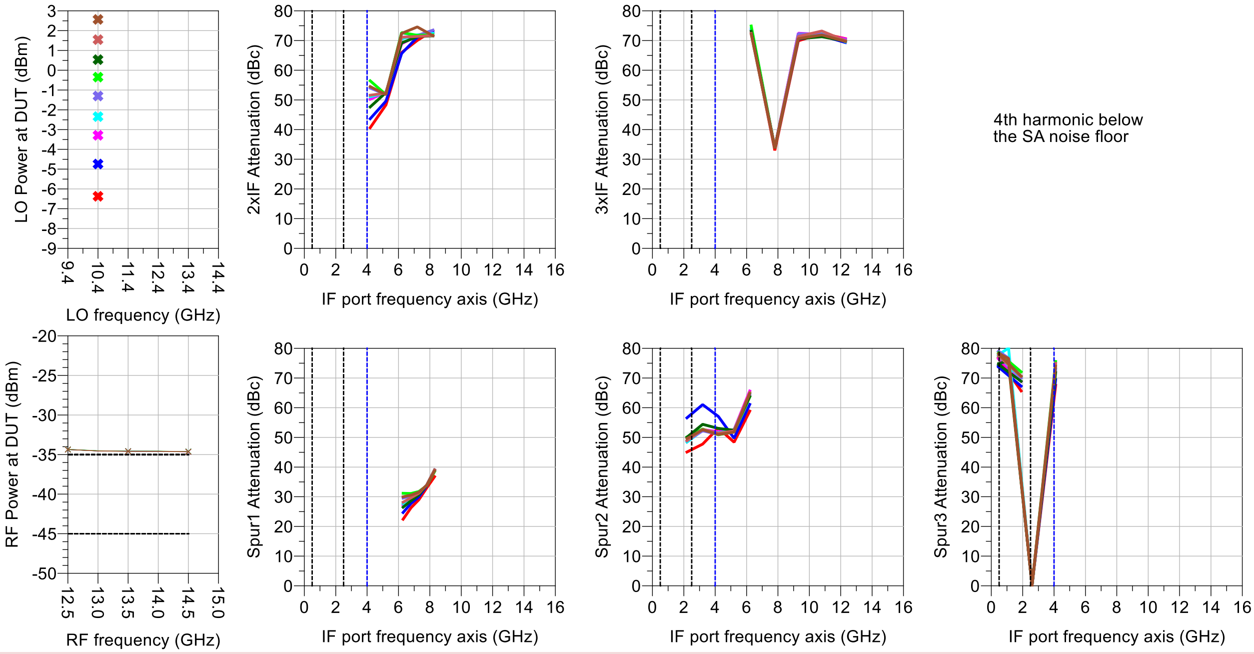
Test conditions unless otherwise noted: Tbase = 25°C, VD1 = 3 V, VG1 = - 0.4 V, ID1 = 32 mA, VD2 = 3 V, VG2 = - 0.4 V, ID2 = 73 mA. VC1 = -5 V (High-Gain) and 0 V (Low-Gain); VC2 = -4.25 V (P_LO = -7, -4 dBm), -3 V (P_LO = -3, -1 dBm) and 1.25 V (P_LO = 0, 2 dBm)

F_LO = 9.4 GHz

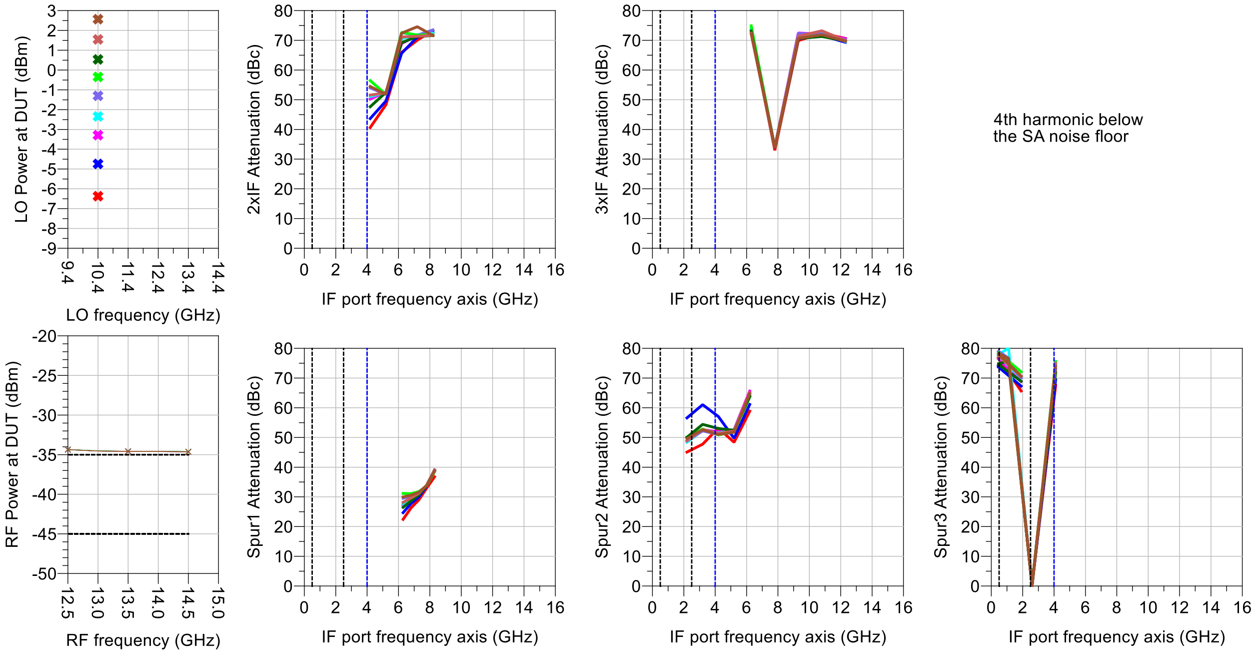
P_LO=-7dBm; P_LO=-5.5dBm; P_LO=-4dBm; P_LO=-3dBm; P_LO=-2dBm; P_LO= 0 dBm; P_LO=1dBm; P_LO=2dBm

Spur1: (2,-1); Spur2: (3,-2); Spur3: (4,-3)

High Gain state



Low Gain state

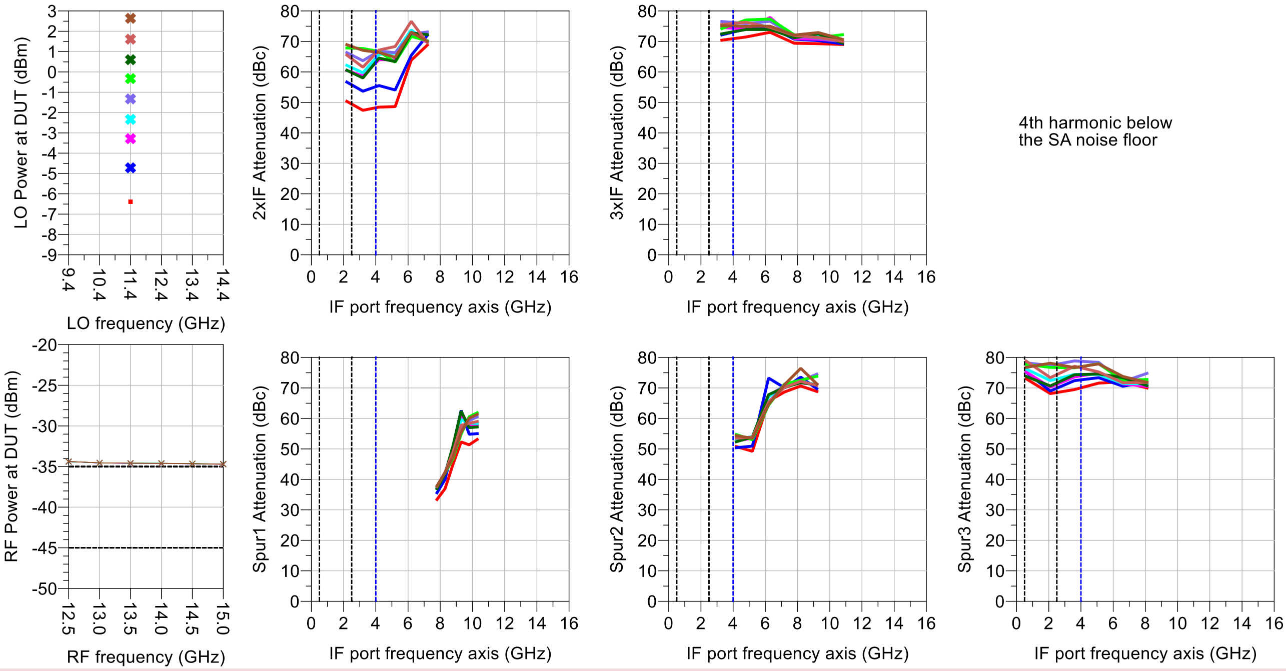


Main Performance – IF harmonics and Spurious tones (F_LO = 10.4 GHz)

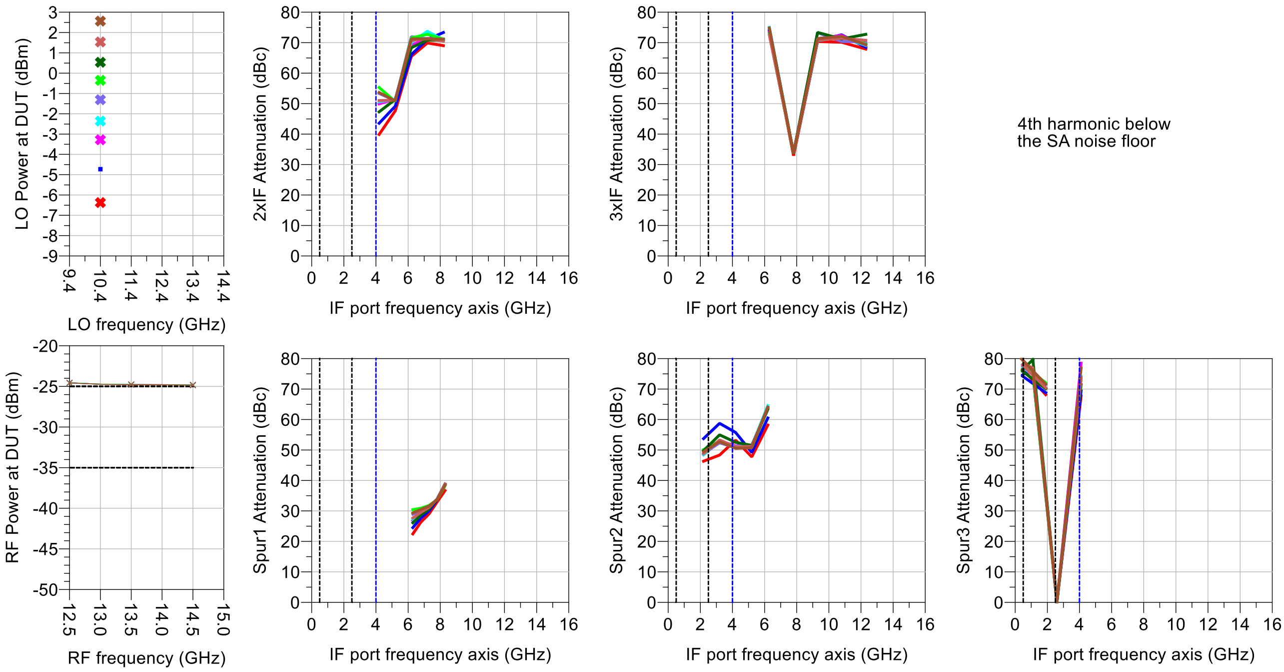
F_LO = 10.4 GHz

P_LO=-7dBm; P_LO=-5.5dBm; P_LO=-4dBm; P_LO=-3dBm; P_LO=-2dBm; P_LO= 0 dBm; P_LO=1dBm; P_LO=2dBm
Spur1: (2,-1); Spur2: (3,-2); Spur3: (4,-3)

High Gain state



Low Gain state

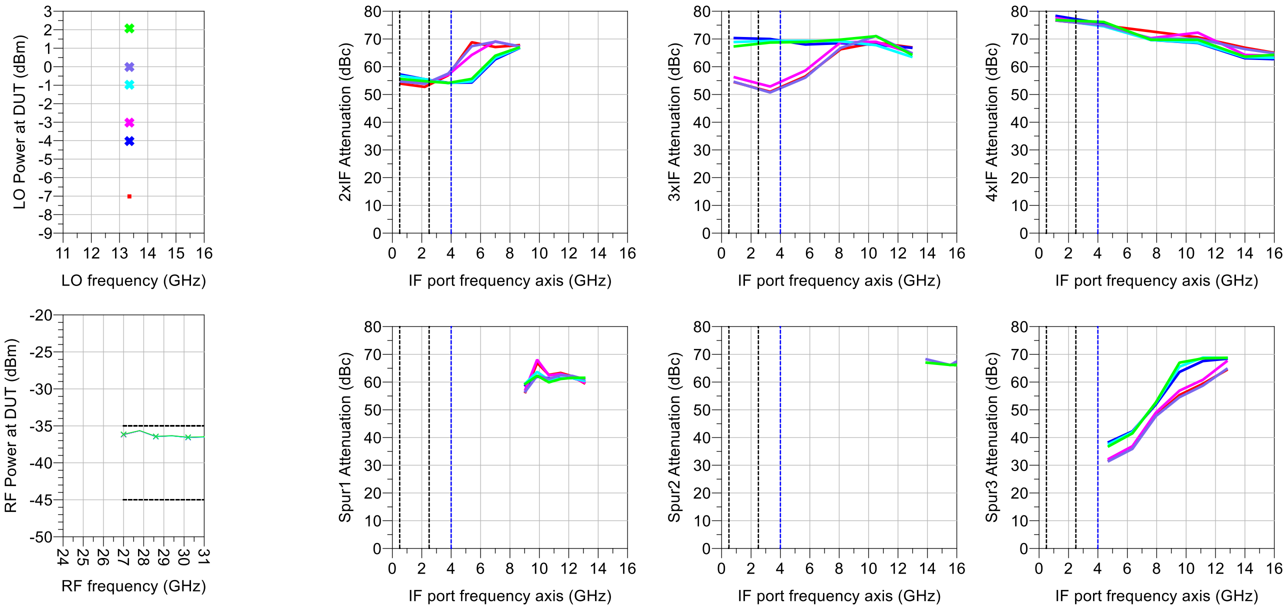


Main Performance – IF harmonics and Spurious tones (F_LO = 11.4 GHz)

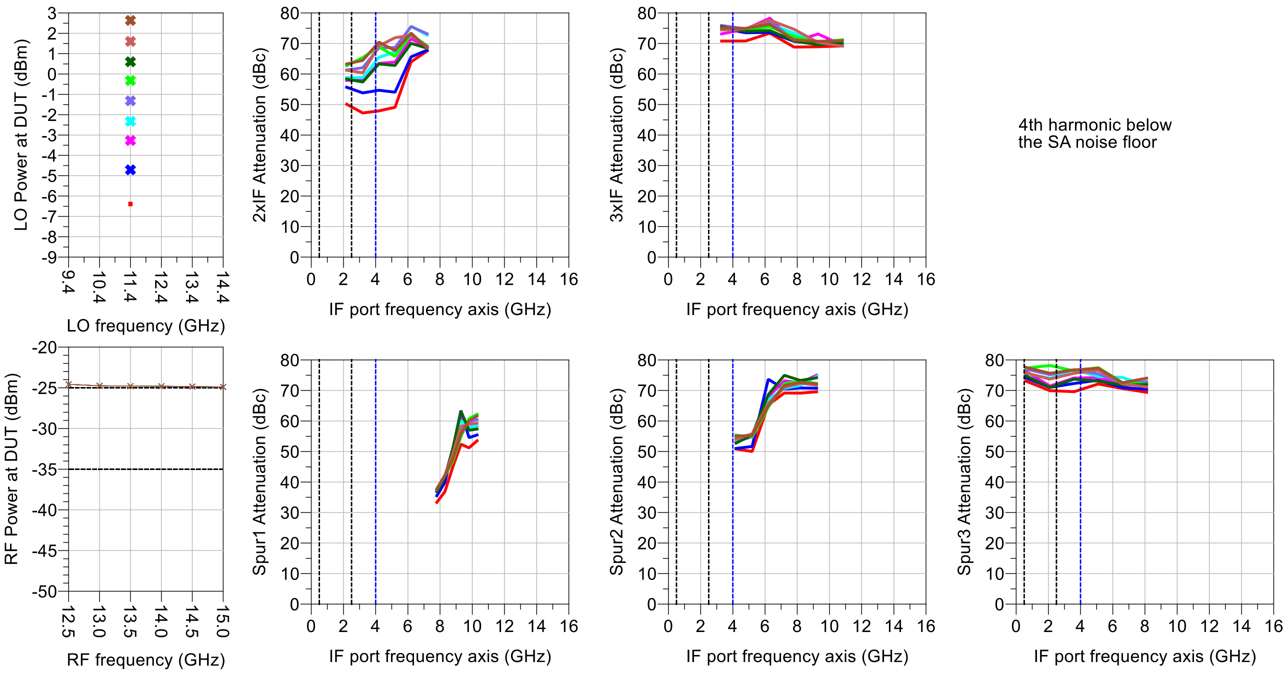
F_LO = 11.4 GHz

P_LO=-7dBm; P_LO=-5.5dBm; P_LO=-4dBm; P_LO=-3dBm; P_LO=-2dBm; P_LO= 0 dBm; P_LO=1dBm; P_LO=2dBm
Spur1: (2,-1); Spur2: (3,-2); Spur3: (4,-3)

High Gain state



Low Gain state

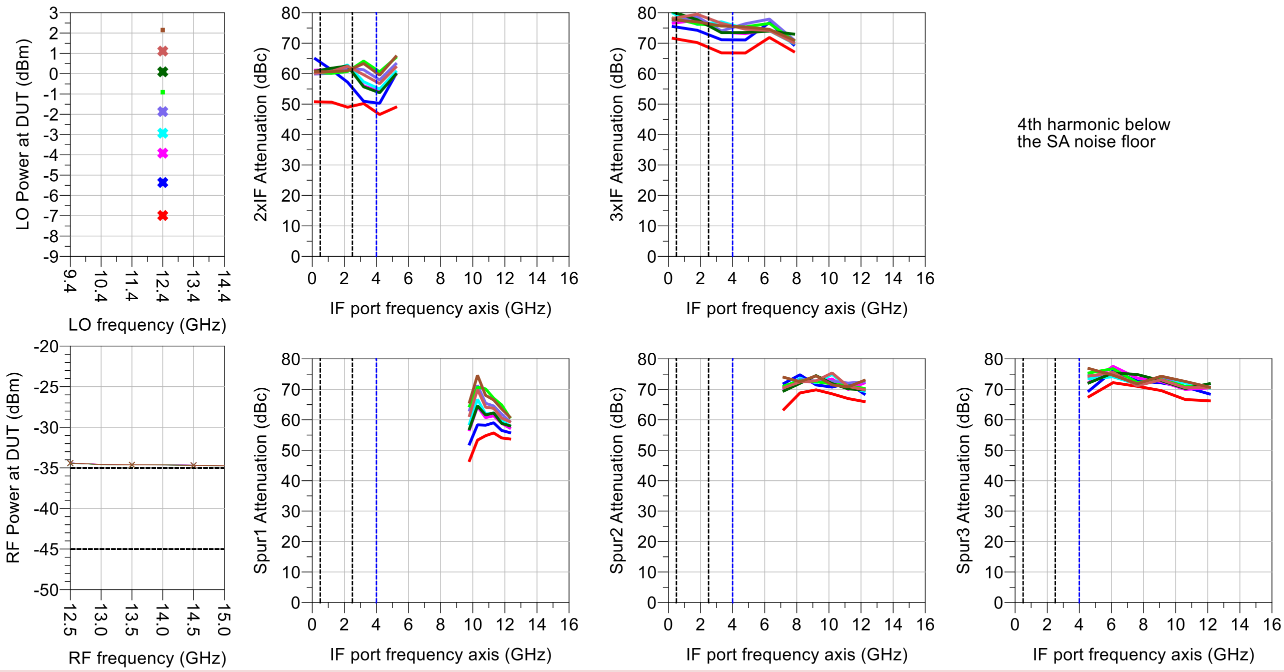


Main Performance – IF harmonics and Spurious tones (F_LO = 12.40 GHz)

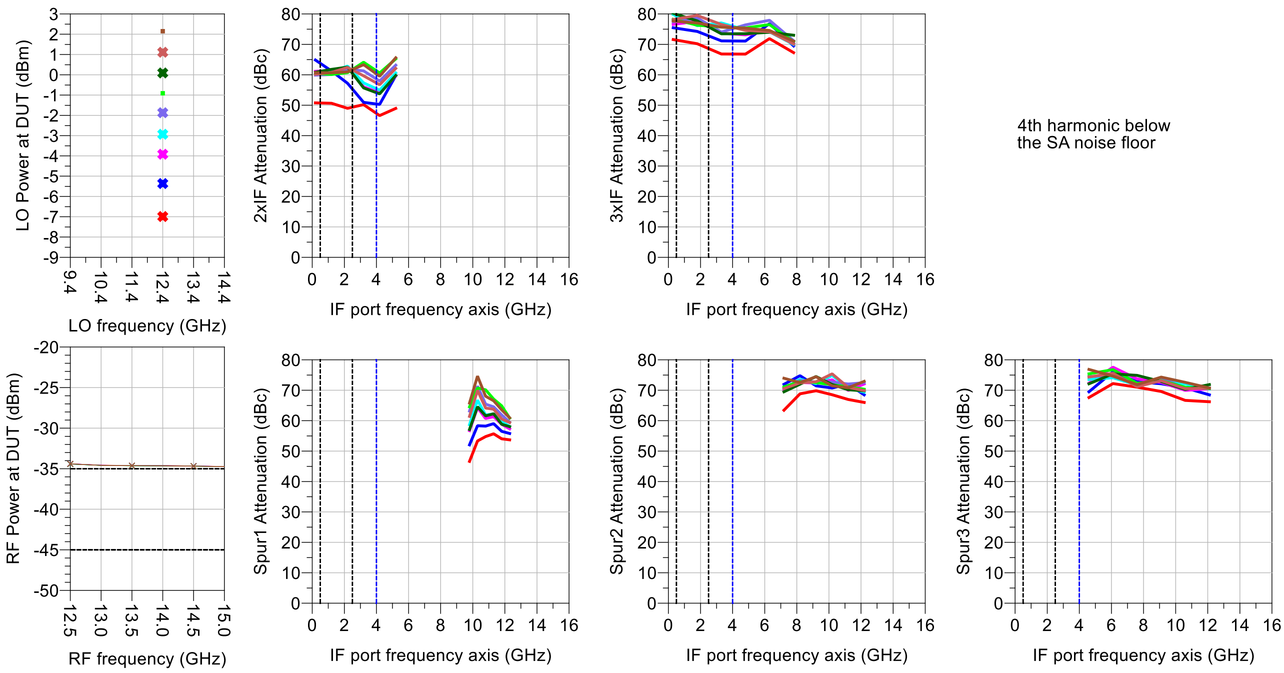
F_LO = 12.40 GHz

P_LO=-7dBm; P_LO=-5.5dBm; P_LO=-4dBm; P_LO=-3dBm; P_LO=-2dBm; P_LO= 0 dBm; P_LO=1dBm; P_LO=2dBm
Spur1: (2,-1); Spur2: (3,-2); Spur3: (4,-3)

High Gain state



Low Gain state



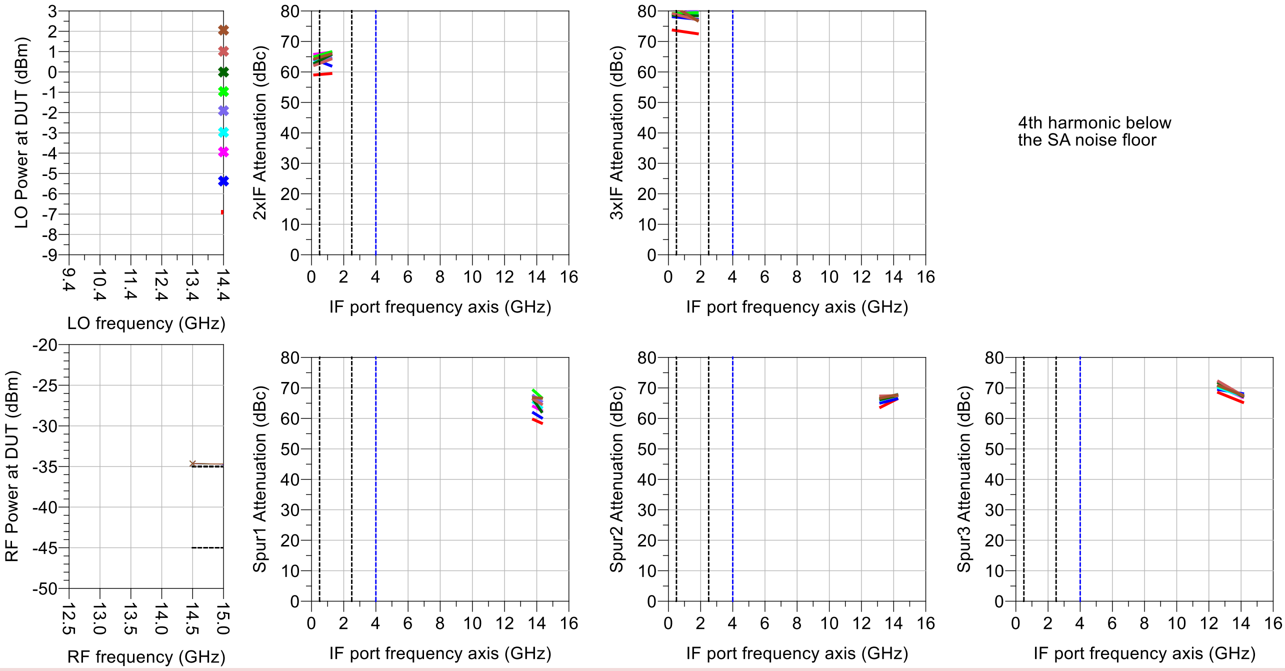
Main Performance – IF harmonics and Spurious tones (F_LO = 13.40 GHz)

F_LO = 13.4 GHz

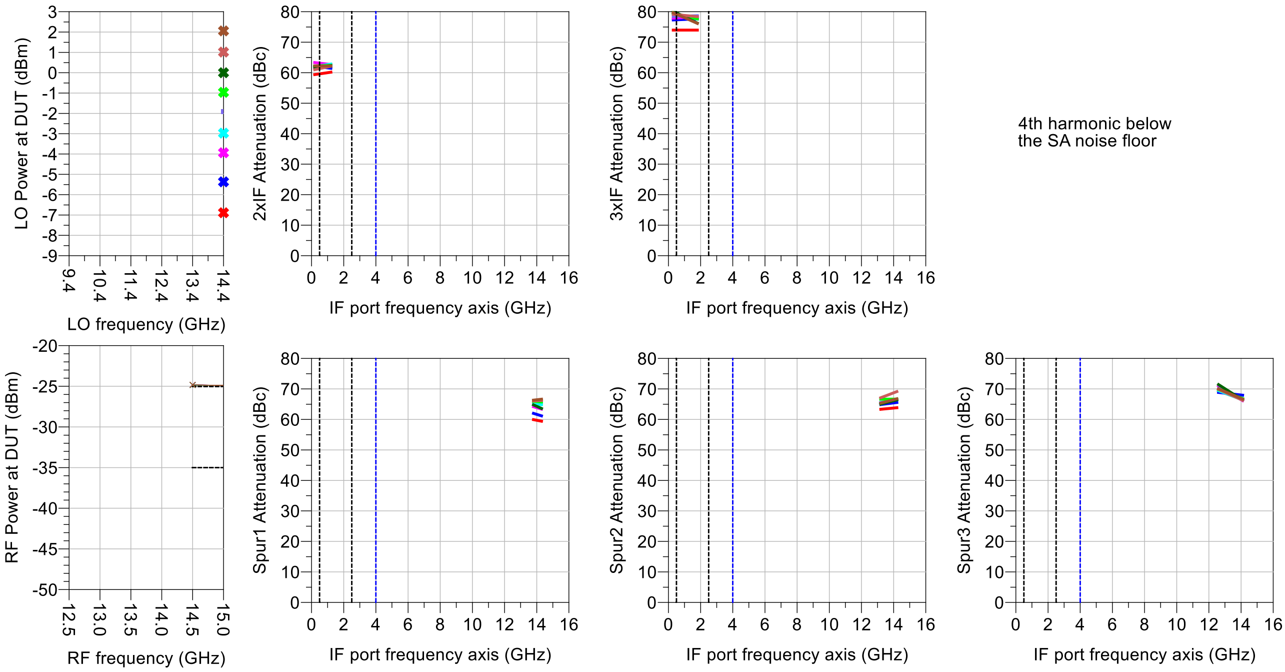
P_LO=-7dBm; P_LO=-5.5dBm; P_LO=-4dBm; P_LO=-3dBm; P_LO=-2dBm; P_LO= 0 dBm; P_LO=1dBm; P_LO=2dBm

Spur1: (2,-1); Spur2: (3,-2); Spur3: (4,-3)

High Gain state



Low Gain state

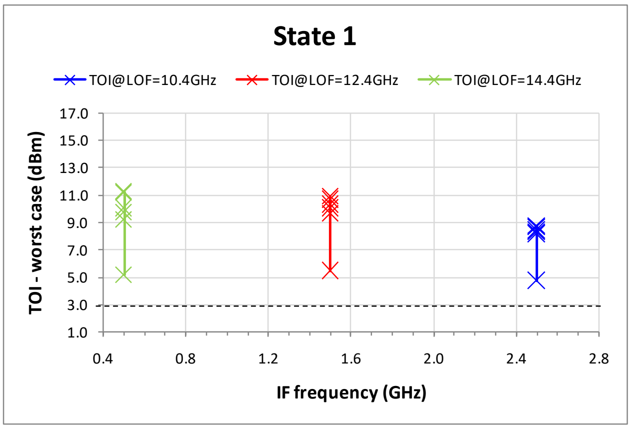


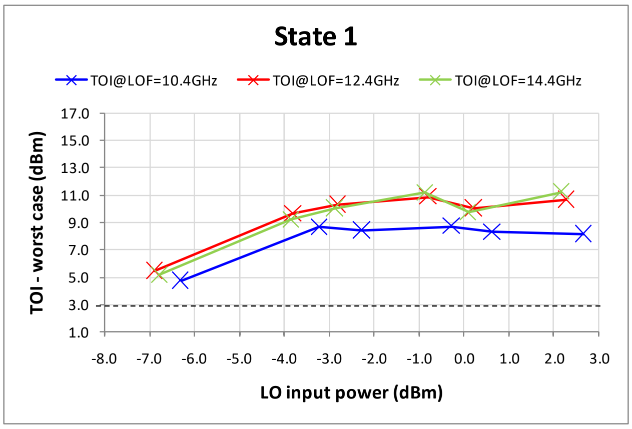
Main Performance – Third Order Intercept Point

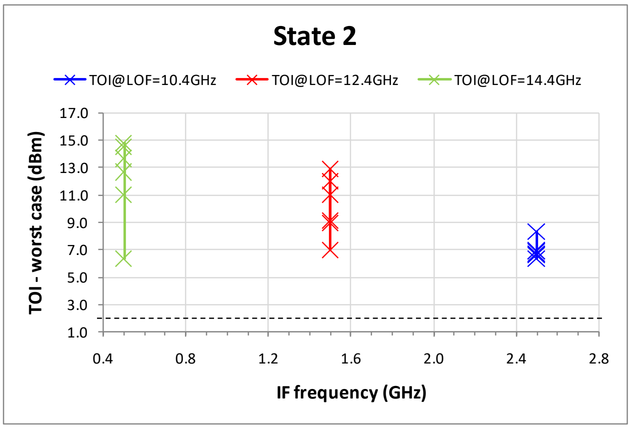
Test conditions unless otherwise noted: Tbase = 25°C, VD1 = 3 V, VG1 = - 0.4 V, ID1 = 32 mA, VD2 = 3 V, VG2 = - 0.4 V, ID2 = 73 mA. VC1 = -5 V (High-Gain) and 0 V (Low-Gain); VC2 = -4.25 V (P_LO = -7, -4 dBm), -3 V (P_LO = -3, -1 dBm) and 1.25 V (P_LO = 0, 2 dBm). RF frequencies = 12.9, 13.9, 14.9 GHz.

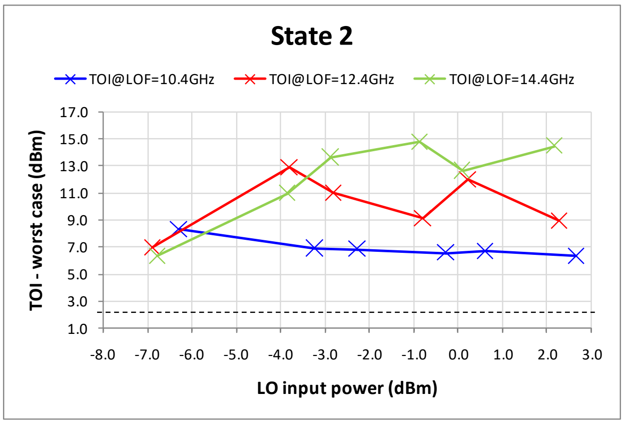
Worst Case TOI as a function of the IF frequency.
P_RF (DCL) = -35 dBm (***High Gain – State 1***)
P_RF (DCL) = -25 dBm (***Low Gain – State 2***)

Worst Case TOI as a function of the P_LO power
P_RF (DCL) = -35 dBm (***High Gain – State 1***)
P_RF (DCL) = -25 dBm (***Low Gain – State 2***)

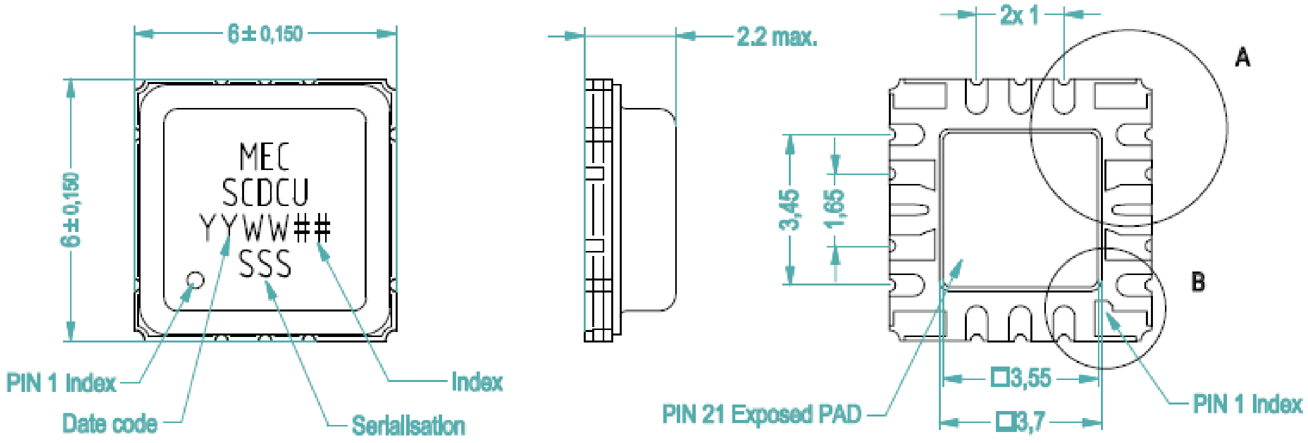


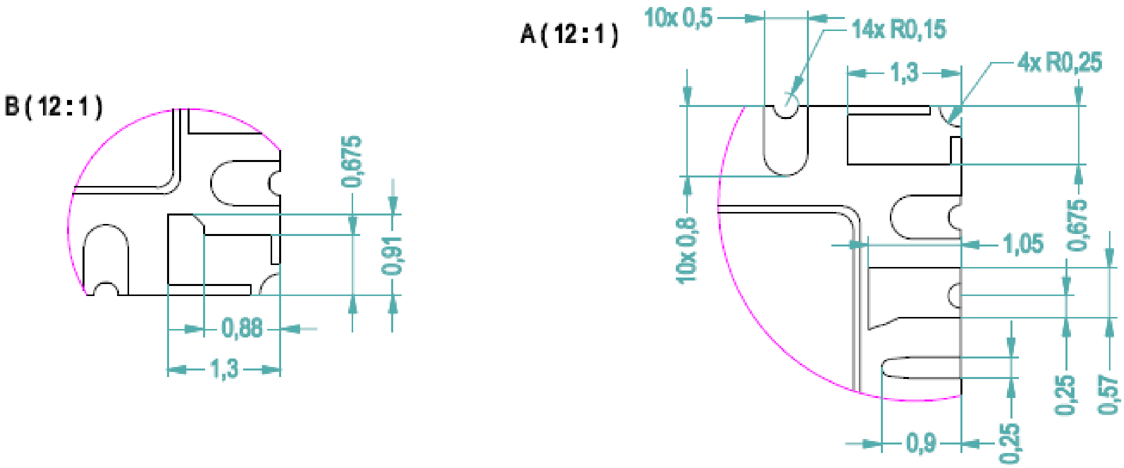


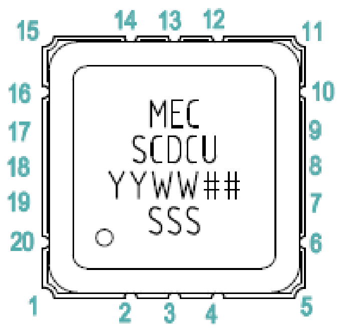


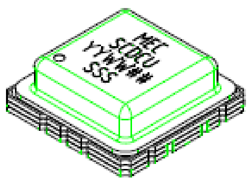


Package Outline and PIN configuration









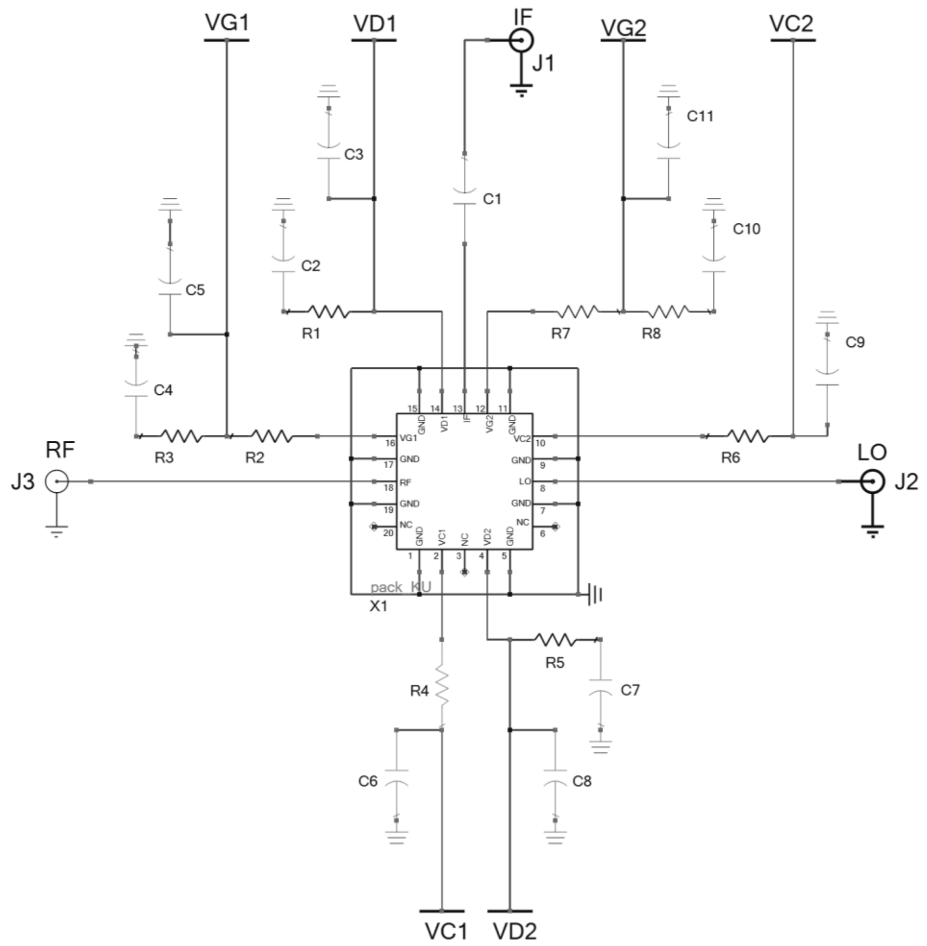
1- GND	8- LO	15- GND
2- VC1	9- GND	16- VG1
3- Nc	10- VC2	17- GND
4- VD2	11- GND	18- RF
5- GND	12- VG2	19- GND
6- Nc	13- IF	20- Nc
7- GND	14- VD1	21- GND

All dimensions are in mm.

It is strongly recommended to ground all pins marked "GND" through the PCB board.
Ensure that the PCB board is designed to provide the best possible ground to the package.

Detailed package dimensions and characteristics are available upon request at contact.mec@mec-mmic.com

Application Circuit



Ref.	Component	Value	Description
C1	SMT 0402 RF Capacitor	100 nF	Ultrabroadband Decoupling Capacitor
C2, C4, C6, C7, C9, C10	SMT 0402 Capacitor	100 pF	Low Frequency Bypass Capacitor
C3, C5, C8, C11	SMT 0402 Capacitor	1 µF	Low Frequency Bypass Capacitor
R1, R2, R4, R5, R6, R7	SMT 0402 Resistor	1 Ω	Low power Resistor
R3, R8	SMT 0402 Resistor	5 Ω	Low power Resistor

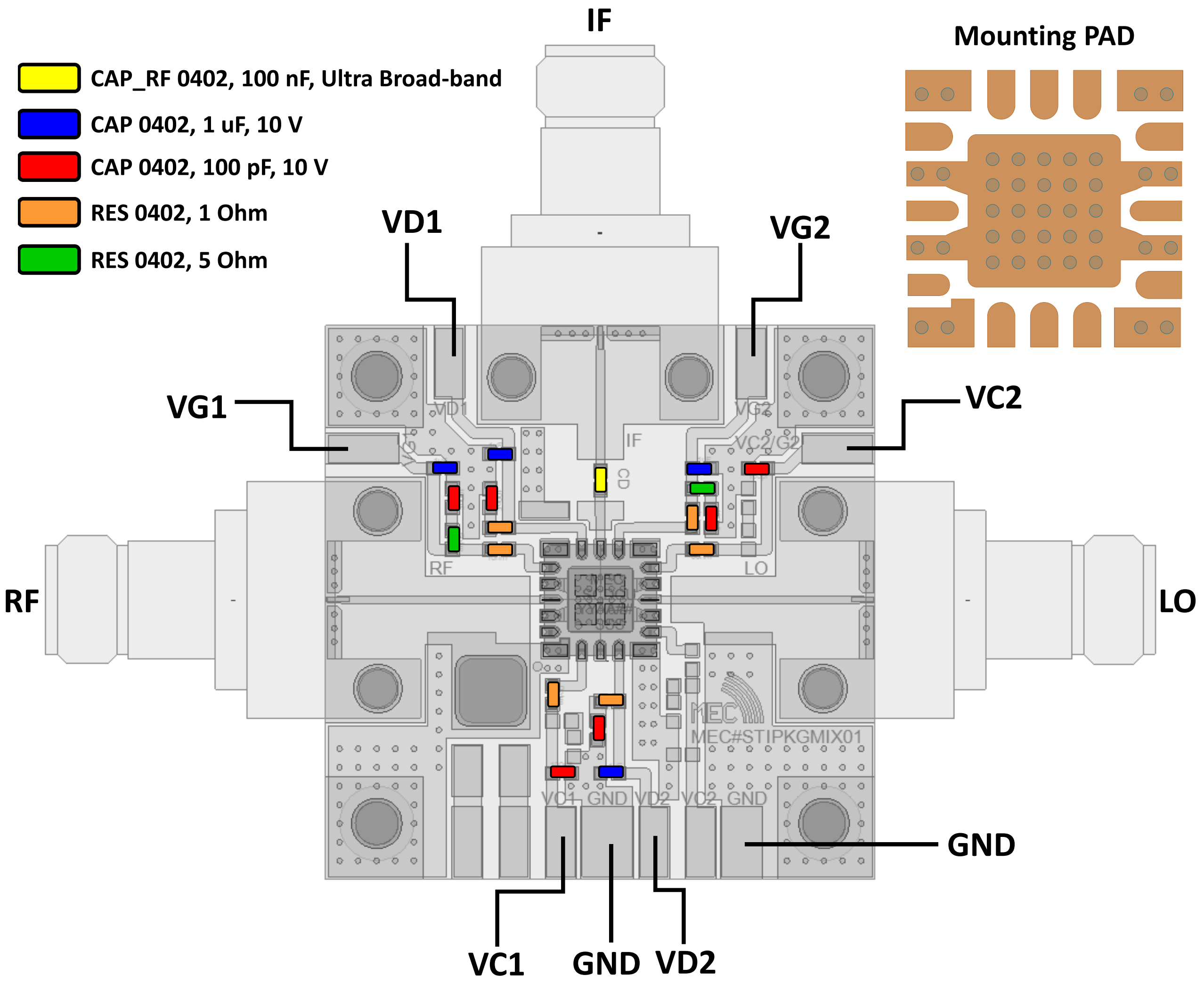
Bias-up Procedure

1. VG set to -1.5 V.
2. VD set to +3 V.
3. Adjust VG until quiescent Id is 104 mA (Vg = -0.4 V Typical).
4. Apply RF signals.

Bias-down Procedure

1. Turn off RF signals.
2. Reduce VG to -1.5 V (Id0 ≈ 0 mA).
3. Set Vd to 0 V.
4. Set Vg to 0 V.

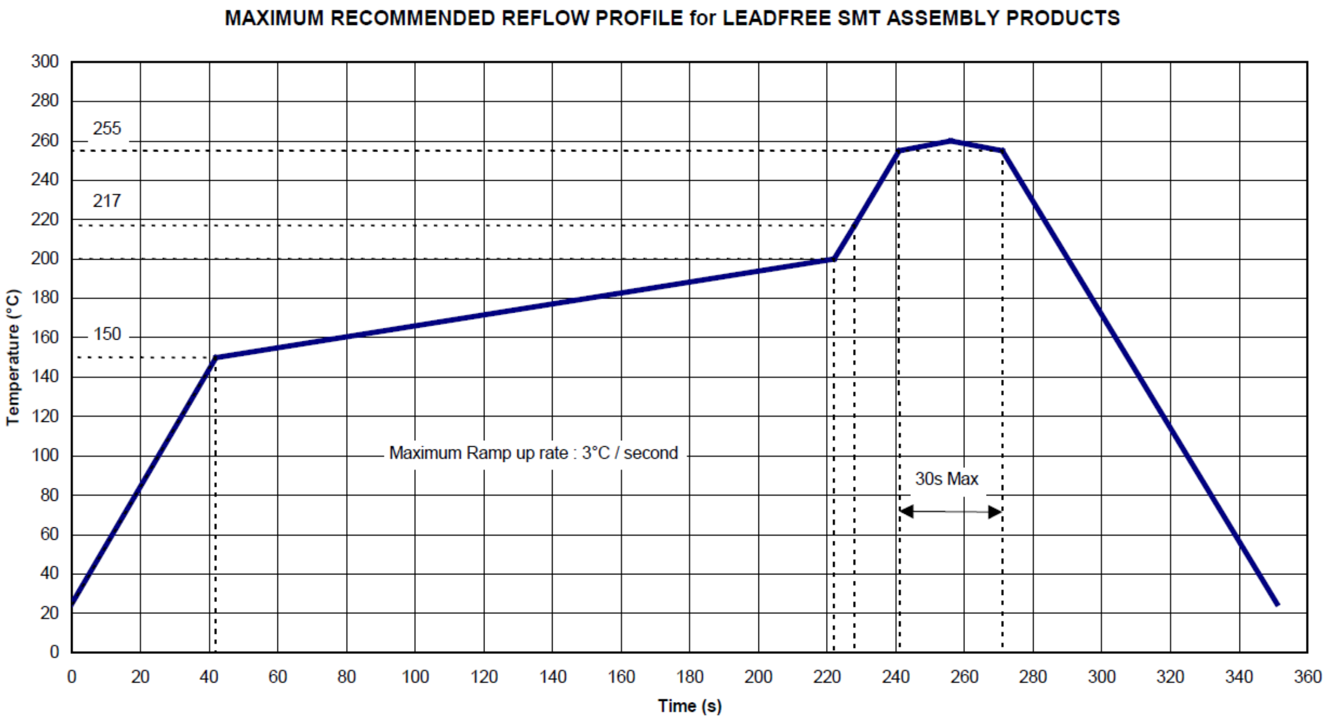
Evaluation Board and Assembly



0.008" thick Rogers Corp. RO4003C (Ɛr = 3.35). Metal layers 0.5 oz. copper cladding. Microstrip to Coplanar transition optimized to access the package. Microstrip to coplanar transition for connector interface optimized for the Southwest Microwave end launch 1492-04A-5.

Solderability and Recommended Soldering Temperature Profile

The package complies with standard surface mount assembly processes (J-STD-020). Peak reflow temperature of 260 °C. Leaded (SnPn) or RoHS leadless solder pasts (SnAgCu) can be used, having gold platted terminations with 0.8 µm minimum of gold (Au)



RoHS Compliance

The product is compliant with the 2011/65/EU RoHS directive 2015/863/EU and REACH N° 1907/2006.

Contact Information

For additional technical Information and Requirements: **contact.mec@mec-mmic.com**

Notice

The furbished information is believed to be reliable. However, performances and specifications contained herein are based on preliminary characterizations and then susceptible to possible variations. On the basis of customer requirements, the product can be tested and characterized in specific operating conditions and, if needed, tuned to meet custom specifications.