United Monolithic Semiconductors

CHA1452-QDG

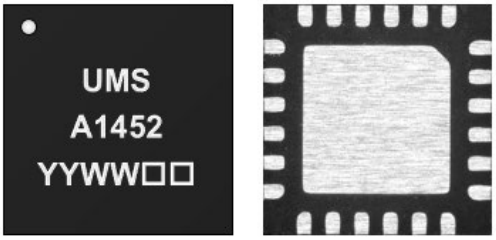
30-44GHz Low Noise Amplifier

GaAs Monolithic Microwave IC in Plastic QFN leadless package

Description

The CHA1452-QDG is a three-stage GaAs Low Noise Amplifier operating over the 30 – 44GHz that includes current regulation circuit on each stage. This LNA typically presents low Noise Figure of 1.8dB associated to a small signal Gain of 20dB.

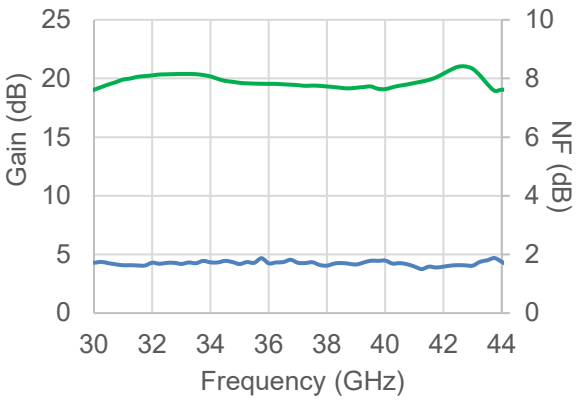
It can provide up to 4dBm output power at 1dB gain compression and needs DC power supply of VSS=-3V and VDD=+3V corresponding to a current of 47mA. The current variation is lower than 2mA when the temperature varies from -40°C to 85°C thanks to the integrated current regulation on each stage of the LNA.
It is supplied in low cost SMD RoHs compliant QFN 4x4 plastic package.



Main Features

- Frequency Range: 30-44GHz
- Noise Figure : 1.8dB
- Linear Gain : 20dB
- Bias: VDD=3V and VSS=-3V (47mA)
- Current variation over temperature from -40°C to 85°C : <2mA
- 24L-QFN Plastic Package 4x4 mm²
- MSL3

Gain and Noise Figure @ 25°C



Main Electrical Characteristics

Tcase = +25°C, VSS=-3V, VDD=+3V (Tcase: QFN backside temperature)

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	30		44	GHz
Gain	Linear Gain		20		dB
NF	Noise Figure		1.8		dB

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Electrical Characteristics

Tcase = +25°C, VSS/VDD = -3V/3V

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	30		44	GHz
Gain	Small signal Gain		20		dB
NF	Noise Figure		1.8		dB
|S11|	Input Return loss		10		dB
|S22|	Output return loss		10		dB
OP1dB	Output Power at 1dB gain compression		4		dBm
OIP3	Output Third order Intercept Point		14		dBm
VDD	Positive quiescent voltage		3		V
VSS	Negative quiescent voltage		-3		V
Id	Quiescent Current		47		mA
PDC	DC Power Consumption		141		mW

These values are representative of on board measurements as defined on the drawing in paragraph "Evaluation board section".

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Absolute Maximum Ratings (1)

Tcase = +25°C

Symbol	Parameter	Values	Unit
VDD	Positive quiescent voltage	6	V
VSS	Negative quiescent voltage	-6	V
Pin	Maximum peak input power overdrive	0	dBm
Id	Quiescent Drain current	70	mA

(1) Operation of this device above anyone of these parameters may cause permanent damage.

Recommended Operating Range (2), (3), (4)

Symbol	Parameter	Values	Unit
VDD	Drain bias voltage	2.5 – 5	V
VSS	Gate bias voltage	-5 – -2.5	V
Pin	Maximum peak input power overdrive (2)	-5	dBm
$T_{junction}$	Junction temperature (4)	175	°C

(2) Electrical performance is defined for specified test conditions

(3) Electrical performance is not guaranteed over all recommended operating conditions

(4) See Device Thermal Performances section

Temperature Range

Tcase	Operating temperature range	-40 to 85	°C
Tstg	Storage temperature range	-55 to 150	°C

Typical Bias Conditions

Tcase=+25°C

Symbol	Pad N°	Parameter	Values	Unit
Vg	9	VSS	-3.5 to -2.5	V
Vd	10	VDD	2.5 to 3.5	V

“Power ON” sequence

1. Set bias VSS to -3V
2. Apply VDD bias voltage to = 3V
3. The current should be around 47mA
4. Apply RF signal

“Power OFF” sequence

1. Turn off RF signal
2. Turn VDD bias voltage to 0V
3. Turn VSS bias voltage to 0V

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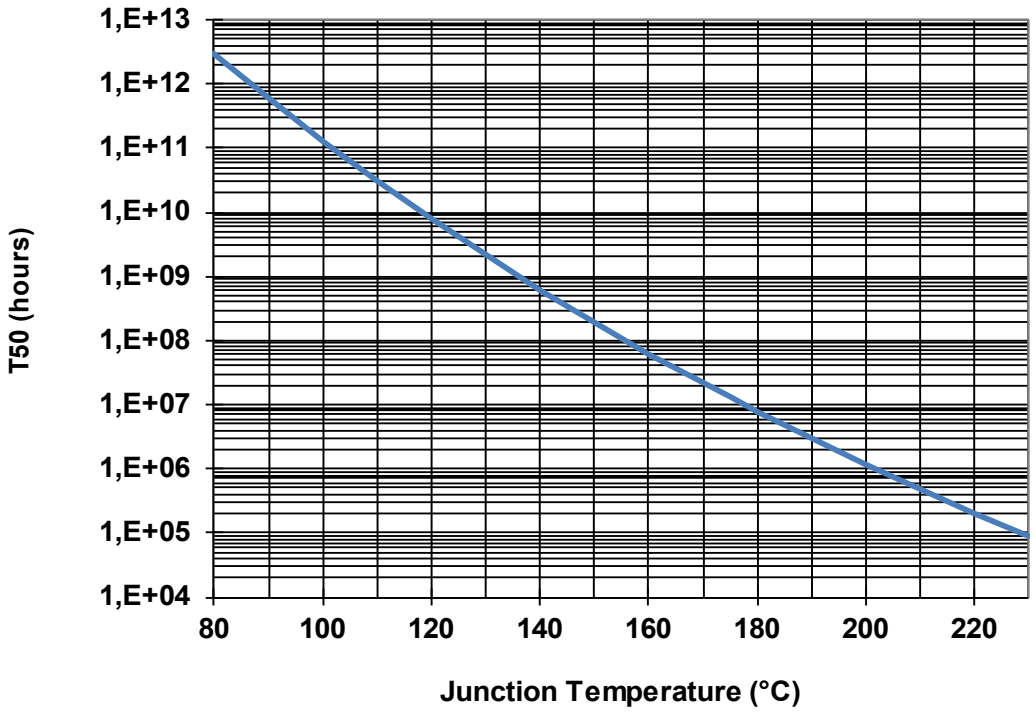
Device thermal performance

All the figures given in this section are obtained assuming that the die is only cooled down by conduction through the package thermal pad.
The temperature is monitored at the QFN backside interface (Tcase).
For nominal operation, the system's maximum temperature must be adjusted to ensure that the junction temperature ($T_{junction}$) remains below the maximum value specified in the Recommended Operating Ratings table.
The system PCB must be designed to comply with this requirement.

Parameter	Biasing conditions	Tjunction (°C)	R_{TH} (°C/W)	T50[2] (hours)
R_{TH} [1] Thermal Resistance (Junction to Case)	VDD= 3V VSS=-3V Pdiss= 145mW	121	248	7E+09
	VDD= 2.5V VSS= -2.5V Pdiss= 92.5mW	108	249	4E+10

[1] Assuming 85°C Tcase

[2] The time at which 50% of the products are expected to have failed or reached the end of their useful life.



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Typical Package Sij parameters

Tcase=+25°C, VSS = -3.0V, VDD = +3.0V

Freq (GHz)	S11 (dB)	PhS11 (°)	S21 (dB)	PhS21 (°)	S12 (dB)	PhS12 (°)	S22 (dB)	PhS22 (°)
26	-5.143	53.243	14.42	-119.145	-51.349	-40.197	-6.661	159.365
26.5	-6.025	40.155	15.109	-148.366	-49.122	-56.164	-5.362	145.768
27	-7.086	30.206	15.69	-174.383	-48.085	-84.318	-4.657	143.664
27.5	-8.263	18.641	16.318	161.083	-48.826	-106.32	-4.896	144.2
28	-9.148	2.972	17.049	137.072	-47.081	-104.045	-6.143	141.384
28.5	-9.578	-14.941	17.741	112.28	-44.471	-146.282	-8.153	129.455
29	-9.644	-31.758	18.205	87.657	-44.252	-163.346	-9.766	107.564
29.5	-9.824	-45.394	18.621	64.042	-44.883	169.482	-9.717	90.281
30	-10.801	-59.632	19.041	41.127	-43.549	158.139	-9.947	87.332
30.5	-12.898	-80.352	19.495	17.85	-42.648	122.75	-11.714	96.301
31	-15.255	-112.044	19.91	-5.859	-43.048	105.894	-15.5	119.118
31.5	-15.408	-146.995	20.147	-30.092	-42.632	92.114	-19.034	179.753
32	-13.481	-166.276	20.265	-53.509	-41.768	57.208	-17.185	-125.42
32.5	-12.326	-176.432	20.355	-76.798	-39.55	41.864	-15.903	-96.459
33	-13.066	177.754	20.385	-99.527	-41.094	32.95	-19.226	-71.121
33.5	-16.123	175.468	20.367	-122.234	-40.547	1.936	-26.782	26.713
34	-22.877	-172.23	20.179	-145.09	-39.945	-12.997	-15.846	96.467
34.5	-32.209	-142.654	19.798	-165.596	-39.666	-33	-11.117	113.915
35	-30.073	38.322	19.632	174.906	-40.881	-30.325	-9.53	128.494
35.5	-24.926	56.364	19.566	155.451	-38.623	-65.869	-9.664	143.672
36	-24.314	92.984	19.541	135.767	-38.087	-77.045	-10.748	154.106
36.5	-19.814	138.866	19.502	115.895	-37.498	-93.487	-13.073	154.698
37	-15.506	155.971	19.434	96.059	-37.094	-115.691	-15.647	134.199
37.5	-13.352	163.192	19.396	76.627	-37.265	-132.637	-14.795	114.27
38	-12.32	160.976	19.319	56.914	-38.208	-140.984	-12.337	109.694
38.5	-12.663	151.155	19.198	37.356	-37.9	-152.373	-11.283	111.381
39	-13.084	136.215	19.211	18.749	-37.879	-168.847	-12.208	110.803
39.5	-12.596	114.86	19.323	-1.114	-37.04	166.752	-14.897	92.684
40	-11.036	98.613	19.093	-19.56	-38.23	157.18	-14.738	45.225
40.5	-10.018	80.669	19.391	-38.427	-39.133	137.864	-10.703	30.673
41	-9.548	67.15	19.62	-58.541	-38.026	119.705	-8.164	35.406
41.5	-9.784	52.352	19.883	-78.57	-36.698	110.804	-7.101	48.943
42	-10.849	25.691	20.419	-100.449	-37.043	86.136	-8.059	66.141
42.5	-11.479	-23.483	21.001	-126.573	-35.604	66.527	-12.001	100.908
43	-9.351	-82.652	20.824	-156.098	-34.601	37.911	-11.131	171.028
43.5	-8.439	-120.685	19.538	177.16	-36.793	20.085	-8.126	-158.84
44	-8.937	-126.312	19.045	158.112	-35.329	-4.443	-8.061	-137.04
44.5	-7.635	-145.535	18.776	133.339	-36.062	-22.847	-10.999	-114.79
45	-6.662	-175.836	18.234	106.703	-35.795	-44.905	-21.744	-49.458
45.5	-5.288	151.966	16.897	79.352	-37.939	-74.352	-10.639	53.226
46	-4.175	129.915	14.89	55.497	-39.48	-93.676	-5.96	70.353

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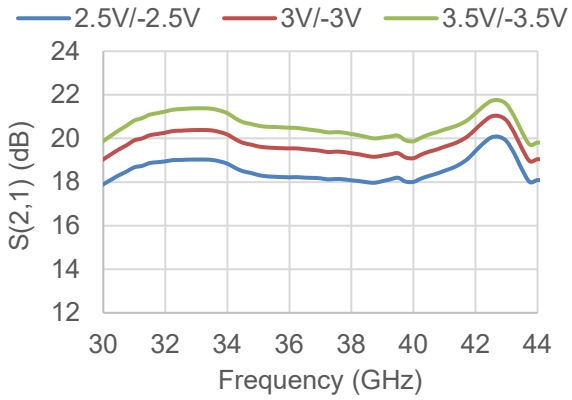
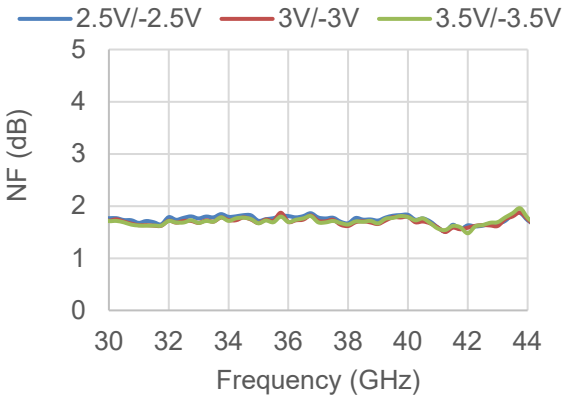
Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.
Test conditions : CW, Tcase = 25°C, VSS/VDD= -2.5V/+2.5V ; -3V/+3V ; -3.5V/+3.5V

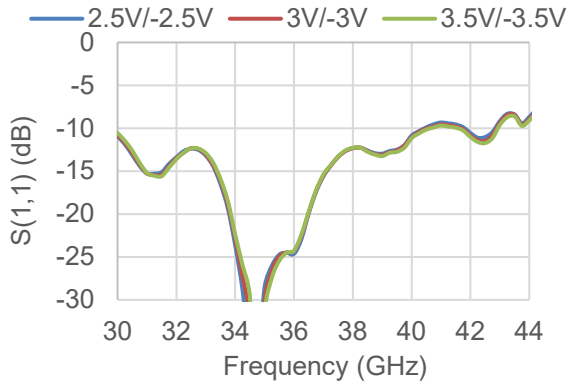
Linear Gain vs. Frequency and Bias



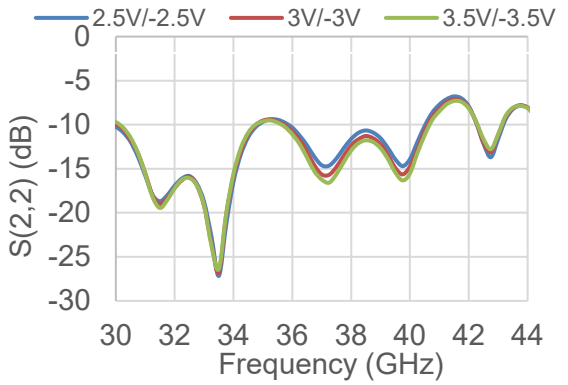
Noise Figure vs. Frequency and Bias



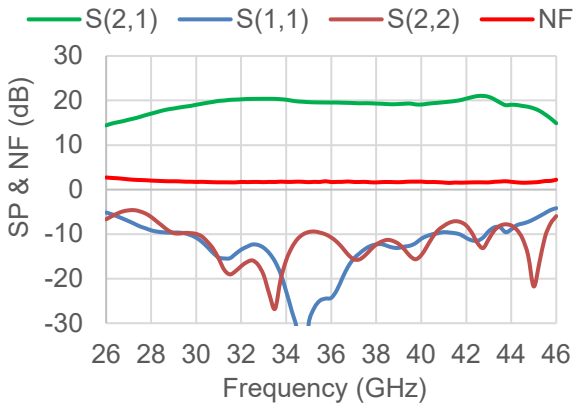
Input Return Loss vs. Frequency and Bias



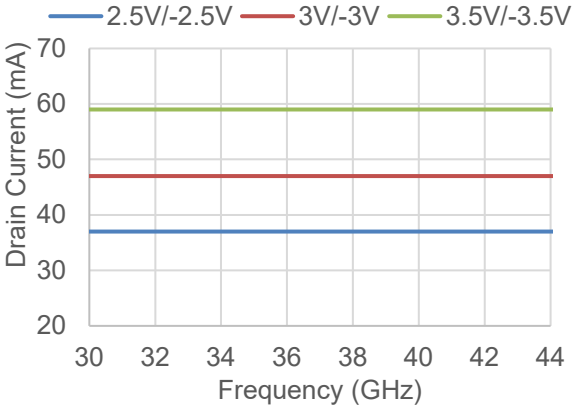
Output Return Loss vs. Frequency and Bias



S-parameters and Noise large band at -3V/3V



Drain Current vs. Frequency vs. Bias



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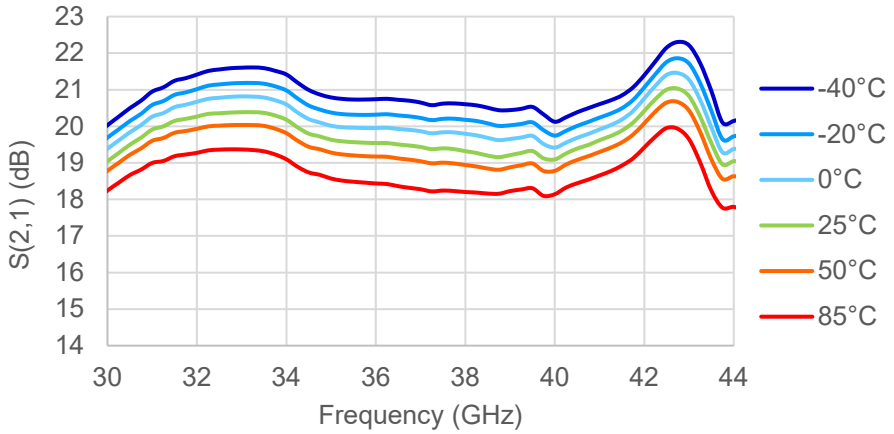
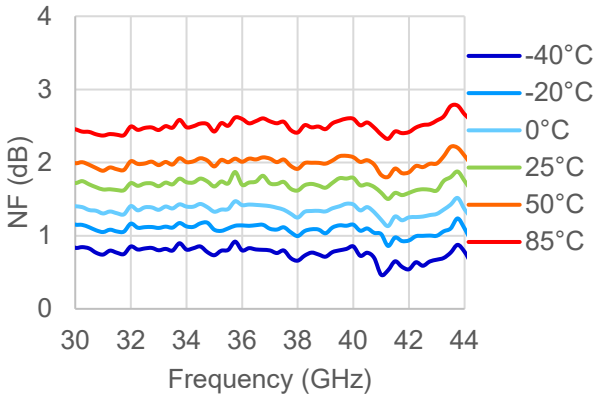
Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.
Test conditions : CW, Tcase = -40°C/-20°C/0°C/25°C/50°C/85°C, VSS /VDD= -3V/3V

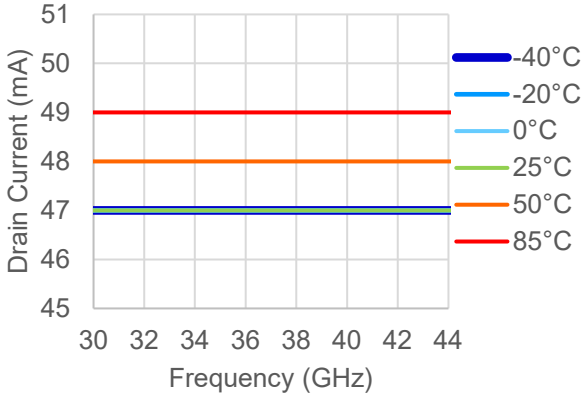
Linear Gain versus Temperature



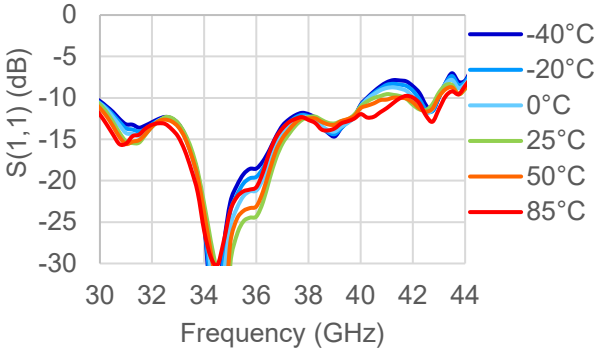
Noise Figure vs. frequency and Temperature



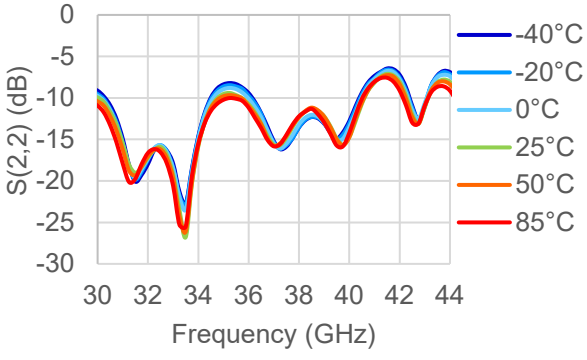
Drain Current vs. frequency and Temperature



Input return loss vs. frequency and Temperature



Output return loss vs. frequency and Temperature



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Typical Board Measurements

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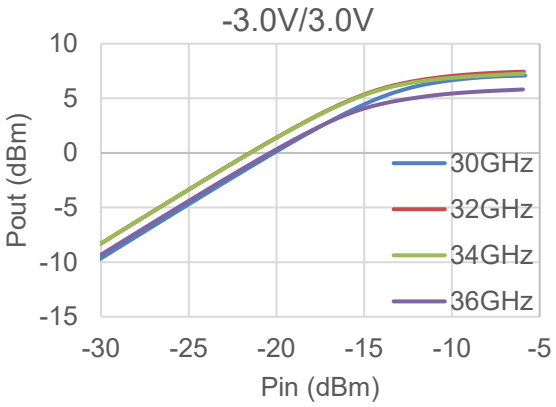
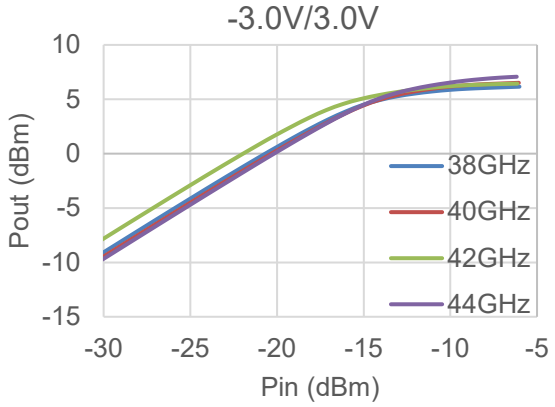
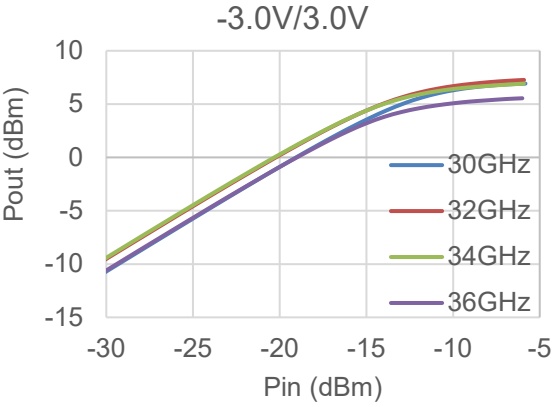
Output Power vs. Input Power @ -40°C



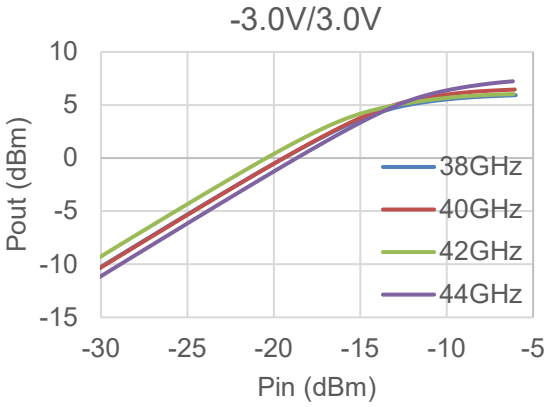
Output Power vs. Input Power@ -40°C



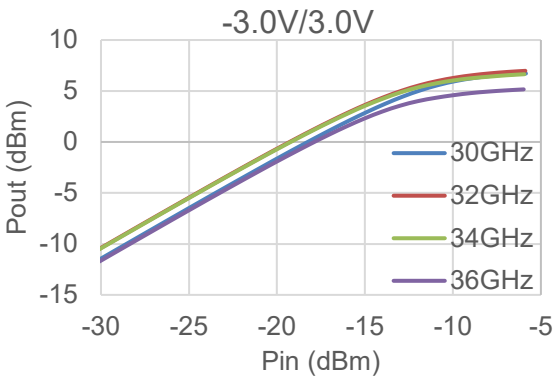
Output Power vs. Input Power @ 25°C



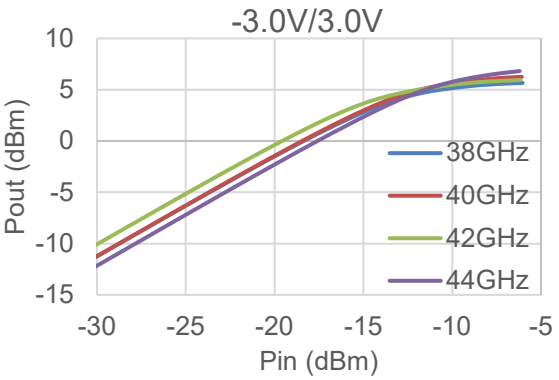
Output Power vs. Input Power @ 25°C



Output Power vs. Input Power @ 85°C



Output Power vs. Input Power @ 85°C



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Typical Board Measurements

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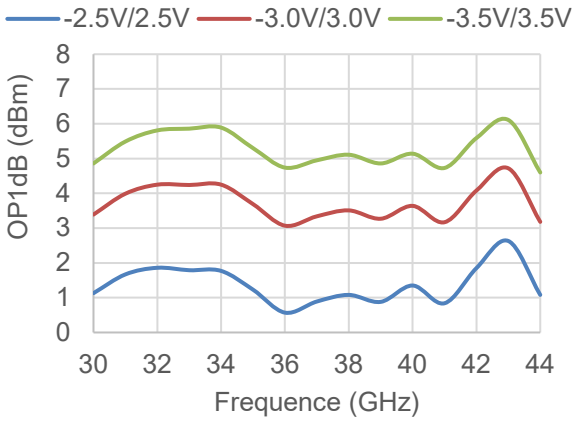
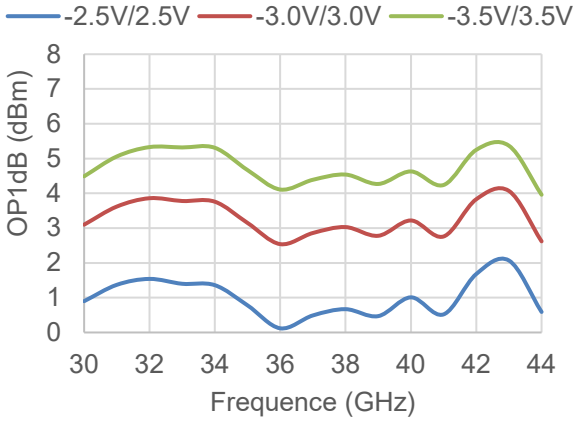
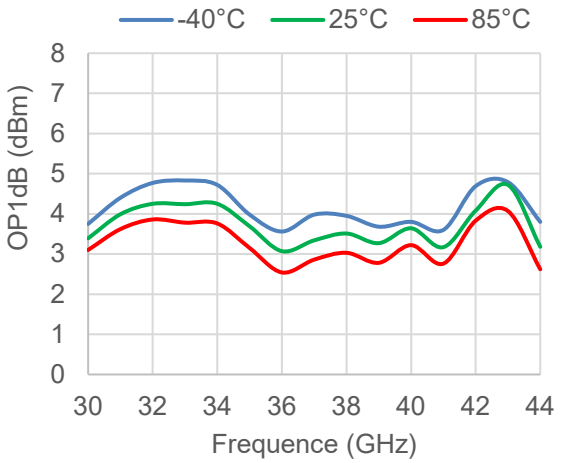
OP1dB vs. frequency @ 25°C and Bias



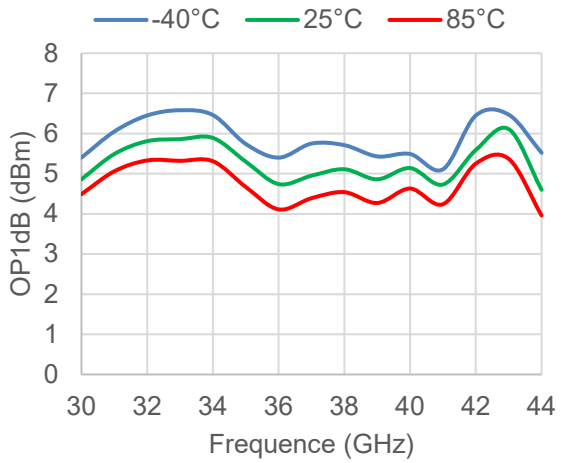
OP1dB vs. frequency @ 85°C and Bias



OP1dB vs. frequency @ -3V/3V and Temperature



OP1dB vs. frequency @ -3.5V/3.5V and Temperature



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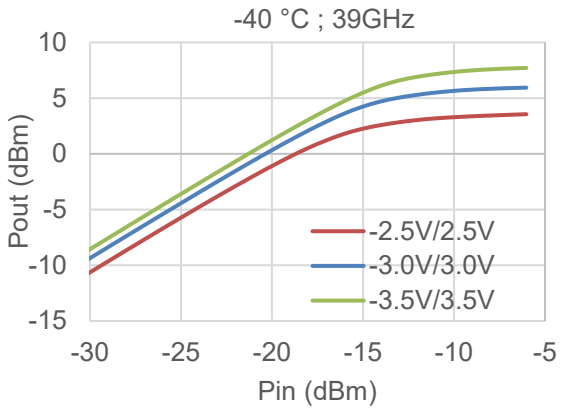
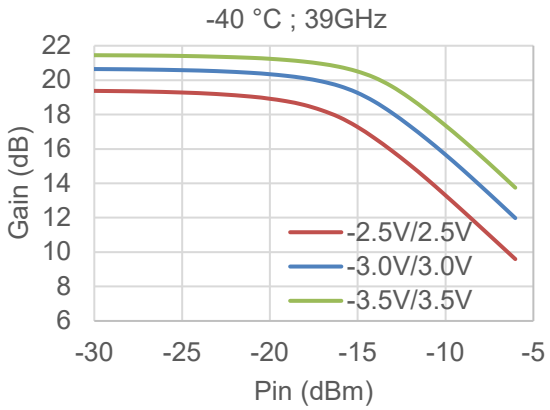
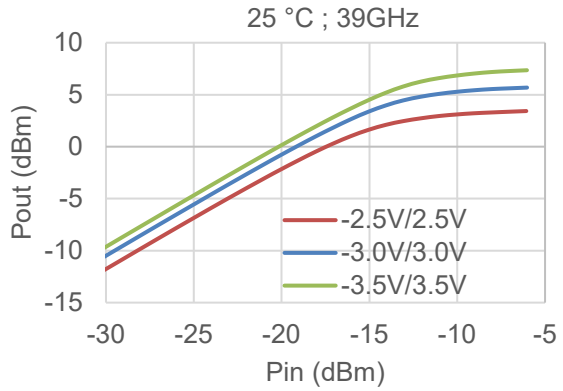
Output Power vs. Input Power



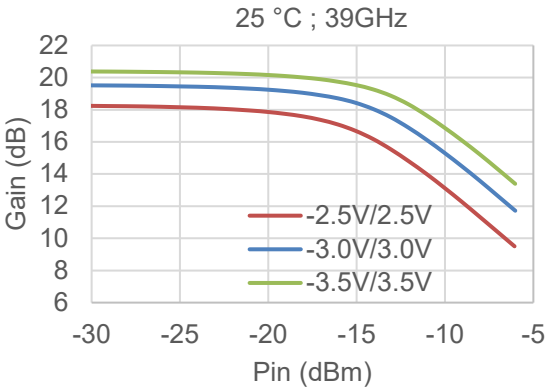
Power Gain vs. Input Power



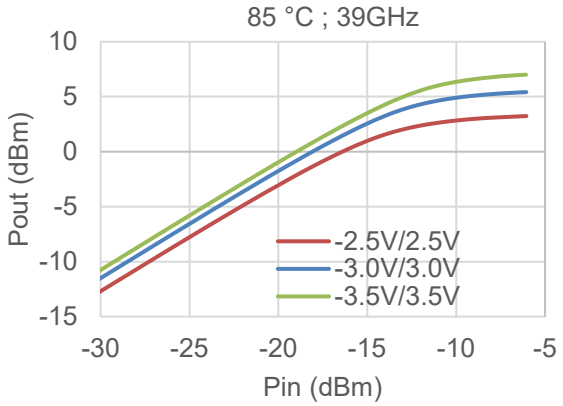
Output Power vs. Input Power



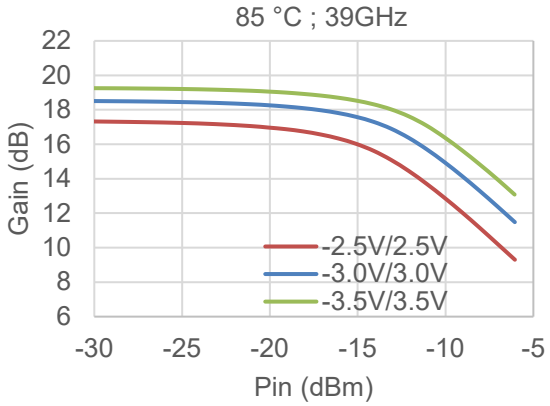
Power Gain vs. Input Power



Output Power vs. Input Power



Power Gain vs. Input Power



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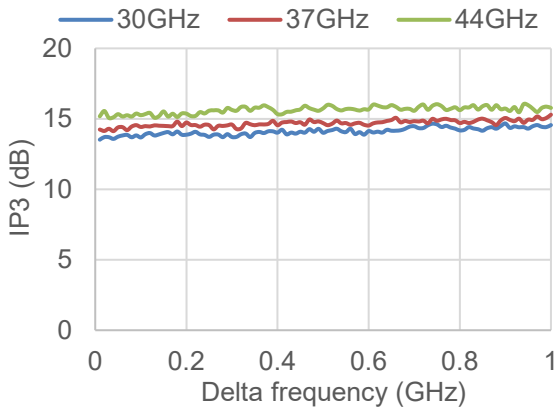
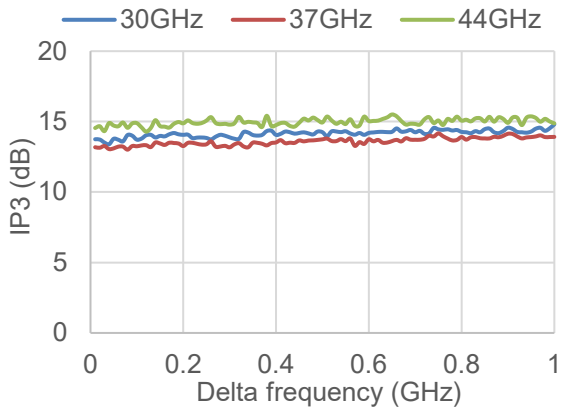
Typical Board Measurements

Measurements are given in the board reference planes.
Test conditions : CW, Tcase = 25°C/85°C, VSS/VDD=-3V/3V, Pin=-30dBm

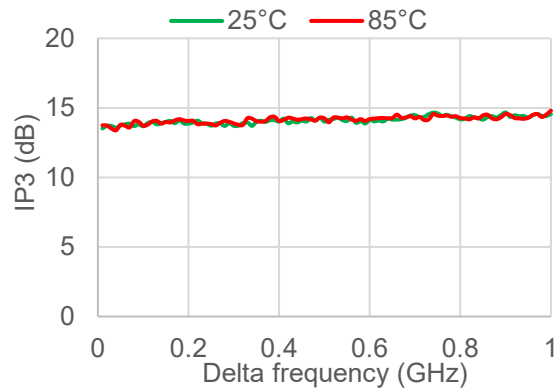
OIP3 vs. Delta Frequency at 25°C



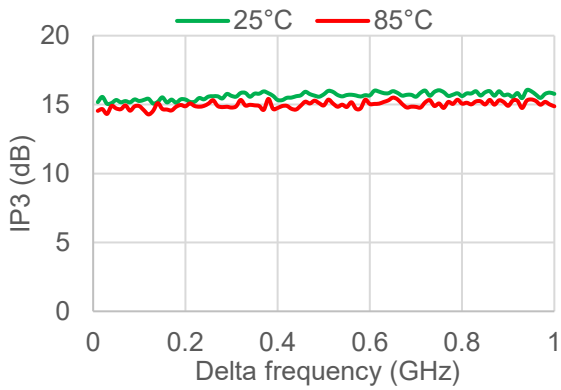
OIP3 vs. Delta Frequency at 85°C



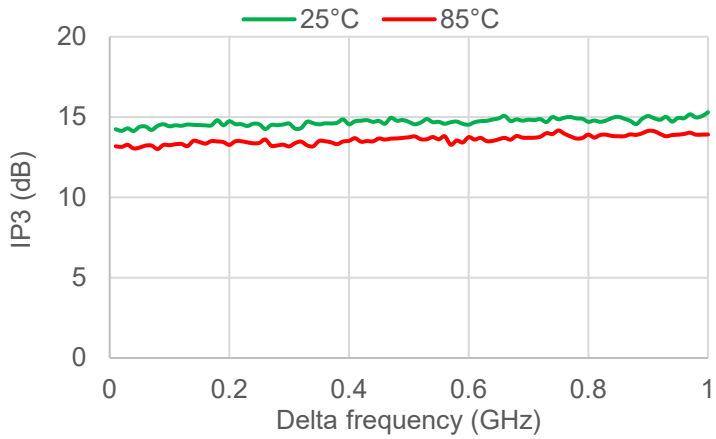
OIP3 vs. Delta Frequency vs. Temperature at 30GHz



OIP3 vs. Delta Frequency vs. Temperature at 44GHz



OIP3 vs. Delta Frequency vs. Temperature at 37GHz



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Typical Board Measurements

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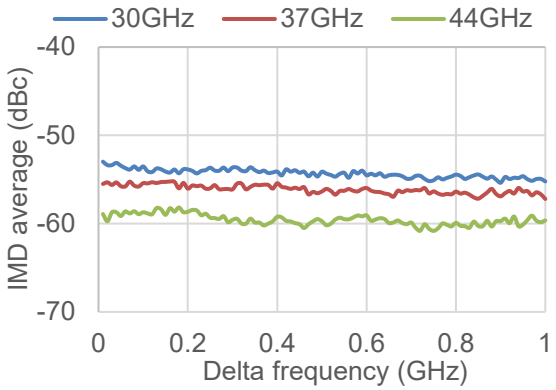
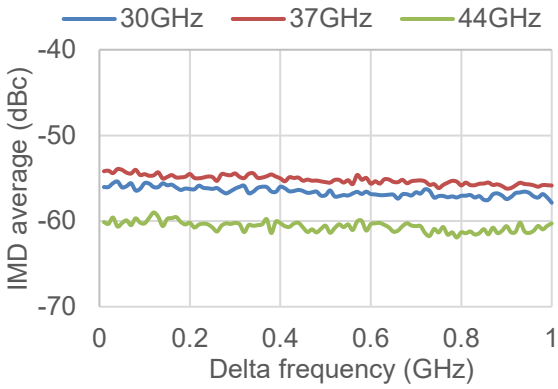
Test conditions : CW, Tcase = 25°C/85°C, VSS/VDD=-3V/3V, Pin=-30dBm

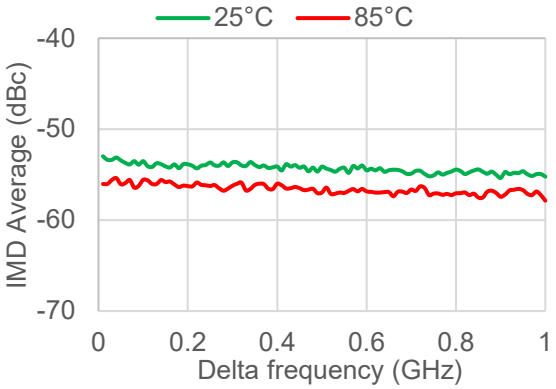
IMD vs. Delta Frequency at 25°C



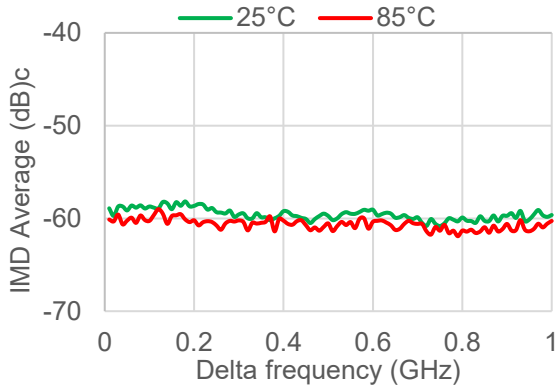
IMD vs. Delta Frequency at 85°C



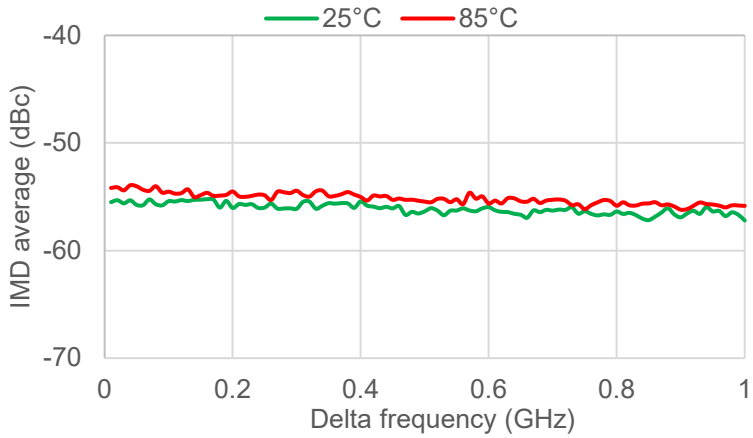
IMD vs. Delta Frequency vs. Temperature at 30GHz



IMD vs. Delta Frequency vs. Temperature at 44GHz



IMD vs. Delta Frequency vs. Temperature at 37GHz



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Typical Board Measurements

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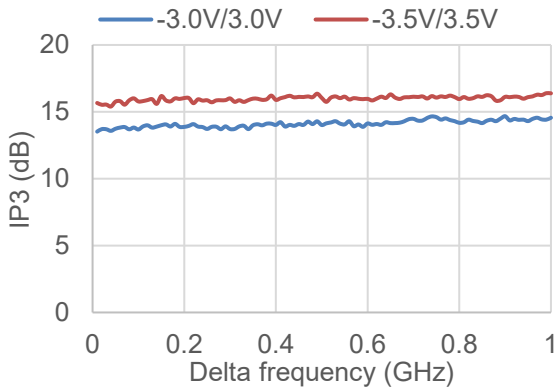
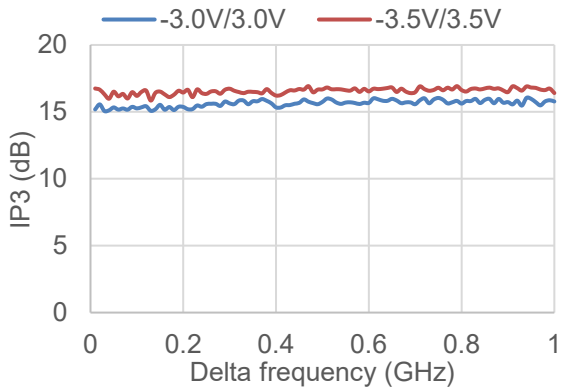
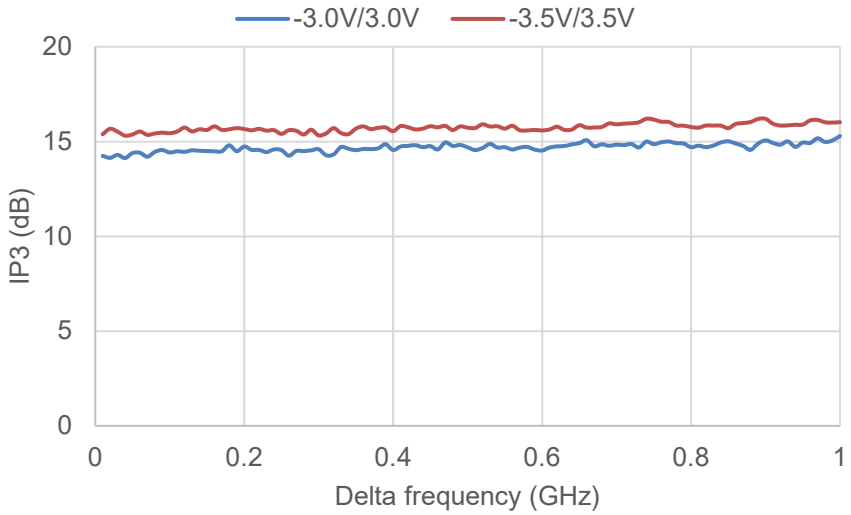
OIP3 vs. delta frequency vs. biasing at 30GHz



OIP3 vs. delta frequency vs. biasing at 44GHz



OIP3 vs. delta frequency vs. biasing at 37GHz



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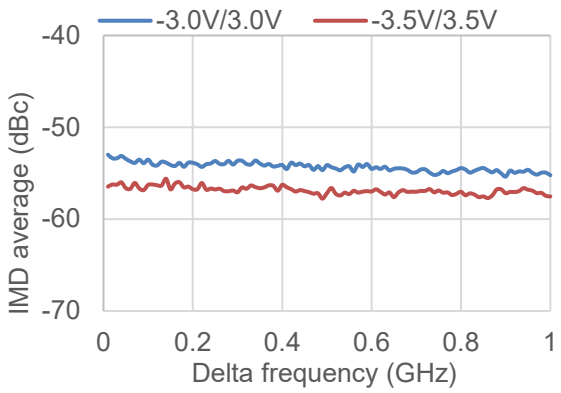
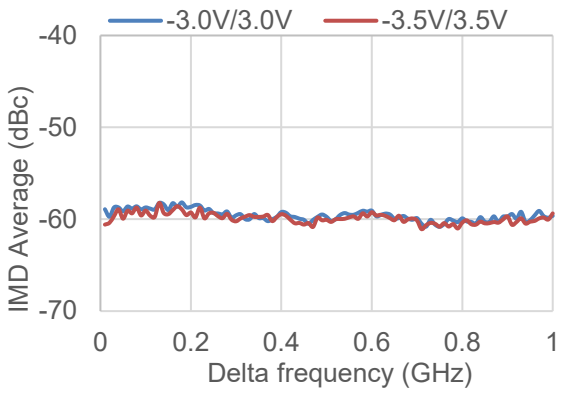
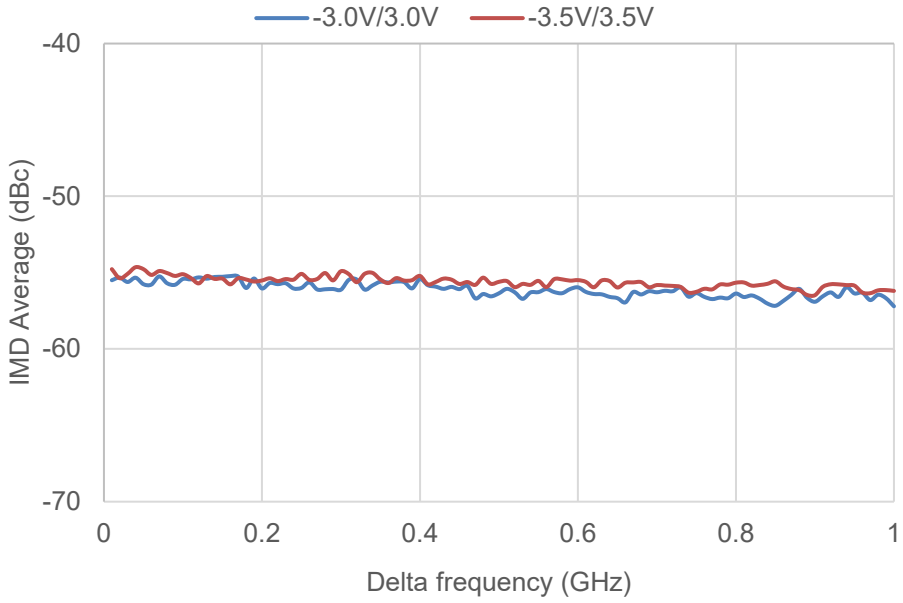
IMD vs. delta frequency vs. biasing at 30GHz



IMD vs. delta frequency vs. biasing at 44GHz



IMD vs. delta frequency vs. biasing at 37GHz



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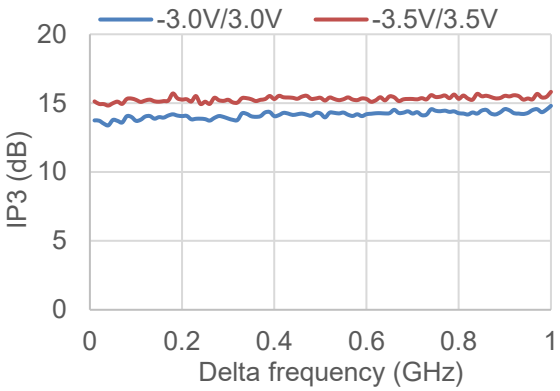
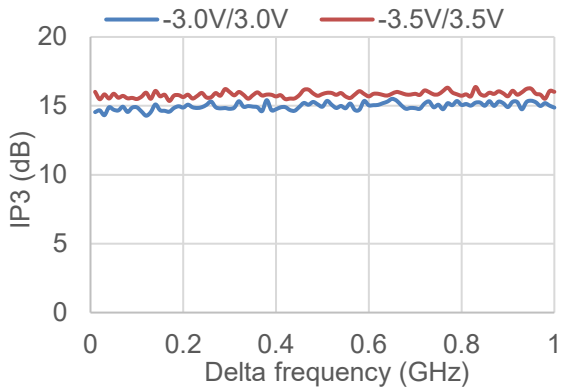
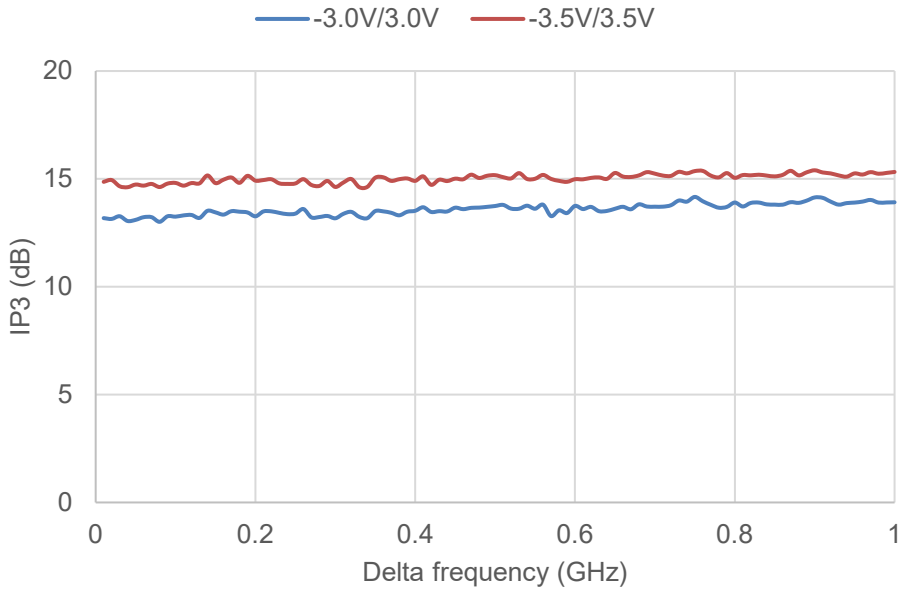
OIP3 vs. Delta Frequency vs. Biasing at 30GHz



OIP3 vs. Delta Frequency vs. Biasing at 44GHz



IMD vs. Delta Frequency vs. Biasing at 37GHz



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Typical Board Measurements

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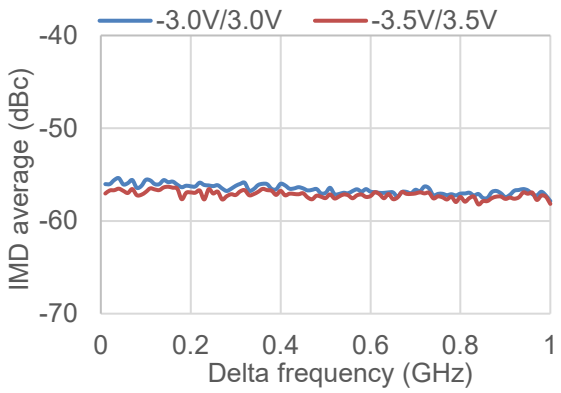
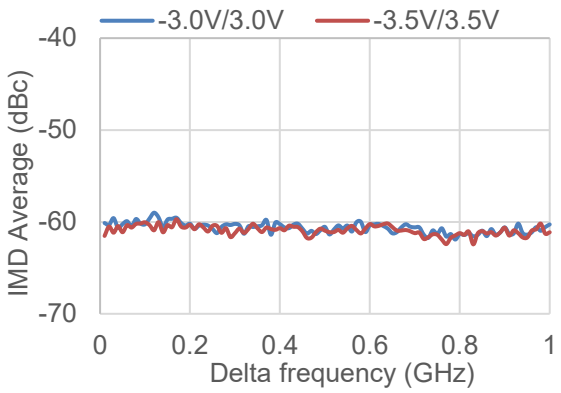
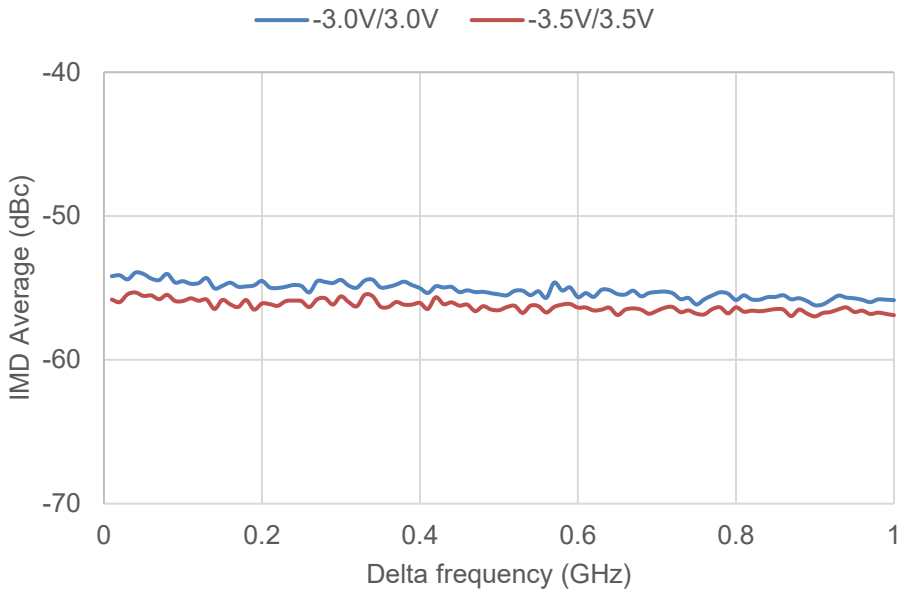
IMD vs. Delta Frequency vs. Biasing at 30GHz



IMD vs. Delta Frequency vs. Biasing at 44GHz



IMD vs. Delta Frequency vs. Biasing at 37GHz



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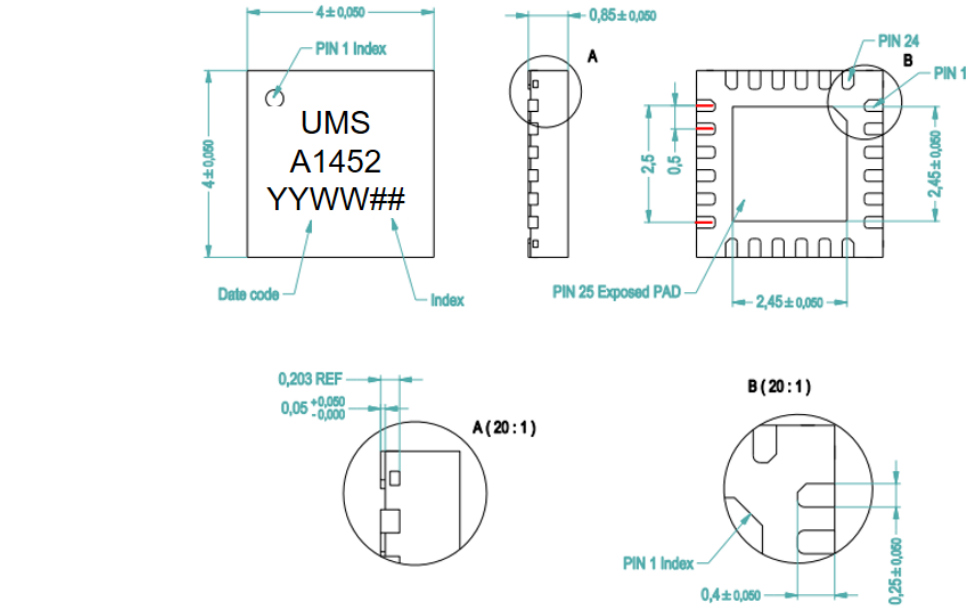
Package outline (1)



Units :	mm	1- NC	11- NC	21- NC
Finish:	Matt tin	2- GND(2)	12- GND(2)	22- NC
MSL Rating:	MSL3	3- GND(2)	13- GND(2)	23- NC
Lead Free (Green)		4- RF in	14- GND(2)	24- NC
From the standard :	JEDEC MO-220	5- GND(2)	15- RF out	25- GND(2)
NC:	(VGGD) Not Connected	6- GND(2)	16- GND(2)	
		7- NC	17- GND(2)	
		8- NC	18- NC	
		9- Vg	19- NC	
		10- Vd	20- NC	

(1) Refer to the application note AN0017 (https://www.ums-rf.com) for general consideration and recommendations for Molded Plastic QFN/DFN packages.

(2) 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.

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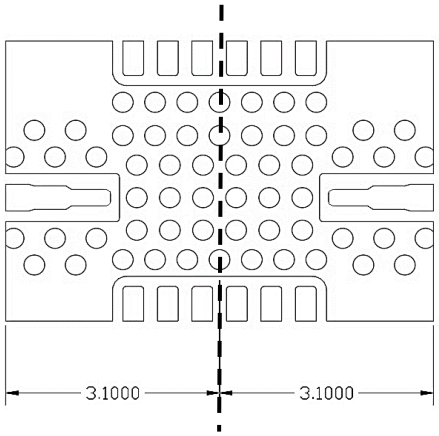
Definition of the Sij reference planes

The reference planes used measurements given above are symmetrical from the symmetrical axis of the package (see drawing beside). The input and output reference planes are located at 3.1mm offset (input wise and output wise respectively) from this axis.



ESD sensitivity

Standard	Value
JS-001-2017	HBM Class 1B (500V passed)
JESD22-C101	CDM Class IV (2kV passed)

Package Information

Parameter	Value
Package body material	RoHS-compliant
	Low stress Injection Molded Plastic
Lead finish	100% Matt tin
MSL Rating	MSL3

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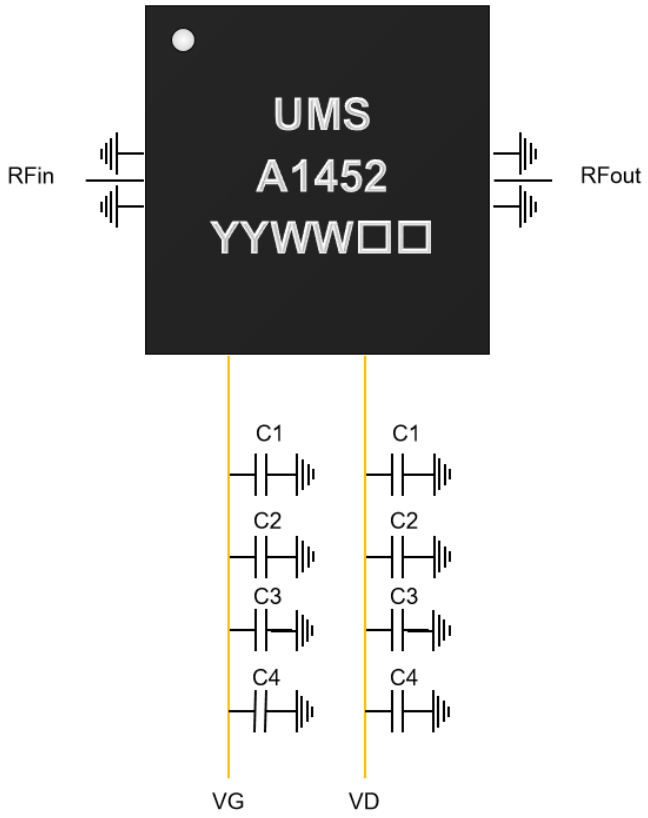
Recommended assembly plan



Recommended circuit bonding table

	Label	Value	Description
	C1	120pF	Capacitor 120pF ±15% 20V
	C2	10nF	Capacitor 10nF ±10% 20V
	C3	1µF	Capacitor 1µF ±10% 20V
	C4	10µF	Capacitor 10µF ±10% 20V
	VG	-3V	VSS negative supply voltage
	VD	+3V	VDD positive supply voltage

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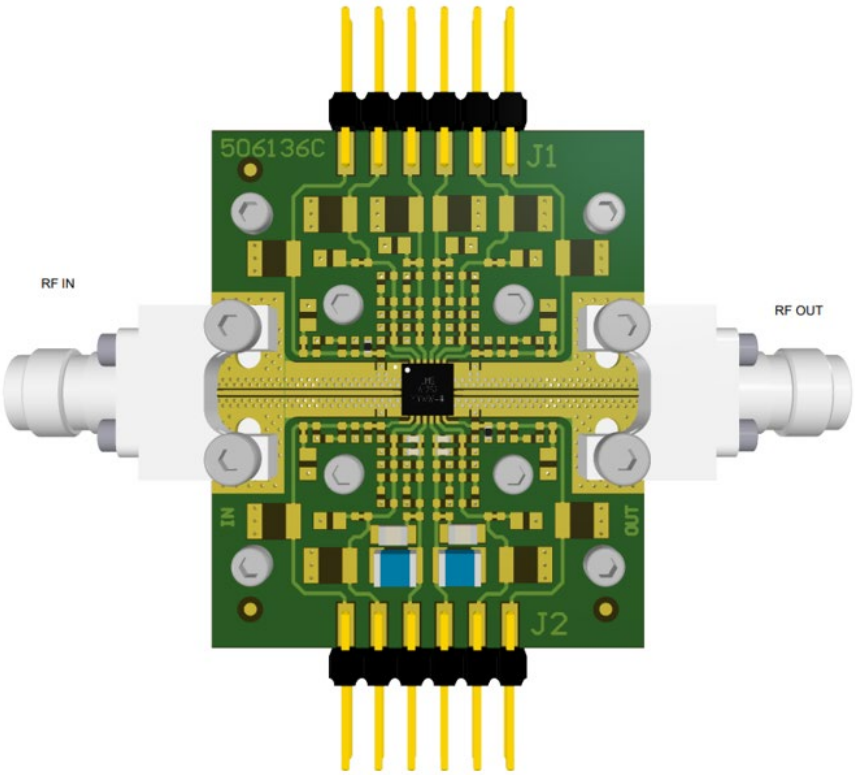
Evaluation board(1)

- Compatible with the proposed footprint.
- Based on typically Ro4003 / 8mils or equivalent.
- Using a micro-strip to coplanar transition to access the package.
- Recommended for the implementation of this product on a module board.
- Decoupling capacitors of 120pF, 10nF, 1µF, 10µF ±10% are recommended for all DC accesses.
- See application note AN0017 for details.



Biasing Matrix South

1	2	3	4	5	6
		VG	VD		GND

Note: All board measurements are performed using shielded cables, even for DC bias, to ensure safe operation.

(1) Refer to the application note AN0031 available at http://www.ums-rf.com for the description of Evaluation Board for Packaged Die and recommendations for this UMS package.

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Note

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Recommended package footprint

Refer to the application note AN0017 available at https://www.ums-rf.com for package foot print recommendations.

SMD mounting procedure

For the mounting process standard techniques involving solder paste and a suitable reflow process can be used. For further details, see application note AN0017 at https://www.ums-rf.com.

Recommended environmental management

UMS products are compliant with the regulation in particular with the directives RoHS N°2011/65 and REACh N°1907/2006. More environmental data are available in the application note AN0019 also available at https://www.ums-rf.com.

Recommended ESD management

Refer to the application note AN0020 available at https://www.ums-rf.com for ESD sensitivity and handling recommendations for the UMS package products.

Description of Evaluation Board

Refer to the application note AN0031 available at http://www.ums-rf.com for the description of Evaluation Board for Packaged Die and recommendations for this UMS package.

Ordering Information

QFN 4x4 package:	CHA1452-QDG/XY	
Evaluation Board:	EVB-CHA1452-QDG	
	Stick: XY = 20	Tape & reel: XY = 21

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