

DC-12GHz Reflective SPDT

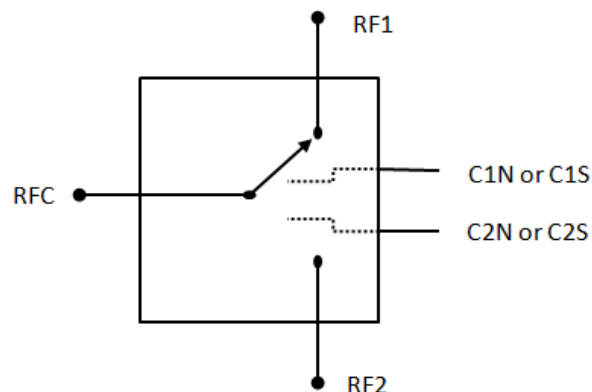
GaN Monolithic Microwave IC

Description

The CHS7012-99F is a monolithic FET based reflective switch in the DC-12GHz frequency band.

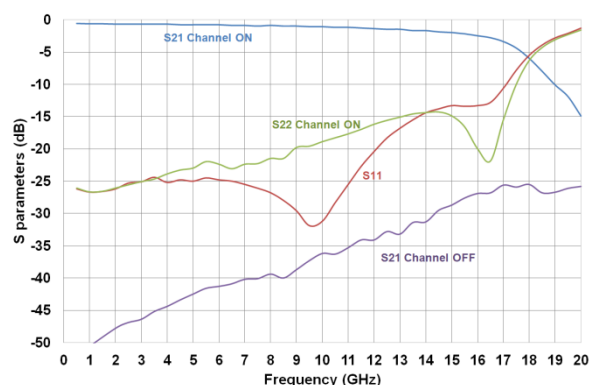
It is designed for a wide range of applications, from military to commercial communication systems.

It is developed on a robust 0.25μm gate length GaN/SiC HEMT process and is available as bare die.



Main Features

- Broadband performances: DC-12GHz
- Insertion Loss: 1.4dB
- Isolation: 35dB
- Input power at 1dB compression: 40.5dBm
- Switching time: 20ns
- Control: -25V / 0V
- Chip size 1.15x1.65x0.1mm



Main Electrical Characteristics

Tamb.= +25°C

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	DC		12	GHz
IL	On state insertion loss ⁽²⁾		1.4		dB
ISOL	Off state isolation		35		dB
Ton / Toff	Switching time 50% control to 90% RF, and 50% control to 10% RF ⁽³⁾		20		ns

Electrical Characteristics ⁽¹⁾T_{amb.} = +25°C, V_L = -25 V / V_H = 0 V

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	DC		12	GHz
IL	On state insertion loss ⁽²⁾		1.4		dB
ISOL	Off state isolation		35		dB
RL_ON	On state input and output return losses		15		dB
RL_OFF	Off state output return losses		2.5		dB
VH	Control voltage high level		0		V
VL	Control voltage low level	-30	-25		V
IP1dB	Input Power @1dB gain compression. Freq. >0.5GHz		40.5		dBm
Ton / Toff	Switching time 50% control to 90% RF, and 50% control to 10% RF ⁽³⁾		20		ns
Ic	Current consumption on the control supply voltage		0.5		mA

⁽¹⁾ These values are representative of measurements done in test fixture with a bonding wire of typically 0.35 to 0.4nH. Reference planes of on-board measurements are defined in the paragraph S-parameters reference planes

⁽²⁾ Variation rate of insertion loss with temperature in the range -40°C to +85°C: -0.007dB/°C .

⁽³⁾ for RF power up to P_{in}=40dBm .

SPDT truth table

PAD C1N or C1S	PAD C2N or C2S	Electrical path RFC to RF1	Electrical path RFC to RF2
VH	VL	ON	OFF
VL	VH	OFF	ON

Absolute Maximum Ratings ⁽¹⁾T_{amb.} = +25°C

Symbol	Parameter	Values	Unit
VL	Control voltage low level	-40	V
P _{in}	Maximum peak input power overdrive	41.5	dBm
T _j	Junction temperature	230	°C

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

Temperature Range

T _a	Operating temperature range	-40 to +85	°C
T _{stg}	Storage temperature range	-55 to +150	°C

Typical on-board Sij parameters

Tamb.= +25°C, C1N/C1S=0V, C2N/C2S=-25V , on-state RFC-RF1 path

Freq (GHz)	S11 (dB)	PhS11 (°)	S12 (dB)	PhS12 (°)	S21 (dB)	PhS21 (°)	S22 (dB)	PhS22 (°)
2	-26.2	-60	-0.7	-33.4	-0.7	-33.4	-26.1	-58.7
2.5	-25.3	-72.6	-0.7	-41.6	-0.7	-41.6	-25.6	-76
3	-25.1	-86.1	-0.7	-49.9	-0.7	-49.9	-25.1	-89.3
3.5	-24.4	-95.2	-0.7	-58.3	-0.7	-58.3	-24.7	-103.1
4	-25.2	-109.2	-0.7	-66.6	-0.8	-66.6	-23.9	-108.7
4.5	-24.8	-121.8	-0.8	-75.1	-0.8	-75	-23.3	-117.2
5	-25	-131.5	-0.8	-83.3	-0.8	-83.4	-23	-129
5.5	-24.5	-142.7	-0.8	-92.3	-0.9	-91.9	-22	-134.1
6	-24.8	-156.9	-0.8	-100.8	-0.9	-100.8	-22.4	-146
6.5	-25	-158.1	-0.9	-109.7	-0.8	-109.5	-23.1	-160.1
7	-25.5	-171.2	-0.9	-118.2	-1	-118.1	-22.4	-167
7.5	-26.1	176.7	-1	-127.4	-1	-127.7	-22.3	-169
8	-26.8	161	-0.9	-136.7	-0.9	-136.4	-21.5	-179.4
8.5	-28	140.1	-1	-145.2	-1	-145	-21.5	176.6
9	-29.6	115	-1	-155.1	-1.1	-155.1	-19.8	174.4
9.5	-31.9	81.4	-1.1	-164	-1	-164.1	-19.6	167.9
10	-31.2	42.5	-1.1	-174.1	-1.1	-174.1	-18.9	164.6
10.5	-28.3	3.5	-1.2	176.4	-1.2	175.9	-18.3	162.1
11	-25.5	-22.8	-1.2	165.9	-1.2	165.9	-17.7	157.5
11.5	-22.7	-43.2	-1.3	155.9	-1.3	155.8	-17	154.8
12	-20.4	-58.7	-1.4	144.9	-1.4	145	-16.2	150.4
12.5	-18.3	-73.9	-1.5	134.1	-1.5	134.1	-15.6	146
13	-16.8	-86.8	-1.5	123	-1.6	123.1	-15.1	142.8
13.5	-15.5	-100.4	-1.7	111.4	-1.7	111.4	-14.6	136.9
14	-14.4	-110.2	-1.7	99.9	-1.8	99.9	-14.4	132.5
14.5	-13.8	-121.2	-1.9	87.4	-2	87.5	-14.3	126.1
15	-13.3	-129.9	-2	74.5	-2	74	-14.9	121.2
15.5	-13.4	-134.4	-2.2	60.4	-2.2	60.4	-16.6	117.3
16	-13.3	-133.7	-2.5	45.4	-2.5	45.4	-20	126.4
16.5	-12.8	-129.4	-2.8	29	-2.9	29.6	-21.9	165.5
17	-10.6	-124.2	-3.4	11.4	-3.5	10.8	-15.5	-162.6
17.5	-7.8	-126.7	-4.4	-8.4	-4.4	-7.9	-10	-164.3
18	-5.5	-135.3	-6	-27.3	-6	-27.4	-6.3	-176.5
18.5	-3.9	-148	-8	-43.2	-8.1	-43.3	-4.3	168.3
19	-2.8	-160.5	-10.1	-57.8	-10.1	-57.8	-3.1	155.9
19.5	-2.1	-168.8	-11.9	-71.9	-12	-72.2	-2.3	145.1
20	-1.3	-179.9	-14.9	-87.4	-14.9	-87.6	-1.6	134.7

Typical on-board Sij parameters

Tamb.= +25°C, C1N/C1S=-25V, C2N/C2S=0V , off-state RFC-RF1 path

Freq (GHz)	S11 (dB)	PhS11 (°)	S12 (dB)	PhS12 (°)	S21 (dB)	PhS21 (°)	S22 (dB)	PhS22 (°)
2	-26.2	-60	-47.8	62.7	-48.8	61	-1.8	161.2
2.5	-25.3	-72.6	-46.9	60.2	-47.3	59.6	-1.9	157.2
3	-25.1	-86.1	-46.4	56.6	-46.3	56.4	-2	153.2
3.5	-24.4	-95.2	-45.2	53.6	-45.2	53.8	-2	149.2
4	-25.2	-109.2	-44.4	54.9	-44.2	53.5	-2.1	146.1
4.5	-24.8	-121.8	-43.4	49	-43.1	49.1	-2.2	142.3
5	-25	-131.5	-42.5	49.9	-42.5	49.6	-2.2	138.1
5.5	-24.5	-142.7	-41.6	42.5	-41.8	43.4	-2.3	135.7
6	-24.8	-156.9	-41.3	40.2	-41.2	40.9	-2.3	131.1
6.5	-25	-158.1	-40.9	37.2	-40.9	37.6	-2.3	127.2
7	-25.5	-171.2	-40.2	36.7	-40.1	37.6	-2.3	123.3
7.5	-26.1	176.7	-40.1	32.6	-40.2	30.2	-2.4	118.5
8	-26.8	161	-39.4	29.7	-39.5	28.4	-2.4	114.9
8.5	-28	140.1	-40	29.3	-40.1	27.9	-2.4	111.2
9	-29.6	115	-38.7	34.1	-38.8	33.8	-2.5	107.8
9.5	-31.9	81.4	-37.3	32.7	-37.3	33.1	-2.4	104.7
10	-31.2	42.5	-36.2	21.3	-36.1	19.4	-2.4	101.5
10.5	-28.3	3.5	-36.3	19.8	-36.3	20.7	-2.5	98.6
11	-25.5	-22.8	-35.3	14.3	-35.2	13.4	-2.5	95.3
11.5	-22.7	-43.2	-34.1	9.3	-34.1	8.9	-2.5	92.2
12	-20.4	-58.7	-34.1	1.7	-34.2	1.1	-2.5	88.4
12.5	-18.3	-73.9	-32.8	-4.8	-32.8	-5.3	-2.6	85.2
13	-16.8	-86.8	-33.2	-9.2	-33.3	-8.9	-2.7	81.9
13.5	-15.5	-100.4	-31.4	-18.7	-31.5	-18.9	-2.7	78.6
14	-14.4	-110.2	-31.3	-22.1	-31.3	-22	-2.7	75.9
14.5	-13.8	-121.2	-29.5	-36.1	-29.5	-35.7	-2.8	73
15	-13.3	-129.9	-28.7	-44.9	-28.7	-45.1	-2.8	70.4
15.5	-13.4	-134.4	-27.6	-65.2	-27.6	-65.2	-2.9	67.1
16	-13.3	-133.7	-26.9	-77.9	-26.9	-78	-3	64.1
16.5	-12.8	-129.4	-26.8	-95.1	-26.9	-95.5	-3.2	61
17	-10.6	-124.2	-25.6	-111	-25.6	-111.4	-3.3	58.3
17.5	-7.8	-126.7	-25.9	-133.9	-25.8	-134.1	-3.5	55.7
18	-5.5	-135.3	-25.5	-152.9	-25.6	-152.8	-3.7	52.4
18.5	-3.9	-148	-26.8	-165.4	-26.9	-165.4	-4	48.9
19	-2.8	-160.5	-26.7	177.4	-26.7	177.5	-4.3	46.1
19.5	-2.1	-168.8	-26.1	171.6	-26.2	172.4	-4.8	43.9
20	-1.3	-179.9	-25.8	147.6	-25.9	147.2	-5.4	40.6

Device thermal information

The device thermal performances given below are based on UMS rules to evaluate the junction temperature.

This same procedure is the basis for junction temperature evaluation of the samples used to derive the Median lifetime and activation energy for the particular technology on which the CHS7012-99F is fabricated (GaN Power HEMT 0.25 μ m).

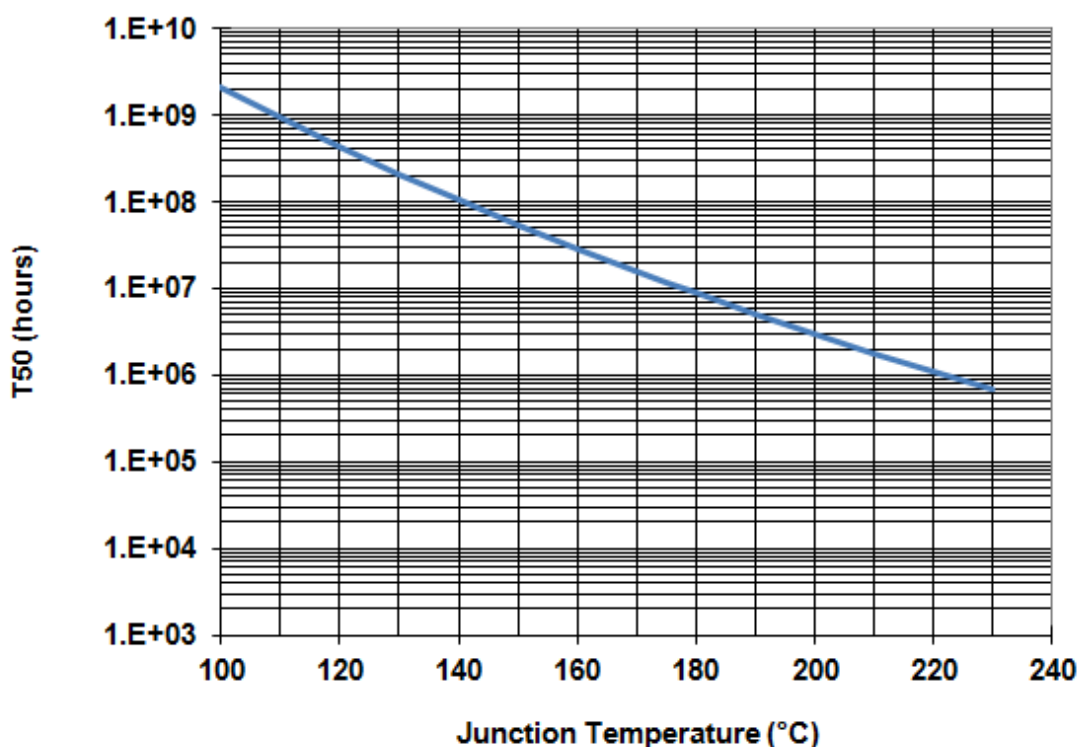
The temperature T_b is defined as the chip back side temperature

The thermal resistance (R_{th_eq}) is given for the full circuit, and assumes CW operation mode.

Thermal Resistance ⁽¹⁾	R_{th_eq}	$T_b=85^{\circ}\text{C}$, $V_H=0\text{V}/V_L=-25\text{V}$,	24.2	$^{\circ}\text{C/W}$
Junction Temperature	T_j	$P_{in}=41.1\text{dBm}$ $P_{out}=39.1\text{dBm}$	200	$^{\circ}\text{C}$
Median Life	T_{50}	$P_{diss}=4.75\text{W CW}$	3×10^6	Hrs

⁽¹⁾ Thermal resistance measured to back of carrier plate. Thermal analysis is highly recommended, more details are available on request.

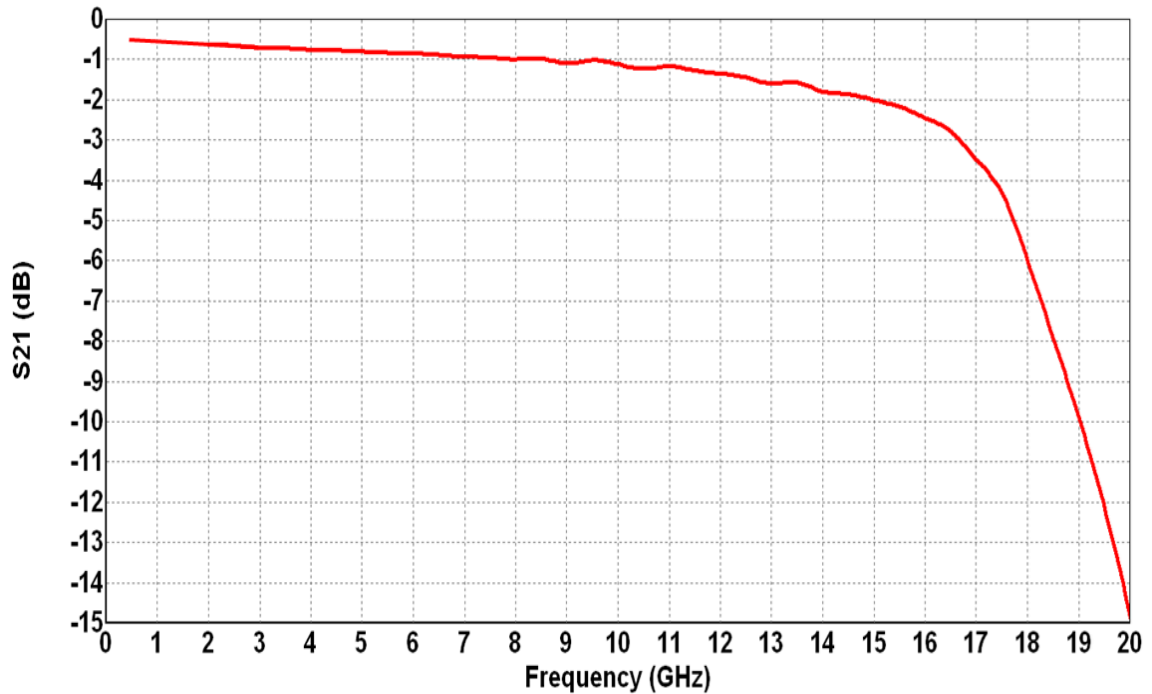
Median Life Time versus Junction Temperature



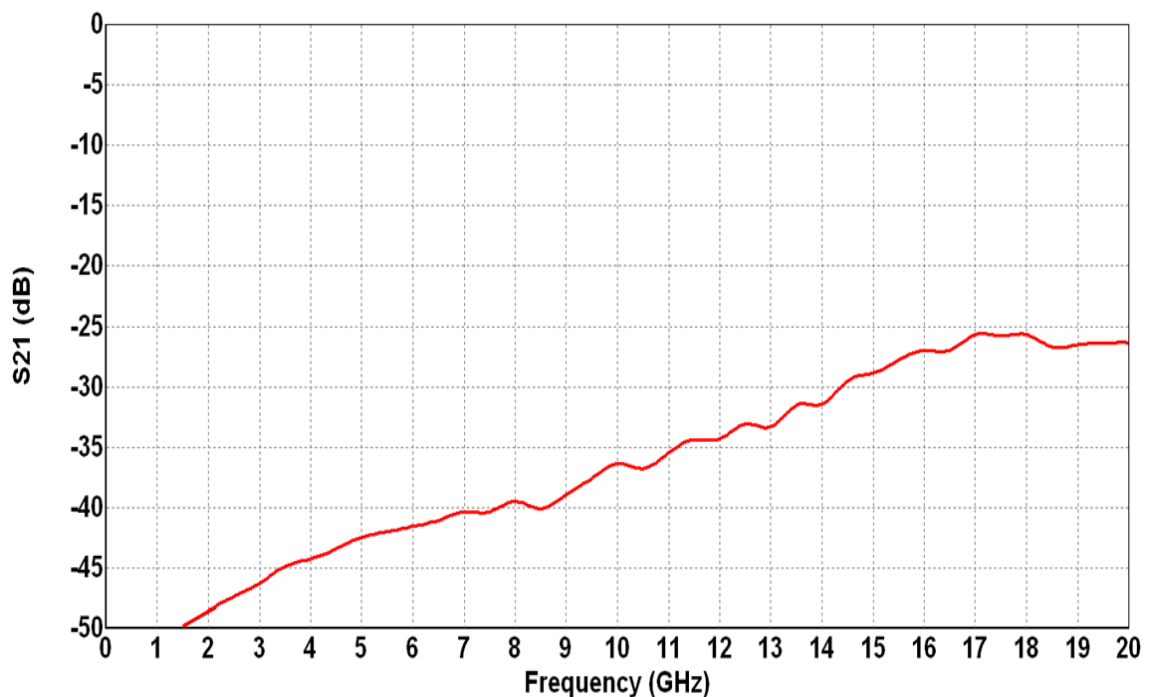
Typical Board Measurements

Tamb.= +25°C, VL=-25V, VH=0V

ON state RFC-RF1 path : S21 versus Frequency (C1N/C1S=0V, C2N/C2S=-25V)



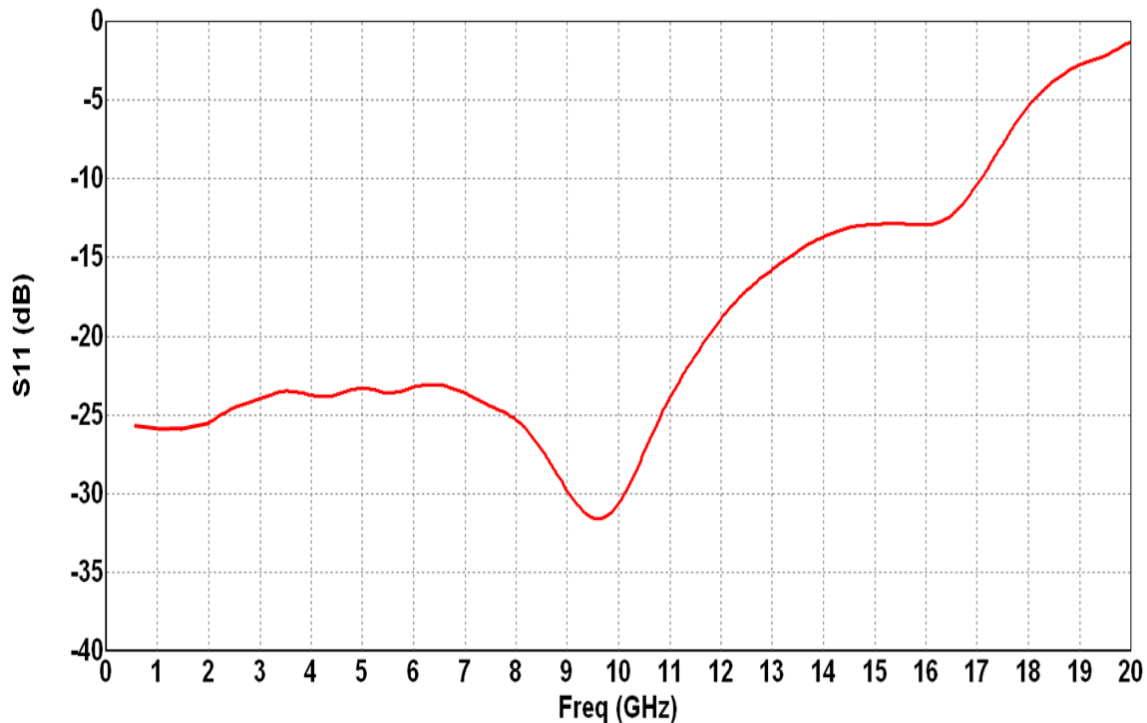
OFF state RFC-RF1 path: S21 versus Frequency (C1N/C1S=-25V, C2N/C2S=0V)



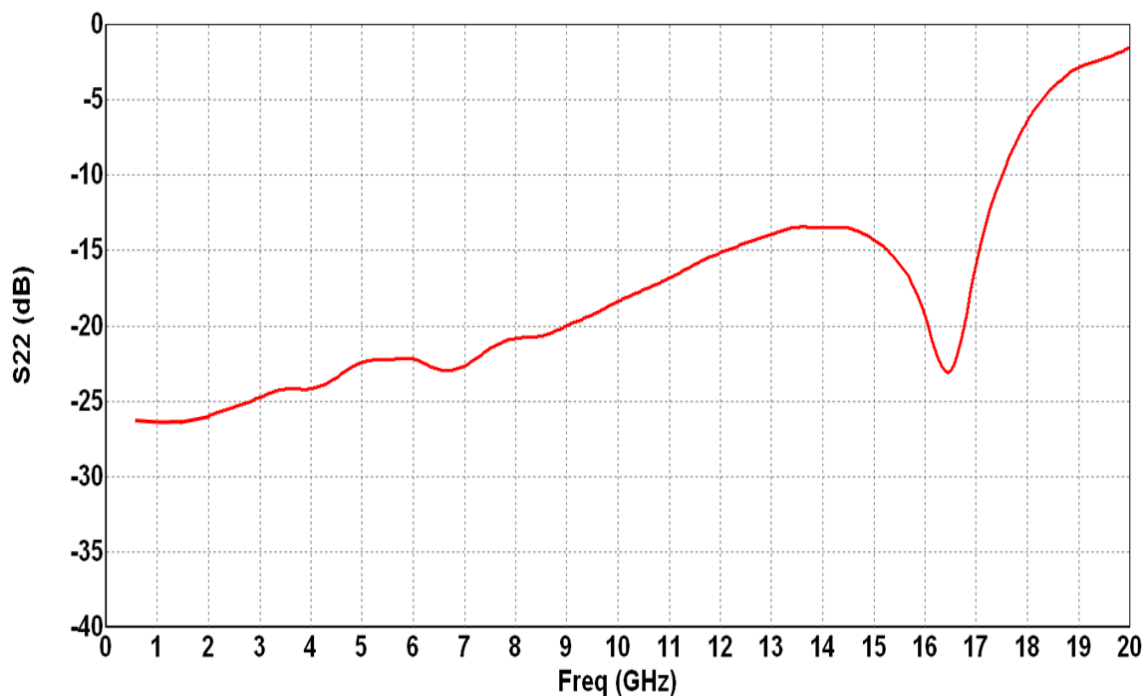
Typical Board Measurements

Tamb.= +25°C, VL=-25V, VH=0V

ON state RFC-RF1 path: S11 versus Frequency (C1N/C1S=0V, C2N/C2S=-25V)

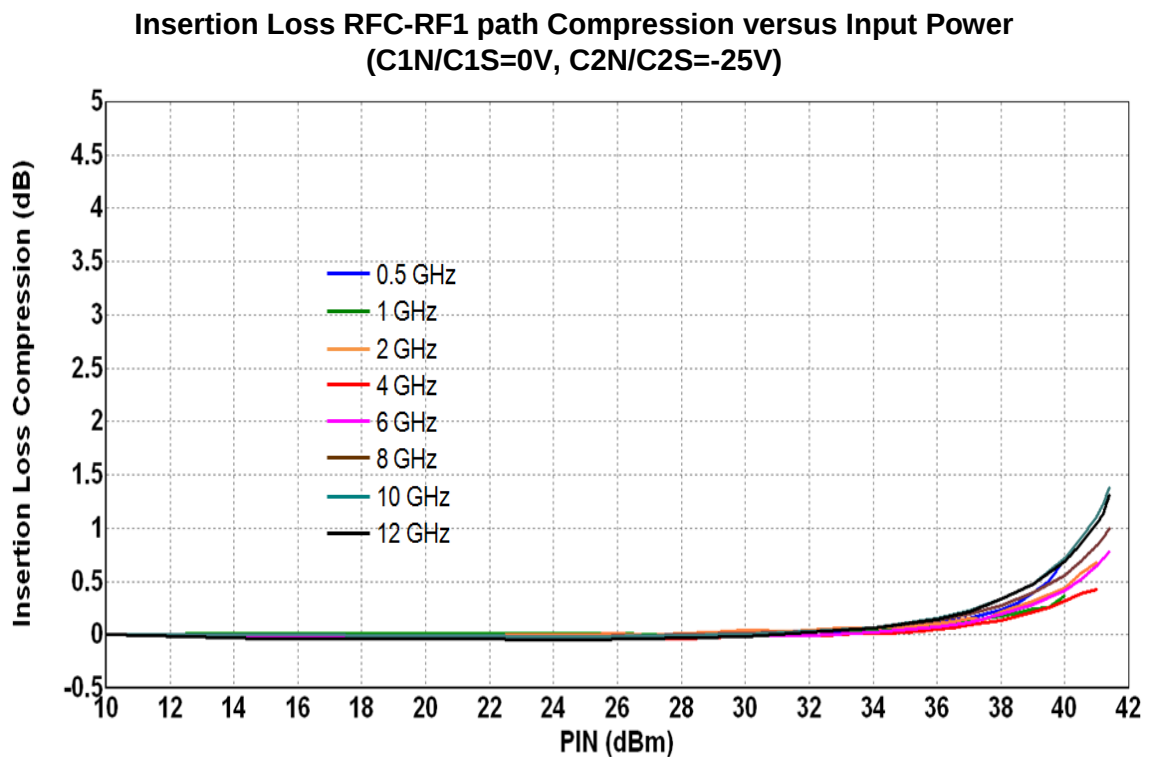
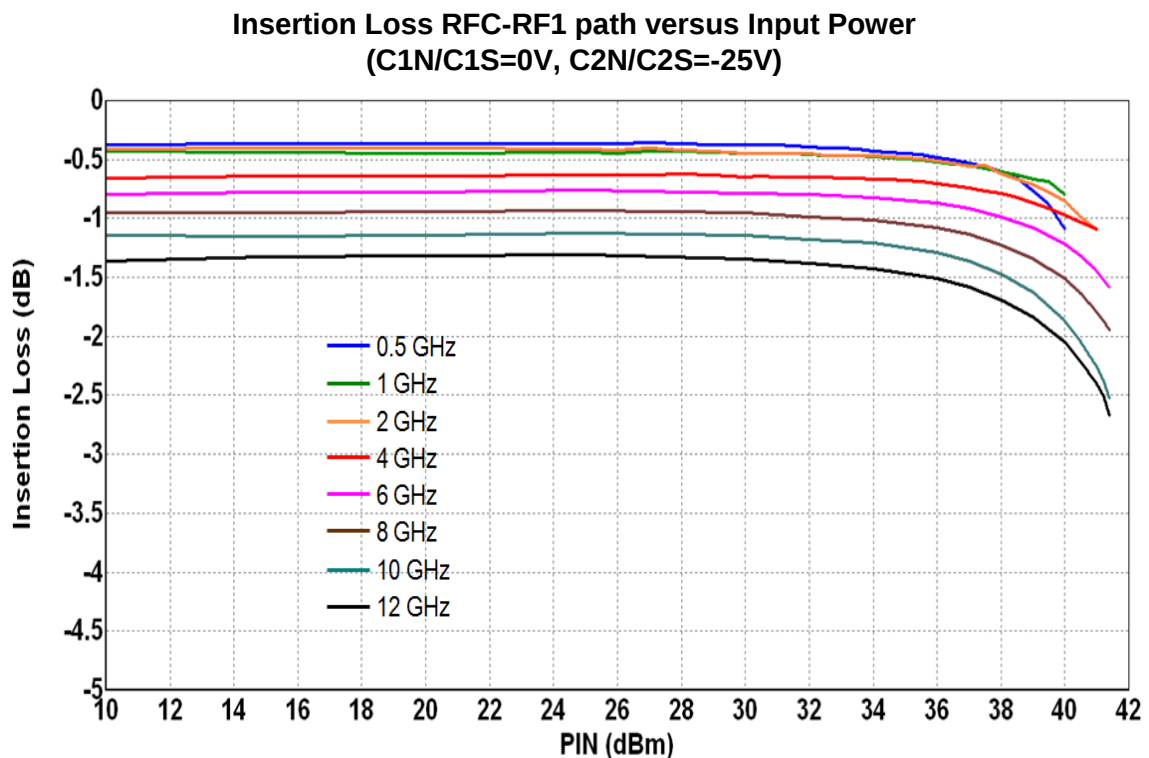


ON state RFC-RF1 path: S22 versus Frequency (C1N/C1S=0V, C2N/C2S=-25V)

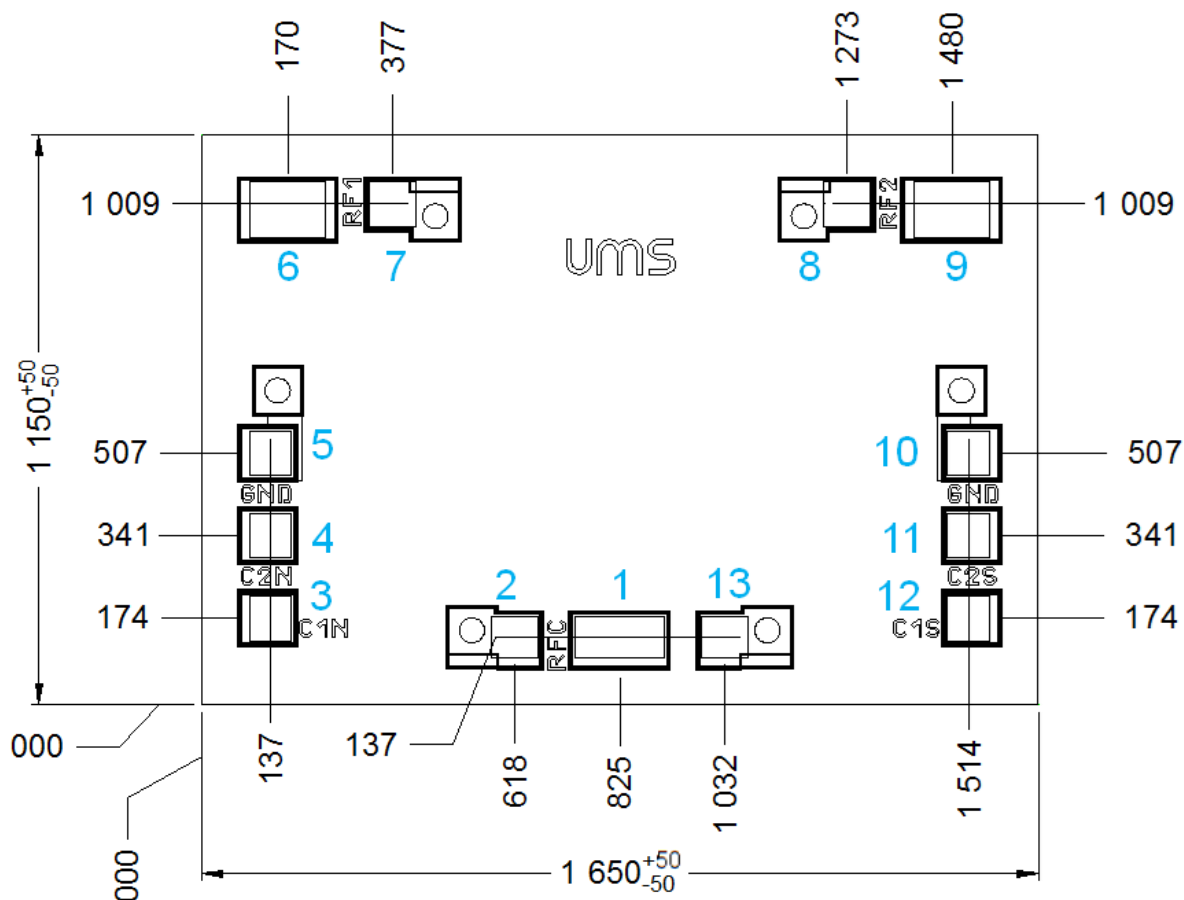


Typical Board Measurements

T_{amb.} = +25°C, V_L = -25V, V_H = 0V



Mechanical data



All dimensions are in micrometers

Chip size (dicing streets included) = 1650μm x 1150μm ±50μm

Chip thickness = 100μm

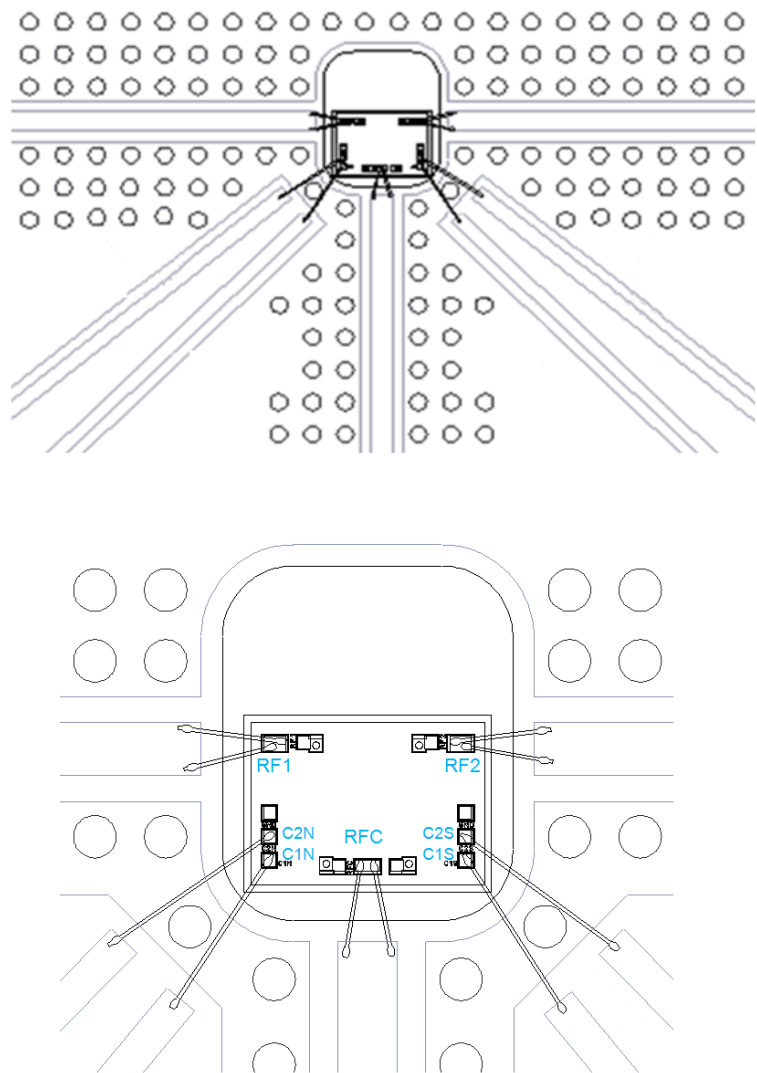
RF pads (1) = 196 x 115μm²

RF pads (6,9) = 196 x 130μm²

DC pads (3,4,11,12) = 117 x 112μm²

PAD Number	Name	Description
1	RFC	Input RF port RFC
6	RF1	Output RF port 1
9	RF2	Output RF port 2
3,12	C1N / C1S	Control voltage of path RFC-RF1
4,11	C2N / C2S	Control voltage of path RFC-RF2
2,5,7,8,10,13	GND	Ground (Not connected)

Recommended assembly plan



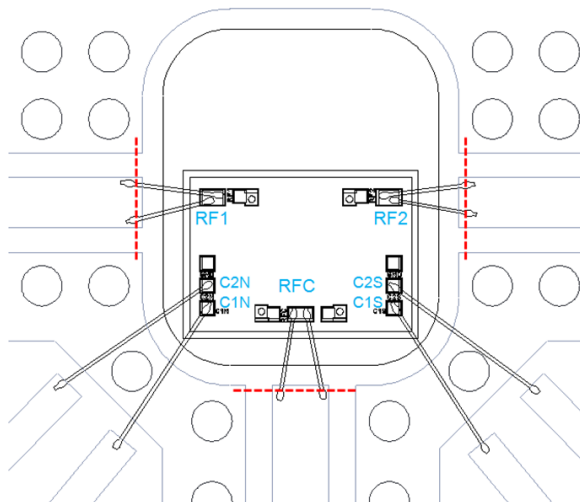
Recommended RF bonding wires: length<0.7mm / Ø25µm

Recommended circuit bonding table

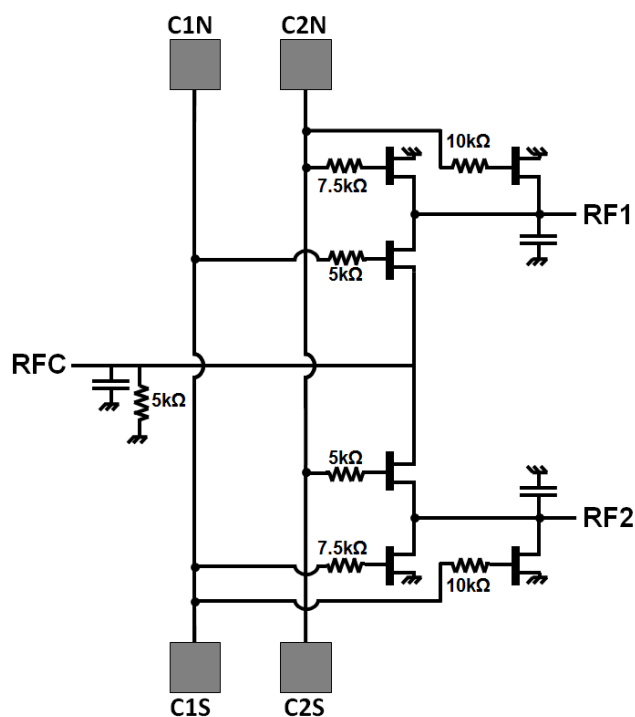
Label	Type	Decoupling	Comment
C1N, C2N C1S, C2S	Control voltage	Not required	SPDT switch pad control
RFC, RF1, RF2	RF access	External DC block must be used to ensure DC decoupling	The MMIC is DC coupled

Definition of the Sij reference planes

The reference planes used for Sij and power measurements given above are shown in the figure opposite



DC Schematic



Use either PAD C1N or PAD C1S to control RFC-RF1 path.

Use either PAD C2N or PAD C2S to control RFC-RF2 path.

Notes

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 products.

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 handling and assembly methodology

Refer to the application note AN0026 available at <https://www.ums-rf.com> for assembly recommendations for the UMS products based on GaN on SiC technology.

Ordering Information

Chip form:

CHS7012-99F/00

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