4-14GHz 6-bit digital attenuator

GaAs Monolithic Microwave IC in SMD leadless package

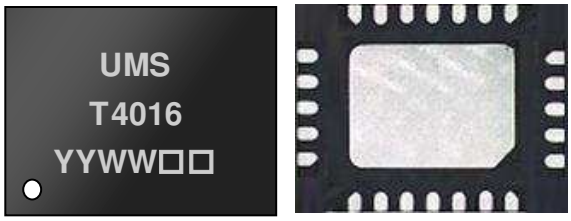
Description

The CHT4016-QEG is a 4-14GHz 6-bit digital attenuator designed to address a dynamic of 31.5dB by 0.5dB step.

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

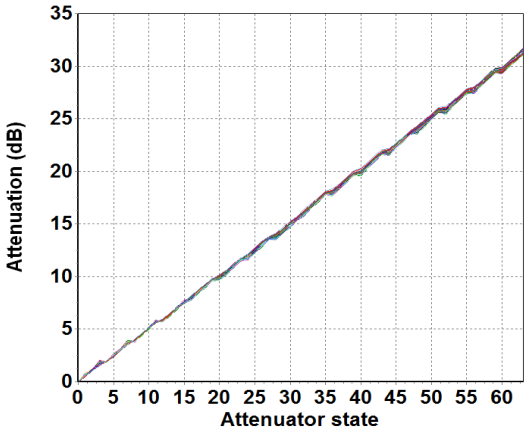
The circuit is manufactured with a pHEMT process, 0.25µm gate length, via holes through the substrate, air bridges and electron beam gate lithography.

It is available in chip form and in RoHS compliant SMD package.



Main Features

- Broadband performances: 4-14GHz
- 6-bit digital control interface
- 0.5dB Attenuator step
- 31.5dB Dynamic
- 0.2dB RMS attenuation error
- 24L-QFN4x5
- MSL1



Main Electrical Characteristics

Tamb.= +25°C

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	4		14	GHz
IL	Insertion Loss		7		dB
Dyn	Dynamic		31.5		dB
Att_err	Attenuation error		±0.8		dB

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Electrical Characteristics

Tamb.= +25°C, V+ = +5.0V, V- = -5.0V

	Parameter	Min	Typ	Max	Unit
Freq	Operating frequency	4		14	GHz
IL	Insertion Loss		7		dB
S11	Input Return Loss		-14		dB
S22	Output Return Loss		-14		dB
P1dB	Input power at 1dB gain compression		23		dBm
Dyn	Dynamic		31.5		dB
LSB	Attenuator elementary step		0.5		dB
Att_err	Attenuation error		±0.8		dB
Rms_att	RMS attenuation error		0.2		dB
Phivar	Phase variation		-1/+13		°
Rms_Phivar	RMS of phase variation		6		°
V+	Positive supply voltage		5		V
V-	Negative supply voltage		-5		V
Vctrl_L	Control voltage low level	-1.5	0		V
Vctrl_H	Control voltage high level		-5	-3.5	V
I_V+	Positive supply DC current		6		mA
I_V-	Negative supply DC current		18		mA

The measurement calibration planes are defined in the paragraph “Definition of the Sij reference planes”.

Absolute Maximum Ratings (1)

Tamb.= +25°C

Symbol	Parameter	Values	Unit
V+	Maximum positive bias voltage	6	V
V-	Maximum negative bias voltage	-6	mA
Ai	CTRL voltage (Vctrl_low, Vctrl_high)	-6,+2	V
Pin	Maximum peak input power overdrive (2)	+25	dBm
Ta	Operating temperature range	-40 to +85	°C
Tstg	Storage temperature range	-55 to +150	°C

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

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Definitions

n: Attenuator state index with $0 \leq n \leq 63$
Phase_S21(n) : Measured phase of S21 in degree at attenuation state n
dB_S21(n) : Measured magnitude of S21 in dB at attenuation state n

Attenuation Error (Att_err)

Att_err(n)= dB_S21 (n) - dB_S21(0) –0.5xn (dB)

The translation of Att_err(n) from dB to linear is given by: Att_err_lin(n) = $10^{\frac{Att\_err(n)}{20}}$

Phase variation (Phivar)

Phivar(n) = Phase_S21(n) - Phase_S21(0) (°)

RMS Attenuation Error (Rms_att_err)

$$Rms\_att\_err = 20\log\left(1+\sqrt{\frac{1}{64}.\sum_{n=0}^{63}(1-Att\_err\_lin(n))^2}\right) \text{ (dB)}$$

RMS Phase variation (Rms_Phivar)

$$Rms\_Phivar = \sqrt{\frac{\sum_{n=0}^{63}(Phi\ var(n))^2}{64}} \text{ (°)}$$

Biasing conditions

Pin number	Pad name	Value
20	A1	-5V or 0V
19	A2	-5V or 0V
18	A3	-5V or 0V
17	A4	-5V or 0V
16	A5	-5V or 0V
15	A6	-5V or 0V
13	-5V	-5V
12	+5V	+5V

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Attenuator control table

Voltage to apply on pads A1 to A6

State	Att (dB)	A6	A5	A4	A3	A2	A1
0	0	0	0	0	0	0	0
1	0.5	0	0	0	0	0	-5
2	1	0	0	0	0	-5	0
3	1.5	0	0	0	0	-5	-5
4	2	0	0	0	-5	0	0
5	2.5	0	0	0	-5	0	-5
6	3	0	0	0	-5	-5	0
7	3.5	0	0	0	-5	-5	-5
8	4	0	0	-5	0	0	0
9	4.5	0	0	-5	0	0	-5
10	5	0	0	-5	0	-5	0
11	5.5	0	0	-5	0	-5	-5
12	6	0	0	-5	-5	0	0
13	6.5	0	0	-5	-5	0	-5
14	7	0	0	-5	-5	-5	0
15	7.5	0	0	-5	-5	-5	-5
16	8	0	-5	0	0	0	0
17	8.5	0	-5	0	0	0	-5
18	9	0	-5	0	0	-5	0
19	9.5	0	-5	0	0	-5	-5
20	10	0	-5	0	-5	0	0
21	10.5	0	-5	0	-5	0	-5
22	11	0	-5	0	-5	-5	0
23	11.5	0	-5	0	-5	-5	-5
24	12	0	-5	-5	0	0	0
25	12.5	0	-5	-5	0	0	-5
26	13	0	-5	-5	0	-5	0
27	13.5	0	-5	-5	0	-5	-5
28	14	0	-5	-5	-5	0	0
29	14.5	0	-5	-5	-5	0	-5
30	15	0	-5	-5	-5	-5	0
31	15.5	0	-5	-5	-5	-5	-5

State	Att (dB)	A6	A5	A4	A3	A2	A1
32	16	-5	0	0	0	0	0
33	16.5	-5	0	0	0	0	-5
34	17	-5	0	0	0	-5	0
35	17.5	-5	0	0	0	-5	-5
36	18	-5	0	0	-5	0	0
37	18.5	-5	0	0	-5	0	-5
38	19	-5	0	0	-5	-5	0
39	19.5	-5	0	0	-5	-5	-5
40	20	-5	0	-5	0	0	0
41	20.5	-5	0	-5	0	0	-5
42	21	-5	0	-5	0	-5	0
43	21.5	-5	0	-5	0	-5	-5
44	22	-5	0	-5	-5	0	0
45	22.5	-5	0	-5	-5	0	-5
46	23	-5	0	-5	-5	-5	0
47	23.5	-5	0	-5	-5	-5	-5
48	24	-5	-5	0	0	0	0
49	24.5	-5	-5	0	0	0	-5
50	25	-5	-5	0	0	-5	0
51	25.5	-5	-5	0	0	-5	-5
52	26	-5	-5	0	-5	0	0
53	26.5	-5	-5	0	-5	0	-5
54	27	-5	-5	0	-5	-5	0
55	27.5	-5	-5	0	-5	-5	-5
56	28	-5	-5	-5	0	0	0
57	28.5	-5	-5	-5	0	0	-5
58	29	-5	-5	-5	0	-5	0
59	29.5	-5	-5	-5	0	-5	-5
60	30	-5	-5	-5	-5	0	0
61	30.5	-5	-5	-5	-5	0	-5
62	31	-5	-5	-5	-5	-5	0
63	31.5	-5	-5	-5	-5	-5	-5

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Typical Package Sij parameters (state 0)

Tamb.= +25°C, V+ = +5.0V, V-=-5.0V, Vctrl=-5V

Freq (GHz)	S11 (dB)	PhS11 (°)	S12 (dB)	PhS12 (°)	S21 (dB)	PhS21 (°)	S22 (dB)	PhS22 (°)
2.00	-11.51	-71.88	-4.85	-88.20	-4.84	-88.12	-10.87	-65.93
2.25	-11.90	-78.18	-4.87	-100.63	-4.86	-100.58	-11.09	-72.31
2.50	-12.33	-84.57	-4.88	-112.68	-4.88	-112.69	-11.35	-78.91
2.75	-12.87	-91.31	-4.93	-124.78	-4.92	-124.85	-11.71	-85.96
3.00	-13.47	-98.40	-4.96	-137.12	-4.96	-137.08	-12.19	-93.52
3.25	-14.14	-104.76	-4.97	-148.89	-4.96	-149.08	-12.71	-100.80
3.50	-15.08	-111.66	-5.03	-161.06	-5.07	-161.05	-13.44	-108.35
3.75	-16.13	-118.90	-5.14	-173.97	-5.12	-173.65	-14.30	-116.44
4.00	-17.35	-123.41	-5.17	174.57	-5.19	174.75	-15.26	-123.60
4.25	-18.74	-126.68	-5.25	162.92	-5.22	163.08	-16.41	-129.42
4.50	-20.36	-128.23	-5.31	150.60	-5.31	150.62	-17.80	-136.21
4.75	-22.06	-125.73	-5.38	138.62	-5.38	138.68	-19.49	-141.06
5.00	-23.56	-117.84	-5.50	127.14	-5.47	127.04	-21.62	-143.00
5.25	-25.74	-109.30	-5.58	114.67	-5.60	114.47	-24.00	-128.03
5.50	-25.34	-85.52	-5.61	102.84	-5.64	103.10	-25.96	-111.59
5.75	-23.14	-81.55	-5.77	91.17	-5.74	91.47	-25.67	-90.35
6.00	-21.40	-79.22	-5.84	79.27	-5.83	79.32	-24.15	-77.19
6.25	-19.73	-82.40	-5.94	67.47	-5.92	67.51	-22.18	-72.46
6.50	-18.35	-87.20	-5.99	55.87	-6.03	55.95	-20.46	-72.93
6.75	-17.32	-94.63	-6.17	43.50	-6.14	43.81	-19.25	-76.28
7.00	-16.51	-101.50	-6.24	32.10	-6.18	32.13	-18.24	-81.10
7.25	-15.78	-109.30	-6.28	21.00	-6.29	20.67	-17.44	-86.39
7.50	-15.23	-117.71	-6.39	8.56	-6.44	8.75	-17.06	-93.17
7.75	-14.76	-127.24	-6.42	-2.93	-6.44	-2.96	-16.60	-100.09
8.00	-14.63	-135.55	-6.50	-14.60	-6.49	-14.40	-16.50	-106.58
8.25	-14.53	-145.41	-6.61	-26.80	-6.59	-26.88	-16.55	-113.50
8.50	-14.44	-154.44	-6.61	-38.79	-6.59	-38.70	-16.71	-121.40
8.75	-14.62	-161.48	-6.66	-50.20	-6.66	-50.26	-17.07	-128.04
9.00	-14.75	-171.17	-6.71	-62.72	-6.74	-62.79	-17.71	-135.45
9.25	-14.87	-179.53	-6.74	-75.33	-6.73	-75.02	-18.55	-142.02
9.50	-15.30	173.47	-6.84	-87.05	-6.80	-86.89	-19.41	-147.47
9.75	-15.72	164.66	-6.89	-99.05	-6.89	-99.55	-20.62	-153.23
10.00	-16.10	158.29	-6.91	-111.85	-6.91	-111.77	-22.32	-156.73
10.25	-16.55	152.06	-6.93	-124.38	-6.94	-124.07	-24.19	-156.91
10.50	-16.87	145.31	-7.09	-137.03	-7.07	-136.99	-26.47	-151.83
10.75	-17.25	140.00	-7.14	-149.68	-7.12	-149.74	-28.47	-139.87
11.00	-17.49	134.80	-7.16	-161.90	-7.14	-161.90	-28.55	-118.18
11.25	-17.71	128.38	-7.24	-174.95	-7.26	-175.09	-26.87	-104.86
11.50	-17.85	122.32	-7.31	171.83	-7.34	171.87	-25.02	-101.47
11.75	-17.95	116.49	-7.45	159.29	-7.40	159.62	-23.40	-100.50
12.00	-18.07	109.01	-7.51	146.31	-7.50	146.40	-21.97	-103.81
12.25	-18.19	100.79	-7.63	133.37	-7.59	133.10	-20.69	-109.02
12.50	-18.47	92.58	-7.69	120.21	-7.74	120.24	-19.83	-115.36
12.75	-18.90	84.81	-7.90	106.81	-7.89	107.40	-19.24	-121.89
13.00	-19.58	75.39	-7.94	93.97	-7.97	93.82	-18.38	-130.71
13.25	-20.37	71.31	-8.07	81.10	-8.09	81.38	-17.89	-139.00
13.50	-20.77	64.59	-8.19	67.94	-8.15	68.14	-17.67	-147.40
13.75	-21.63	60.26	-8.24	54.35	-8.20	54.24	-17.38	-157.45
14.00	-22.26	55.86	-8.30	40.83	-8.31	40.60	-17.30	-166.38
14.25	-23.63	51.24	-8.41	26.84	-8.45	26.95	-17.32	-175.22
14.50	-25.02	57.16	-8.60	12.53	-8.55	12.78	-17.36	174.81
14.75	-25.34	62.70	-8.76	-1.14	-8.71	-1.27	-17.50	165.15
15.00	-26.03	76.13	-8.89	-14.91	-8.92	-15.17	-17.87	155.88

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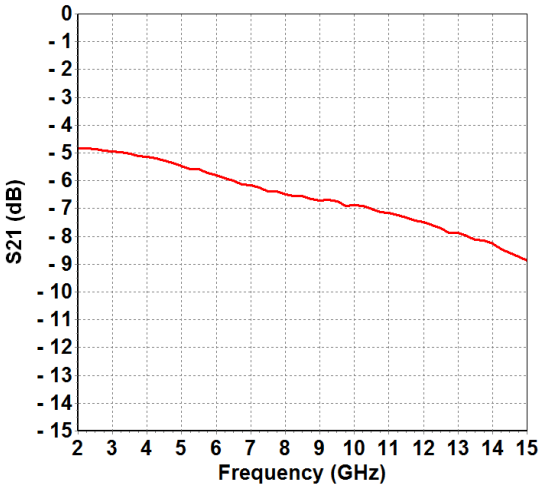
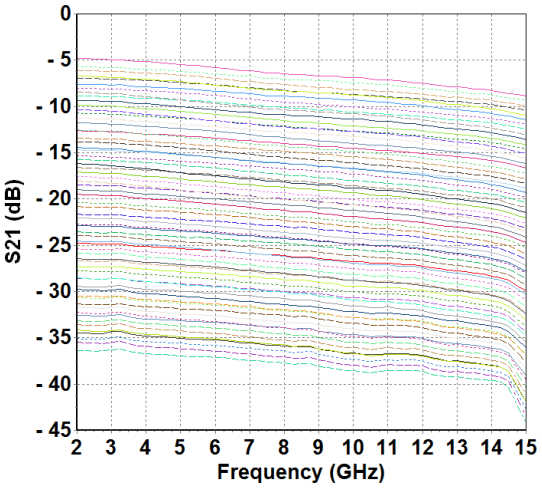
Typical Board Measurements

Tamb.= +25°C, V+ = +5.0V, V-=-5.0V

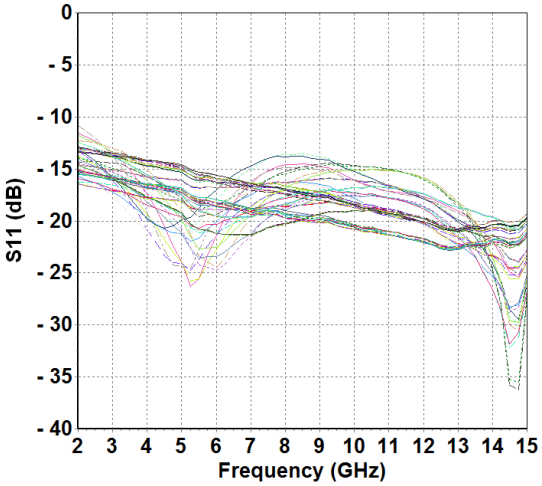
S21 versus Frequency
Attenuator state 0



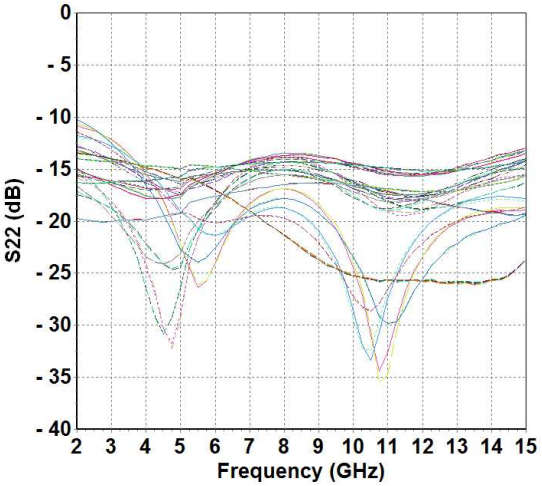
S21 versus Frequency
All attenuator states



S11 versus Frequency
All attenuator states



S22 versus Frequency
All attenuator states



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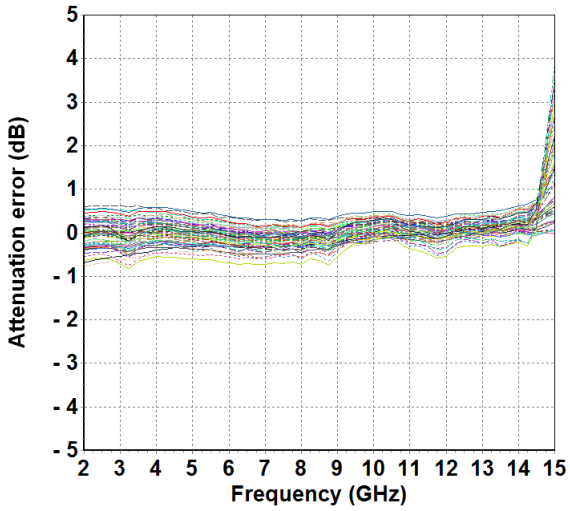
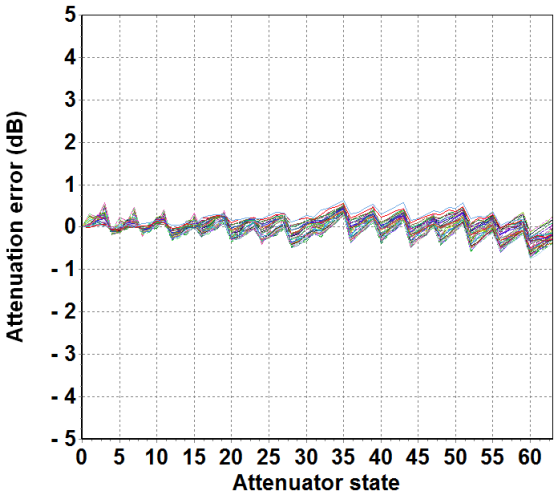
Typical Board Measurements

Tamb.= +25°C, V+ = +5.0V, V-=-5.0V

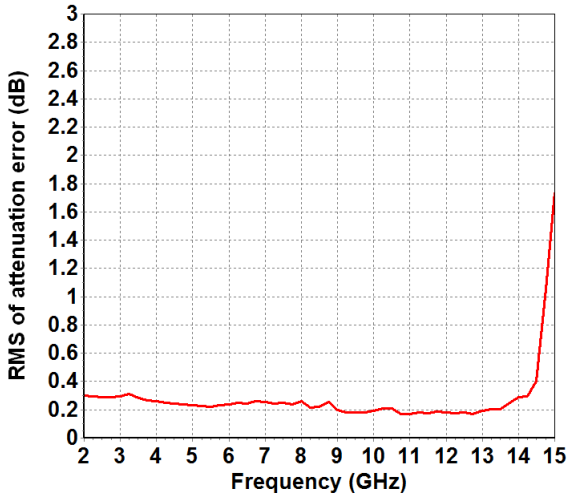
Attenuation error versus frequency
All attenuator states



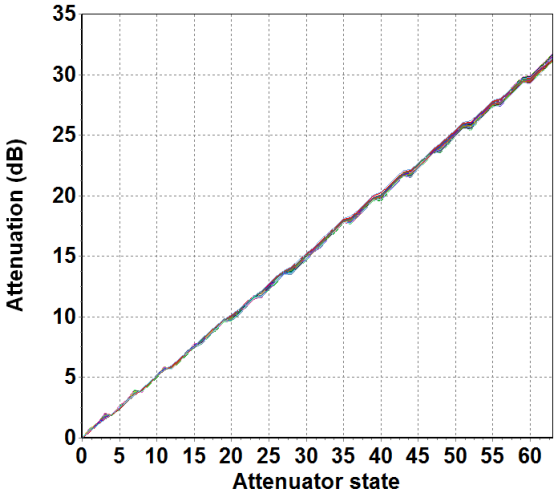
Attenuation error versus attenuator state
Frequency bandwidth 4-14GHz



RMS of attenuation error



Attenuation versus attenuator state
Frequency bandwidth 4-14GHz



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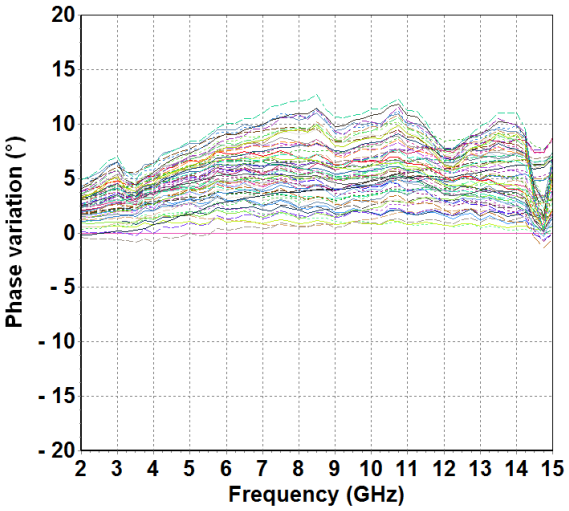
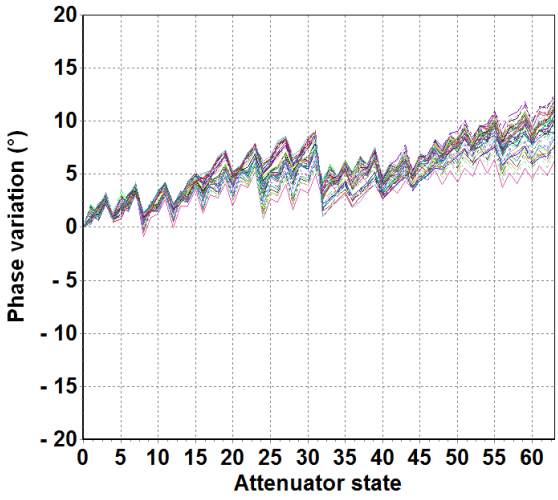
Typical Board Measurements

Tamb.= +25°C, V+ = +5.0V, V-=-5.0V

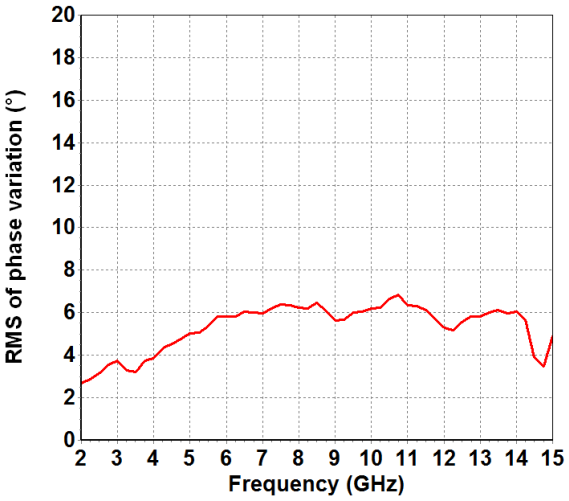
Phase variation versus Frequency
All attenuator states



Phase variation versus attenuator state
Frequency bandwidth 4-14GHz



RMS of phase variation



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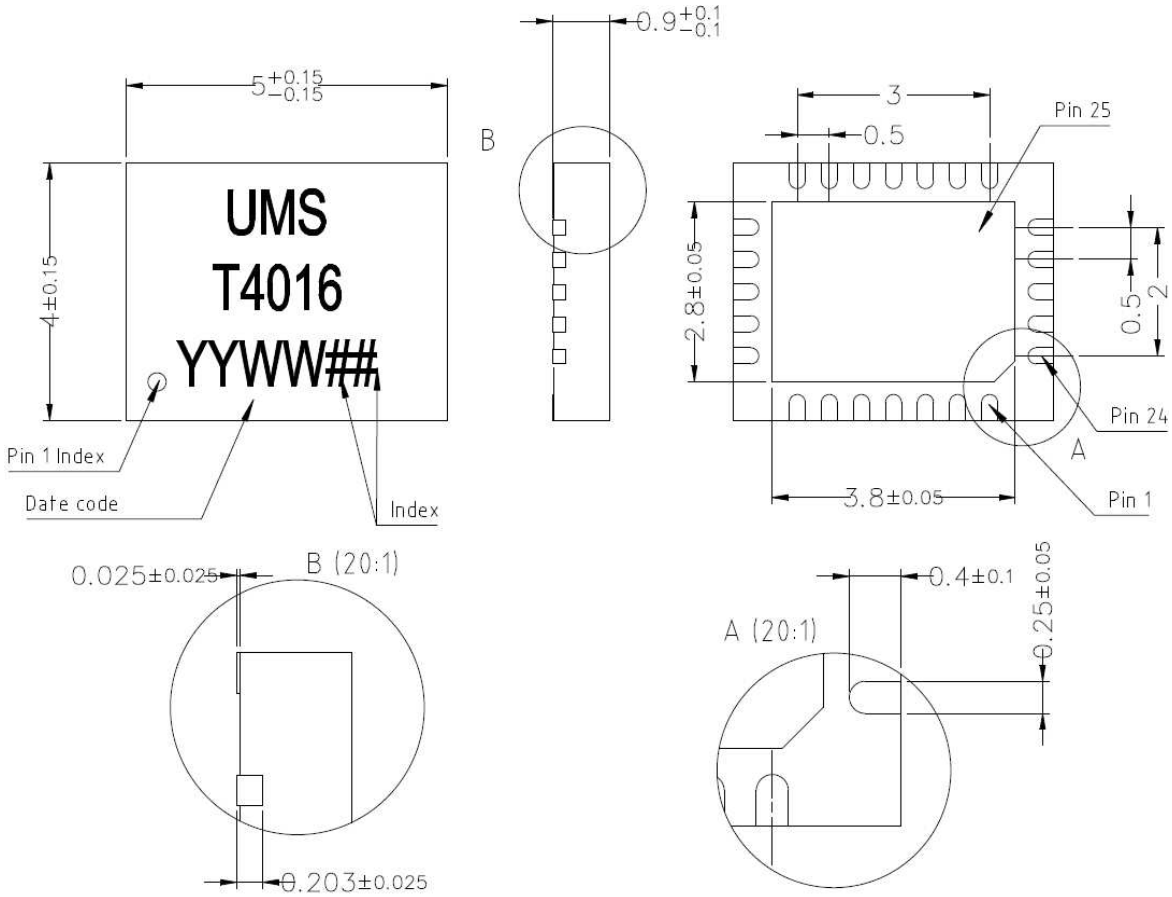
Package outline (1)



Matt tin, Lead Free (Green)	1- Nc	9- Nc	17- A4
Units : mm	2- Nc	10- RF out	18- A3
From the standard : JEDEC MO-220 (VGHD)	3- Nc	11- Gnd(2)	19- A2
	4- Nc	12- 5V	20- A1
25- GND	5- Nc	13- -5V	21- Gnd(2)
	6- Nc	14- Gnd(2)	22- RF in
	7- Nc	15- A6	23- Nc
	8- Nc	16- A5	24- Nc

(1) The package outline drawing included to this data-sheet is given for indication. Refer to the application note AN0017 (http://www.ums-gaas.com) for exact package dimensions.

(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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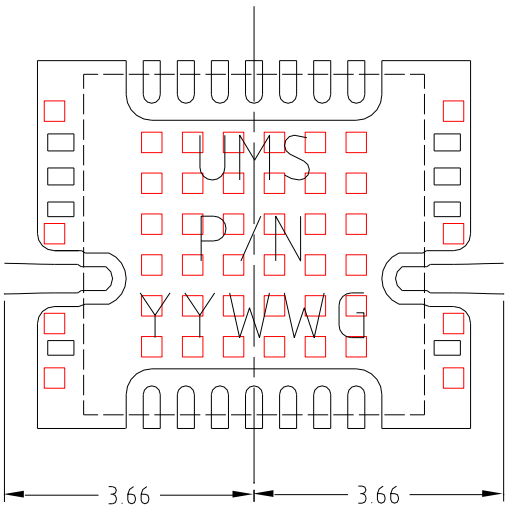
Definition of the Sij reference planes

The reference planes used for measurements given above are symmetrical from the symmetrical axis of the package (see drawing beside). The input and output reference planes are located at 3.66mm offset (input wise and output wise respectively) from this axis.



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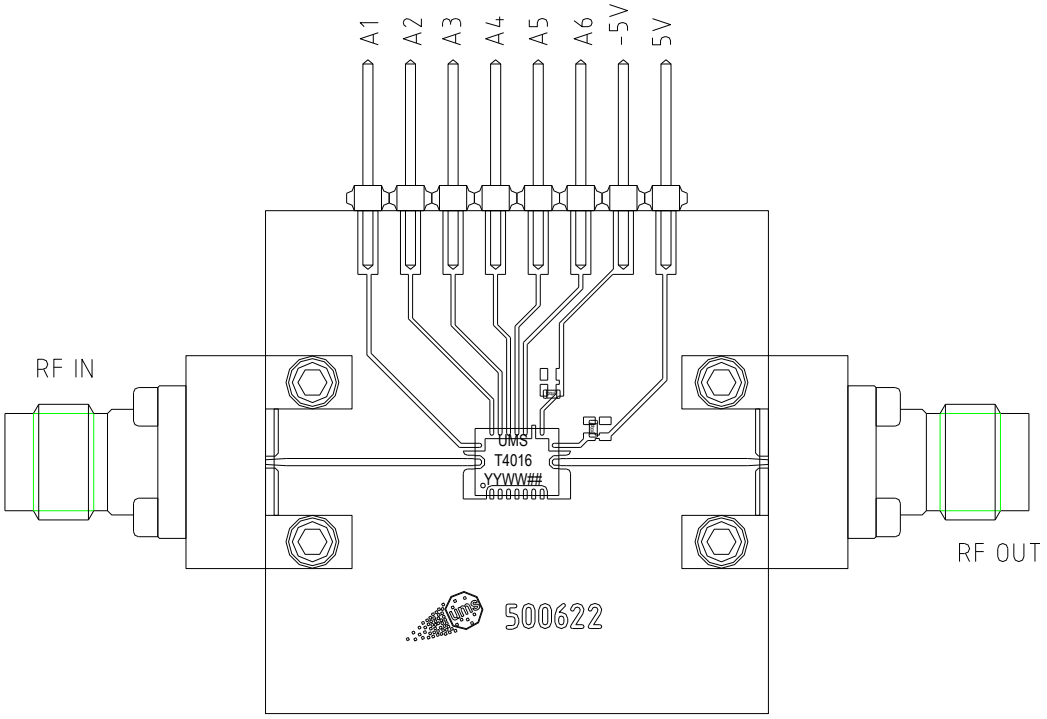
Evaluation mother board

- 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 10nF ±10% are recommended for the biasing accesses.
- See application note AN0017 for details.



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Recommended package footprint

Refer to the application note AN0017 available at http://www.ums-gaas.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.

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 http://www.ums-gaas.com.

Recommended ESD management

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

Ordering Information

QFN 4x5 package:	CHT4016-QEG/XY	
	Stick: XY = 20	Tape & reel: XY = 21

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