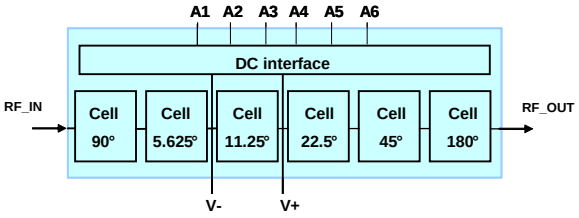
5-6GHz 6-bit Phase-Shifter

GaAs Monolithic Microwave IC

Description

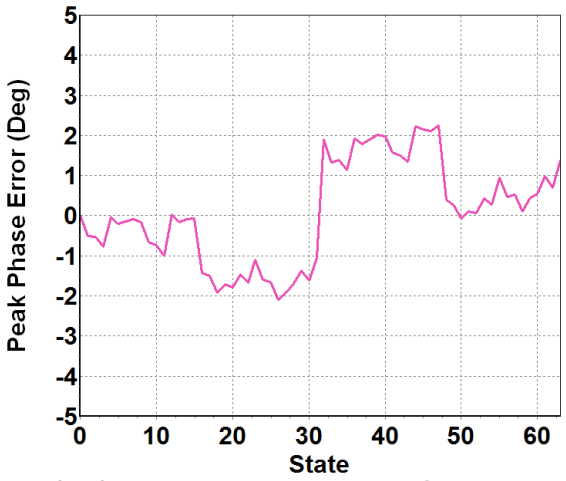
The CHP4014-98F is a 6-bit digital phase shifter MMIC with a 0°-360° range. It is designed for 5 to 6GHz frequency range applications. The circuit supports a variety of C-band phased array applications including industrial sensors and military radars.
The circuit is manufactured with a Power pHEMT process, 0.25µm gate length.

It is available in chip form.



Main Features

- Broadband performances: 5-6GHz
- 5.625° phase step
- 6dB Losses
- 26dBm input power at -1dB comp.
- I/O reversible
- TTL compatible control inputs
- chip size 3.54x2.54x0.1mm



Peak Phase Error versus state @ 5.5GHz
(wafer measurement)

Main Characteristics

Tamb.= +25°C

Symbol	Parameter	Min	Typ	Max	Unit
Fop	Operating frequency range	5		6	GHz
Ls	Insertion loss		6	7	dB
P1dB	Input power at 1dB compression		26		dBm
VAi(1)	Voltage control	0	3.3	7	V

(1) i=1, 2, 3, 4, 5, and 6

ESD Protection: Electrostatic discharge sensitive device. Observe handling precautions!

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Main Characteristics

Tamb.= +25°C

Symbol	Parameter	Min	Typ	Max	Unit
Fop	Operating frequency range	5		6	GHz
PhS	Phase Shifting Range	0		360	deg
PhS step	Phase Shifting Step		5.625		deg
PPE	Peak Phase Error		+/- 4	+/- 7	deg
RMSPE_Std	RMS Phase Error Standard Deviation		1	2	deg
RMSPE	RMS Phase Error		1	2	deg
Ls	Insertion Loss		6	7	dB
LsV	Insertion Loss variation		+/- 0.4	+/- 0.7	dB
RL_In	Input Return Loss	-10	-17		dB
RL_Out	Output Return Loss	-12	-20		dB
P1dB	Input power at 1dB compression (CW)		26		dBm
IIP3	Input Third Order Intercept		32		dBm
Ts	Switching time		20	50	ns
V_low	Control Input (A1-A6) – low level	0		0.4	V
V_high	Control Input (A1-A6) – high level	2.4	3.3	7	V
V+	Positive Supply Voltage		5		V
V-	Negative Supply Voltage		- 5		V
I+	Positive Supply Current		3.5	10	mA
I-	Negative Supply Current		3.5	10	mA
Top	Operating temperature	-40		+85	deg

Absolute Maximum Ratings (1)

Tamb.= +25°C

Symbol	Parameter	Values	Unit
V+	Maximum DC positive supply voltage	+8	V
V-	Maximum DC positive supply voltage	-8	V
Ai(2)	Phase Shifter CTRL voltage (V_low, V_high)	-2 , +8	V
Pin	Maximum peak input power overdrive	+30	dBm
Top	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.

(2) i= (1, 2, 3, 4, 5, and 6)

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Peak Phase Error (PPE) definition

$PPE_{(i)}$ =measured_phase$(S21)_{(i)}$ – measured_phase$(S21)_{(0)}$ – theoretical_phase$_{(i)}$

where (i) is the state (from 0 to 63)

RMS Phase Error (RMSPE) definition

$$\text{RMS\_PE}=\sqrt{\frac{\sum_{i=0}^{63} PPE^2(i)}{64}}$$

Where i is the state number (from 0 to 63).

Insertion Losses Variation (LsV) definition

$LsV_{(i)}$ =measured_dB$(S21)_{(i)}$ – measured_dB$(S21)_{(0)}$

where (i) is the state (from 0 to 63)

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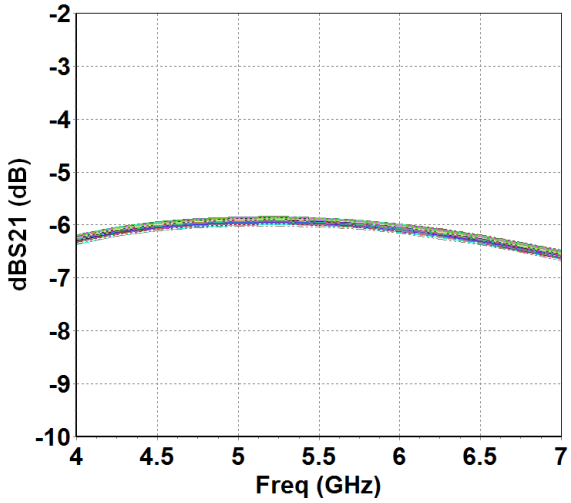
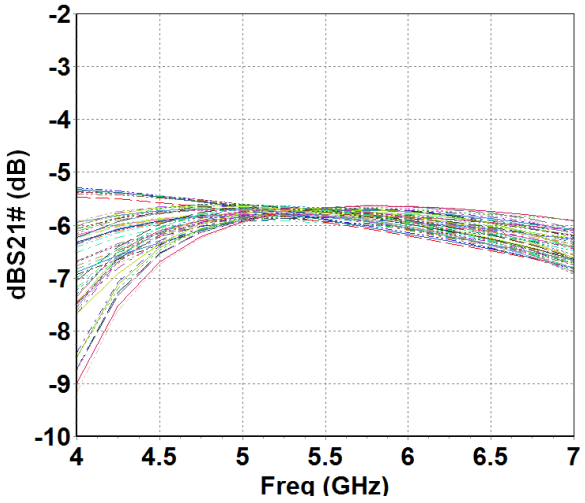
Typical on-wafer results with 0.3nH inductance on input and output [S] parameters

Tamb.= +25°C; V+=+5V; V-= -5V

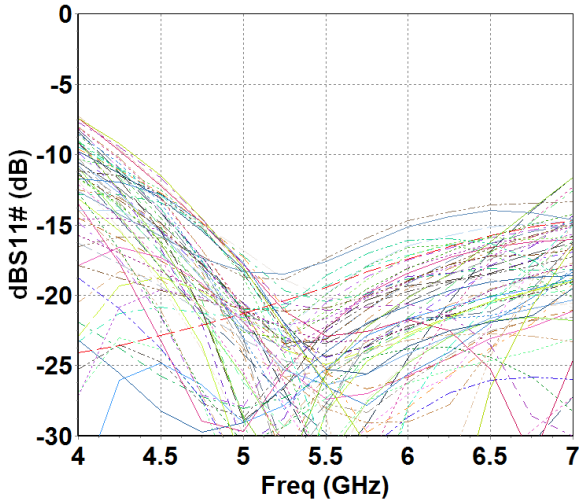
S21 versus frequency
State 0; 100% wafer



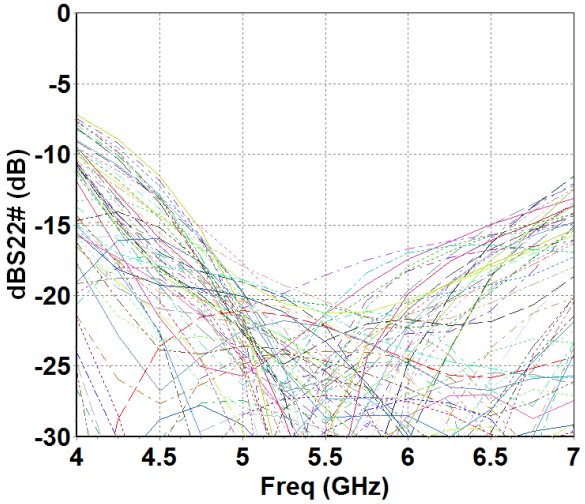
S21 versus frequency
All Phase States, one chip



S11 versus frequency
All Phase States, one chip



S22 versus frequency
All Phase States, one chip



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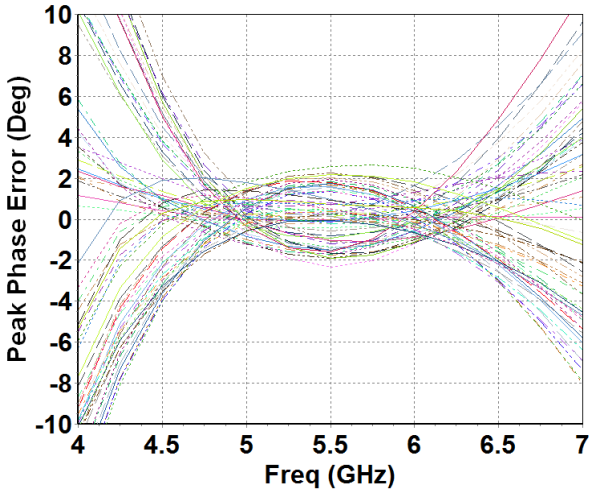
Typical on-wafer results

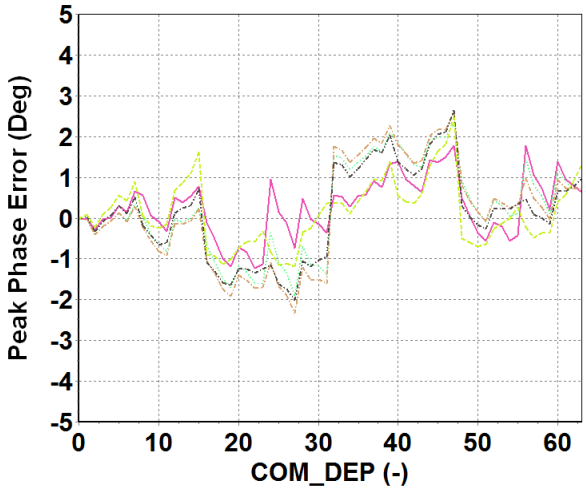
Phase shifter performances: Peak phase error

Tamb.= +25°C; V+=+5V; V-= -5V

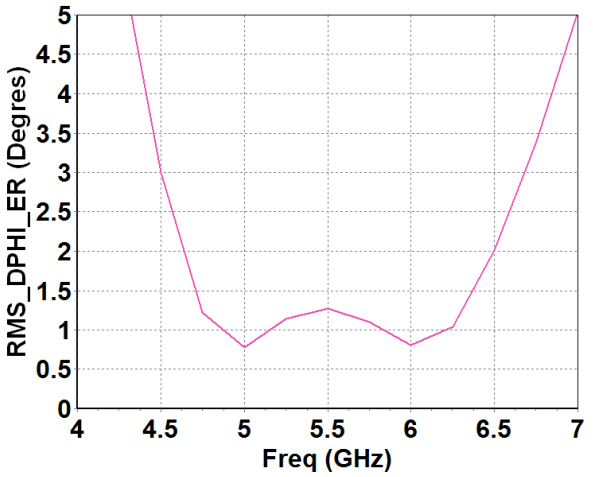
Peak phase error (deg) versus frequency
All Phase States, one chip



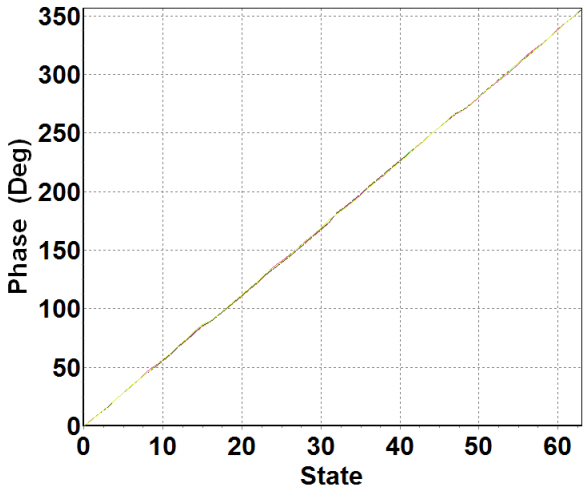
Peak phase error (deg) versus Phase State
Frequency = [5 – 6GHz], one chip



RMS Phase error



Peak phase (deg) versus Phase state
Frequency = [5 – 6GHz], one chip



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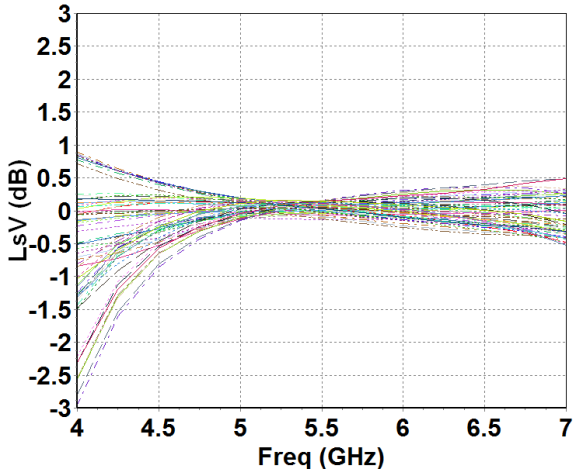
Typical on-wafer results

Phase shifter performances: Insertion loss variation

Tamb.= +25°C; V+=+5V; V-= -5V

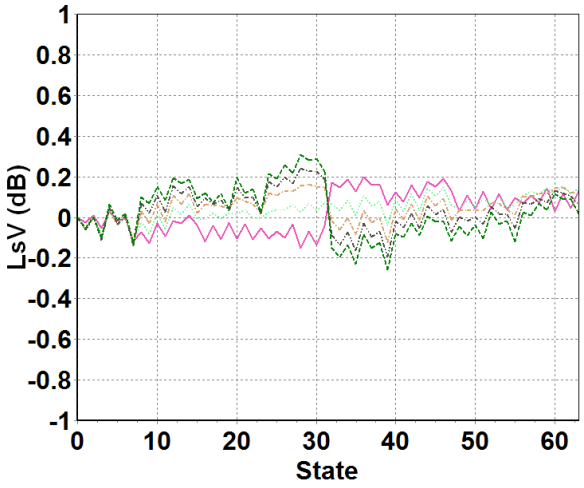
Insertion loss variation (dB) versus frequency

All Phase States, one chip



Insertion loss variation (dB) versus Phase State

Frequency = [5 - 6GHz], one chip



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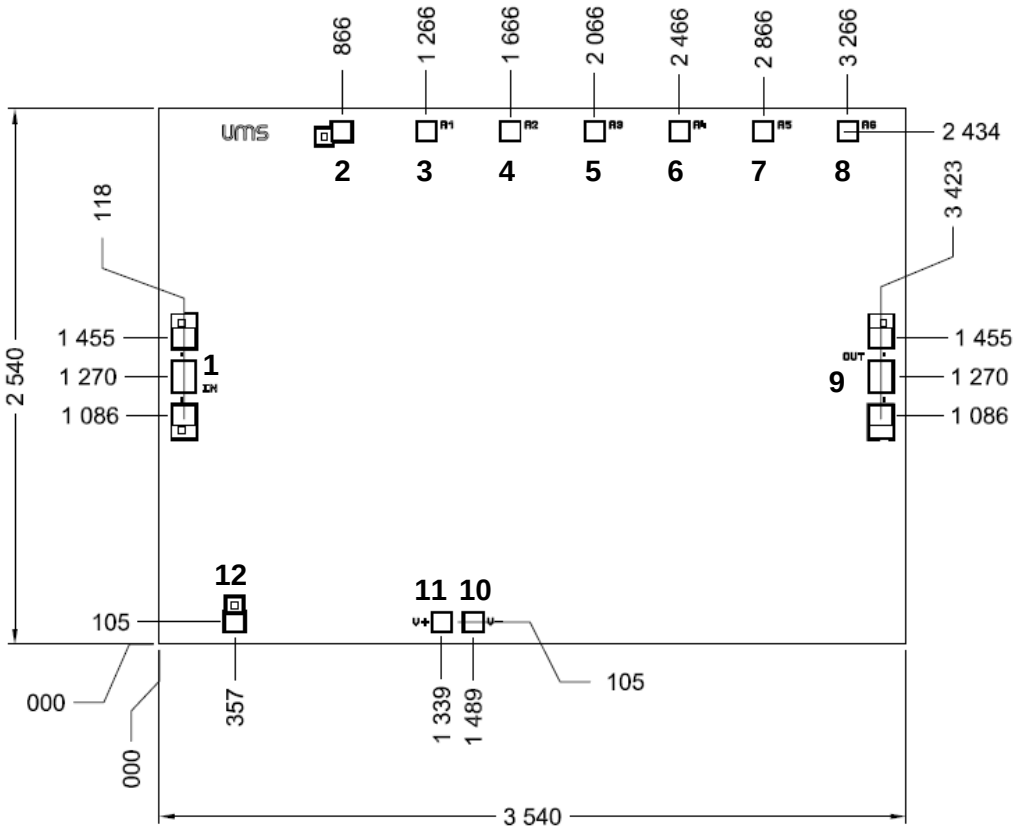
Mechanical dimensions and pads allocation



Unit: µm; tolerance: +/- 35µm

Chip thickness = 100µm +/- 10µm
RF pads (1, 9) = 122 x 160µm²
DC and control pads (2, 3, 4, 5, 6, 7, 8, 10, 11, 12) = 100 x 100µm²

Pin number	Pad name	Description
1	IN	Input RF:
3	A1	Shifter bit 1
4	A2	Shifter bit 2
5	A3	Shifter bit 3
6	A4	Shifter bit 4
7	A5	Shifter r bit 5
8	A6	Shifter tor bit 6
9	OUT	Output RF
10	V-	-5V supply voltage: interface
11	V+	+5V supply voltage: interface
2, 12	GND	NC

RF_in and RF_out are AC coupled (serie capacitances inside the circuit).

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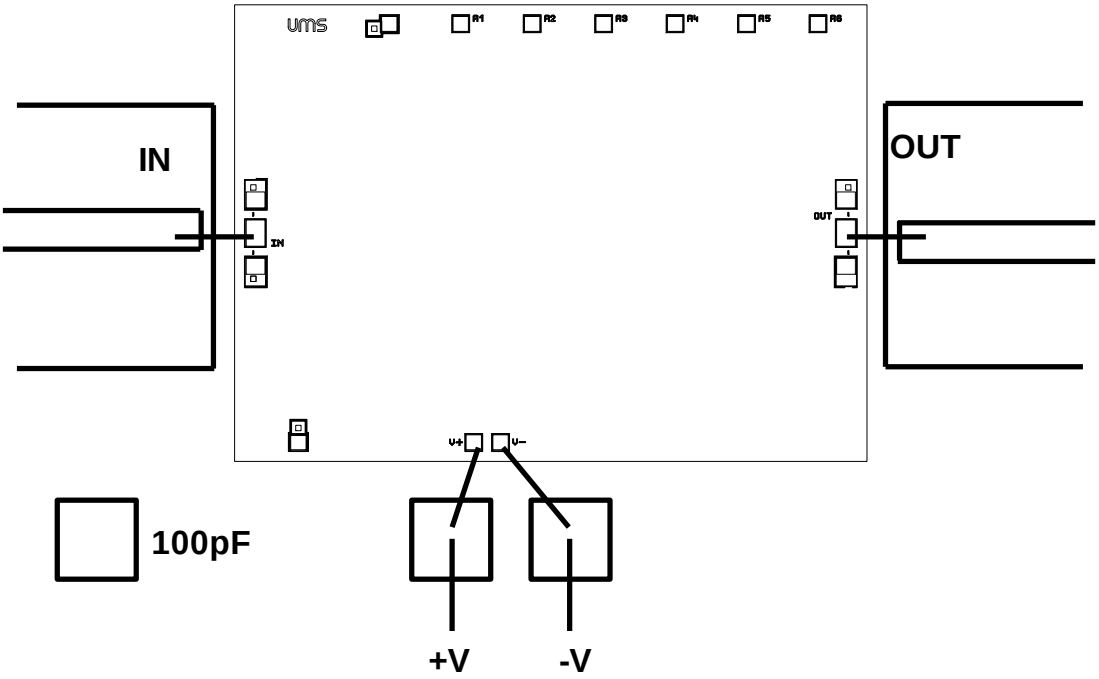
Bonding recommendations

Port	Connection
IN (1) OUT (9)	Inductance (Lbonding) = 0.3nH one wire: diameter 25µm, length 0.4mm
DC and Interface pads	Inductance (Lbonding) = 0.8nH one wire: diameter 25µm, length 1.0mm

Recommended assembly diagram



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Phase Shifter Control Interface

The 6-bit phase shifter is controlled by 6 control pads (A1 to A6). Reference state is “0”. State is “0” when 0V is applied, state is “1” when +3.3V is applied.

State	A1	A2	A3	A4	A5	A6	Phase (deg)
0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	5,625
2	0	1	0	0	0	0	11,25
3	1	1	0	0	0	0	16,875
4	0	0	1	0	0	0	22,5
5	1	0	1	0	0	0	28,125
6	0	1	1	0	0	0	33,75
7	1	1	1	0	0	0	39,375
8	0	0	0	1	0	0	45
9	1	0	0	1	0	0	50,625
10	0	1	0	1	0	0	56,25
11	1	1	0	1	0	0	61,875
12	0	0	1	1	0	0	67,5
13	1	0	1	1	0	0	73,125
14	0	1	1	1	0	0	78,75
15	1	1	1	1	0	0	84,375
16	0	0	0	0	1	0	90
17	1	0	0	0	1	0	95,625
18	0	1	0	0	1	0	101,25
19	1	1	0	0	1	0	106,875
20	0	0	1	0	1	0	112,5
21	1	0	1	0	1	0	118,125
22	0	1	1	0	1	0	123,75
23	1	1	1	0	1	0	129,375
24	0	0	0	1	1	0	135
25	1	0	0	1	1	0	140,625
26	0	1	0	1	1	0	146,25
27	1	1	0	1	1	0	151,875
28	0	0	1	1	1	0	157,5
29	1	0	1	1	1	0	163,125
30	0	1	1	1	1	0	168,75
31	1	1	1	1	1	0	174,375
32	0	0	0	0	0	1	180
33	1	0	0	0	0	1	185,625
34	0	1	0	0	0	1	191,25
35	1	1	0	0	0	1	196,875
36	0	0	1	0	0	1	202,5
37	1	0	1	0	0	1	208,125
38	0	1	1	0	0	1	213,75
39	1	1	1	0	0	1	219,375
40	0	0	0	1	0	1	225
41	1	0	0	1	0	1	230,625
42	0	1	0	1	0	1	236,25
43	1	1	0	1	0	1	241,875
44	0	0	1	1	0	1	247,5
45	1	0	1	1	0	1	253,125
46	0	1	1	1	0	1	258,75
47	1	1	1	1	0	1	264,375
48	0	0	0	0	1	1	270
49	1	0	0	0	1	1	275,625
50	0	1	0	0	1	1	281,25
51	1	1	0	0	1	1	286,875
52	0	0	1	0	1	1	292,5
53	1	0	1	0	1	1	298,125
54	0	1	1	0	1	1	303,75
55	1	1	1	0	1	1	309,375
56	0	0	0	1	1	1	315
57	1	0	0	1	1	1	320,625
58	0	1	0	1	1	1	326,25
59	1	1	0	1	1	1	331,875
60	0	0	1	1	1	1	337,5
61	1	0	1	1	1	1	343,125
62	0	1	1	1	1	1	348,75
63	1	1	1	1	1	1	354,375

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

Ordering Information

Chip form:	CHP4014-98F/00

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