RF Power Amplifier IC For 2.5 GHz ISM

MAAPSS0093 V1

Features

- Perfect for 2.4 GHz Cordless DECT (WDECT)
- Single Positive Voltage Operation
- Power Added Efficiency As High As 55%
- IP_3: +43 dBm
- Output Power: 26.5 dBm @ 3.3 V
  28.5 dBm @ 5.0 V
- 100% Duty Cycle
- 2200 to 2600 MHz Operation
- Lead-Free MSOP-8EP Package
- 100% Matte Tin Plating over Copper
- Halogen-Free "Green" Mold Compound
- 260°C Reflow Compatible
- RoHS* Compliant Version of MA02303GJ

Description

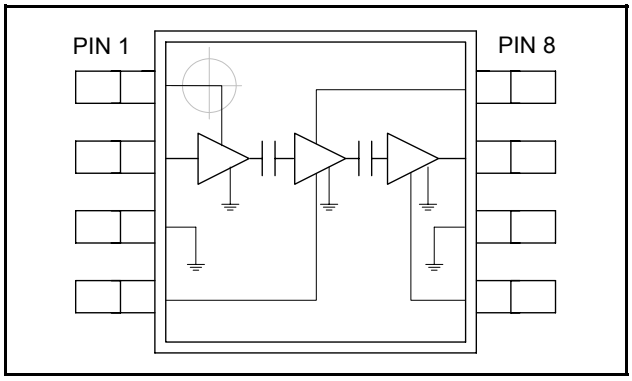
The MAAPSS0093 is an RF power amplifier based on M/A-COM's Self-Aligned MSAG® MESFET Process. This product is designed for use in 2.4 GHz ISM products. For booster applications, it features a low power "bypass" mode and output power control via V_{DD1}.

Ordering Information

Part Number	Description
MAAPSS0093	Bulk Packaging
MAAPSS0093TR-3000	3000 piece reel
MAAPSS0093SMB	Sample Test Board

Note: Reference Application Note M513 for reel size information.

Functional Schematic



PIN Configuration [1]

PIN	Function	Description
1	V_D1	Drain voltage, first stage
2	RF_{IN} / V_G1	RF input and drain voltage for first stage
3	GND	Ground
4	V_G2	Gate bias voltage, second stage
5	V_G3	Gate bias voltage, third stage
6	GND	Ground
7	RF_{OUT} / V_D3	RF output and drain voltage for third stage
8	V_D2	Drain voltage for second stage

1. The exposed pad centered on the package bottom must be connected to electrical (RF and DC) and thermal ground.

Absolute Maximum Ratings [2,3]

Rating	Symbol	Value
DC Supply Voltage	V_{DD}	5.5 V
RF Input Power	P_{IN}	10 mW
Junction Temperature	T_J	150°C
Storage Temperature Range	T_{STG}	-40°C to +150°C
Operating Temperature Range	T_{OPER}	-40°C to +100°C
Moisture Sensitivity		JEDEC Level 1

2. Exceeding any one or combination of these limits may cause permanent damage to this device.
3. M/A-COM does not recommend sustained operation near these survivability limits.

* Restrictions on Hazardous Substances, European Union Directive 2002/95/EC.

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Electrical Specifications: V_{DD} = +3.3 V, P_{IN} = -2 dBm, Duty Cycle = 100 %, T_S = 37 °C[4]

Measured on evaluation board shown on page 5.

Characteristic	Symbol	Unit	Min.	Typ.	Max.
Output Power, f = 2450 MHz	P_{OUT}	dBm	25.3	26.5	—
Power Added Efficiency, f = 2450 MHz	η	%	43	51	—
Current, f = 2450 MHz	I_{DD}	mA	—	265	415
Current for linear operation, f = 2450 MHz	I_{DD}	mA	—	265	—
Gain, f = 2450 MHz, linear operation	G	dB	—	29.5	—
Harmonics, f = 2450 MHz	$2f$, $3f$, $4f$	dBc	—	-40	-30
Input VSWR, f = 2450 MHz	—	Ratio	—	—	2.0:1
Off Isolation (V_{DD}=0 V)	—	dB	—	40	—
Noise Figure, f = 2450 MHz	—	dB	—	3.6	—
Thermal Resistance, junction to package bottom	R_{TH}	°C/W	—	25	—
Third Order Intercept Point (f_1=2450 MHz, f_2 = 2451 MHz, P_{IN} = -20 dBm/tone)	IP_3	dBm	—	43	—
Load Mismatch (V_{DD} = 5.5 V, VSWR = 8:1, P_{IN} = 0 dBm)	—		No Degradation in Power Output		
Stability (P_{IN} = -2 to 2 dBm, V_{DD} = 0 to +5.5 V, Load VSWR = 5:1, all phases)	—		All non-harmonically related outputs more than 60 dB below desired signal		

4. T_S is the temperature measured at the soldering point of the downset paddle on the bottom of the package.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

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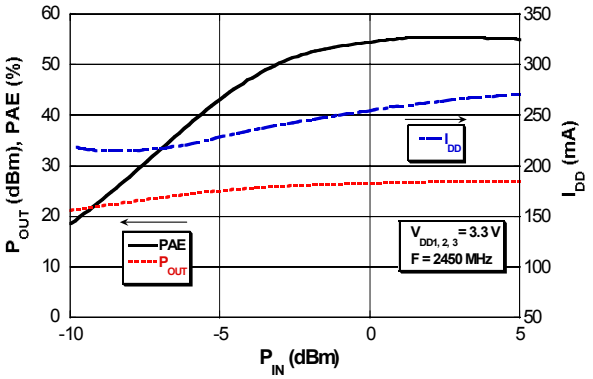
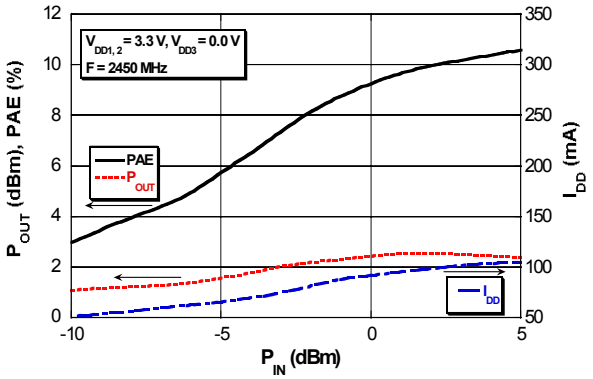
Typical Characteristics

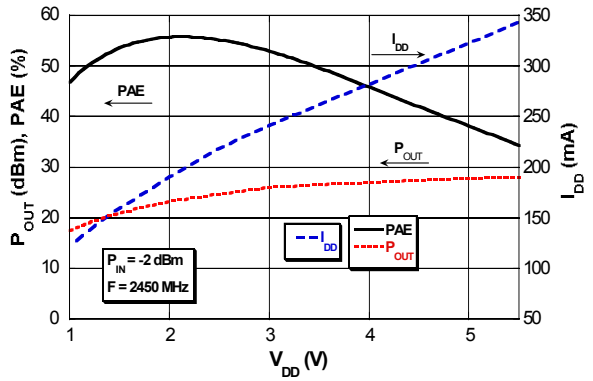
Output Power, Drain Current and Efficiency vs. Input Power



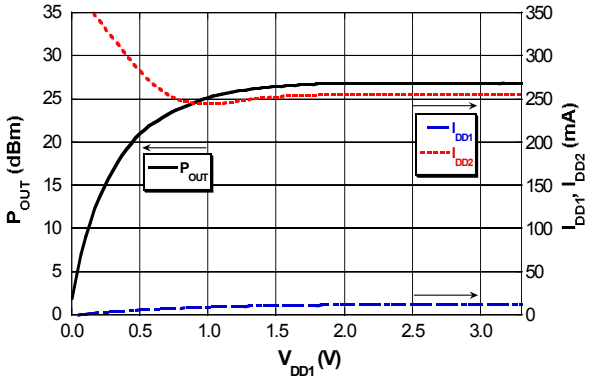
Output Power, Drain Current and Efficiency vs. Input Power for Low Current "Bypass" Mode ($V_{DD1,2}$ = 3.3 V, V_{DD3} = 0.0 V)



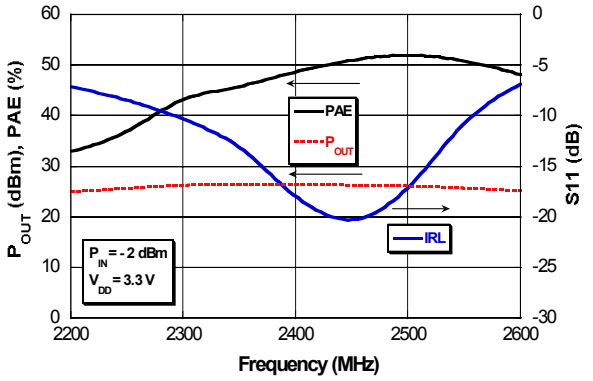
Output Power, Drain Current and Efficiency vs. Voltage



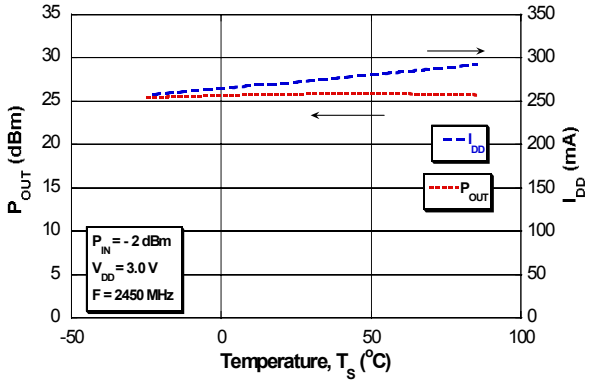
Output Power and Drain Current vs. V_{DD1} for Power Control



Output Power, Input Return Loss and Efficiency vs. Frequency



Output Power and Drain Current at V_{DD} = +3.0 V vs. Temperature



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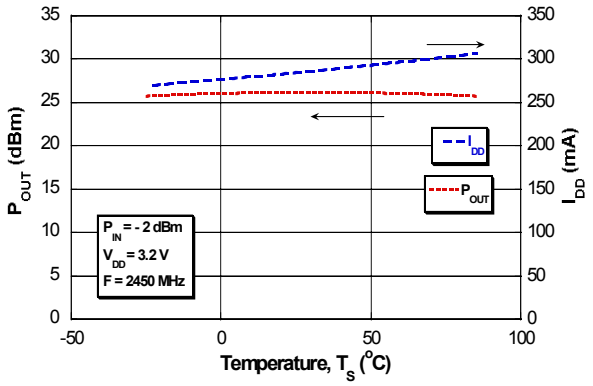
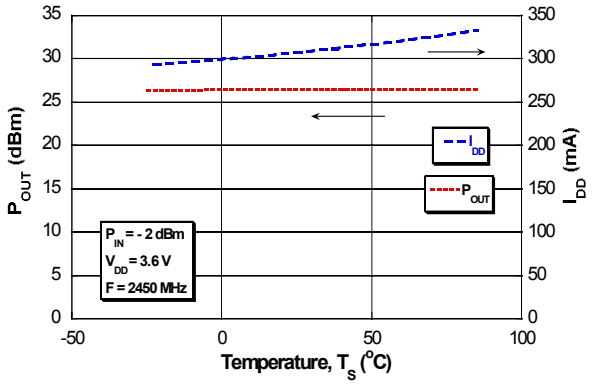
Typical Characteristics

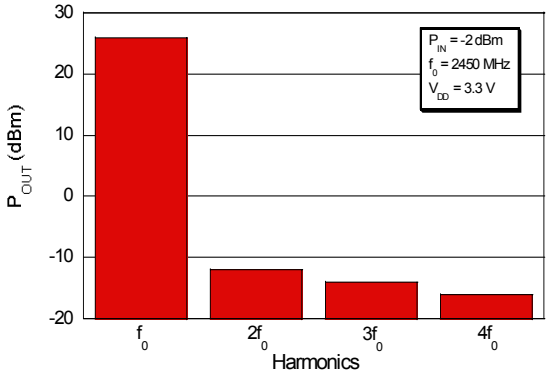
Output Power and Drain Current at V_{DD} = +3.2 V vs. Temperature



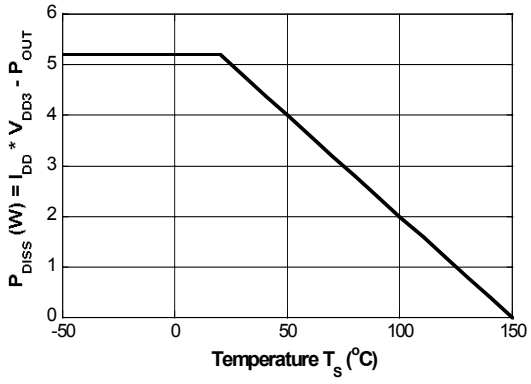
Output Power and Drain Current at V_{DD} = +3.6V vs. Temperature



Harmonics



Maximum Operating Temperature (Ts) to Maintain <150 °C Junction Temperature.



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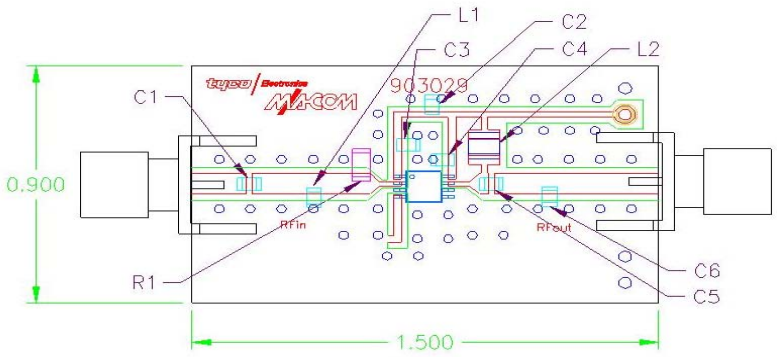
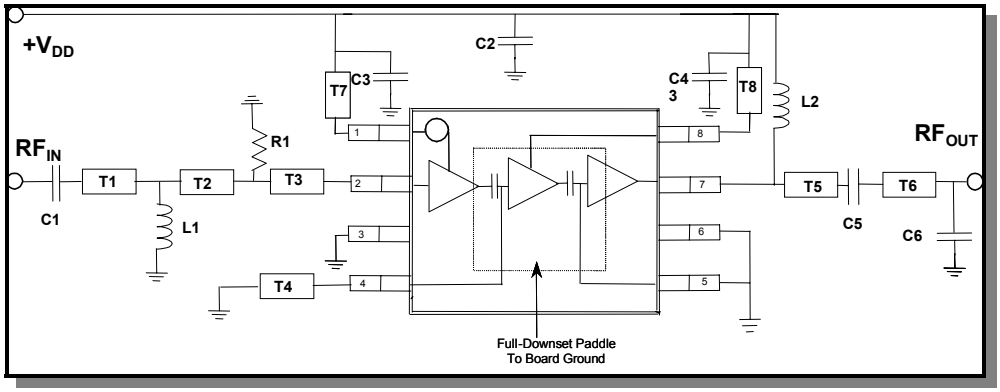
Evaluation Board



Component layout and printed circuit drawing for evaluation board (60 mil board).

Application Information



Evaluation Board Schematic

List of Components

Discrete Components	Transmission Line Lengths*
C1 – C4 = 100 pF multilayer ceramic chip capacitor (Dielectric Labs C11AH101K5TXL)	T1 = 0.15" T2 = 0.21" T3 = 0.11" (Not very critical) T4 = 0.16" T5 = 0.13" T6 = 0.16" T7 = 0.13" (Not very critical) T8 = 0.077" (Not very critical) T1, T2, T3, T5, T6 are 0.077" wide T4, T7, and T8 are 0.026" wide
C5 = 2.0 pF multilayer ceramic chip capacitor (Dielectric Labs C11AH2R0BTXL)	
C6 = 1.2 pF multilayer ceramic chip capacitor (Dielectric Labs C11AH1R2B5TXL)	
R1 = 300 Ω chip resistor (P300ECT-ND)	
L1 = 1.8 nH chip inductor (Toko TKS235CT-ND)	
L2 = 27 nH chip inductor (Coilcraft 1008CS-270XKBB)	

*The board material is 0.060" FR-4 (distance is between RF and GND) with a dielectric constant of about 4.3 (standard FR-4).

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Designing with the MAAPSS0093

The MAAPSS0093 is built using a near-enhancement mode FET that operates from a single supply voltage. A negative voltage is not required because the FET is designed to operate with a +0V DC gate bias.

There is no impedance matching or RF choking on this IC – these functions are supplied externally. This approach offers the highest level of performance, the lowest bill of materials cost, and far fewer components than a discrete design.

To duplicate MAAPSS0093 data sheet performance, your circuit board must recreate the same impedances developed on this evaluation board. The table below has one-port s-parameter measurements looking into the traces on the evaluation board. S-parameters of the MAAPSS0093 are not supplied because the device is designed to operate under large-signal conditions.

Frequency	V_{DD1} Pin 1		RF_{IN}/V_{GG1} Pin 2		V_{GG2} Pin 4		RF_{OUT}/V_{DD3} Pin 7		V_{DD2} Pin 8	
GHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
0.2	0.98890	168.89	0.98437	158.43	0.98990	157.75	0.96758	88.92	0.98740	170.03
0.3	0.88449	130.14	0.97810	148.00	0.98811	147.07	0.93440	52.01	0.87259	126.11
0.4	0.96296	162.21	0.96932	138.02	0.98733	136.83	0.89791	28.02	0.95647	168.46
0.5	0.98166	159.36	0.96033	128.52	0.98729	126.92	0.85525	8.85	0.97951	165.71
0.6	0.98669	150.11	0.95221	119.37	0.98779	117.53	0.80306	-8.42	0.98325	157.06
0.7	0.98659	142.94	0.94257	110.68	0.98796	108.67	0.75165	-23.19	0.98331	150.64
0.8	0.98701	136.46	0.93372	102.50	0.98912	100.34	0.70235	-36.51	0.98362	144.92
0.9	0.98696	130.40	0.92399	94.78	0.98928	92.48	0.65785	-49.03	0.98291	139.57
1.0	0.98757	124.64	0.91521	87.48	0.99004	85.10	0.61674	-61.22	0.98248	134.49
1.1	0.98793	119.13	0.90655	80.60	0.99099	78.16	0.58189	-73.60	0.98325	129.55
1.2	0.98766	113.79	0.89741	74.13	0.99165	71.67	0.55207	-86.36	0.98254	124.75
1.3	0.98685	108.52	0.88850	68.01	0.99162	65.55	0.52778	-99.76	0.98097	119.95
1.4	0.98253	103.08	0.87922	62.20	0.99228	59.78	0.51054	-113.87	0.97567	114.77
1.5	0.91016	98.26	0.87041	56.61	0.99283	54.27	0.50134	-128.62	0.88506	109.11
1.6	0.97895	96.95	0.85901	51.24	0.99372	49.02	0.50184	-143.72	0.96660	110.93
1.7	0.98693	91.94	0.84867	46.25	0.99362	44.08	0.51099	-159.03	0.97912	105.76
1.8	0.98885	87.51	0.83780	41.39	0.99411	39.33	0.52890	-174.06	0.98174	101.51
1.9	0.98968	83.39	0.82602	36.67	0.99457	34.73	0.55378	171.57	0.98247	97.56
2.0	0.99001	79.46	0.81268	32.09	0.99405	30.31	0.58373	158.06	0.98252	93.75
2.1	0.98939	75.68	0.79856	27.65	0.99409	26.02	0.61689	145.85	0.96646	89.86
2.2	0.99079	72.12	0.78264	23.35	0.99430	21.85	0.65283	133.76	0.98349	87.18
2.3	0.99100	68.61	0.76563	19.11	0.99427	17.75	0.68573	123.12	0.98395	83.71
2.4	0.99134	65.25	0.74652	14.96	0.99425	13.76	0.71788	113.31	0.98474	80.41
2.5	0.99146	61.98	0.72506	10.91	0.99399	9.82	0.74798	104.32	0.98447	77.23
2.6	0.99178	58.73	0.70186	6.91	0.99400	5.85	0.77528	95.95	0.98507	74.04
2.7	0.99134	55.49	0.67587	2.97	0.99331	1.90	0.79976	88.27	0.98381	70.83
2.8	0.98781	52.20	0.64683	-0.91	0.99282	-2.00	0.82079	81.13	0.98006	67.52
2.9	0.96980	48.90	0.61470	-4.81	0.99214	-5.98	0.83832	74.49	0.96403	63.91
3.0	0.95172	48.55	0.57400	-8.86	0.99108	-9.98	0.85400	68.30	0.90400	62.55
3.1	0.98242	46.16	0.52740	-11.19	0.98954	-13.99	0.86663	62.57	0.95087	63.65
3.2	0.99063	43.08	0.48956	-13.34	0.98827	-18.12	0.87801	57.07	0.97696	60.24
3.3	0.99392	40.27	0.44620	-15.29	0.98684	-22.42	0.88698	51.92	0.98397	57.19
3.4	0.99353	37.51	0.40182	-16.23	0.98579	-26.81	0.89353	46.93	0.98539	54.35
3.5	0.99183	34.87	0.35797	-15.65	0.98338	-31.29	0.89823	42.18	0.98374	51.69
3.6	0.98528	32.36	0.31683	-13.12	0.98114	-36.02	0.90042	37.52	0.97595	49.24

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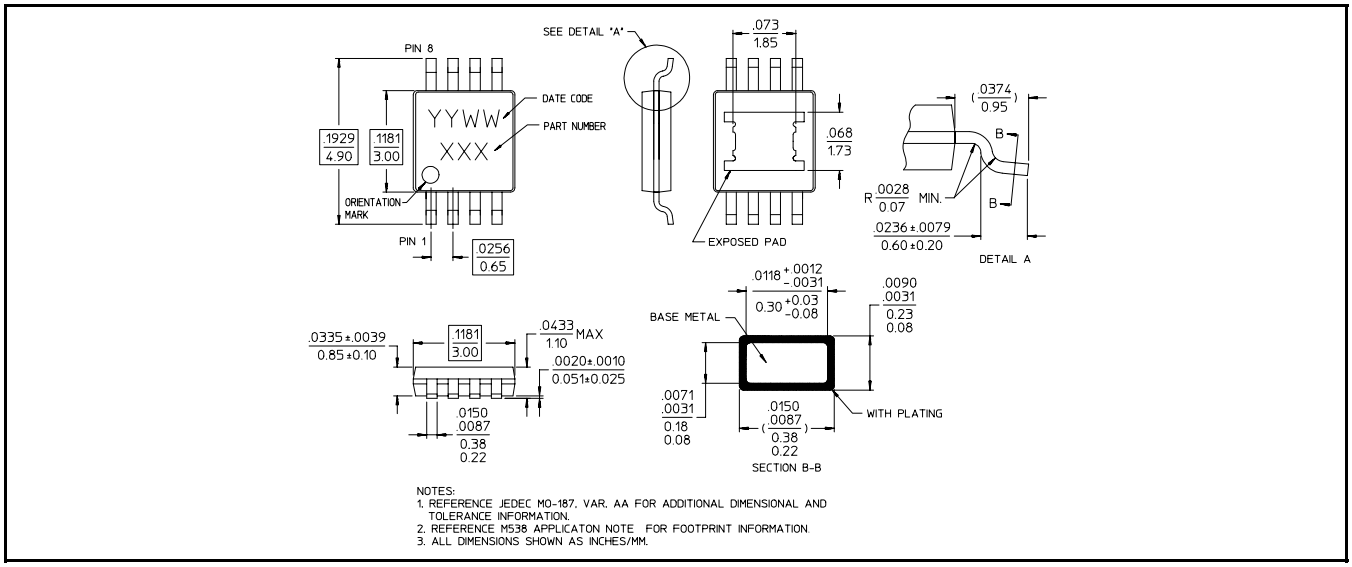
GHz	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
3.7	0.98115	30.74	0.28368	-7.89	0.97774	-40.95	0.89832	32.95	0.97468	47.68
3.8	0.99055	28.59	0.26456	-0.17	0.97527	-46.15	0.88711	28.34	0.98255	45.41
3.9	0.99468	26.15	0.26206	8.43	0.97149	-51.66	0.85217	23.98	0.98187	42.91
4.0	0.99541	23.85	0.27526	16.18	0.96801	-57.48	0.78439	25.69	0.97076	41.20
4.1	0.99675	21.53	0.30017	21.62	0.96214	-63.64	0.91321	26.53	0.98240	39.66
4.2	0.99695	19.34	0.33169	24.71	0.95817	-70.37	0.95402	19.53	0.98870	37.44
4.3	0.99709	17.08	0.36614	25.86	0.95218	-77.52	0.95927	14.12	0.99033	35.21
4.4	0.99625	14.89	0.40041	25.61	0.94464	-85.24	0.95907	9.50	0.99064	33.12
4.5	0.99600	12.71	0.43430	24.41	0.93766	-93.67	0.95776	5.12	0.99008	31.05
4.6	0.99528	10.53	0.46785	22.33	0.92733	-102.87	0.95648	0.78	0.98931	29.00
4.7	0.99356	8.29	0.49729	18.61	0.90989	-112.87	0.95538	-3.70	0.98729	26.91
4.8	0.98985	6.02	0.50830	15.70	0.89316	-122.91	0.95299	-8.40	0.98183	24.79
4.9	0.98183	3.77	0.53008	12.03	0.87835	-135.47	0.94875	-13.35	0.96994	22.79
5.0	0.96606	1.91	0.51899	5.22	0.76901	-147.15	0.94290	-18.71	0.94954	21.59
5.1	0.95907	1.19	0.48184	8.12	0.80492	-149.68	0.93754	-24.50	0.95096	21.58
5.2	0.97380	-0.08	0.51026	7.72	0.86212	-162.69	0.93242	-31.40	0.96888	20.35
5.3	0.98447	-2.18	0.52064	4.75	0.87712	-176.53	0.92307	-39.86	0.97525	18.47
5.4	0.98993	-4.47	0.51978	2.19	0.88096	170.41	0.90396	-50.55	0.98503	17.01
5.5	0.99206	-6.71	0.51313	-0.14	0.88478	157.90	0.86790	-64.94	0.99094	14.98
5.6	0.99234	-8.95	0.50465	-2.02	0.89099	145.89	0.79942	-85.01	0.99192	13.15
5.7	0.99149	-11.15	0.49217	-3.82	0.89655	134.39	0.69417	-115.75	0.99221	11.35
5.8	0.98990	-13.42	0.47394	-5.03	0.90165	123.67	0.55561	-163.96	0.99216	9.58
5.9	0.98628	-15.52	0.45693	-5.12	0.90854	113.69	0.51158	134.06	0.99070	7.95
6.0	0.98532	-17.49	0.44346	-4.72	0.91522	104.42	0.59033	85.74	0.98983	6.41

Lead-Free MSOP-8EP†



† Reference Application Note M538 for lead-free solder reflow recommendations.

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