Freescale Semiconductor
Technical Data

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RoHS

RF Power LDMOS Transistor

N-Channel Enhancement-Mode Lateral MOSFET

This 45 W asymmetrical Doherty RF power LDMOS transistor is designed for cellular base station applications covering the frequency range of 2300 to 2400 MHz.

2300 MHz

- Typical Doherty Single-Carrier W-CDMA Performance: V_{DD} = 28 Vdc, I_{DQA} = 500 mA, V_{GSB} = 0.8 Vdc, P_{out} = 45 W Avg., Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

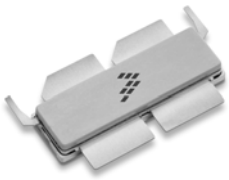
Frequency	G_{ps} (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)
2300 MHz	15.6	46.2	8.1	–28.9
2350 MHz	15.9	46.5	8.1	–30.4
2400 MHz	16.1	45.3	8.0	–33.9

Features

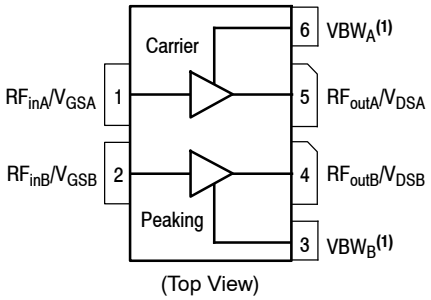
- Advanced High Performance In-Package Doherty
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Designed for Digital Predistortion Error Correction Systems

AFT23H201-24SR6

2300–2400 MHz, 45 W AVG., 28 V AIRFAST RF POWER LDMOS TRANSISTOR



ACP-1230S-4L2L



(Top View)

Figure 1. Pin Connections

1. Device cannot operate with V_{DD} current supplied through pin 3 and pin 6.

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	–0.5, +65	Vdc
Gate-Source Voltage	V_{GS}	–6.0, +10	Vdc
Operating Voltage	V_{DD}	32, +0	Vdc
Storage Temperature Range	T_{stg}	–65 to +150	°C
Case Operating Temperature Range	T_C	–40 to +150	°C
Operating Junction Temperature Range (1,2)	T_J	–40 to +225	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 75°C, 45 W Avg., W-CDMA, 28 Vdc, I_{DQA} = 500 mA, V_{GSB} = 0.8 Vdc, 2350 MHz	$R_{\theta JC}$	0.27	°C/W

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	2
Machine Model (per EIA/JESD22-A115)	B
Charge Device Model (per JESD22-C101)	III

Table 4. Electrical Characteristics (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics (4)					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 65 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 32 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics - Side A, Carrier					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 140 μAdc)	$V_{GS(th)}$	0.8	1.2	1.6	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 500 mAdc, Measured in Functional Test)	$V_{GSA(Q)}$	1.4	1.8	2.2	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 1.4 Adc)	$V_{DS(on)}$	0.1	0.14	0.4	Vdc
On Characteristics - Side B, Peaking					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 200 μAdc)	$V_{GS(th)}$	0.8	1.2	1.6	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 2 Adc)	$V_{DS(on)}$	0.1	0.14	0.4	Vdc

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.nxp.com/RF/calculators.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.nxp.com/RF and search for AN1955.
4. Each side of device measured separately.

(continued)

Table 4. Electrical Characteristics (T_A = 25°C unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Functional Tests (1,2) (In Freescale Doherty Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQA} = 500 mA, V_{GSB} = 0.8 Vdc, P_{out} = 45 W Avg., f = 2300 MHz, Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset.					
Power Gain	G_{ps}	14.6	15.6	17.6	dB
Drain Efficiency	η_D	44.0	46.2	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	7.6	8.1	—	dB
Adjacent Channel Power Ratio	ACPR	—	–28.9	–26.5	dBc
Load Mismatch (2) (In Freescale Doherty Test Fixture, 50 ohm system) I_{DQA} = 500 mA, V_{GSB} = 0.8 Vdc, f = 2350 MHz, 12 μsec(on), 10% Duty Cycle					
VSWR 10:1 at 32 Vdc, 350 W Pulsed CW Output Power (3 dB Input Overdrive from 200 W Pulsed CW Rated Power)	No Device Degradation				
Typical Performance (In Freescale Doherty Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQA} = 500 mA, V_{GSB} = 0.8 Vdc, 2300–2400 MHz Bandwidth					
P_{out} @ 1 dB Compression Point, CW	P1dB	—	210	—	W
P_{out} @ 3 dB Compression Point (3)	P3dB	—	290	—	W
AM/PM (Maximum value measured at the P3dB compression point across the 2300–2400 MHz frequency range)	Φ	—	–10.4	—	°
VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)	VBW_{res}	—	110	—	MHz
Gain Flatness in 100 MHz Bandwidth @ P_{out} = 45 W Avg.	G_F	—	0.5	—	dB
Gain Variation over Temperature (–30°C to +85°C)	ΔG	—	0.006	—	dB/°C
Output Power Variation over Temperature (–30°C to +85°C)	ΔP1dB	—	0.003	—	dB/°C

Table 5. Ordering Information

Device	Tape and Reel Information	Package
AFT23H201-24SR6	R6 Suffix = 150 Units, 56 mm Tape Width, 13-inch Reel	ACP-1230S-4L2L

1. Part internally matched both on input and output.
2. Measurements made with device in an asymmetrical Doherty configuration.
3. P3dB = P_{avg} + 7.0 dB where P_{avg} is the average output power measured using an unclipped W-CDMA single-carrier input signal where output PAR is compressed to 7.0 dB @ 0.01% probability on CCDF.

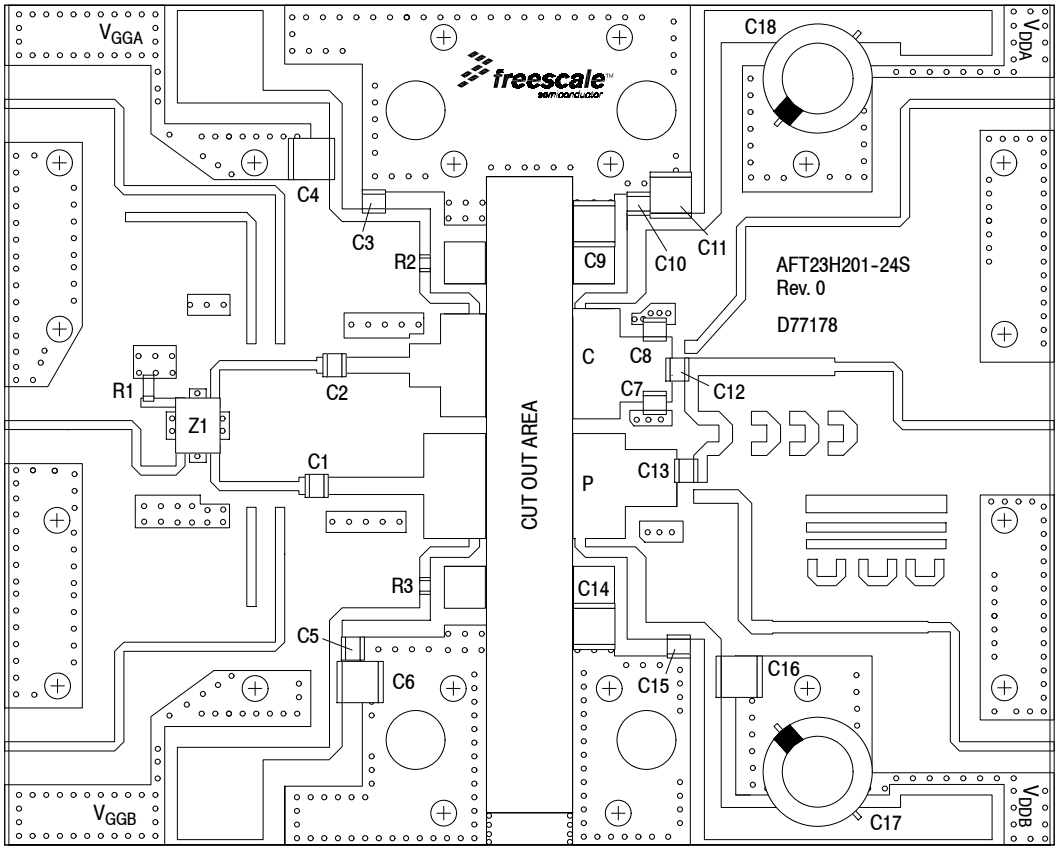


Figure 2. AFT23H201-24SR6 Test Circuit Component Layout

Table 6. AFT23H201-24SR6 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2, C3, C5, C10, C13, C15	6.2 pF Chip Capacitors	ATC100B6R2CT500XT	ATC
C4, C6, C9, C11, C14, C16	10 μF Chip Capacitors	C5750X7S2A106M230KB	TDK
C7, C8	0.3 pF Chip Capacitors	ATC100B0R3CT500XT	ATC
C12	5.1 pF Chip Capacitor	ATC100B5R1CT500XT	ATC
C17, C18	470 μF, 63 V Electrolytic Capacitors	MCGPR63V477M13×26	Multicomp
R1	50 Ω, 4 W Chip Resistor	CW12010T0050GBK	ATC
R2, R3	2.7 Ω, 1/4 W Chip Resistors	CRCW12062R7FKEA	Vishay
Z1	2300–2700 MHz Band, 90°, 2 dB Hybrid Coupler	X3C25P1-02S	Anaren
PCB	Rogers RO4350B, 0.020″, ε_r = 3.66	D77178	MTL

TYPICAL CHARACTERISTICS — 2300–2400 MHz

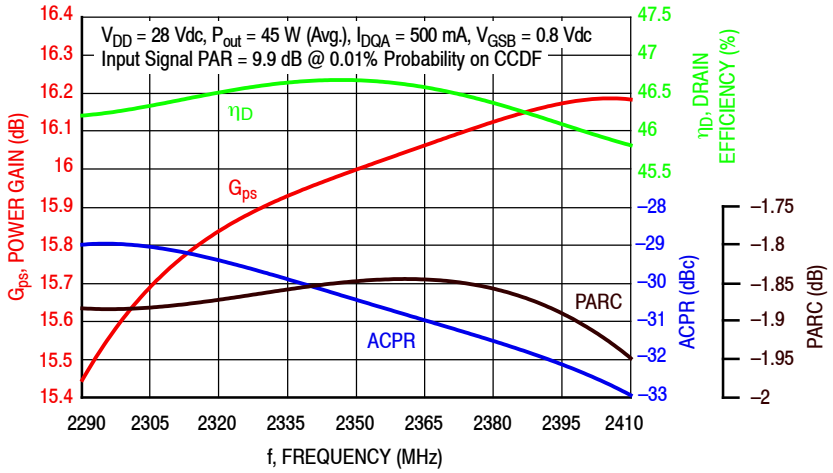


Figure 3. Single-Carrier Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 45 Watts Avg.

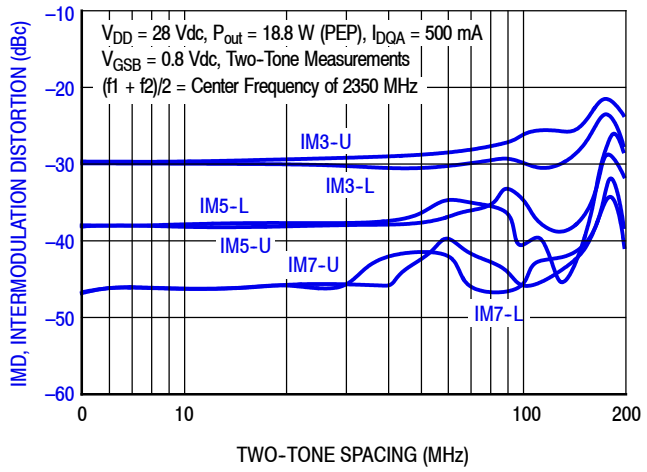


Figure 4. Intermodulation Distortion Products versus Two-Tone Spacing

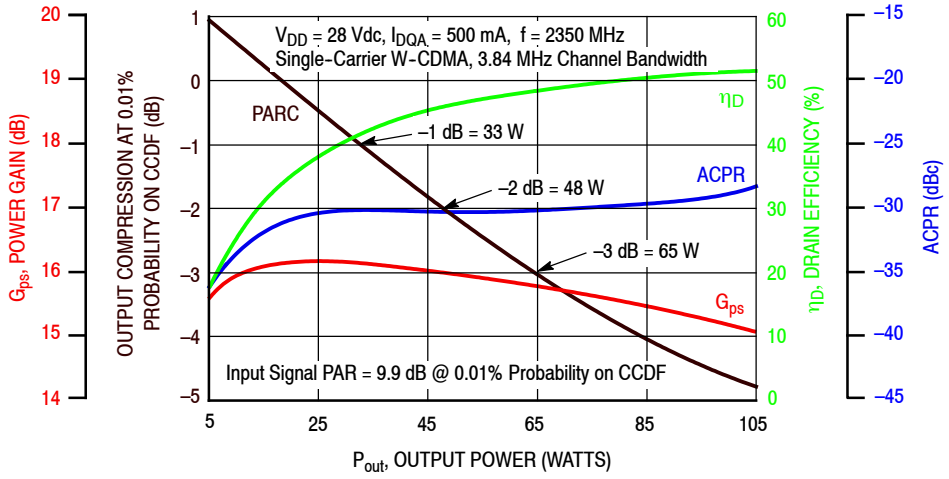


Figure 5. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

TYPICAL CHARACTERISTICS — 2300–2400 MHz

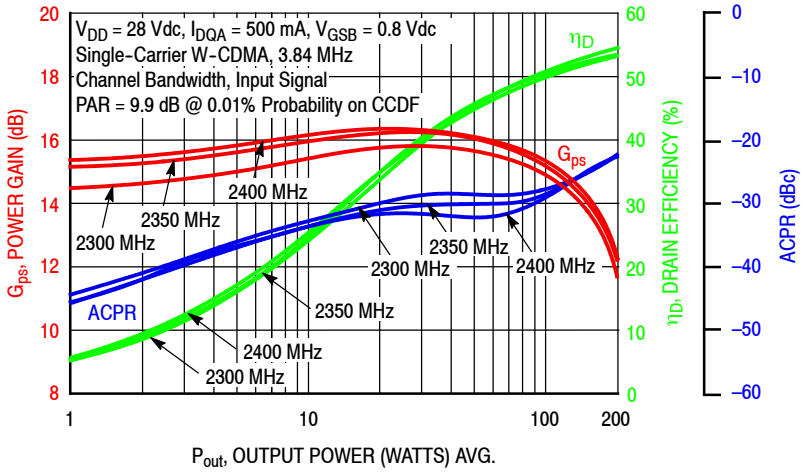


Figure 6. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

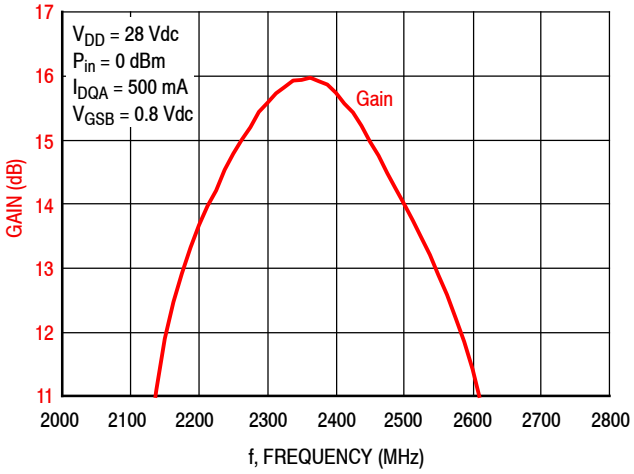


Figure 7. Broadband Frequency Response

Table 7. Carrier Side Load Pull Performance — Maximum Power Tuning

V_{DD} = 28 Vdc, I_{DQA} = 718 mA, Pulsed CW, 10 μsec(on), 10% Duty Cycle

			Max Output Power					
			P1dB					
f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Z_{load} (1) (Ω)	Gain (dB)	(dBm)	(W)	η_D (%)	AM/PM (°)
2300	4.83 – j10.4	3.84 + j8.05	1.86 – j4.07	17.8	51.8	150	56.4	–15
2350	8.01 – j11.5	5.97 + j8.77	1.78 – j3.87	18.2	51.7	149	54.8	–16
2400	12.3 – j11.8	9.31 + j8.15	1.78 – j3.85	18.4	51.7	148	56.1	–17

			Max Output Power					
			P3dB					
f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Z_{load} (2) (Ω)	Gain (dB)	(dBm)	(W)	η_D (%)	AM/PM (°)
2300	4.83 – j10.4	4.06 + j8.72	1.76 – j4.21	15.5	52.5	179	57.0	–20
2350	8.01 – j11.5	6.71 + j9.55	1.69 – j4.15	16.0	52.5	178	55.7	–21
2400	12.3 – j11.8	10.9 + j8.55	1.78 – j4.01	16.2	52.4	176	57.7	–23

(1) Load impedance for optimum P1dB power.

(2) Load impedance for optimum P3dB power.

Z_{source} = Measured impedance presented to the input of the device at the package reference plane.

Z_{in} = Impedance as measured from gate contact to ground.

Z_{load} = Measured impedance presented to the output of the device at the package reference plane.

Table 8. Carrier Side Load Pull Performance — Maximum Efficiency Tuning

V_{DD} = 28 Vdc, I_{DQA} = 718 mA, Pulsed CW, 10 μsec(on), 10% Duty Cycle

			Max Drain Efficiency					
			P1dB					
f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Z_{load} (1) (Ω)	Gain (dB)	(dBm)	(W)	η_D (%)	AM/PM (°)
2300	4.83 – j10.4	3.79 + j8.35	3.84 – j3.13	20.1	50.3	106	64.3	–21
2350	8.01 – j11.5	6.14 + j9.16	3.79 – j2.54	20.8	49.9	99	64.1	–23
2400	12.3 – j11.8	9.61 + j8.46	3.05 – j2.48	20.5	50.2	105	64.4	–23

			Max Drain Efficiency					
			P3dB					
f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Z_{load} (2) (Ω)	Gain (dB)	(dBm)	(W)	η_D (%)	AM/PM (°)
2300	4.83 – j10.4	3.75 + j8.96	3.48 – j2.66	18.0	50.9	123	64.2	–30
2350	8.01 – j11.5	6.48 + j9.90	3.00 – j2.97	18.2	51.3	136	63.8	–29
2400	12.3 – j11.8	10.9 + j8.87	2.97 – j2.67	18.4	51.0	127	64.5	–31

(1) Load impedance for optimum P1dB efficiency.

(2) Load impedance for optimum P3dB efficiency.

Z_{source} = Measured impedance presented to the input of the device at the package reference plane.

Z_{in} = Impedance as measured from gate contact to ground.

Z_{load} = Measured impedance presented to the output of the device at the package reference plane.

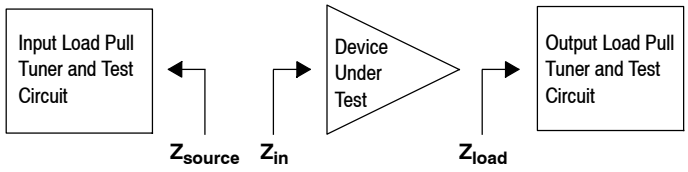


Table 9. Peaking Side Load Pull Performance — Maximum Power Tuning

V_{DD} = 28 Vdc, V_{GSB} = 0.8 Vdc, Pulsed CW, 10 μsec(on), 10% Duty Cycle

			Max Output Power					
			P1dB					
f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Z_{load} (1) (Ω)	Gain (dB)	(dBm)	(W)	η_D (%)	AM/PM (°)
2300	3.97 – j8.26	3.01 + j8.39	1.99 – j4.10	13.9	53.3	216	58.7	–27
2350	5.95 – j8.53	4.90 + j9.38	1.89 – j4.32	13.9	53.3	212	55.5	–27
2400	9.05 – j7.82	8.10 + j9.74	1.94 – j4.34	13.9	53.2	209	57.4	–27

			Max Output Power					
			P3dB					
f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Z_{load} (2) (Ω)	Gain (dB)	(dBm)	(W)	η_D (%)	AM/PM (°)
2300	3.97 – j8.26	3.27 + j8.82	2.03 – j4.40	11.7	54.1	254	59.6	–33
2350	5.95 – j8.53	5.57 + j9.91	1.89 – j4.60	11.7	54.0	250	56.2	–33
2400	9.05 – j7.82	9.53 + j9.92	1.97 – j4.55	11.7	53.9	244	57.5	–33

(1) Load impedance for optimum P1dB power.
(2) Load impedance for optimum P3dB power.
Z_{source} = Measured impedance presented to the input of the device at the package reference plane.
Z_{in} = Impedance as measured from gate contact to ground.
Z_{load} = Measured impedance presented to the output of the device at the package reference plane.

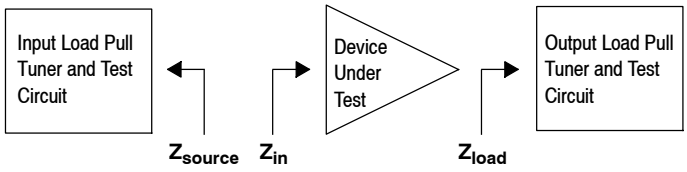
Table 10. Peaking Side Load Pull Performance — Maximum Efficiency Tuning

V_{DD} = 28 Vdc, V_{GSB} = 0.8 Vdc, Pulsed CW, 10 μsec(on), 10% Duty Cycle

			Max Drain Efficiency					
			P1dB					
f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Z_{load} (1) (Ω)	Gain (dB)	(dBm)	(W)	η_D (%)	AM/PM (°)
2300	3.97 – j8.26	2.66 + j8.38	3.63 – j2.47	15.0	51.9	154	68.8	–34
2350	5.95 – j8.53	4.18 + j9.54	3.38 – j1.91	15.4	51.4	139	68.7	–36
2400	9.05 – j7.82	7.22 + j10.3	3.06 – j2.39	15.0	51.6	146	67.5	–34

			Max Drain Efficiency					
			P3dB					
f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Z_{load} (2) (Ω)	Gain (dB)	(dBm)	(W)	η_D (%)	AM/PM (°)
2300	3.97 – j8.26	2.97 + j8.80	3.49 – j2.96	12.9	52.8	189	68.8	–41
2350	5.95 – j8.53	5.00 + j10.0	3.27 – j2.92	13.2	52.7	187	68.4	–41
2400	9.05 – j7.82	8.84 + j10.5	2.88 – j2.86	13.0	52.7	184	67.3	–41

(1) Load impedance for optimum P1dB efficiency.
(2) Load impedance for optimum P3dB efficiency.
Z_{source} = Measured impedance presented to the input of the device at the package reference plane.
Z_{in} = Impedance as measured from gate contact to ground.
Z_{load} = Measured impedance presented to the output of the device at the package reference plane.



P1dB - TYPICAL CARRIER SIDE LOAD PULL CONTOURS — 2350 MHz

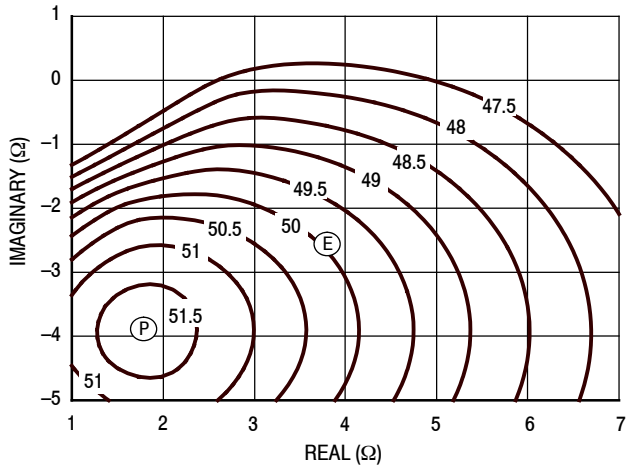


Figure 8. P1dB Load Pull Output Power Contours (dBm)

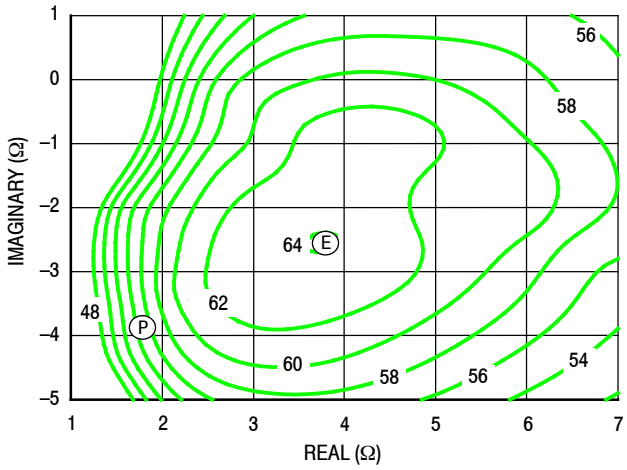


Figure 9. P1dB Load Pull Efficiency Contours (%)

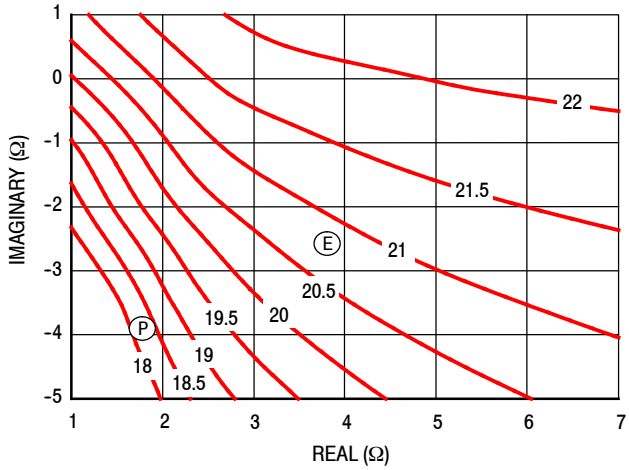


Figure 10. P1dB Load Pull Gain Contours (dB)

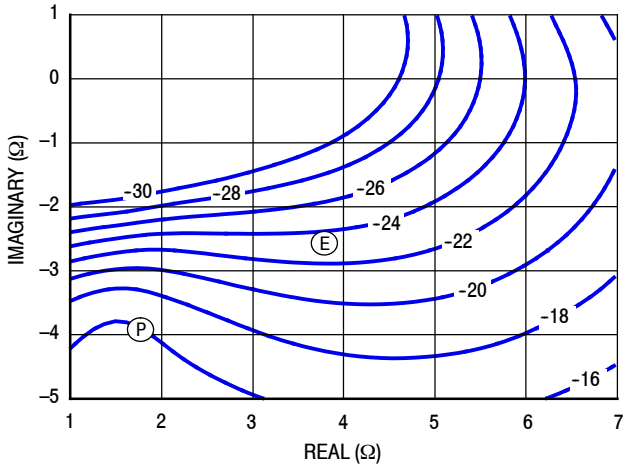


Figure 11. P1dB Load Pull AM/PM Contours (°)

NOTE: Ⓟ = Maximum Output Power

Ⓔ = Maximum Drain Efficiency

Gain

Drain Efficiency

Linearity

Output Power

P3dB - TYPICAL CARRIER SIDE LOAD PULL CONTOURS — 2350 MHz

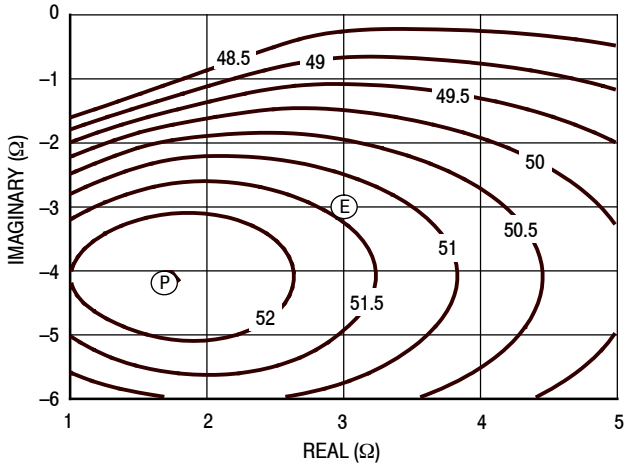


Figure 12. P3dB Load Pull Output Power Contours (dBm)

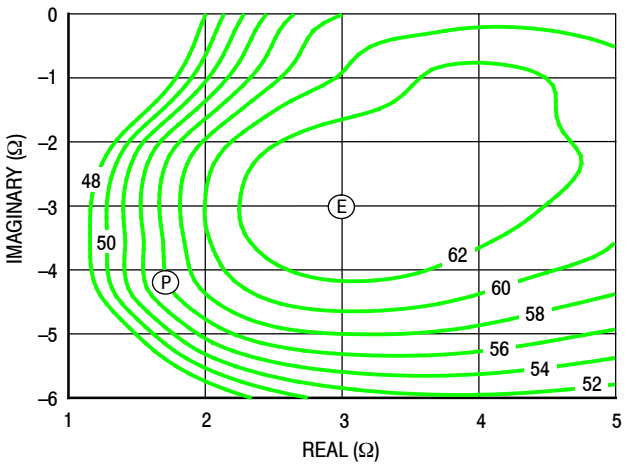


Figure 13. P3dB Load Pull Efficiency Contours (%)

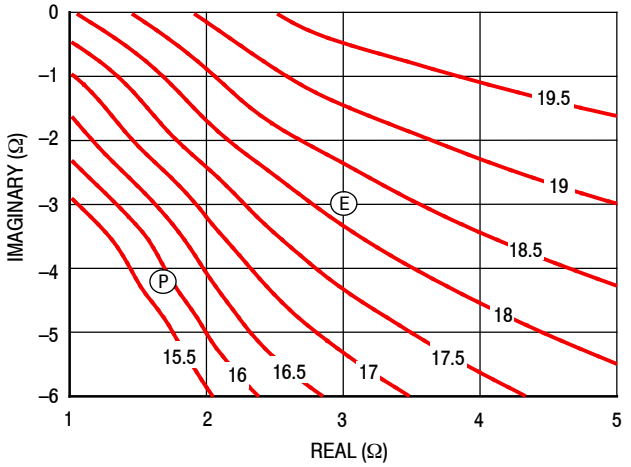


Figure 14. P3dB Load Pull Gain Contours (dB)

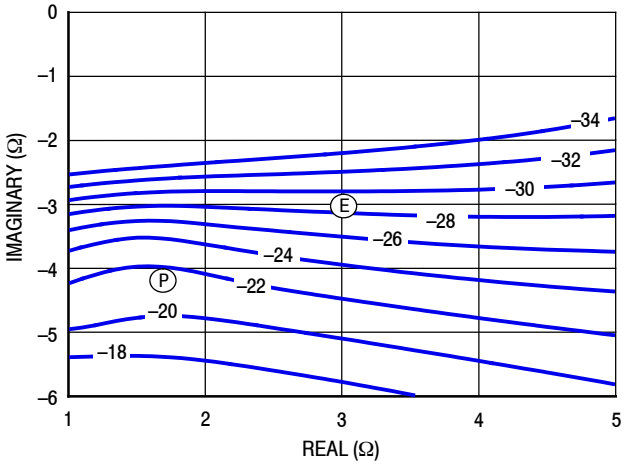


Figure 15. P3dB Load Pull AM/PM Contours (°)

NOTE: Ⓟ = Maximum Output Power

Ⓔ = Maximum Drain Efficiency

Gain

Drain Efficiency

Linearity

Output Power

P1dB - TYPICAL PEAKING SIDE LOAD PULL CONTOURS — 2350 MHz

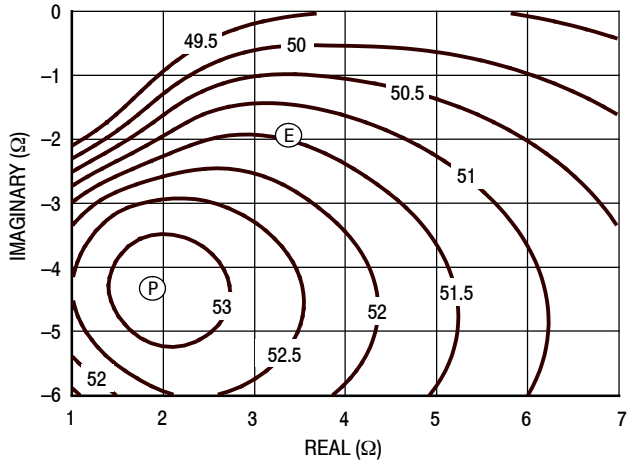


Figure 16. P1dB Load Pull Output Power Contours (dBm)

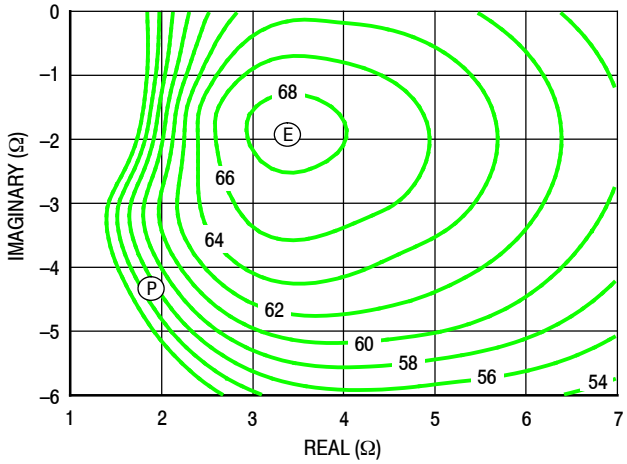


Figure 17. P1dB Load Pull Efficiency Contours (%)

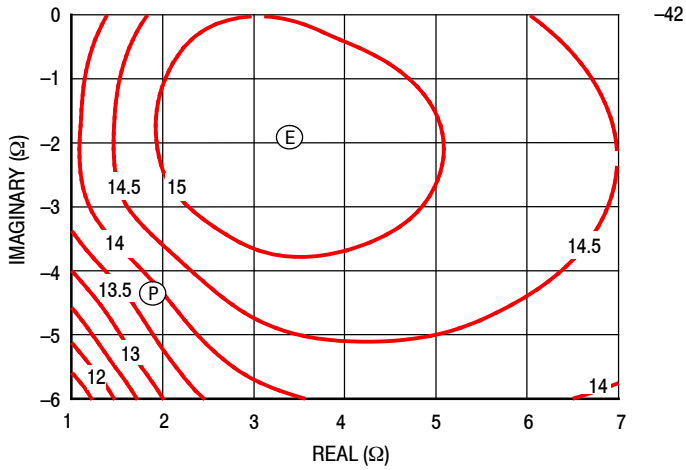


Figure 18. P1dB Load Pull Gain Contours (dB)

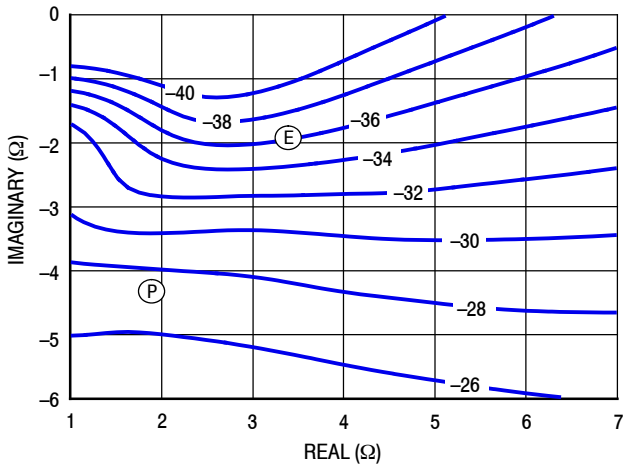


Figure 19. P1dB Load Pull AM/PM Contours (°)

NOTE: Ⓟ = Maximum Output Power

Ⓔ = Maximum Drain Efficiency

Gain

Drain Efficiency

Linearity

Output Power

P3dB - TYPICAL PEAKING SIDE LOAD PULL CONTOURS — 2350 MHz

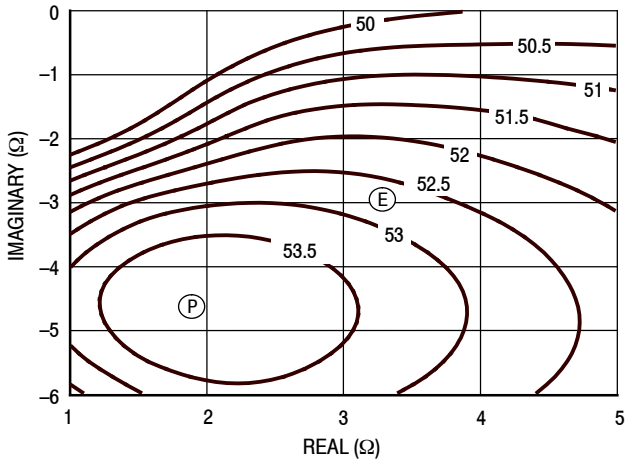


Figure 20. P3dB Load Pull Output Power Contours (dBm)

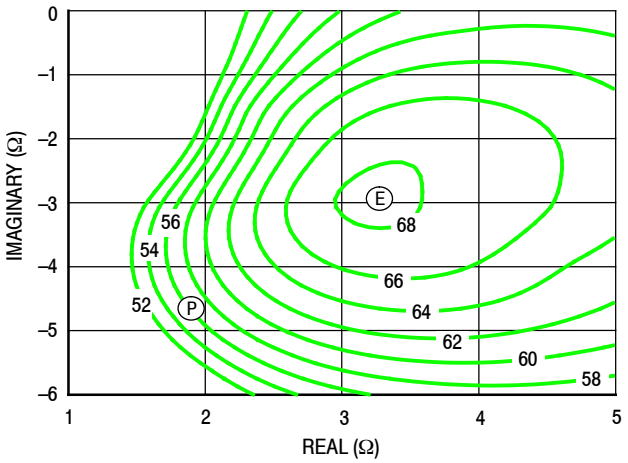


Figure 21. P3dB Load Pull Efficiency Contours (%)

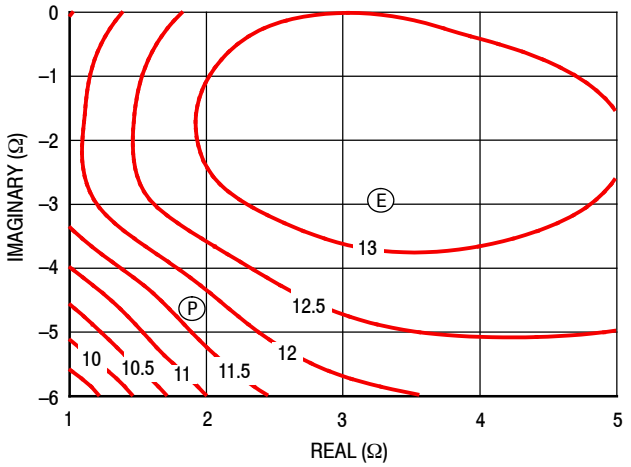


Figure 22. P3dB Load Pull Gain Contours (dB)

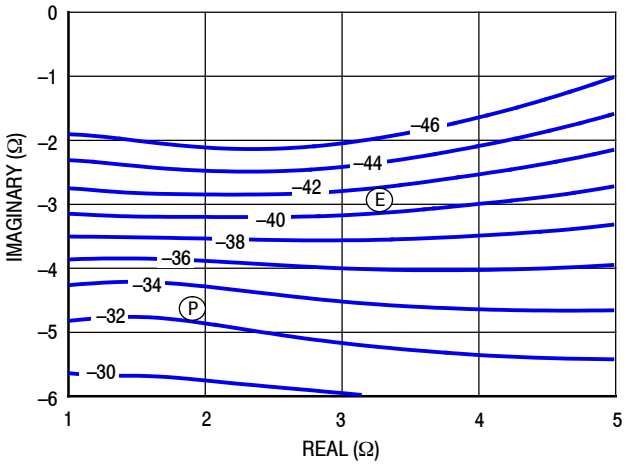


Figure 23. P3dB Load Pull AM/PM Contours (°)

NOTE: Ⓟ = Maximum Output Power

Ⓔ = Maximum Drain Efficiency

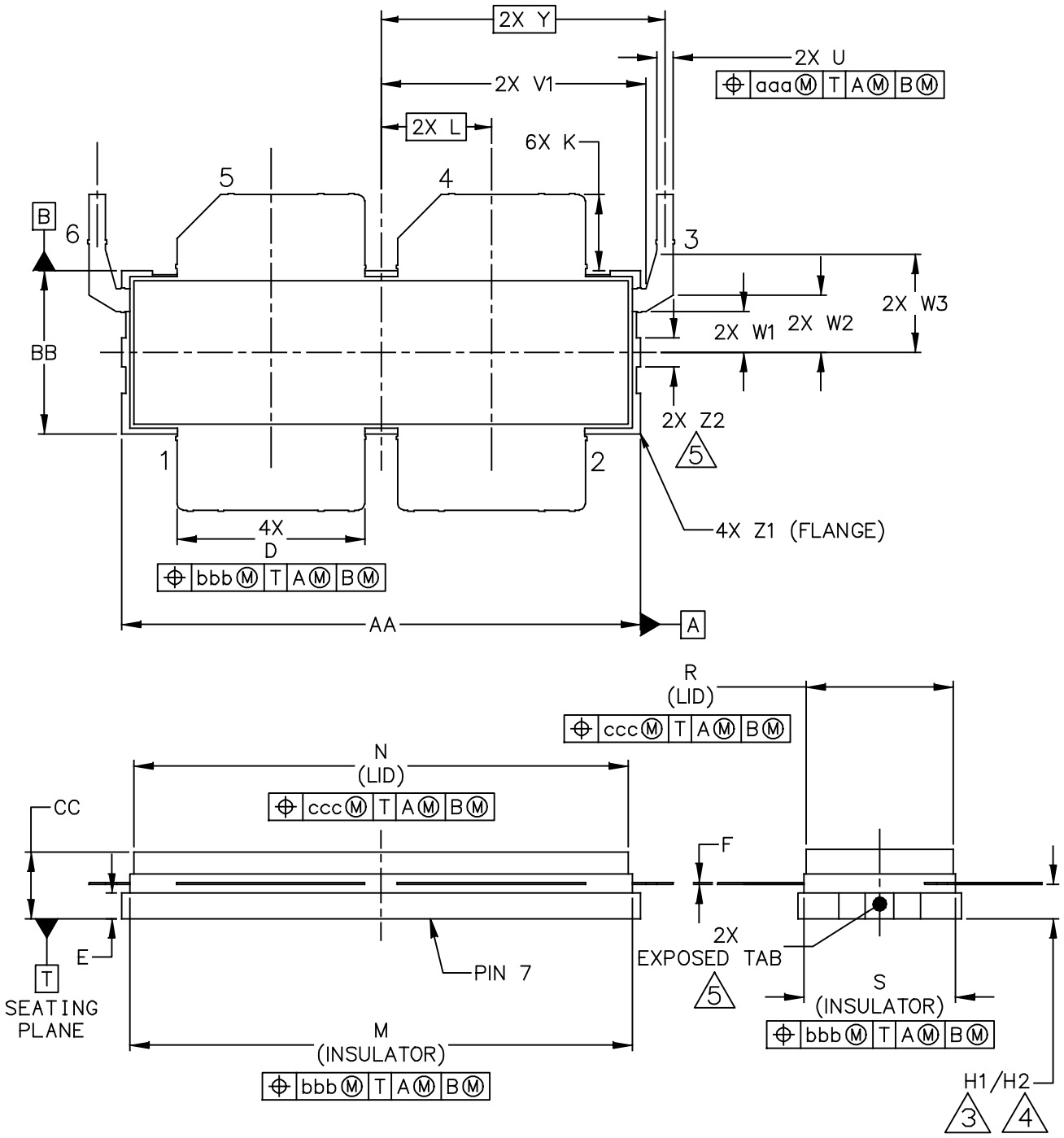
Gain

Drain Efficiency

Linearity

Output Power

PACKAGE DIMENSIONS



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TITLE: ACP-1230S-4L2L	DOCUMENT NO: 98ASA00812D	REV: A
	STANDARD: NON-JEDEC	
	SOT1800-2	18 FEB 2016

NOTES:

1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.

2. CONTROLLING DIMENSION: INCH

3. DIMENSIONS H1 AND H2 ARE MEASURED .030 INCH (0.762 MM) AWAY FROM FLANGE PARALLEL TO DATUM B. H1 APPLIES TO PINS 1, 2, 4 & 5. H2 APPLIES TO PINS 3 & 6.

4. TOLERANCE OF DIMENSION H2 IS TENTATIVE.

5. THESE SURFACES OF THE HEAT SLUG ARE NOT PART OF THE SOLDERABLE SURFACES AND MAY REMAIN UNPLATED.

6. DIMENSIONS "M" AND "S" DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS .012 INCH PER SIDE. DIMENSIONS "M" AND "S" DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE –T–.

7. DIMENSIONS "D", "U" AND "K" DO NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .010 INCH TOTAL IN EXCESS OF THE "D", "U" AND "K" DIMENSION AT MAXIMUM MATERIAL CONDITION.

8. DATUM –A– AND –B– TO BE DETERMINED AT DATUM –T–.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX	DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
AA	1.265	1.275	32.13	32.39	R	.365	.375	9.27	9.53
BB	.395	.405	10.03	10.29	S	.365	.375	9.27	9.53
CC	.160	.190	4.06	4.83	U	.035	.045	0.89	1.14
D	.455	.465	11.56	11.81	V1	.640	.655	16.26	16.64
E	.062	.066	1.57	1.68	W1	.105	.115	2.67	2.92
F	.004	.007	0.10	0.18	W2	.135	.145	3.43	3.68
H1	.082	.090	2.08	2.29	W3	.245	.255	6.22	6.48
H2	.078	.094	1.98	2.39	Y	0.695 BSC		17.65 BSC	
K	.175	.195	4.45	4.95	Z1	R.000	R.040	R0.00	R1.02
L	0.270 BSC		6.86 BSC		Z2	.060	.100	1.52	2.54
M	1.219	1.241	30.96	31.52	aaa	.015		0.38	
N	1.218	1.242	30.94	31.55	bbb	.010		0.25	
					ccc	.020		0.51	

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SOT1800–2 18 FEB 2016

PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following resources to aid your design process.

Application Notes

- AN1908: Solder Reflow Attach Method for High Power RF Devices in Air Cavity Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

Software

- Electromigration MTTF Calculator
- .s2p File

Development Tools

- Printed Circuit Boards

To Download Resources Specific to a Given Part Number:

1. Go to http://www.nxp.com/RF
2. Search by part number
3. Click part number link
4. Choose the desired resource from the drop down menu

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	July 2016	• Initial release of data sheet

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