Freescale Semiconductor
Technical Data

Document Number: AFT23S160W02S
Rev. 0, 11/2013

VRoHS

RF Power LDMOS Transistors

N−Channel Enhancement−Mode Lateral MOSFETs

These 45 watt RF power LDMOS transistors are designed for cellular base station applications requiring very wide instantaneous bandwidth capability covering the frequency range of 2300 to 2400 MHz.

- Typical Single−Carrier W−CDMA Performance: V_{DD} = 28 Vdc, I_{DQ} = 1100 mA, P_{out} = 45 Watts Avg., Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

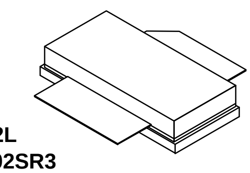
Frequency	G_{ps} (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)	IRL (dB)
2300 MHz	17.7	31.0	6.8	−34.6	−18
2350 MHz	17.8	30.5	6.7	−34.5	−25
2400 MHz	17.9	30.3	6.6	−33.9	−14

Features

- Designed for Wide Instantaneous Bandwidth Applications
- Greater Negative Gate−Source Voltage Range for Improved Class C Operation
- Able to Withstand Extremely High Output VSWR and Broadband Operating Conditions
- Optimized for Doherty Applications
- In Tape and Reel. R3 Suffix = 250 Units, 56 mm Tape Width, 13−inch Reel.

AFT23S160W02SR3
AFT23S160W02GSR3

2300−2400 MHz, 45 W AVG., 28 V AIRFAST RF POWER LDMOS TRANSISTORS



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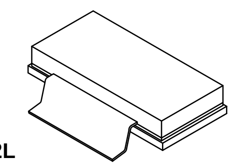

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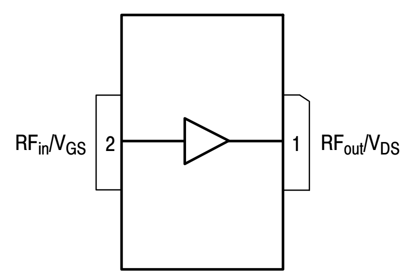

(Top View)

Figure 1. Pin Connections

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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 +125	°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 81°C, 45 W CW, 28 Vdc, I_{DQ} = 1100 mA, 2400 MHz	$R_{\theta JC}$	0.53	°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)	IV

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

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
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} = 28 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	5	μAdc
Gate−Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 219 μAdc)	$V_{GS(th)}$	0.9	1.3	1.7	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 1100 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	1.4	1.8	2.2	Vdc
Drain−Source On−Voltage (V_{GS} = 6 Vdc, I_D = 2.19 Adc)	$V_{DS(on)}$	0.1	0.2	0.3	Vdc
Functional Tests (4,5) (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1100 mA, P_{out} = 45 W Avg., f = 2400 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}	17.0	17.9	19.0	dB
Drain Efficiency	η_D	28.0	30.3	—	%
Output Peak−to−Average Ratio @ 0.01% Probability on CCDF	PAR	6.1	6.6	—	dB
Adjacent Channel Power Ratio	ACPR	—	−33.9	−31.5	dBc
Input Return Loss	IRL	—	−14	−8	dB

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.freescale.com/rf. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes − AN1955.
4. Part internally matched both on input and output.
5. Measurements made with device in straight lead configuration before any lead forming operation is applied. Lead forming is used for gull wing (GS) parts.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
Load Mismatch (In Freescale Test Fixture, 50 ohm system) I_{DQ} = 1100 mA, f = 2350 MHz					
VSWR 10:1 at 32 Vdc, 165 W CW Output Power (3 dB Input Overdrive from 210 W CW Rated Power)	No Device Degradation				
Typical Performance (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1100 mA, 2300−2400 MHz Bandwidth					
P_{out} @ 1 dB Compression Point, CW	P1dB	—	155	—	W
AM/PM (Maximum value measured at the P3dB compression point across the 2300−2400 MHz bandwidth)	Φ	—	−15.5	—	°
VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)	VBW_{res}	—	80	—	MHz
Gain Flatness in 100 MHz Bandwidth @ P_{out} = 45 W Avg.	G_F	—	0.14	—	dB
Gain Variation over Temperature (−30°C to +85°C)	ΔG	—	0.018	—	dB/°C
Output Power Variation over Temperature (−30°C to +85°C)	ΔP1dB	—	0.01	—	dB/°C

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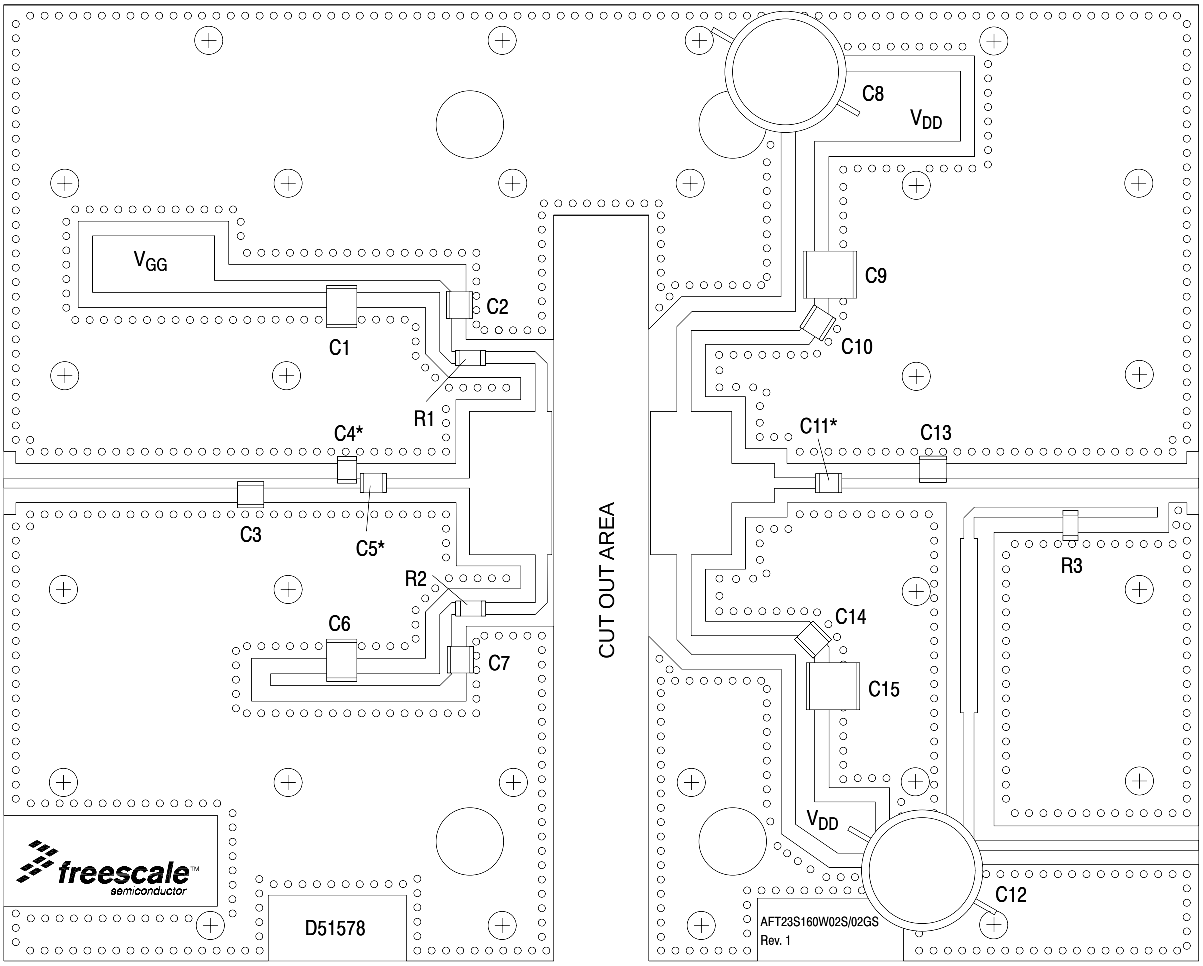

*C4, C5 and C11 are mounted vertically.

Figure 2. AFT23S160W02SR3 Test Circuit Component Layout

Table 5. AFT23S160W02SR3 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C6	2.2 μF Chip Capacitors	C3225X7R1H225M200AB	TDK
C2, C5, C7, C10, C11, C14	4.7 pF Chip Capacitors	ATC100B4R7BT500XT	ATC
C3	0.1 pF Chip Capacitor	ATC100B0R1BT500XT	ATC
C4, C13	0.3 pF Chip Capacitors	ATC100B0R3BT500XT	ATC
C8, C12	470 μF, 63 V Electrolytic Capacitors	B41693A8477Q7	EPCOS
C9, C15	10 μF Chip Capacitors	C5750X7S2A106M230KB	TDK
R1, R2	3.3 Ω, 1/4 W Chip Resistors	WCR1206-3R3FI	Welwyn
R3	0 Ω, 2 A Chip Jumper	WCR1206-R005JI	Welwyn
PCB	Rogers RO4350B, 0.020″, ε_r = 3.5	D51578	MTL

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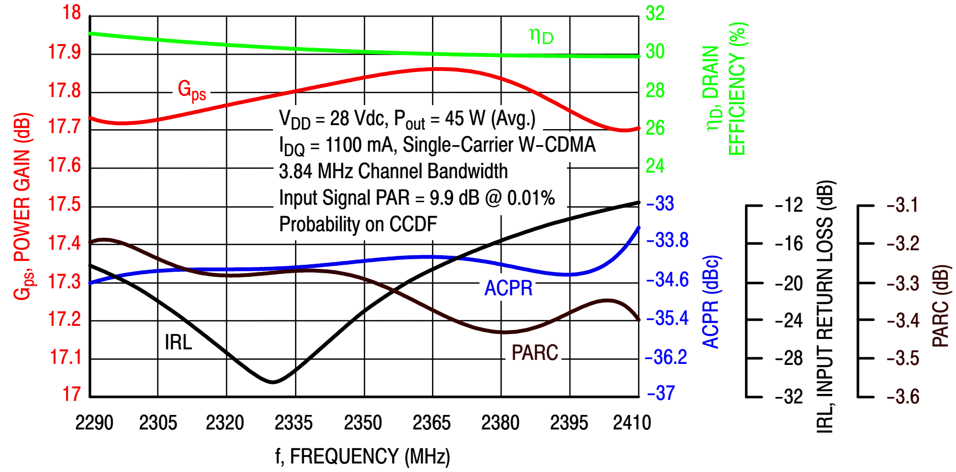

Figure 3. Single−Carrier Output Peak−to−Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 45 Watts Avg.

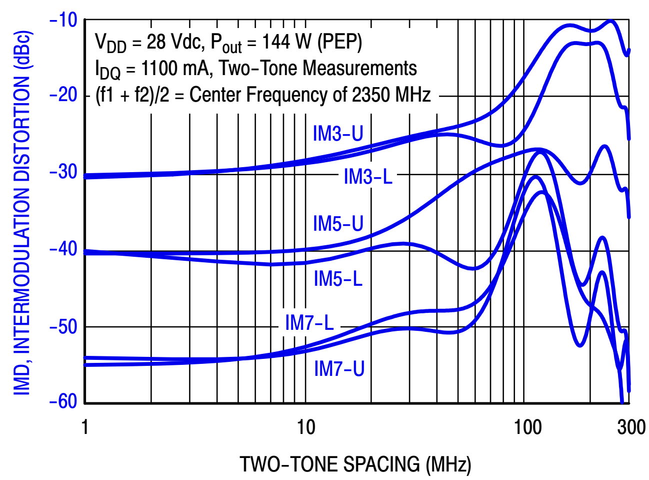

Figure 4. Intermodulation Distortion Products versus Two−Tone Spacing

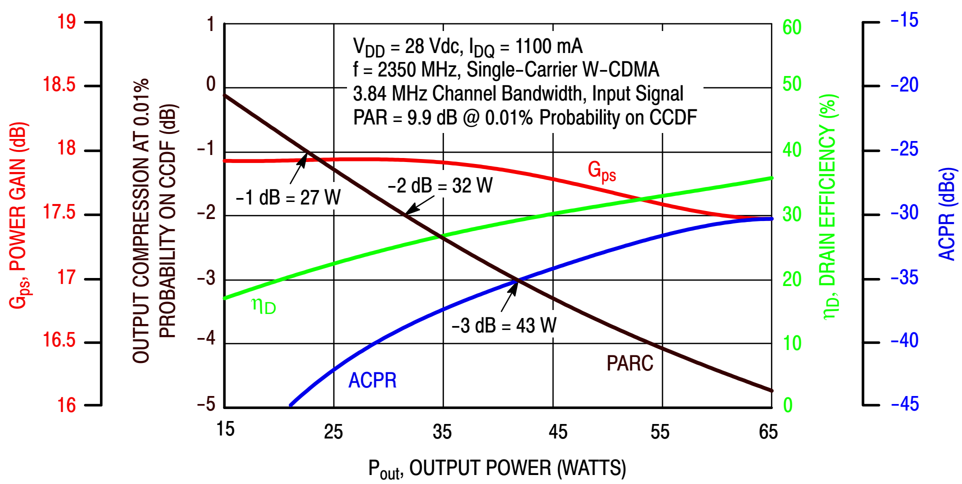

Figure 5. Output Peak−to−Average Ratio Compression (PARC) versus Output Power

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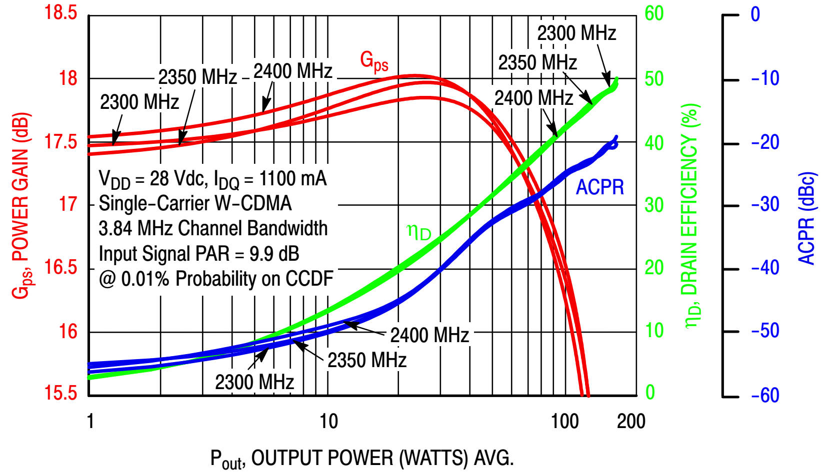

Figure 6. Single−Carrier W−CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

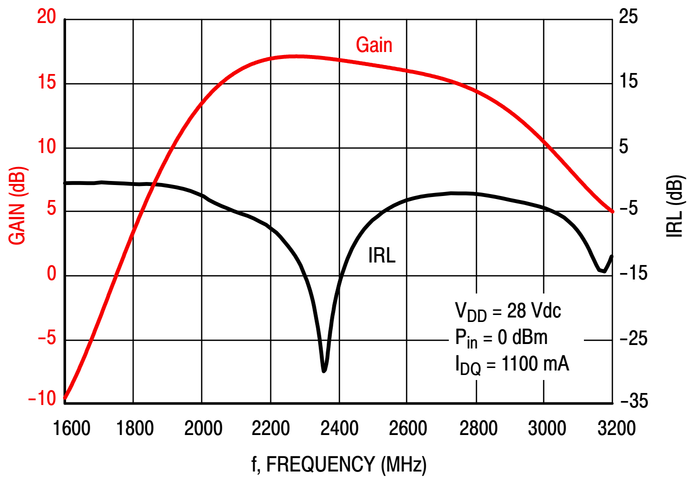

Figure 7. Broadband Frequency Response

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V_{DD} = 28 Vdc, I_{DQ} = 1246 mA, Pulsed CW, 10 μsec(on), 10% Duty Cycle

f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Max Output Power P1dB					
			Z_{load} (1) (Ω)	Gain (dB)	(dBm)	(W)	$η_D$ (%)	AM/PM (°)
2300	3.05 - j9.21	3.18 + j8.65	2.49 - j5.63	18.0	53.4	220	53.3	-11
2350	4.59 - j10.1	4.32 + j9.21	2.59 - j6.01	17.9	53.3	215	52.1	-11
2400	7.50 - j11.0	6.42 + j10.4	2.63 - j6.16	18.0	53.2	208	51.0	-12

f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Max Output Power P3dB					
			Z_{load} (2) (Ω)	Gain (dB)	(dBm)	(W)	$η_D$ (%)	AM/PM (°)
2300	3.05 - j9.21	3.21 + j9.07	2.46 - j5.99	15.7	54.2	264	53.7	-17
2350	4.59 - j10.1	4.52 + j9.79	2.64 - j6.20	15.8	54.1	257	53.2	-17
2400	7.50 - j11.0	6.97 + j11.1	2.79 - j6.34	16.0	54.0	252	52.8	-17

(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.

Figure 8. Load Pull Performance — Maximum Power Tuning

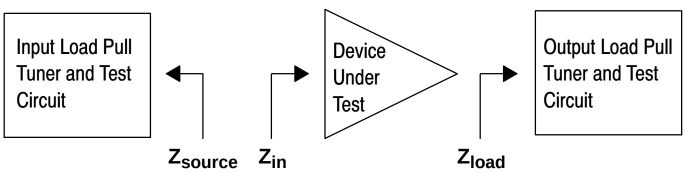
V_{DD} = 28 Vdc, I_{DQ} = 1246 mA, Pulsed CW, 10 μsec(on), 10% Duty Cycle

f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Max Drain Efficiency P1dB					
			Z_{load} (1) (Ω)	Gain (dB)	(dBm)	(W)	$η_D$ (%)	AM/PM (°)
2300	3.05 - j9.21	3.12 + j8.82	3.76 - j3.36	20.1	52.0	158	61.8	-17
2350	4.59 - j10.1	4.25 + j9.42	3.59 - j3.23	20.1	51.6	145	60.7	-18
2400	7.50 - j11.0	6.33 + j10.6	3.21 - j3.60	20.1	51.8	151	60.2	-17

f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Max Drain Efficiency P3dB					
			Z_{load} (2) (Ω)	Gain (dB)	(dBm)	(W)	$η_D$ (%)	AM/PM (°)
2300	3.05 - j9.21	3.12 + j9.19	3.83 - j3.50	18.0	52.8	189	63.5	-25
2350	4.59 - j10.1	4.42 + j9.93	3.59 - j3.43	18.1	52.5	180	62.5	-26
2400	7.50 - j11.0	6.85 + j11.3	3.33 - j3.72	18.0	52.7	186	62.1	-25

(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.

Figure 9. Load Pull Performance — Maximum Drain Efficiency Tuning



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P1dB – TYPICAL SIDE LOAD PULL CONTOURS — 2350 MHz

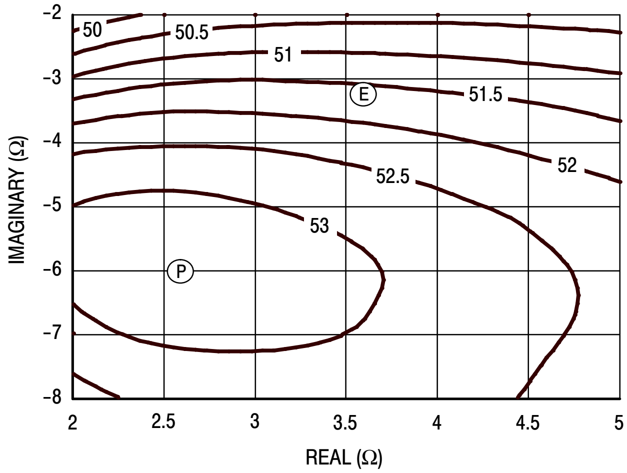

Figure 10. P1dB Load Pull Output Power Contours (dBm)

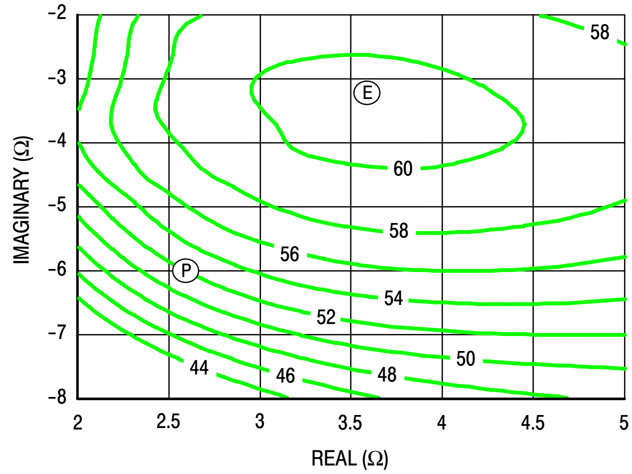

Figure 11. P1dB Load Pull Efficiency Contours (%)

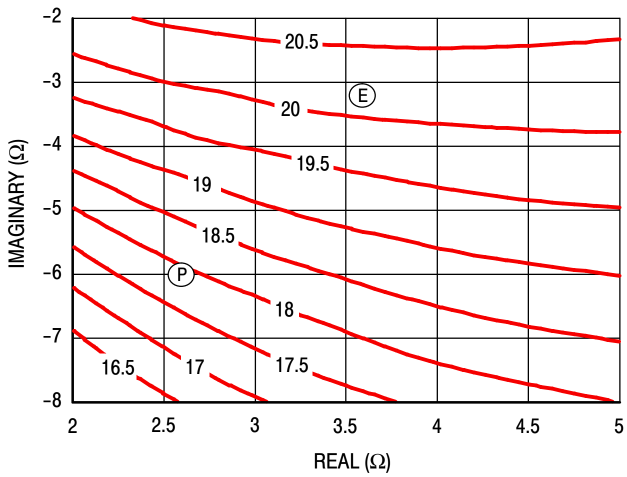

Figure 12. P1dB Load Pull Gain Contours (dB)

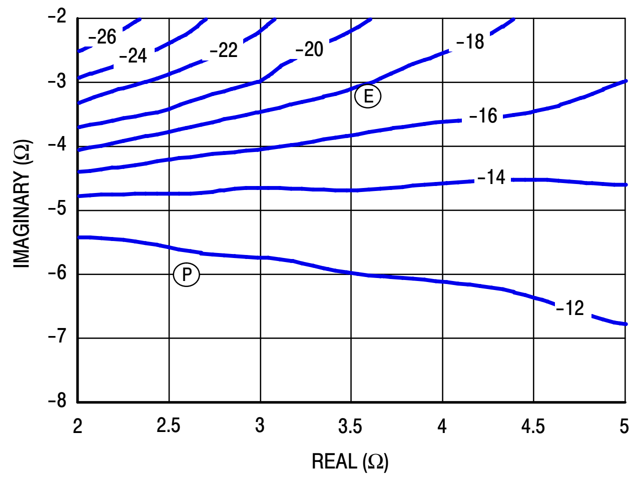

Figure 13. P1dB Load Pull AM/PM Contours (°)

NOTE: (P) = Maximum Output Power

(E) = Maximum Drain Efficiency

Gain
Drain Efficiency
Linearity
Output Power

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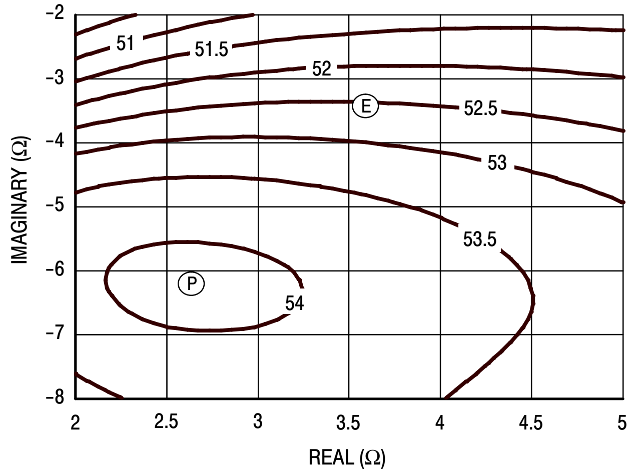

Figure 14. P3dB Load Pull Output Power Contours (dBm)

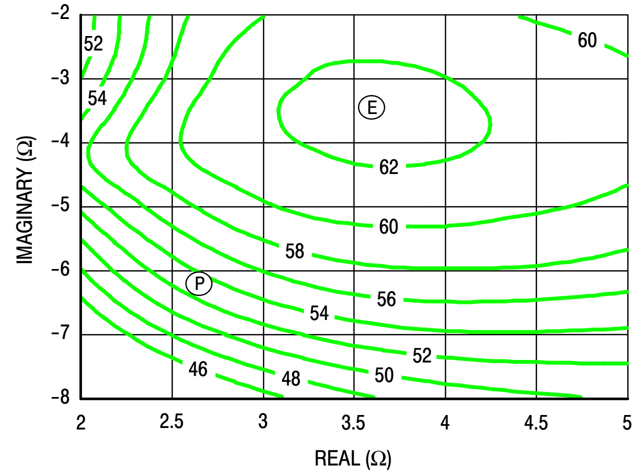

Figure 15. P3dB Load Pull Efficiency Contours (%)

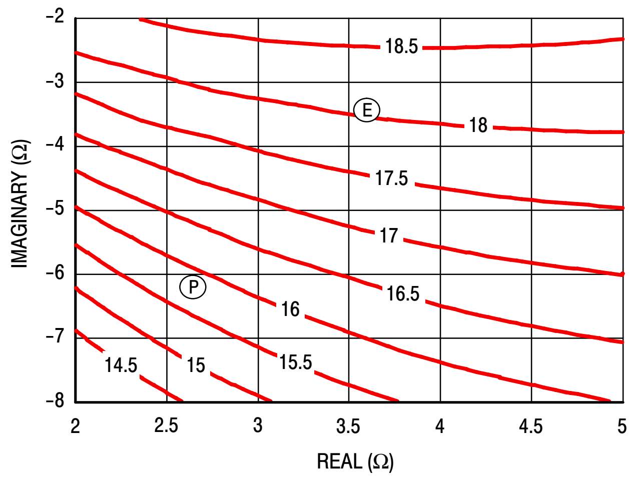

Figure 16. P3dB Load Pull Gain Contours (dB)

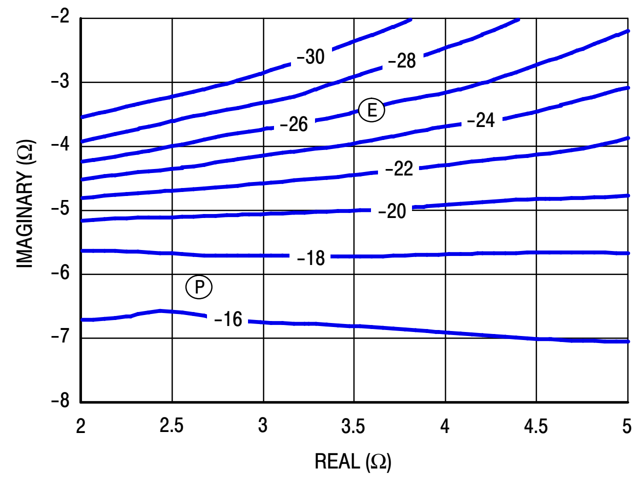

Figure 17. P3dB Load Pull AM/PM Contours (°)

NOTE: (P) = Maximum Output Power

(E) = Maximum Drain Efficiency

Gain
Drain Efficiency
Linearity
Output Power

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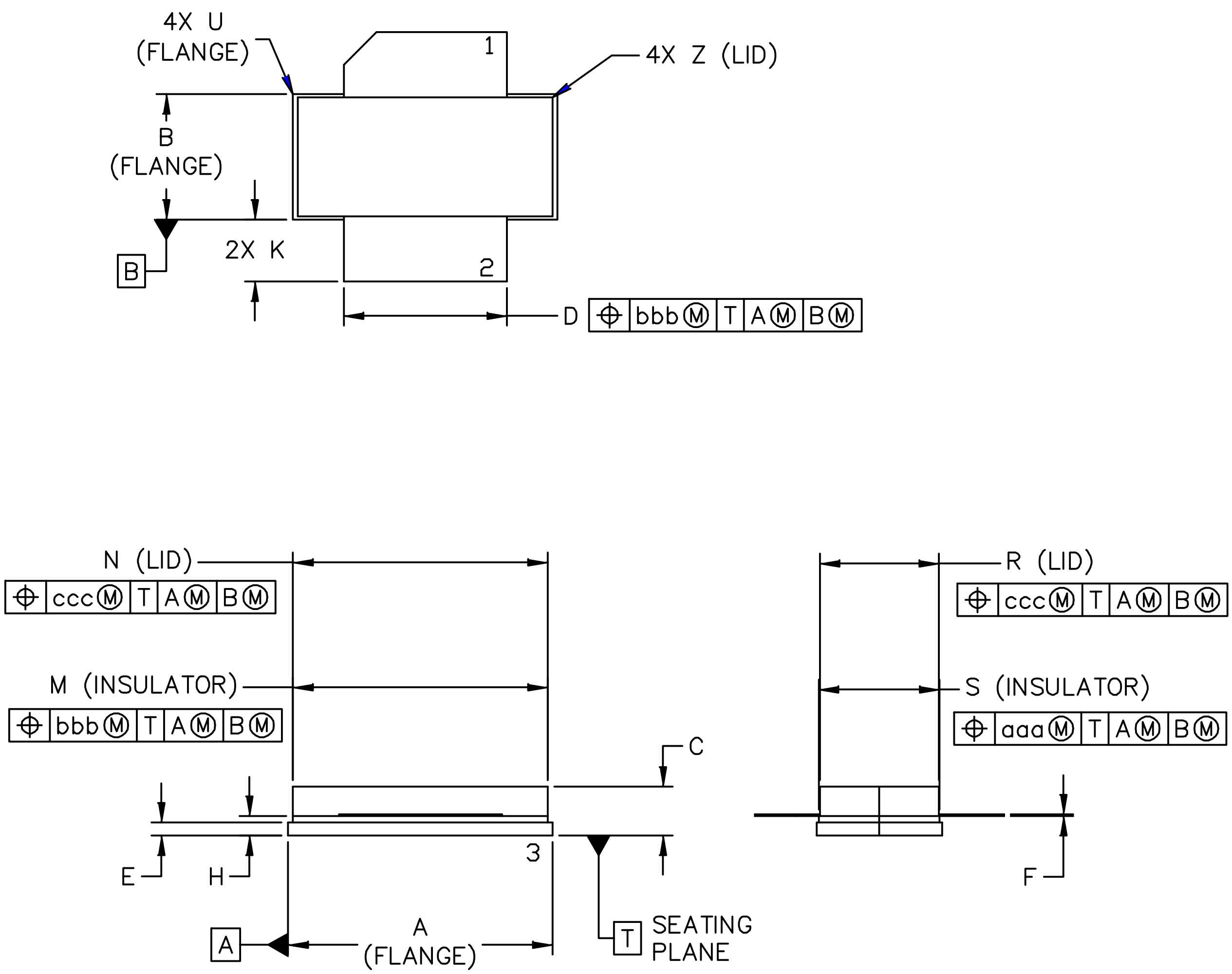
PACKAGE DIMENSIONS



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	STANDARD: NON–JEDEC	

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NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M−1994.

2. CONTROLLING DIMENSION: INCH.

3. DELETED

4. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY.

STYLE 1:
PIN 1. DRAIN
2. GATE
3. SOURCE

DIM	INCH MIN		INCH MAX	MILLIMETER MIN		MILLIMETER MAX	DIM	INCH MIN		INCH MAX	MILLIMETER MIN		MILLIMETER MAX
A	.805	–	.815	20.45	–	20.7	U	–	–	.040	–	–	1.02
B	.380	–	.390	9.65	–	9.91	Z	–	–	.030	–	–	0.76
C	.125	–	.170	3.18	–	4.32	aaa	–	.005	–	–	0.127	–
D	.495	–	.505	12.57	–	12.83	bbb	–	.010	–	–	0.254	–
E	.035	–	.045	0.89	–	1.14	ccc	–	.015	–	–	0.381	–
F	.003	–	.006	0.08	–	0.15	–	–	–	–	–	–	–
H	.057	–	.067	1.45	–	1.7	–	–	–	–	–	–	–
K	.170	–	.210	4.32	–	5.33	–	–	–	–	–	–	–
M	.774	–	.786	19.61	–	20.02	–	–	–	–	–	–	–
N	.772	–	.788	19.61	–	20.02	–	–	–	–	–	–	–
R	.365	–	.375	9.27	–	9.53	–	–	–	–	–	–	–
S	.365	–	.375	9.27	–	9.52	–	–	–	–	–	–	–

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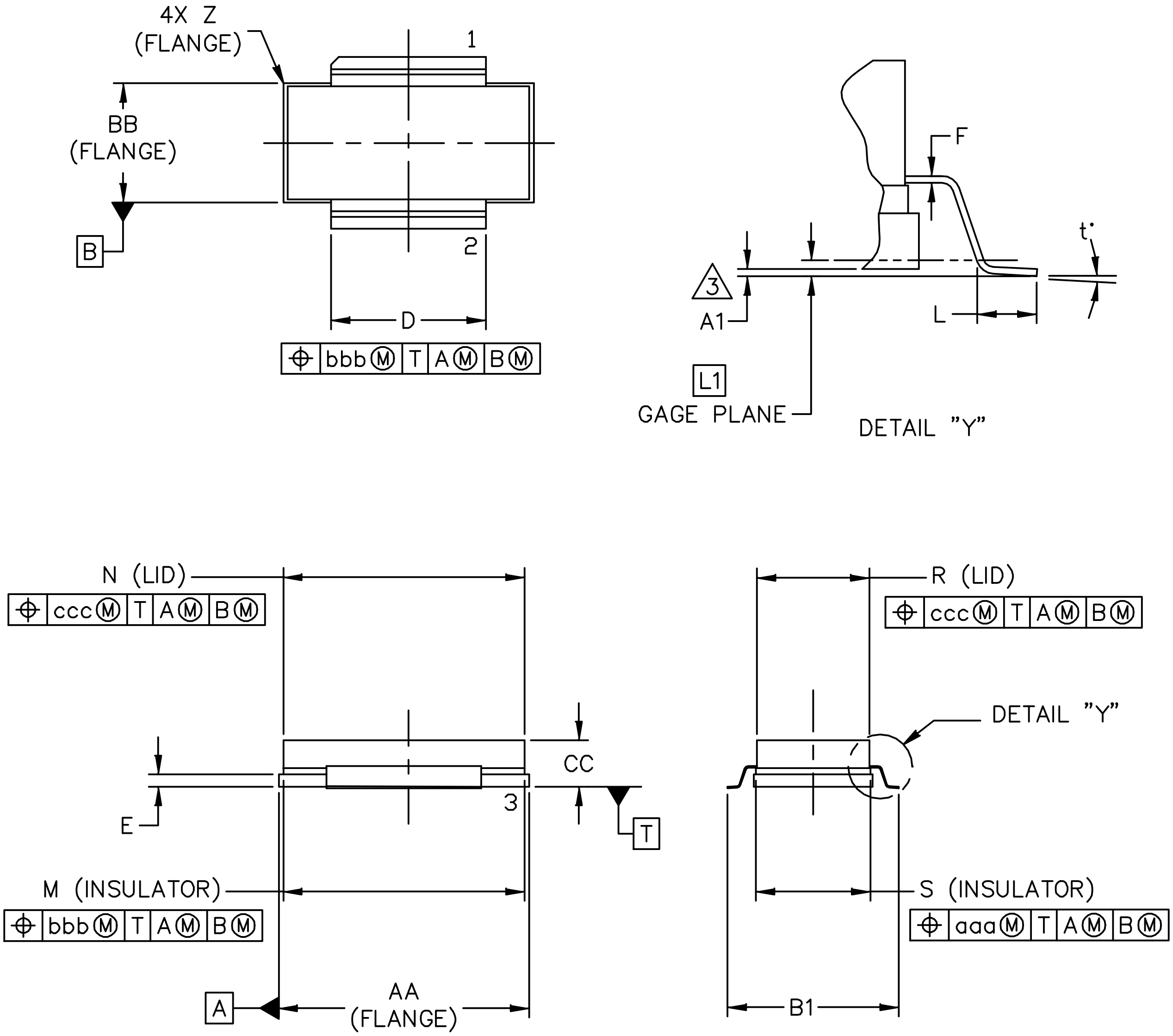

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2. CONTROLLING DIMENSION: INCH.

3. DIMENSION A1 IS MEASURED WITH REFERENCE TO DATUM T. THE POSITIVE VALUE IMPLIES THAT THE PACKAGE BOTTOM IS HIGHER THAN THE LEAD BOTTOM.

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
AA	.805	.815	20.45	20.70	Z	R.000	R.040	R0.00	R1.02
A1	.002	.008	0.05	0.20	t°	0°	8°	0°	8°
BB	.380	.390	9.65	9.91					
B1	.546	.562	13.87	14.27					
CC	.125	.170	3.18	4.32	aaa	.005		0.13	
D	.495	.505	12.57	12.83	bbb	.010		0.25	
E	.035	.045	0.89	1.14	ccc	.015		0.38	
F	.003	.006	0.08	0.15					
L	.038	.046	0.97	1.17					
L1	.010 BSC		0.25 BSC						
M	.774	.786	19.66	19.96					
N	.772	.788	19.61	20.02					
R	.365	.375	9.27	9.53					
S	.365	.375	9.27	9.53					

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	STANDARD: NON–JEDEC	
		05 SEP 2013

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PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following documents, software and tools to aid your design process.

Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

Software

- Electromigration MTTF Calculator
- RF High Power Model
- .s2p File

Development Tools

- Printed Circuit Boards

For Software and Tools, do a Part Number search at http://www.freescale.com, and select the "Part Number" link. Go to the Software & Tools tab on the part's Product Summary page to download the respective tool.

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Nov. 2013	• Initial Release of Data Sheet

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