Document Number: AFT21S240-12S
Rev. 0, 4/2014

RoHS

RF Power LDMOS Transistor

N-Channel Enhancement-Mode Lateral MOSFET

This 55 W RF power LDMOS transistor is designed for cellular base station applications covering the frequency range of 2110 to 2170 MHz.

- Typical Single-Carrier W-CDMA Characterization Performance: V_{DD} = 28 Vdc, I_{DQ} = 1400 mA, P_{out} = 55 W Avg., Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

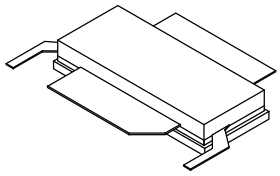
Frequency	G_{ps} (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)	IRL (dB)
2110 MHz	19.5	32.4	7.2	–34.4	–20
2140 MHz	19.8	32.8	7.2	–33.7	–19
2170 MHz	20.2	33.1	7.1	–33.1	–16

Features

- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Designed for Digital Predistortion Error Correction Systems
- Optimized for Doherty Applications
- In Tape and Reel. R3 Suffix = 250 Units, 56 mm Tape Width, 13-inch Reel.

AFT21S240-12SR3

2110–2170 MHz, 55 W AVG., 28 V AIRFAST RF POWER LDMOS TRANSISTOR



NI-880XS-2L2L

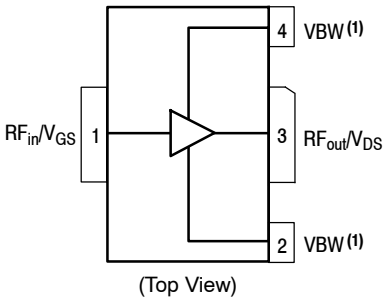


Figure 1. Pin Connections

1. Device cannot operate with the V_{DD} current supplied through pin 2 and pin 4.

freescale Airfast

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, 55 W CW, 28 Vdc, I_{DQ} = 1400 mA, 2140 MHz	$R_{\theta JC}$	0.35	°C/W

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	1C
Machine Model (per EIA/JESD22-A115)	A
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} = 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					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 280 μAdc)	$V_{GS(th)}$	0.8	1.2	1.6	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 1400 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	1.4	1.8	2.2	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 2.8 Adc)	$V_{DS(on)}$	0.1	0.15	0.3	Vdc

Functional Tests (4) (In Freescale Production Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1400 mA, P_{out} = 55 W Avg., f = 2170 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}	19.5	20.4	22.5	dB
Drain Efficiency	η_D	31.5	33.9	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	6.5	6.9	—	dB
Adjacent Channel Power Ratio	ACPR	—	–32.4	–30.0	dBc
Input Return Loss	IRL	—	-16	-9	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.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
Load Mismatch (In Freescale Characterization Test Fixture, 50 ohm system) I_{DQ} = 1400 mA, f = 2140 MHz, 100 μsec Pulse Width, 10% Duty Cycle					
VSWR 10:1 at 32 Vdc, 300 W Pulse Output Power (3 dB Input Overdrive from 230 W Pulse Rated Power)	No Device Degradation				
Typical Performance (In Freescale Characterization Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1400 mA, 2110–2170 MHz Bandwidth					
P_{out} @ 1 dB Compression Point, CW	P1dB	—	230	—	W
AM/PM (Maximum value measured at the P3dB compression point across the 2110–2170 MHz bandwidth)	Φ	—	–20	—	°
VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)	VBW_{res}	—	60	—	MHz
Gain Flatness in 60 MHz Bandwidth @ P_{out} = 55 W Avg.	G_F	—	0.7	—	dB
Gain Variation over Temperature (–30°C to +85°C)	ΔG	—	0.0167	—	dB/°C
Output Power Variation over Temperature (–30°C to +85°C)	ΔP1dB	—	0.0117	—	dB/°C

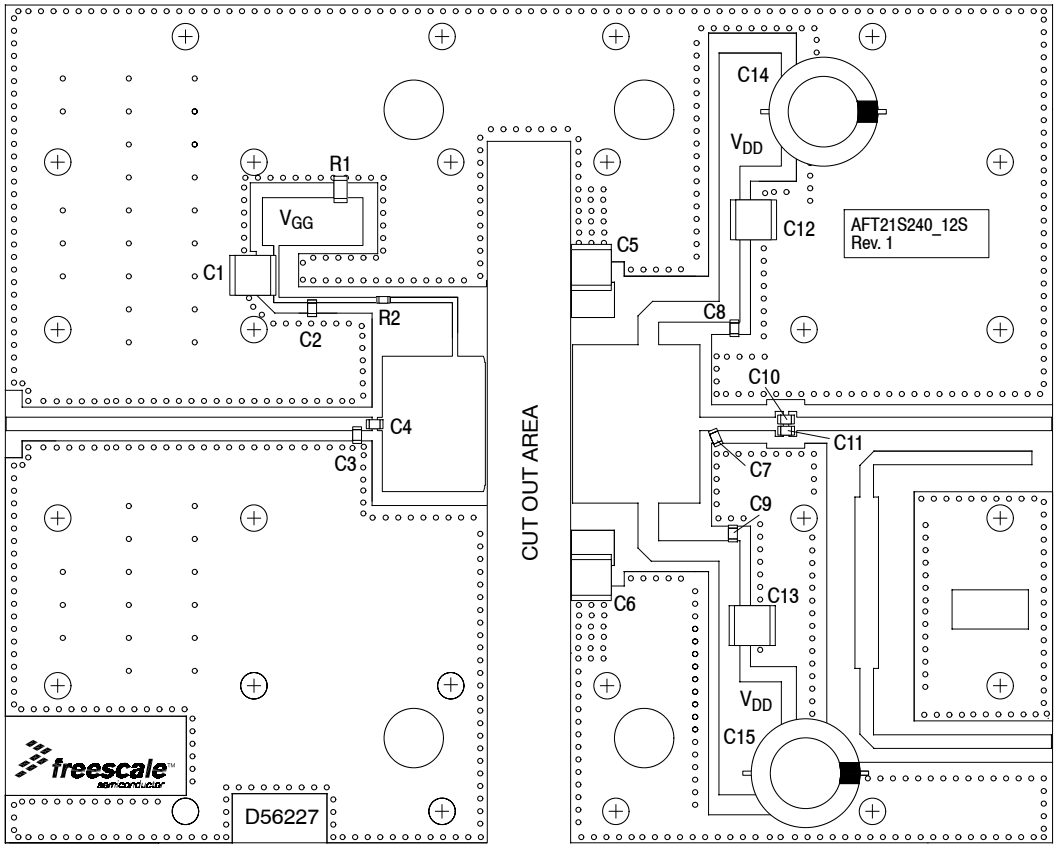
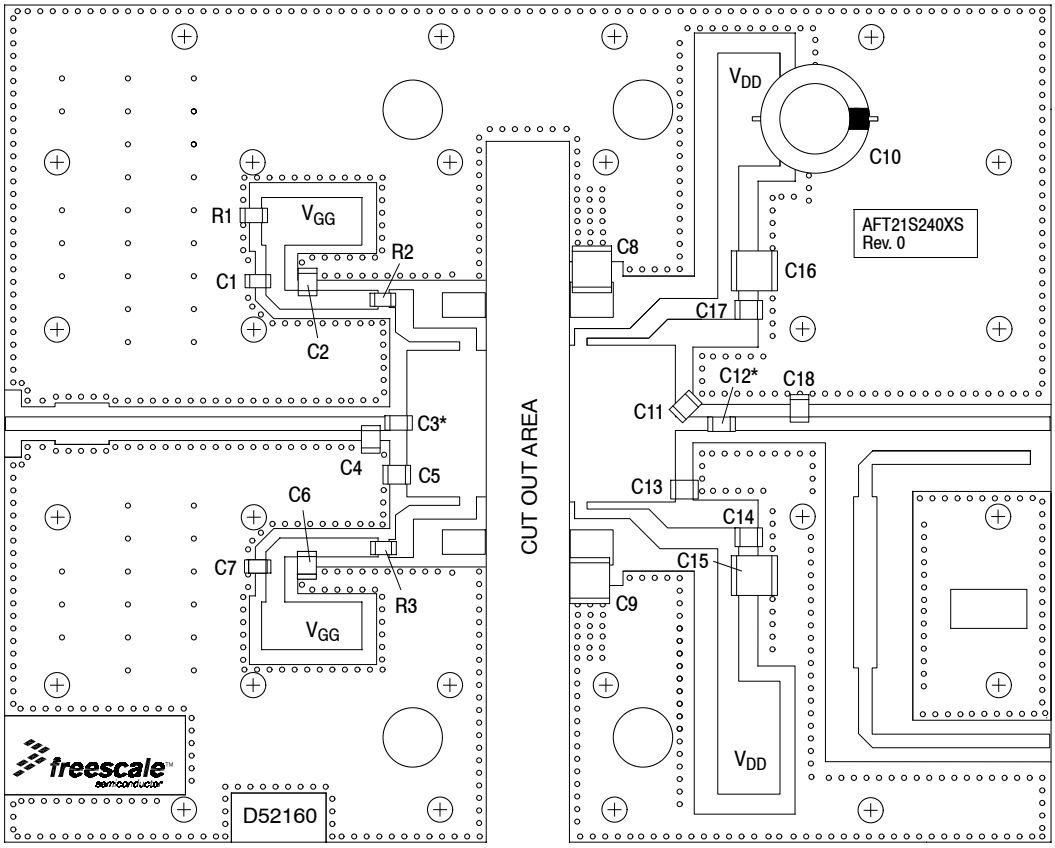


Figure 2. AFT21S240-12SR3 Production Test Circuit Component Layout

Table 5. AFT21S240-12SR3 Production Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C5, C6, C12, C13	10 μF Chip Capacitors	C5750X7S2A106M230KB	TDK
C2, C4	10 pF Chip Capacitors	ATC600F100JT250XT	ATC
C3	0.8 pF Chip Capacitor	ATC600F0R8BT250XT	ATC
C7	0.2 pF Chip Capacitor	ATC600F0R2BT250XT	ATC
C8, C9, C10, C11	8.2 pF Chip Capacitors	ATC600F8R2BT250XT	ATC
C14, C15	220 μF, 100 V Chip Capacitors	MCGPR100V227M16X26-RH	Multicomp
R1	5.6 KΩ, 1/4 W Chip Resistor	CRCW12065K60FKEA	Vishay
R2	10 Ω, 1/4 W Chip Resistor	RK73H2ATTD10R0F	KOA Speer
PCB	Rogers RO4350B, 0.030″, ε_r = 3.66	D56227	MTL



*C3 and C12 are mounted vertically.

Figure 3. AFT21S240-12SR3 Characterization Test Circuit Component Layout

Table 6. AFT21S240-12SR3 Characterization Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C7	10 μF Chip Capacitors	GRM31CR61H106KA12L	MuRata
C2, C6, C14, C17	9.1 pF Chip Capacitors	ATC100B9R1CT500XT	ATC
C3, C12	7.5 pF Chip Capacitors	ATC100B7R5CT500XT	ATC
C4, C5	1.2 pF Chip Capacitors	ATC100B1R2BT500XT	ATC
C8, C9, C15, C16	10 μF Chip Capacitors	C5750X7S2A106M230KB	TDK
C10	470 μF Chip Capacitor	MCGPR63V477M13X26-RH	Multicomp
C11	0.1 pF Chip Capacitor	ATC100B0R1BT500XT	ATC
C13	0.5 pF Chip Capacitor	ATC100B0R5BT500XT	ATC
C18	0.4 pF Chip Capacitor	ATC100B0R4BT500XT	ATC
R1	5.6 KΩ, 1/4 W Chip Resistor	CRCW12065K60FKEA	Vishay
R2, R3	6.04 Ω, 1/4 W Chip Resistors	CRCW12066R04FKEA	Vishay
PCB	Rogers RO4350B, 0.030″, ε_r = 3.66	D52160	MTL

TYPICAL CHARACTERISTICS

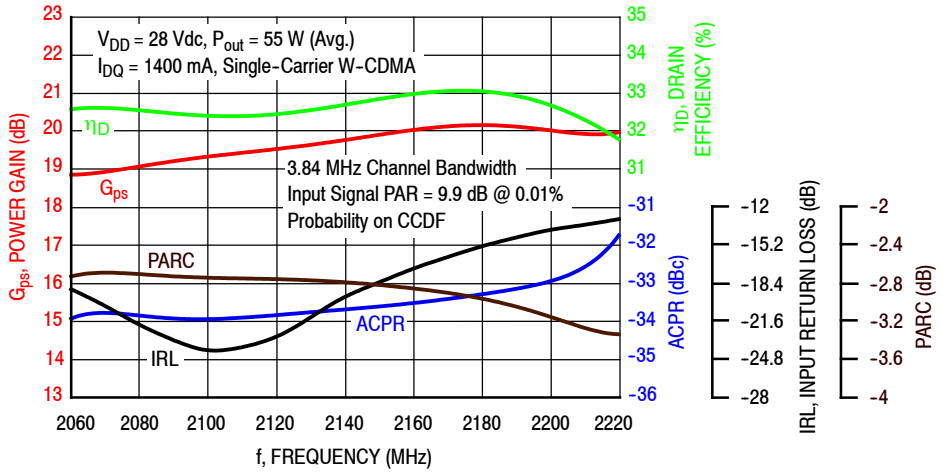


Figure 4. Single-Carrier Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 55 Watts Avg.

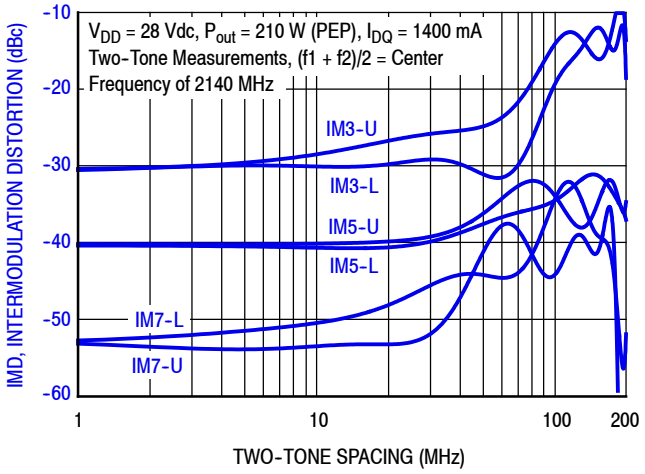


Figure 5. Intermodulation Distortion Products versus Two-Tone Spacing

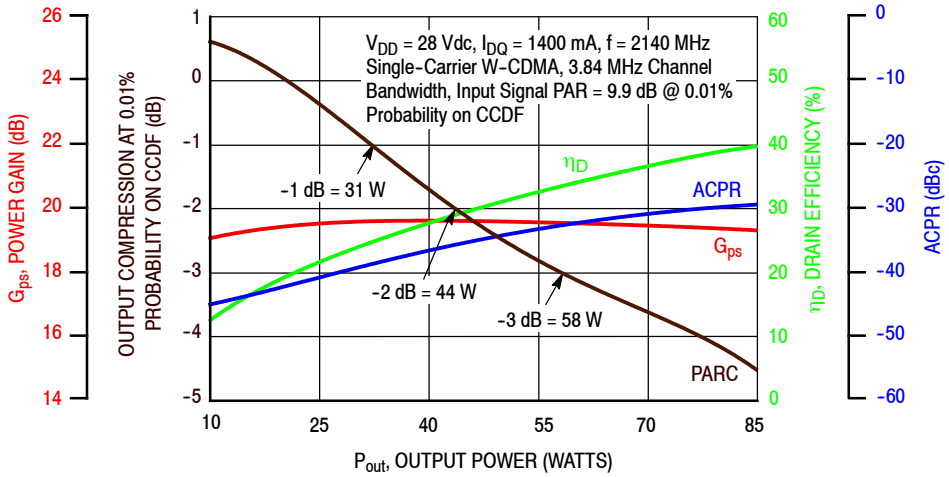


Figure 6. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

TYPICAL CHARACTERISTICS

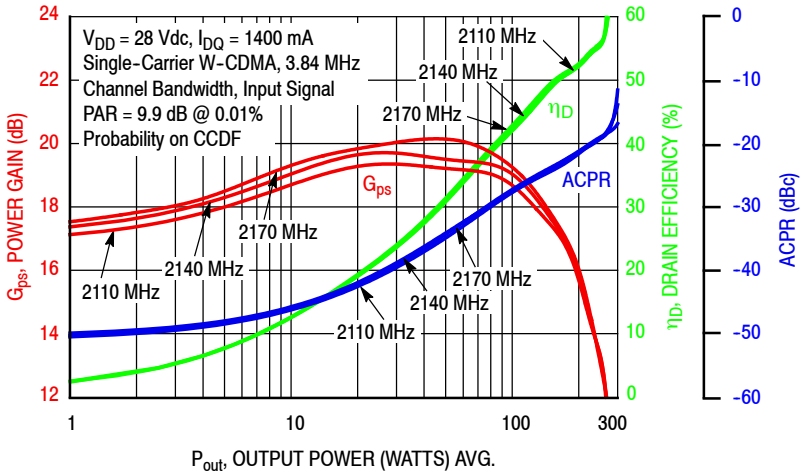


Figure 7. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

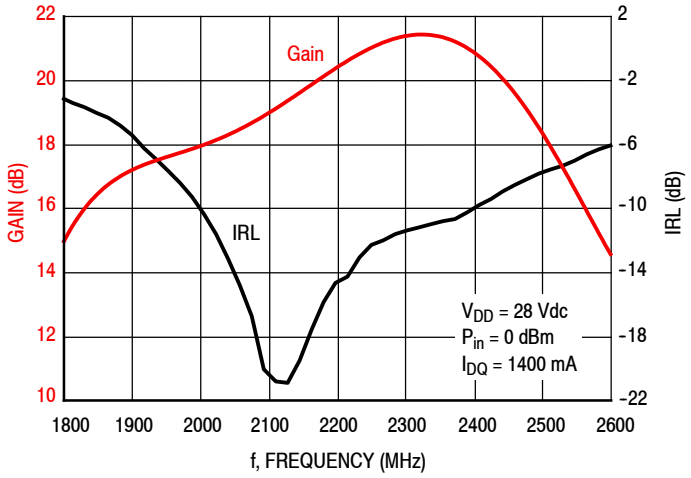


Figure 8. Broadband Frequency Response

Table 7. Load Pull Performance — Maximum Power Tuning

V_{DD} = 28 Vdc, I_{DQ} = 1408 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 (°)
2110	3.33 – j4.79	3.96 + j4.70	1.42 – j2.85	20.3	54.3	268	55.9	–15
2140	4.26 – j4.58	5.09 + j4.19	1.41 – j2.98	20.3	54.4	273	55.8	–15
2170	5.73 – j3.83	6.20 + j2.89	1.44 – j3.19	20.2	54.3	270	54.6	–15

f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Max Output Power P3dB Z_{load} (2) (Ω)	Gain (dB)	(dBm)	(W)	η_D (%)	AM/PM (°)
2110	3.33 – j4.79	4.27 + j4.85	1.45 – j3.07	18.1	55.3	338	58.3	–21
2140	4.26 – j4.58	5.56 + j4.18	1.46 – j3.20	18.1	55.3	339	58.0	–21
2170	5.73 – j3.83	6.72 + j2.56	1.50 – j3.35	18.1	55.3	336	57.1	–21

(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.

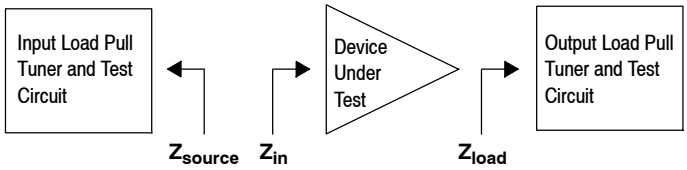
Table 8. Load Pull Performance — Maximum Drain Efficiency Tuning

V_{DD} = 28 Vdc, I_{DQ} = 1408 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 (°)
2110	3.33 – j4.79	4.30 + j4.62	2.36 – j1.84	22.1	53.0	199	64.9	–17
2140	4.26 – j4.58	5.44 + j3.92	2.24 – j1.84	22.2	53.0	198	65.7	–18
2170	5.73 – j3.83	6.50 + j2.50	2.03 – j1.99	22.2	53.0	199	63.5	–18

f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Max Drain Efficiency P3dB Z_{load} (2) (Ω)	Gain (dB)	(dBm)	(W)	η_D (%)	AM/PM (°)
2110	3.33 – j4.79	4.90 + j4.54	2.53 – j1.48	20.4	53.4	218	68.6	–27
2140	4.26 – j4.58	6.03 + j3.73	2.16 – j1.80	20.2	53.8	242	68.6	–27
2170	5.73 – j3.83	6.84 + j1.60	2.03 – j1.65	20.5	53.4	220	67.6	–29

(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 LOAD PULL CONTOURS — 2140 MHz

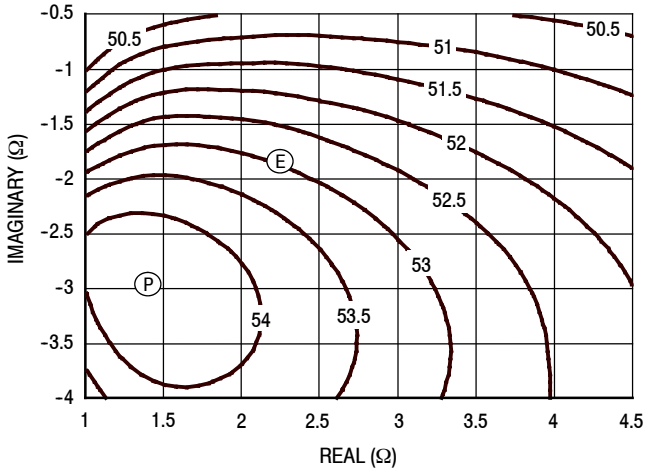


Figure 9. P1dB Load Pull Output Power Contours (dBm)

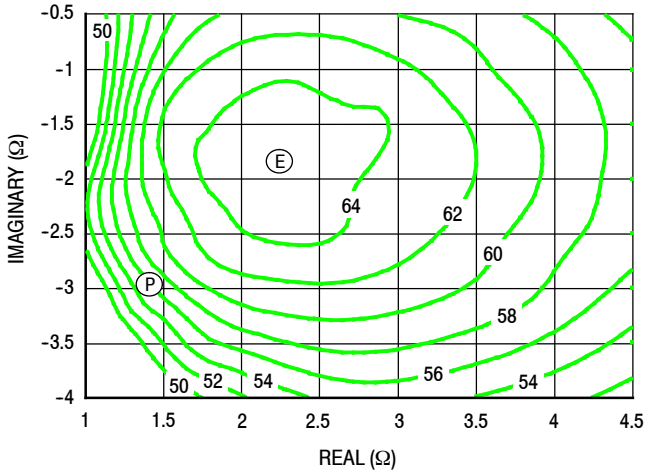


Figure 10. P1dB Load Pull Efficiency Contours (%)

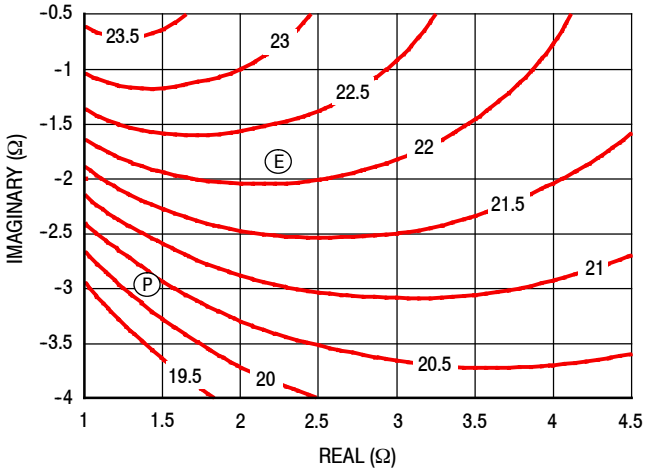


Figure 11. P1dB Load Pull Gain Contours (dB)

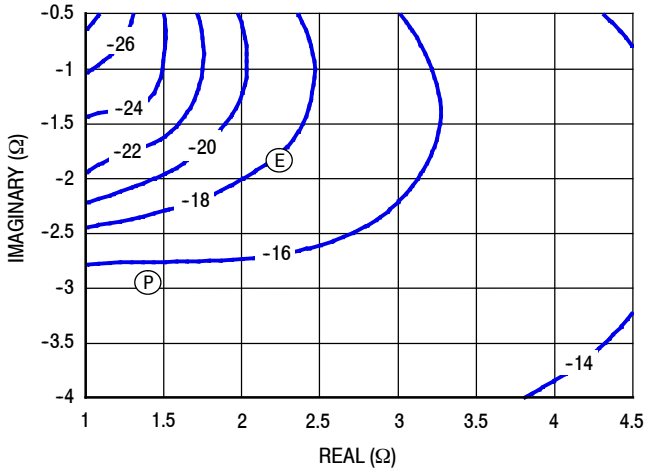


Figure 12. P1dB Load Pull AM/PM Contours (°)

NOTE: Ⓟ = Maximum Output Power

Ⓔ = Maximum Drain Efficiency

Gain

Drain Efficiency

Linearity

Output Power

P3dB - TYPICAL LOAD PULL CONTOURS — 2140 MHz

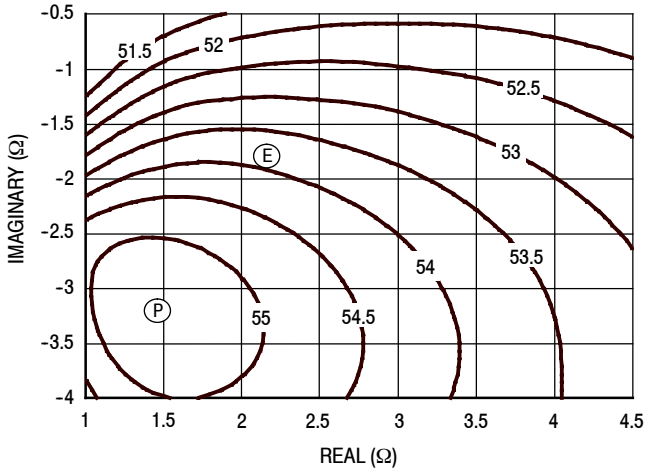


Figure 13. P3dB Load Pull Output Power Contours (dBm)

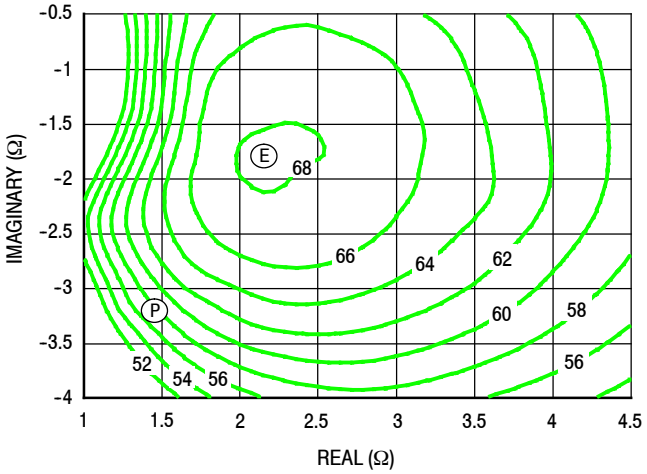


Figure 14. P3dB Load Pull Efficiency Contours (%)

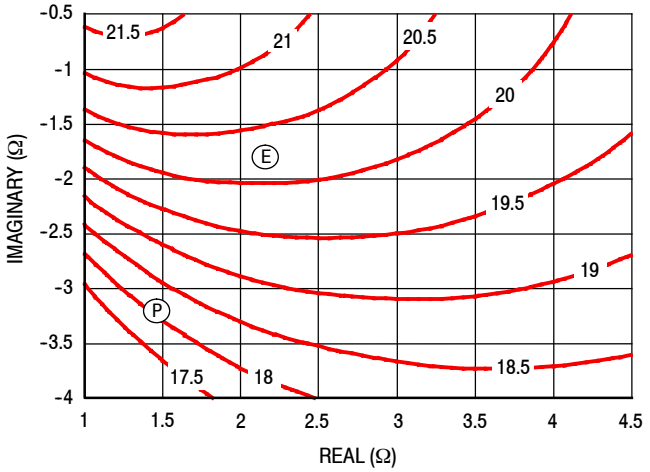


Figure 15. P3dB Load Pull Gain Contours (dB)

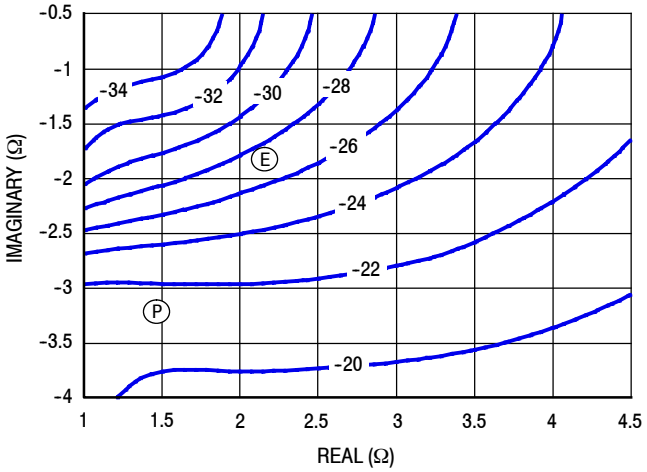


Figure 16. P3dB Load Pull AM/PM Contours (°)

NOTE: Ⓟ = Maximum Output Power

Ⓔ = Maximum Drain Efficiency

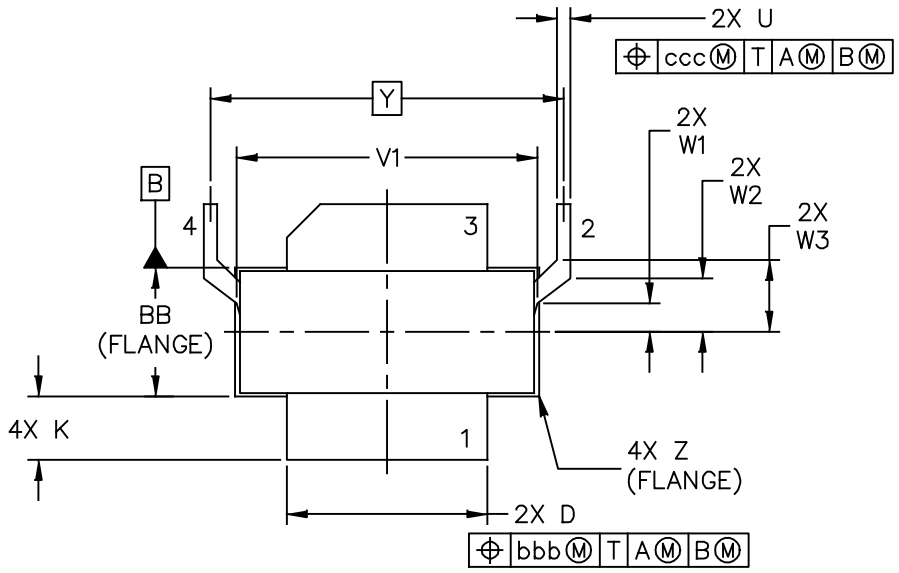
Gain

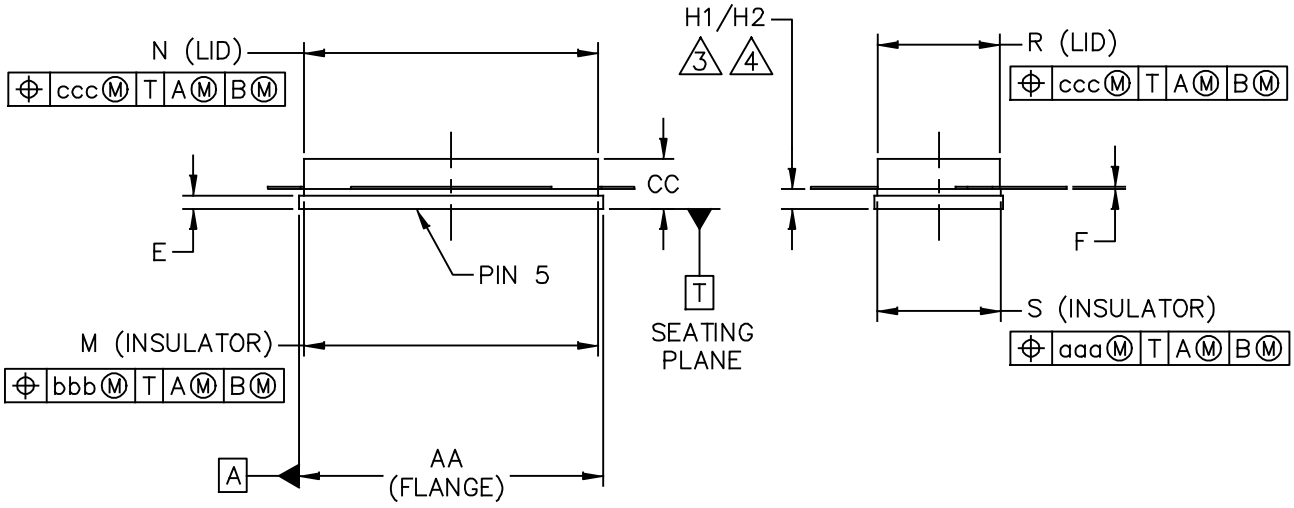
Drain Efficiency

Linearity

Output Power

PACKAGE DIMENSIONS





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	STANDARD: NON-JEDEC	
	29 JAN 2014	

NOTES:

1. CONTROLLING DIMENSION: INCH.

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

3. DIMENSIONS H1 AND H2 ARE MEASURED .030 INCH (0.762 MM) AWAY FROM THE FLANGE TO CLEAR THE EPOXY FLOW OUT REGION PARALLEL TO DATUM B. H1 APPLIES TO PINS 1 AND 3. H2 APPLIES TO PINS 2 AND 4.

4. TOLERANCE OF DIMENSION H2 IS TENTATIVE.

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
AA	.905	.915	22.99	23.24	R	.365	.375	9.27	9.53
BB	.380	.390	9.65	9.91	S	.365	.375	9.27	9.53
CC	.125	.170	3.18	4.32	U	.035	.045	0.89	1.14
D	.595	.605	15.11	15.37	V1	.895	.905	22.73	22.99
E	.035	.045	0.89	1.14	W1	.080	.090	2.03	2.29
F	.004	.007	0.10	0.18	W2	.155	.165	3.94	4.19
H1	.057	.067	1.45	1.70	W3	.210	.220	5.33	5.59
H2	.054	.070	1.37	1.78	Y	1.056 BSC		26.82 BSC	
K	.170	.210	4.32	5.33	Z	R.000	R.040	R.00	R1.02
M	.874	.886	22.20	22.50	aaa	.005		0.13	
N	.872	.888	22.15	22.56	bbb	.010		0.25	
					ccc	.015		0.38	

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STANDARD: NON–JEDEC

29 JAN 2014

PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following resources 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	Apr. 2014	• Initial Release of Data Sheet

How to Reach Us:

Home Page:
freescale.com

Web Support:
freescale.com/support

Document Number: AFT21S240-12S
Rev. 0, 4/2014