Freescale Semiconductor
Technical Data

Document Number: A2T21S160–12S
Rev. 0, 8/2015

RF Power LDMOS Transistor

N–Channel Enhancement–Mode Lateral MOSFET

This 38 W RF power LDMOS transistor is designed for cellular base station applications covering the frequency range of 2110 to 2170 MHz.

2100 MHz

- Typical Single–Carrier W–CDMA Performance: V_{DD} = 28 Vdc, I_{DQ} = 600 mA, P_{out} = 38 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	18.2	33.6	6.8	–33.4	–18
2140 MHz	18.3	33.0	6.7	–33.3	–15
2170 MHz	18.4	32.9	6.7	–33.0	–13

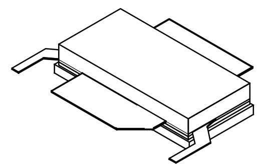
Features

- Greater Negative Gate–Source Voltage Range for Improved Class C Operation
- Designed for Digital Predistortion Error Correction Systems
- Optimized for Doherty Applications

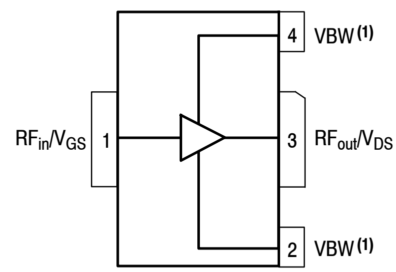
RoHS

A2T21S160–12SR3

2110–2170 MHz, 38 W AVG., 28 V AIRFAST RF POWER LDMOS TRANSISTOR



NI–780S–2L2L



(Top View)

Figure 1. Pin Connections

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

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 73°C, 38 W CW, 28 Vdc, I_{DQ} = 600 mA, 2140 MHz	$R_{\theta JC}$	0.30	°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} = 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 = 151 μAdc)	$V_{GS(th)}$	1.4	1.8	2.2	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 600 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2.2	2.6	3.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 1.5 Adc)	$V_{DS(on)}$	0.1	0.2	0.3	Vdc

Functional Tests [4] (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 600 mA, P_{out} = 38 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.

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain	G_{ps}	17.7	18.4	20.7	dB
Drain Efficiency	η_D	31.1	32.9	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	6.3	6.7	—	dB
Adjacent Channel Power Ratio	ACPR	—	–33.0	–30.9	dBc
Input Return Loss	IRL	—	–13	–7	dB

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.freescale.com/rf/calculators.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf and search for 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 Test Fixture, 50 ohm system) I_{DQ} = 600 mA, f = 2140 MHz					
VSWR 10:1 at 32 Vdc, 190 W CW Output Power (3 dB Input Overdrive from 140 W CW Rated Power)	No Device Degradation				
Typical Performance (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 600 mA, 2110–2170 MHz Bandwidth					
P_{out} @ 1 dB Compression Point, CW	P1dB	—	140	—	W
AM/PM (Maximum value measured at the P3dB compression point across the 2110–2170 MHz bandwidth)	Φ	—	–16.4	—	°
VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)	VBW_{res}	—	90	—	MHz
Gain Flatness in 60 MHz Bandwidth @ P_{out} = 38 W Avg.	G_F	—	0.3	—	dB
Gain Variation over Temperature (–30°C to +85°C)	ΔG	—	0.011	—	dB/°C
Output Power Variation over Temperature (–30°C to +85°C)	ΔP1dB	—	0.009	—	dB/°C

Table 5. Ordering Information

Device	Tape and Reel Information	Package
A2T21S160-12SR3	R3 Suffix = 250 Units, 44 mm Tape Width, 13-inch Reel	NI-780S-2L2L

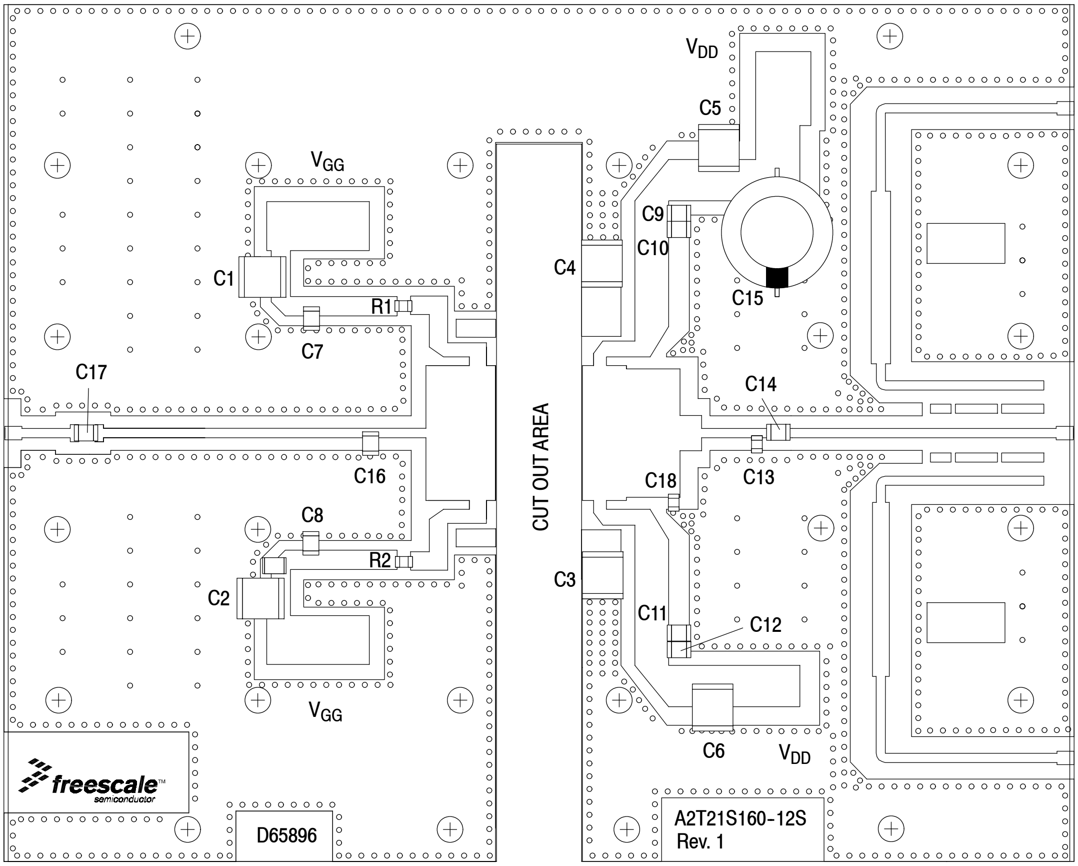


Figure 2. A2T21S160-12SR3 Test Circuit Component Layout

Table 6. A2T21S160-12SR3 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2, C3, C4, C5, C6	10 μF Chip Capacitors	C5750X7S2A106M230KB	TDK
C7, C8, C10, C11, C14, C17	9.1 pF Chip Capacitors	ATC100B9R1CT500XT	ATC
C9	0.8 pF Chip Capacitor	ATC100B0R8BT500XT	ATC
C12	0.9 pF Chip Capacitor	ATC100B0R9BT500XT	ATC
C13, C18	0.1 pF Chip Capacitors	ATC600F0R1BT250XT	ATC
C15	470 μF, 63 V Electrolytic Capacitor	MCGPR63V477M13X26-RH	Multicomp
C16	1.1 pF Chip Capacitor	ATC100B1R1BT500XT	ATC
R1, R2	3 Ω, 1/4 W Chip Resistors	RC1206FR-073RL	Yageo
PCB	Rogers RO4350B, 0.020″, ε_r = 3.66	D65896	MTL

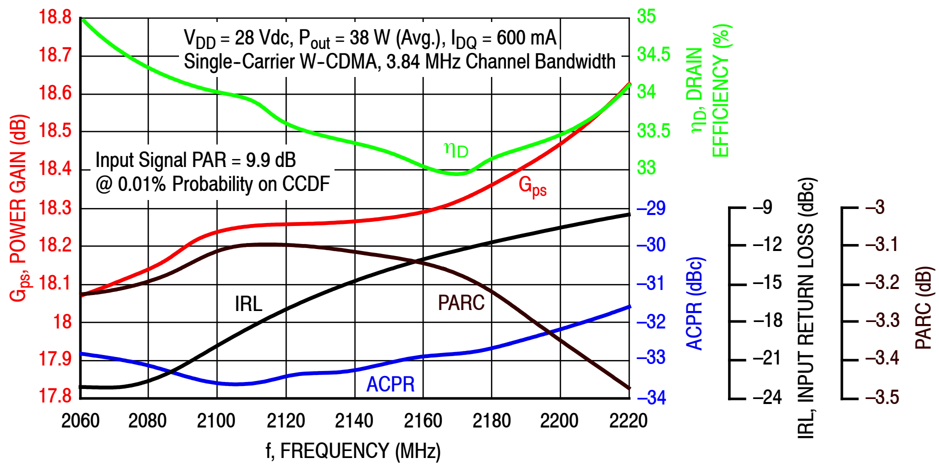


Figure 3. Single-Carrier Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P_{out} = 38 Watts Avg.

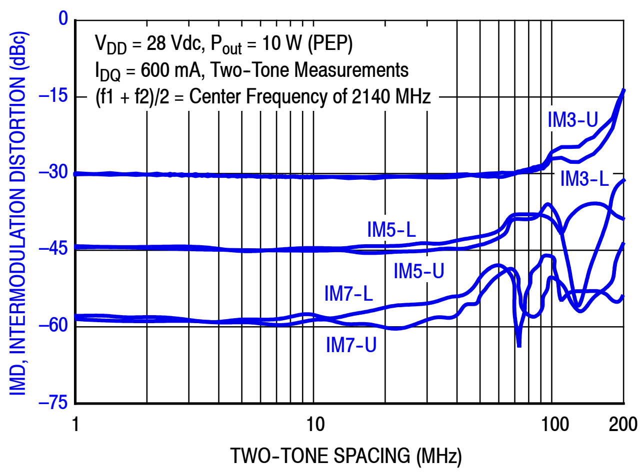


Figure 4. Intermodulation Distortion Products versus Two-Tone Spacing

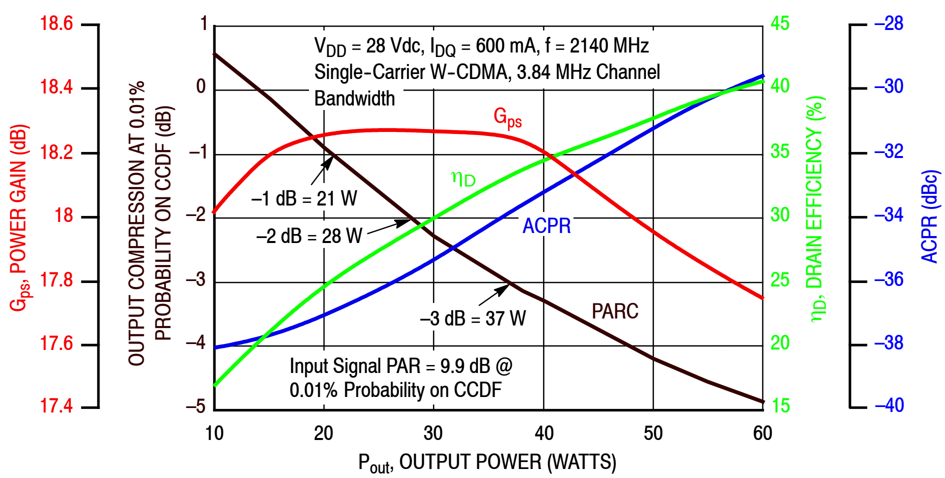


Figure 5. Output Peak-to-Average Ratio Compression (PARC) versus Output Power

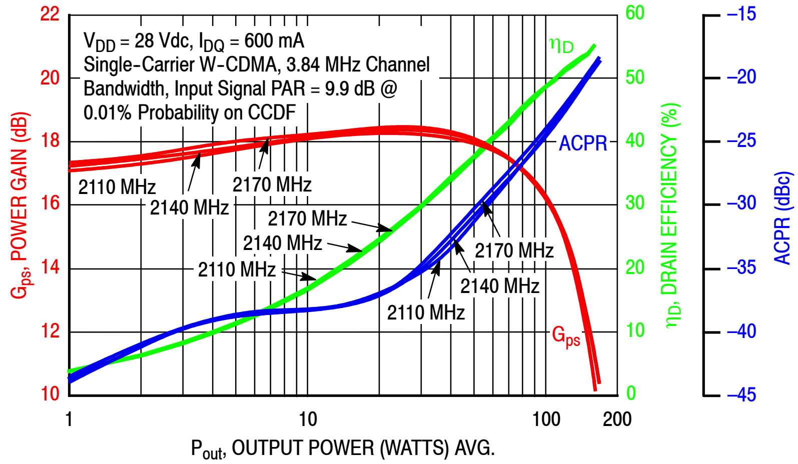


Figure 6. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power

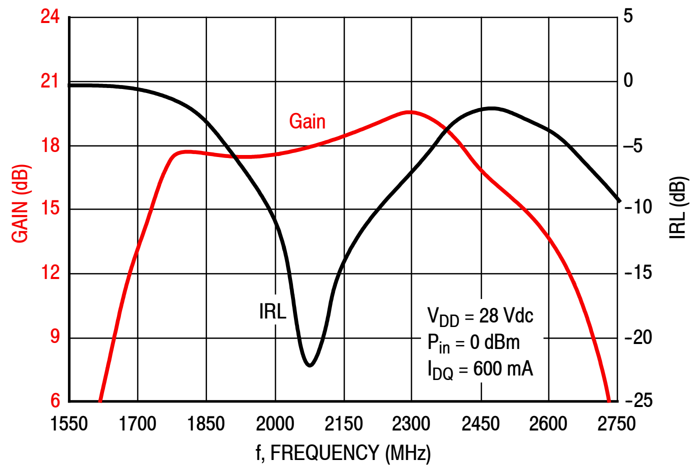


Figure 7. Broadband Frequency Response

Table 7. Load Pull Performance — Maximum Power Tuning

V_{DD} = 28 Vdc, I_{DQ} = 793 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 (°)
2110	2.40 – j5.03	2.40 + j4.74	1.71 – j4.45	18.6	52.5	178	54.8	–14
2140	2.86 – j5.52	2.96 + j5.22	1.70 – j4.29	18.8	52.6	181	55.4	–15
2170	4.27 – j6.11	4.03 + j5.56	1.71 – j4.44	18.8	52.6	182	54.8	–15

			Max Output Power					
			P3dB					
f (MHz)	Z_{source} (Ω)	Z_{in} (Ω)	Z_{load} (2) (Ω)	Gain (dB)	(dBm)	(W)	η_D (%)	AM/PM (°)
2110	2.40 – j5.03	2.33 + j5.03	1.72 – j4.68	16.3	53.3	214	56.3	–18
2140	2.86 – j5.52	2.96 + j5.56	1.71 – j4.64	16.4	53.3	216	56.1	–19
2170	4.27 – j6.11	4.13 + j6.04	1.72 – j4.67	16.5	53.3	215	55.9	–19

(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.

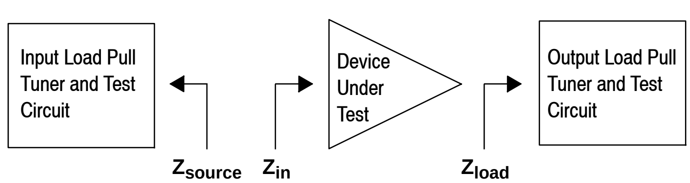
Table 8. Load Pull Performance — Maximum Drain Efficiency Tuning

V_{DD} = 28 Vdc, I_{DQ} = 793 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 (°)
2110	2.40 – j5.03	2.71 + j5.02	3.37 – j2.33	21.8	50.1	102	66.7	–21
2140	2.86 – j5.52	3.42 + j5.53	2.99 – j2.05	22.1	49.9	98	66.6	–22
2170	4.27 – j6.11	4.77 + j5.85	2.70 – j2.14	22.1	50.0	100	66.0	–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 (°)
2110	2.40 – j5.03	2.65 + j5.25	3.37 – j2.33	19.8	50.8	120	68.0	–28
2140	2.86 – j5.52	3.40 + j5.87	2.78 – j2.07	20.1	50.6	115	67.9	–31
2170	4.27 – j6.11	4.90 + j6.17	2.70 – j2.14	20.1	50.7	116	67.4	–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.



P1dB – TYPICAL LOAD PULL CONTOURS — 2140 MHz

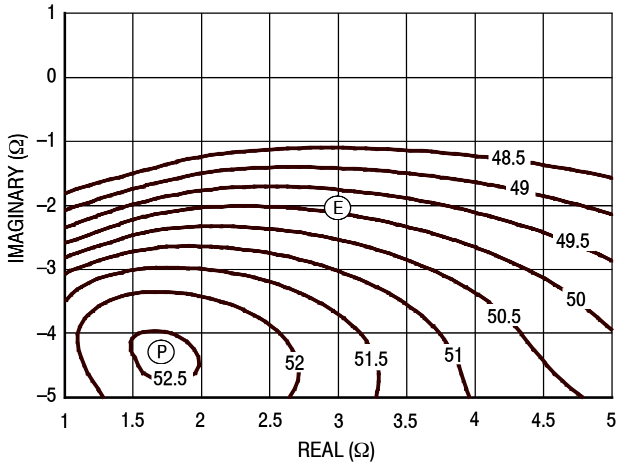


Figure 8. P1dB Load Pull Output Power Contours (dBm)

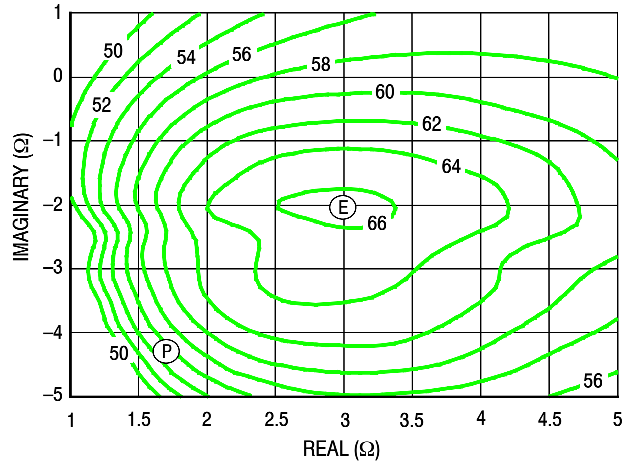


Figure 9. P1dB Load Pull Efficiency Contours (%)

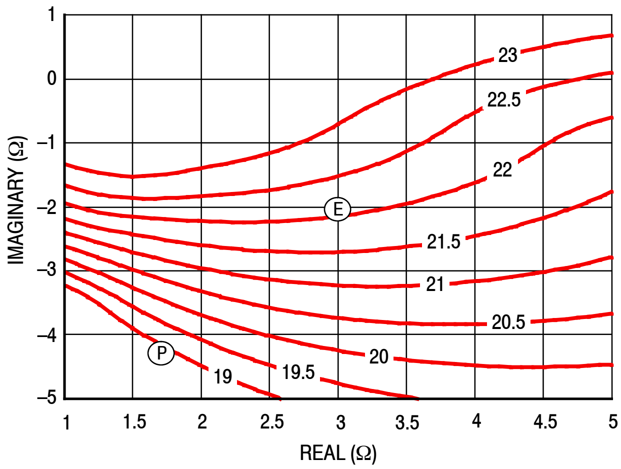


Figure 10. P1dB Load Pull Gain Contours (dB)

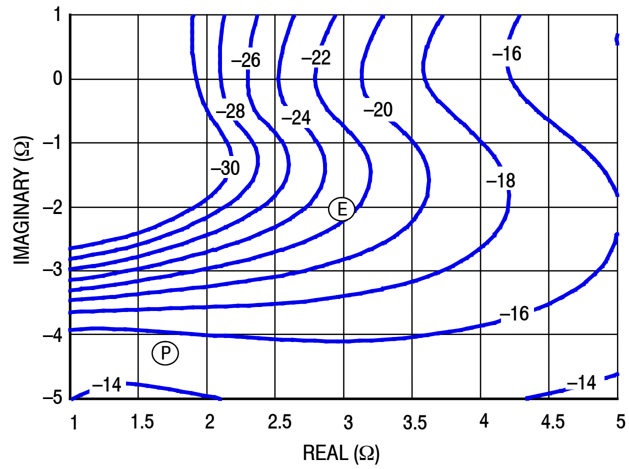


Figure 11. P1dB Load Pull AM/PM Contours (°)

NOTE: P = Maximum Output Power
E = Maximum Drain Efficiency

Gain
Drain Efficiency
Linearity
Output Power

P3dB – TYPICAL LOAD PULL CONTOURS — 2140 MHz

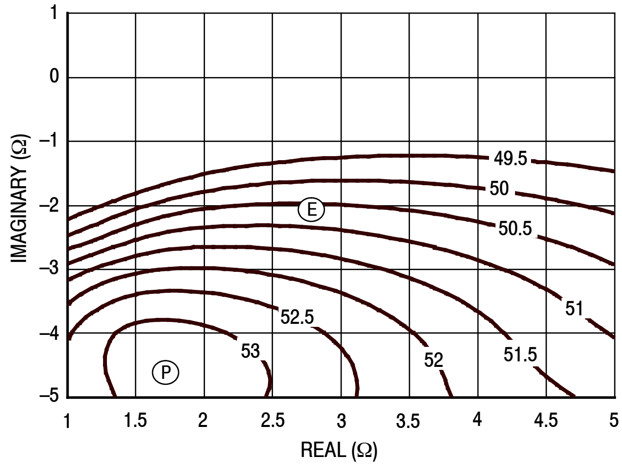


Figure 12. P3dB Load Pull Output Power Contours (dBm)

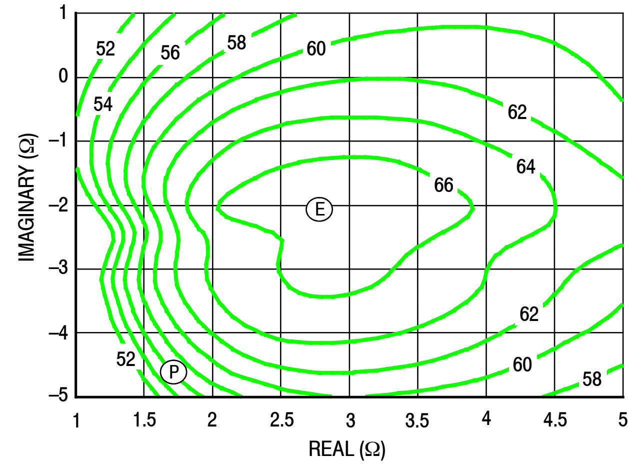


Figure 13. P3dB Load Pull Efficiency Contours (%)

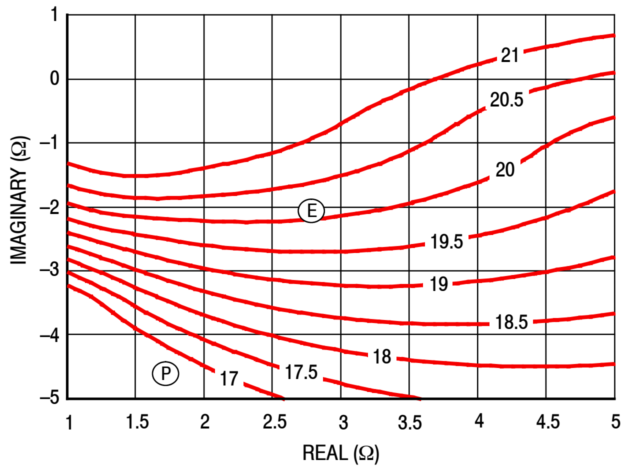


Figure 14. P3dB Load Pull Gain Contours (dB)

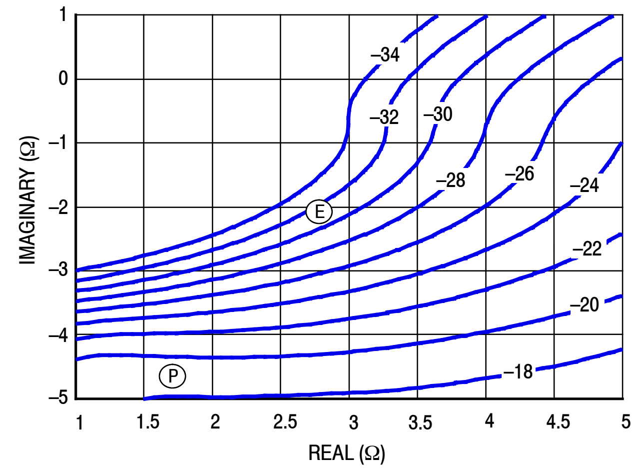
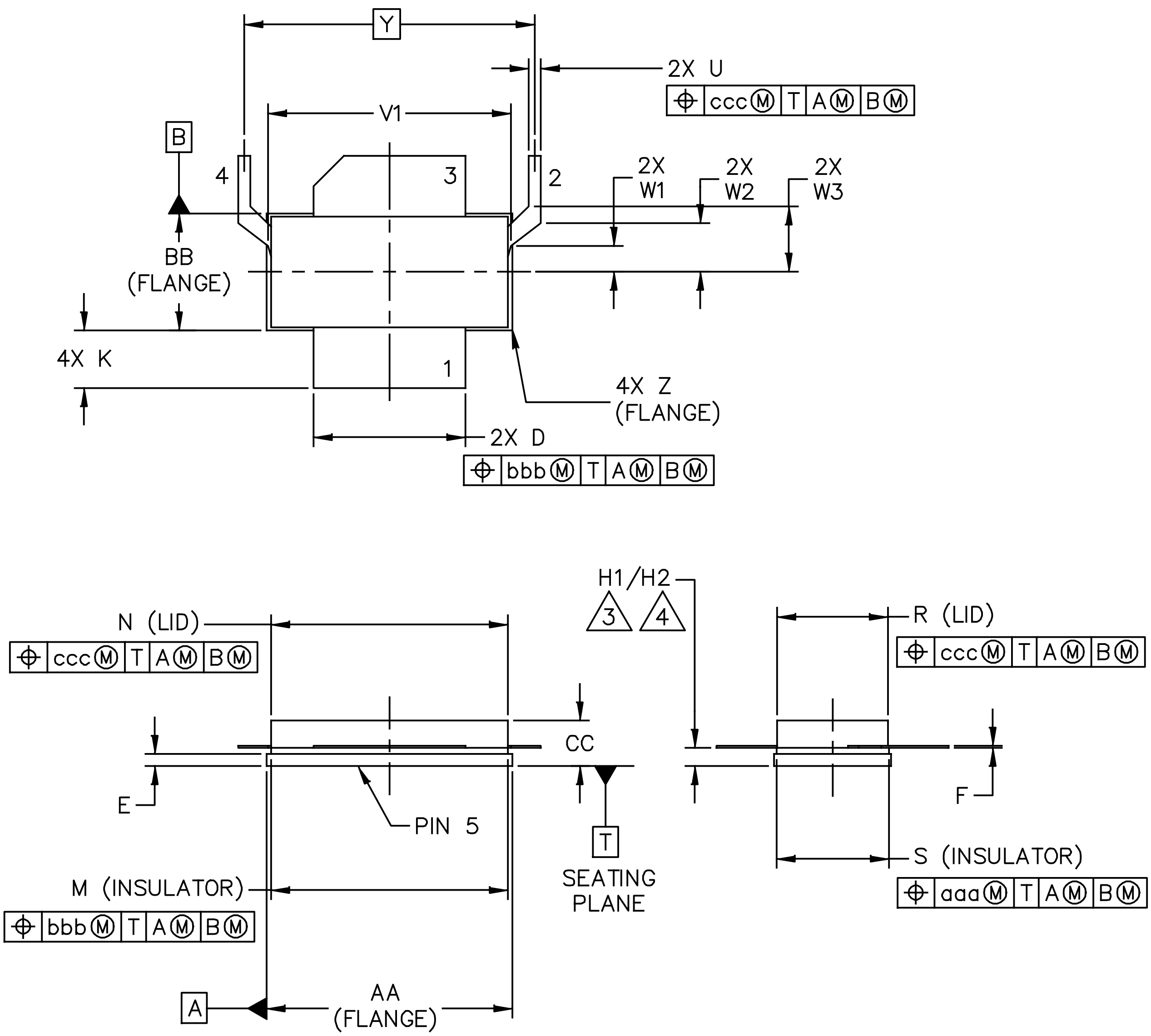


Figure 15. P3dB Load Pull AM/PM Contours (°)

NOTE: (P) = Maximum Output Power
(E) = Maximum Drain Efficiency

Gain
Drain Efficiency
Linearity
Output Power



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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 FLANGE PARALLEL TO DATUM B. H1 APPLIES TO PINS 1 & 3. H2 APPLIES TO PINS 2 & 4.

4. TOLERANCE OF DIMENSION H2 IS TENTATIVE AND COULD CHANGE ONCE SUFFICIENT MANUFACTURING DATA IS AVAILABLE.

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	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	.495	.505	12.57	12.83	V1	.795	.805	20.19	20.45
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	.956 BSC		24.28 BSC	
K	.170	.210	4.32	5.33	Z	R.000	R.040	R0.00	R1.02
M	.774	.786	19.66	19.96	aaa	—	.005 —	—	0.13 —
N	.772	.788	19.61	20.02	bbb	—	.010 —	—	0.25 —
					ccc	—	.015 —	—	0.38 —

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	STANDARD: NON−JEDEC	
		08 MAR 2013

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

To Download Resources Specific to a Given Part Number:

1. Go to http://www.freescale.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	Aug. 2015	• Initial Release of Data Sheet

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Rev. 0, 8/2015

LifeElectronics
Живое партнерство

ООО «ЛайфЭлектроникс» "LifeElectronics" LLC

ИНН 7805602321 КПП 780501001 Р/С 40702810122510004610 ФАКБ "АБСОЛЮТ БАНК" (ЗАО) в г.Санкт-Петербурге К/С 30101810900000000703 БИК 044030703

Компания «Life Electronics» занимается поставками электронных компонентов импортного и отечественного производства от производителей и со складов крупных дистрибьюторов Европы, Америки и Азии.

С конца 2013 года компания активно расширяет линейку поставок компонентов по направлению коаксиальный кабель, кварцевые генераторы и конденсаторы (керамические, пленочные, электролитические), за счёт заключения дистрибьюторских договоров

Мы предлагаем:

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- *Специальные условия для постоянных клиентов.*
- *Подбор аналогов.*
- *Поставку компонентов в любых объемах, удовлетворяющих вашим потребностям.*

- *Приемлемые сроки поставки, возможна ускоренная поставка.*
- *Доставку товара в любую точку России и стран СНГ.*
- *Комплексную поставку.*
- *Работу по проектам и поставку образцов.*
- *Формирование склада под заказчика.*

- *Сертификаты соответствия на поставляемую продукцию (по желанию клиента).*
- *Тестирование поставляемой продукции.*
- *Поставку компонентов, требующих военную и космическую приемку.*
- *Входной контроль качества.*
- *Наличие сертификата ISO.*

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- *Техническую поддержку проекта.*
- *Защиту от снятия компонента с производства.*
- *Оценку стоимости проекта по компонентам.*
- *Изготовление тестовой платы монтаж и пусконаладочные работы.*

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