

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for GSM and GSM EDGE base station applications with frequencies from 1805 to 1880 MHz. Can be used in Class AB and Class C for all typical cellular base station modulation formats.

- Typical GSM Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 800$  mA,  $P_{out} = 72$  Watts CW

Frequency	$G_{ps}$ (dB)	$\eta_D$ (%)
1805 MHz	18.2	49.8
1840 MHz	18.6	51.4
1880 MHz	18.7	53.9

- Capable of Handling 7:1 VSWR, @ 32 Vdc, 1840 MHz, 150 Watts CW Output Power (3 dB Input Overdrive from Rated  $P_{out}$ )
- Typical  $P_{out}$  @ 1 dB Compression Point  $\approx 120$  Watts CW
- Typical GSM EDGE Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 800$  mA,  $P_{out} = 46$  Watts Avg.

Frequency	$G_{ps}$ (dB)	$\eta_D$ (%)	SR1 @ 400 kHz (dBc)	SR2 @ 600 kHz (dBc)	EVM (% rms)
1805 MHz	17.9	41.0	-64	-76	1.6
1840 MHz	18.2	41.9	-63	-76	1.7
1880 MHz	18.3	43.2	-61	-76	2.0

### Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters and Common Source S-Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Optimized for Doherty Applications
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

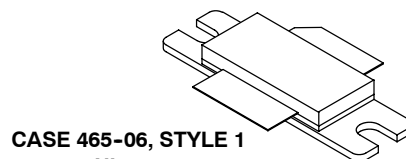
**Table 1. Maximum Ratings**

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	$T_C$	150	°C
Operating Junction Temperature (1,2)	$T_J$	225	°C

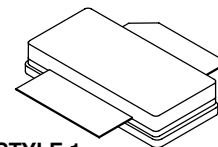
1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

**MRF8S18120HR3**  
**MRF8S18120HSR3**

**1805-1880 MHz, 72 W CW, 28 V**  
**GSM, GSM EDGE**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**



**CASE 465-06, STYLE 1**  
**NI-780**  
**MRF8S18120HR3**



**CASE 465A-06, STYLE 1**  
**NI-780S**  
**MRF8S18120HSR3**

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 79°C, 72 W CW, 28 Vdc, I <sub>DQ</sub> = 800 mA Case Temperature 79°C, 120 W CW, 28 Vdc, I <sub>DQ</sub> = 800 mA	R <sub>θJC</sub>	0.47 0.46	°C/W

**Table 3. ESD Protection Characteristics**

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

**Table 4. Electrical Characteristics** (T<sub>A</sub> = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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**Off Characteristics**

Zero Gate Voltage Drain Leakage Current (V <sub>DS</sub> = 65 Vdc, V <sub>GS</sub> = 0 Vdc)	I <sub>DSS</sub>	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V <sub>DS</sub> = 28 Vdc, V <sub>GS</sub> = 0 Vdc)	I <sub>DSS</sub>	—	—	1	μAdc
Gate-Source Leakage Current (V <sub>GS</sub> = 5 Vdc, V <sub>DS</sub> = 0 Vdc)	I <sub>GSS</sub>	—	—	1	μAdc

**On Characteristics**

Gate Threshold Voltage (V <sub>DS</sub> = 10 Vdc, I <sub>D</sub> = 260 μAdc)	V <sub>GS(th)</sub>	1.2	1.8	2.7	Vdc
Gate Quiescent Voltage (V <sub>DD</sub> = 28 Vdc, I <sub>D</sub> = 800 mAdc, Measured in Functional Test)	V <sub>GS(Q)</sub>	1.8	2.6	3.3	Vdc
Drain-Source On-Voltage (V <sub>GS</sub> = 10 Vdc, I <sub>D</sub> = 2.3 Adc)	V <sub>DS(on)</sub>	0.1	0.2	0.3	Vdc

**Functional Tests** <sup>(3)</sup> (In Freescale Test Fixture, 50 ohm system) V<sub>DD</sub> = 28 Vdc, I<sub>DQ</sub> = 800 mA, P<sub>out</sub> = 72 W CW, f = 1805 MHz

Power Gain	G <sub>ps</sub>	17	18.2	20	dB
Drain Efficiency	η <sub>D</sub>	48	49.8	—	%
Input Return Loss	IRL	—	-11	-8	dB
P <sub>out</sub> @ 1 dB Compression Point, CW	P1dB	112	—	—	W

**Typical Broadband Performance** (In Freescale Test Fixture, 50 ohm system) V<sub>DD</sub> = 28 Vdc, I<sub>DQ</sub> = 800 mA, P<sub>out</sub> = 72 W CW

Frequency	G <sub>ps</sub> (dB)	η <sub>D</sub> (%)	IRL (dB)
1805 MHz	18.2	49.8	-11
1840 MHz	18.6	51.4	-15
1880 MHz	18.7	53.9	-12

1. MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
2. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.
3. Part internally matched both on input and output.

(continued)

**Table 4. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted) (continued)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Typical Performances</b> (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$ , $I_{DQ} = 800\text{ mA}$ , 1805–1880 MHz Bandwidth					
$P_{out}$ @ 1 dB Compression Point, CW	$P_{1dB}$	—	120	—	W
IMD Symmetry @ 94 W PEP, $P_{out}$ where IMD Third Order Intermodulation $\cong 30\text{ dBc}$ (Delta IMD Third Order Intermodulation between Upper and Lower Sidebands $> 2\text{ dB}$ )	$IMD_{sym}$	—	10	—	MHz
VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)	$VBW_{res}$	—	35	—	MHz
Gain Flatness in 75 MHz Bandwidth @ $P_{out} = 72\text{ W CW}$	$G_F$	—	0.5	—	dB
Gain Variation over Temperature ( $-30^\circ\text{C}$ to $+85^\circ\text{C}$ )	$\Delta G$	—	0.01	—	dB/ $^\circ\text{C}$
Output Power Variation over Temperature ( $-30^\circ\text{C}$ to $+85^\circ\text{C}$ )	$\Delta P_{1dB}$	—	0.004	—	dB/ $^\circ\text{C}$

**Typical GSM EDGE Performances** (In Freescale GSM EDGE Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 800\text{ mA}$ ,  $P_{out} = 46\text{ W Avg.}$ , 1805–1880 MHz EDGE Modulation

Frequency	$G_{ps}$ (dB)	$\eta_D$ (%)	SR1 @ 400 kHz (dBc)	SR2 @ 600 kHz (dBc)	EVM (% rms)
1805 MHz	17.9	41.0	-64	-76	1.6
1840 MHz	18.2	41.9	-63	-76	1.7
1880 MHz	18.3	43.2	-61	-76	2.0

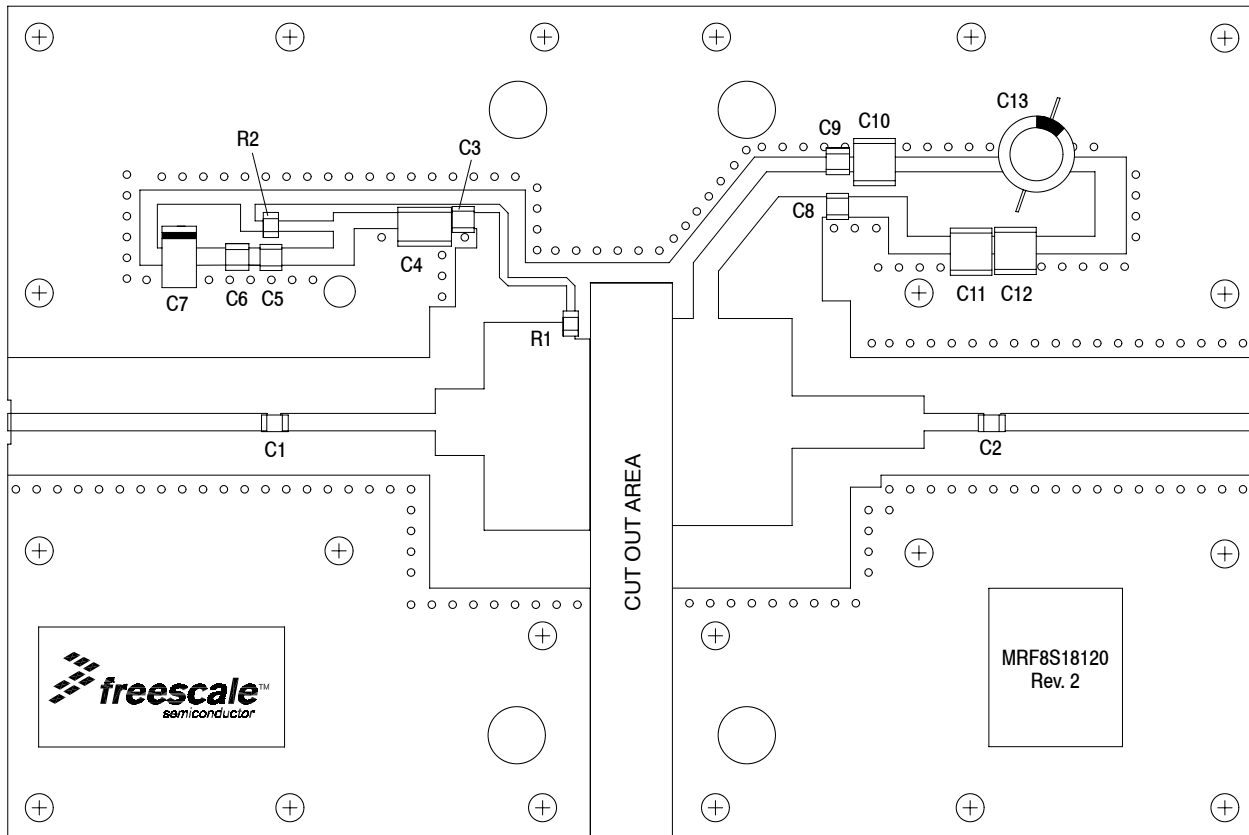
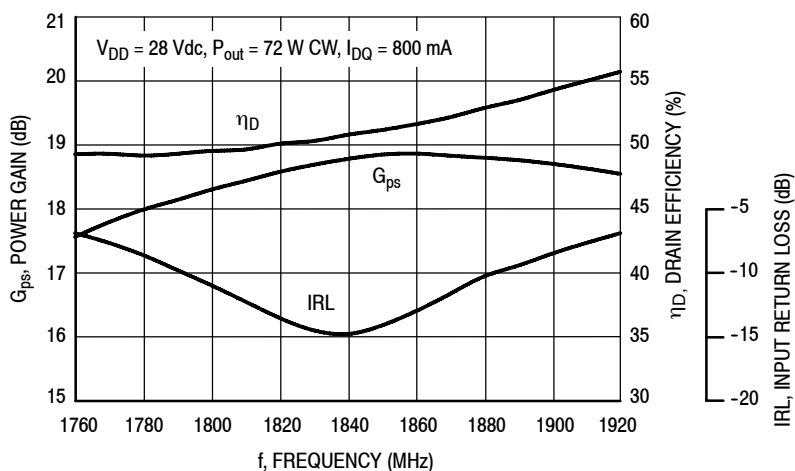


Figure 1. MRF8S18120HR3(HSR3) Test Circuit Component Layout

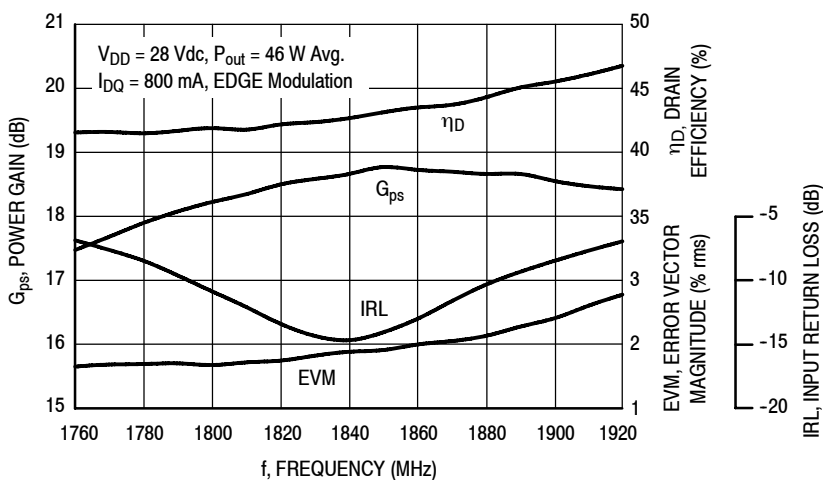
Table 5. MRF8S18120HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	12 pF Chip Capacitors	ATC100B120JT500XT	ATC
C3, C8	9.1 pF Chip Capacitors	ATC100B9R1CT500XT	ATC
C4	10 nF Chip Capacitor	C1825C103K1GAC-TU	Kemet
C5	8.2 pF Chip Capacitor	ATC100B8R2CT500XT	ATC
C6, C9	2.2 $\mu$ F, 100 V Chip Capacitors	C3225X7R2A225KT	TDK
C7	47 $\mu$ F, 16 V Tantalum Capacitor	T491D476K016AT	Kemet
C10, C11, C12	10 $\mu$ F, 50 V Chip Capacitors	GRM55DR61H106KA88L	Murata
C13	330 $\mu$ F, 63 V Electrolytic Capacitor	MCRH63V337M13X21-RH	Multicomp
R1	10 $\Omega$ , 1/4 W Chip Resistor	CRCW120610R0JNEA	Vishay
R2	4.75 $\Omega$ , 1/4 W Chip Resistor	CRCW12064R75FNEA	Vishay
PCB	0.030", $\epsilon_r = 2.55$	250GX-0300-55-22	Arlon

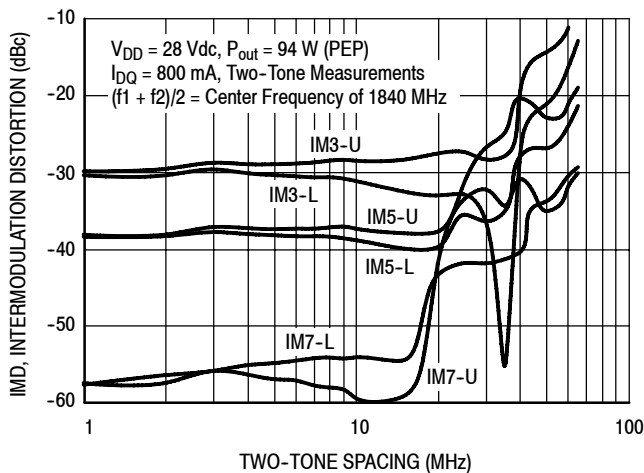
### TYPICAL CHARACTERISTICS



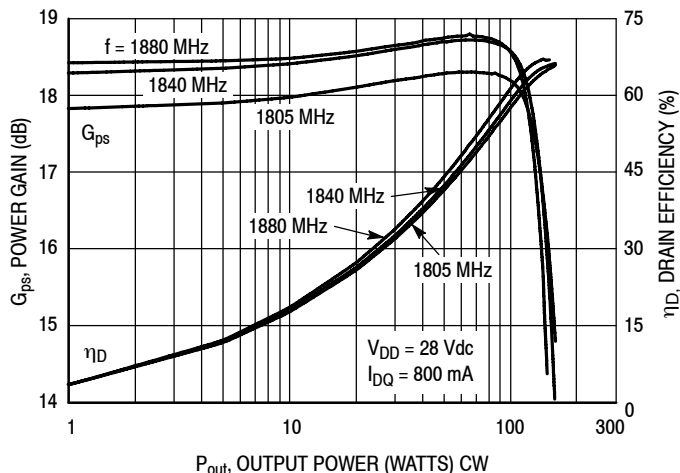
**Figure 2. Power Gain, Input Return Loss and Drain Efficiency versus Frequency @  $P_{out} = 72$  Watts CW**



**Figure 3. Power Gain, Input Return Loss, EVM and Drain Efficiency versus Frequency @  $P_{out} = 46$  Watts Avg.**



**Figure 4. Intermodulation Distortion Products versus Two-Tone Spacing**



**Figure 5. Power Gain and Drain Efficiency versus Output Power**

### TYPICAL CHARACTERISTICS

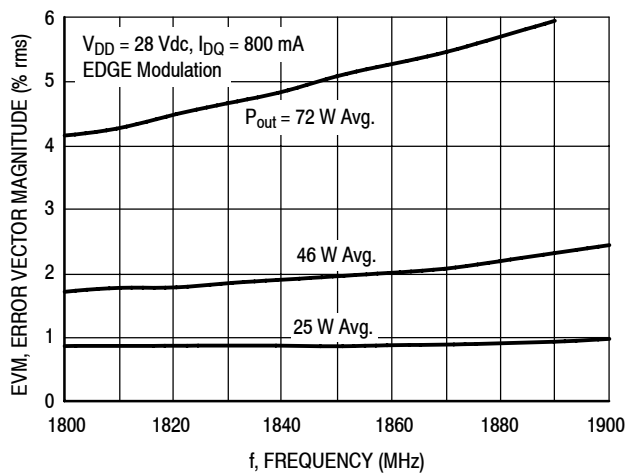


Figure 6. EVM versus Frequency

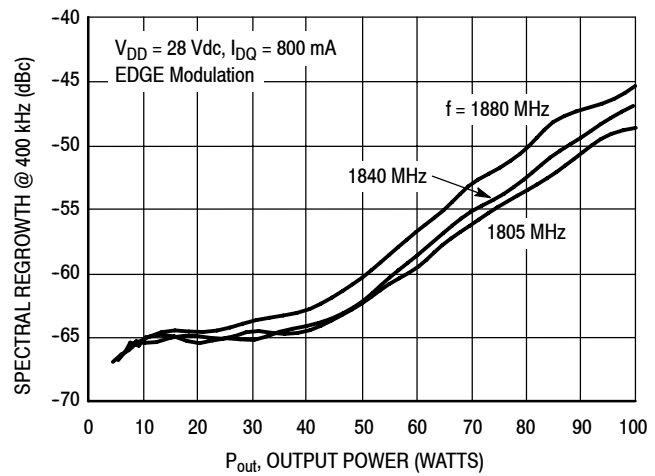


Figure 7. Spectral Regrowth at 400 kHz versus Output Power

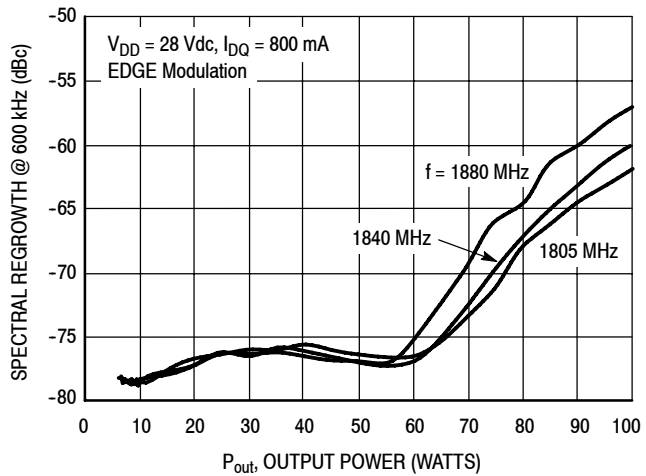


Figure 8. Spectral Regrowth at 600 kHz versus Output Power

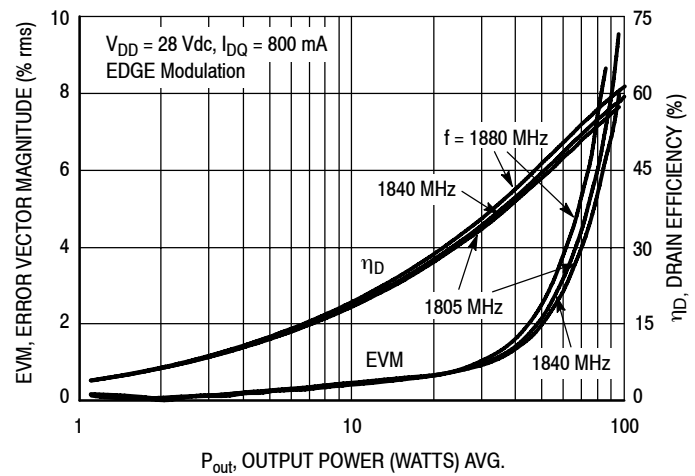


Figure 9. EVM and Drain Efficiency versus Output Power

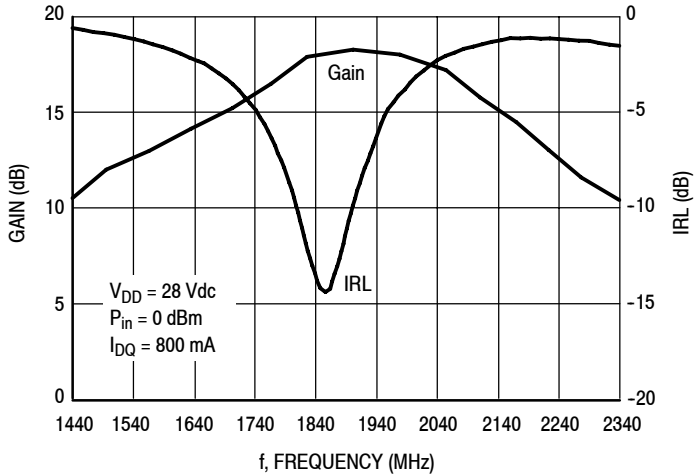


Figure 10. Broadband Frequency Response

### GSM TEST SIGNAL

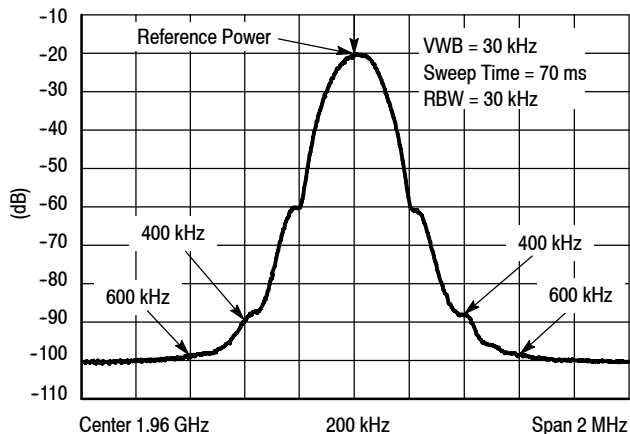


Figure 11. EDGE Spectrum

$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 800 \text{ mA}$ ,  $P_{out} = 72 \text{ W CW}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
1760	1.53 - j1.94	2.32 - j0.41
1780	1.53 - j1.82	2.31 - j0.51
1800	1.56 - j1.90	2.31 - j0.49
1820	1.56 - j1.86	2.32 - j0.40
1840	1.57 - j1.75	2.33 - j0.26
1860	1.51 - j1.64	2.29 - j0.12
1880	1.49 - j1.58	2.29 - j0.01
1900	1.49 - j1.55	2.29 + j0.05
1920	1.48 - j1.53	2.31 + j0.06

$Z_{source}$  = Test circuit impedance as measured from gate to ground.

$Z_{load}$  = Test circuit impedance as measured from drain to ground.

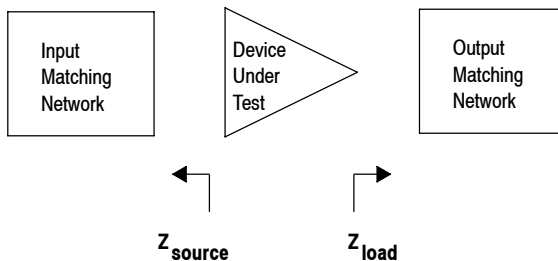
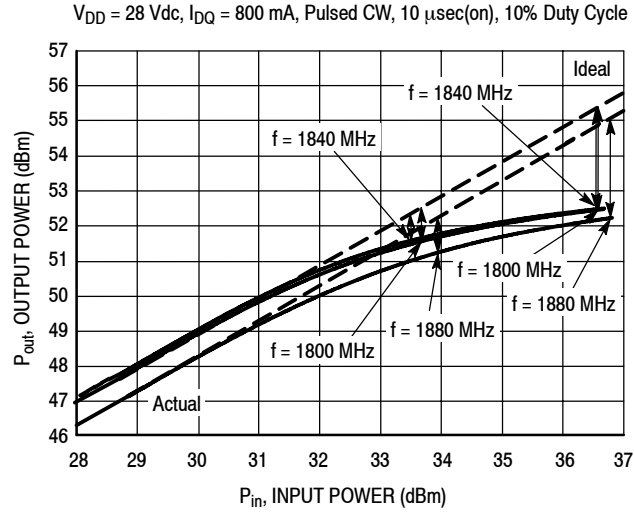


Figure 12. Series Equivalent Source and Load Impedance

## ALTERNATIVE PEAK TUNE LOAD PULL CHARACTERISTICS



NOTE: Load Pull Test Fixture Tuned for Peak P1dB Output Power @ 28 V

f (MHz)	P1dB		P3dB	
	Watts	dBm	Watts	dBm
1805	145	51.6	178	52.5
1840	141	51.5	178	52.5
1880	135	51.3	170	52.3

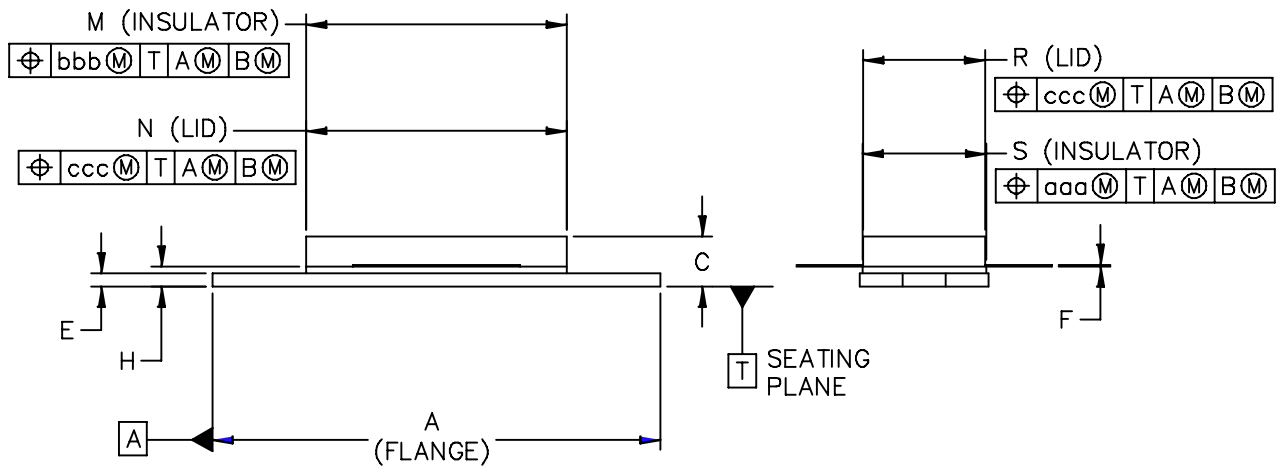
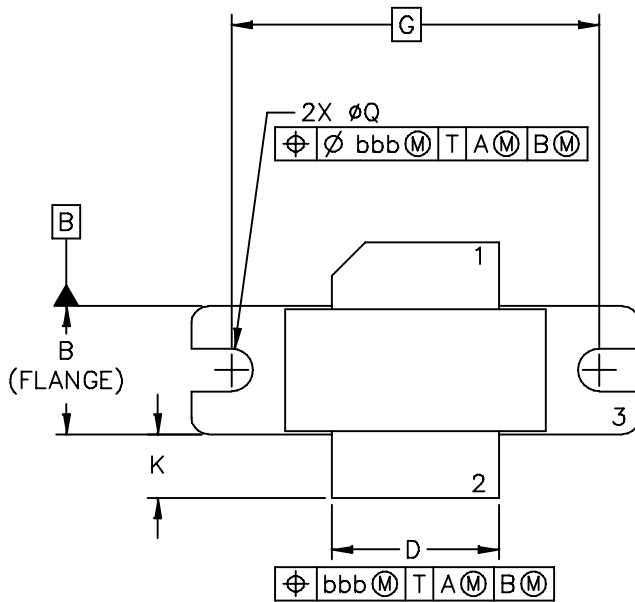
Test Impedances per Compression Level

f (MHz)		$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
1805	P1dB	1.14 - j4.65	1.54 - j2.60
1840	P1dB	1.04 - j4.88	1.49 - j2.75
1880	P1dB	0.94 - j4.59	1.50 - j2.74

**Figure 13. Pulsed CW Output Power versus Input Power @ 28 V**



### PACKAGE DIMENSIONS



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		CASE NUMBER: 465-06		31 MAR 2005	
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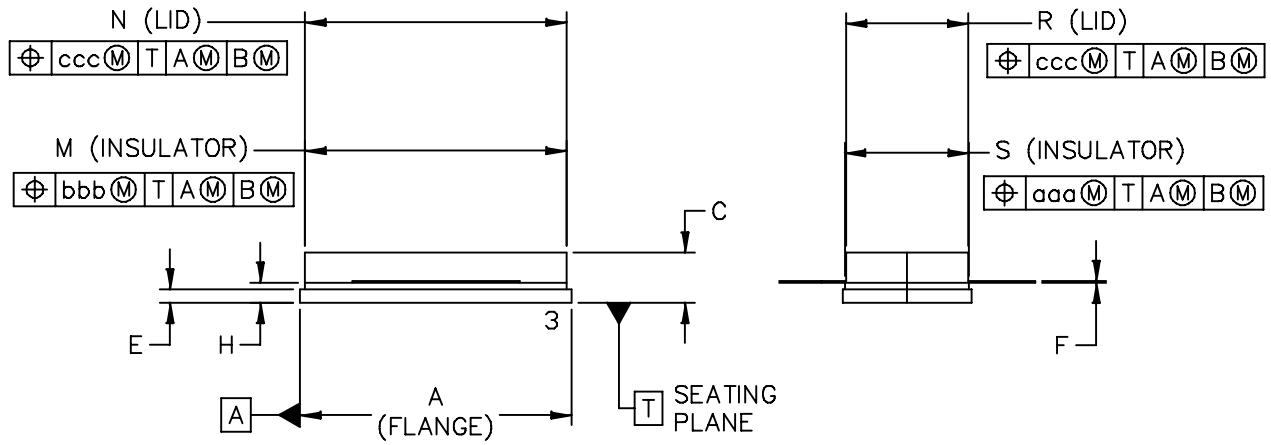
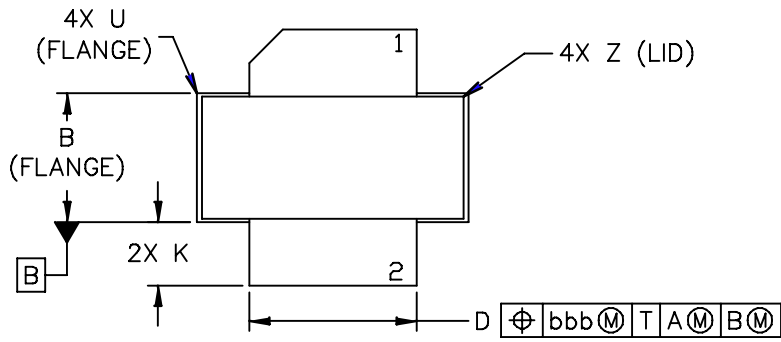
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED .030 (.762) AWAY FROM PACKAGE BODY.

STYLE 1:

- PIN 1. DRAIN  
 2. GATE  
 3. SOURCE

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	1.335	– 1.345	33.91	– 34.16	R	.365	– .375	9.27	– 9.53
B	.380	– .390	9.65	– 9.91	S	.365	– .375	9.27	– 9.52
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	–	–	–	–	–
G	1.100 BSC		27.94 BSC		–	–	–	–	–
H	.057	– .067	1.45	– 1.7	–	–	–	–	–
K	.170	– .210	4.32	– 5.33	–	–	–	–	–
M	.774	– .786	19.66	– 19.96	–	–	–	–	–
N	.772	– .788	19.6	– 20	–	–	–	–	–
Q	∅.118	– ∅.138	∅3	– ∅3.51	–	–	–	–	–
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4. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY.

STYLE 1:

- PIN 1. DRAIN
2. GATE
3. SOURCE

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	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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		STANDARD: NON–JEDEC			

## PRODUCT DOCUMENTATION AND SOFTWARE

Refer to the following documents, tools and software 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

For Software, 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	Sept. 2009	• Initial Release of Data Sheet
1	Oct. 2010	• Changed Human Body Model ESD rating from Class 1A to Class 2 to reflect recent ESD test results of the device, p. 2

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