

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for CDMA and multicarrier GSM base station applications with frequencies from 865 to 960 MHz. Can be used in Class AB and Class C for all typical cellular base station modulation formats.

- Typical Single-Carrier W-CDMA Performance:  $V_{DD} = 28$  Volts,  $I_{DQ} = 1700$  mA,  $P_{out} = 75$  Watts Avg., IQ Magnitude Clipping, Channel Bandwidth = 3.84 MHz, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF.

Frequency	$G_{ps}$ (dB)	$\eta_D$ (%)	Output PAR (dB)	ACPR (dBc)
920 MHz	18.8	36.0	6.3	-39.5
940 MHz	18.7	37.0	6.2	-38.6
960 MHz	18.6	38.5	5.9	-37.1

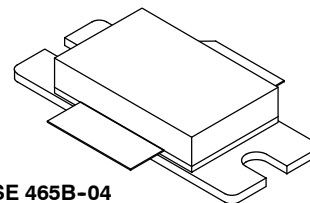
- Capable of Handling 7:1 VSWR, @ 32 Vdc, 940 MHz, 380 Watts CW <sup>(1)</sup> Output Power (3 dB Input Overdrive from Rated  $P_{out}$ ), Designed for Enhanced Ruggedness
- Typical  $P_{out}$  @ 1 dB Compression Point  $\approx$  260 Watts CW

### Features

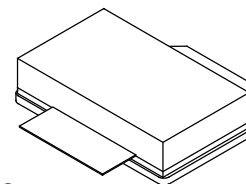
- 100% PAR Tested for Guaranteed Output Power Capability
- Characterized with Series Equivalent Large-Signal Impedance Parameters and Common Source S-Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Optimized for Doherty Applications
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

**MRF8S9260HR3**  
**MRF8S9260HSR3**

**920-960 MHz, 75 W AVG., 28 V**  
**SINGLE W-CDMA**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**



**CASE 465B-04**  
**NI-880**  
**MRF8S9260HR3**



**CASE 465C-03**  
**NI-880S**  
**MRF8S9260HSR3**

**Table 1. Maximum Ratings**

Rating	Symbol	Value	Unit
Drain-Source Voltage	$V_{DSS}$	-0.5, +70	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 <sup>(2,3)</sup>	$T_J$	225	°C
CW Operation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	CW	280 1.5	W W/°C

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value <sup>(3,4)</sup>	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 75 W CW, 28 Vdc, $I_{DQ} = 1800$ mA Case Temperature 80°C, 265 W CW, 28 Vdc, $I_{DQ} = 1100$ mA	$R_{\theta JC}$	0.37 0.31	°C/W

- Exceeds recommended operating conditions. See CW operation data in Maximum Ratings table.
- Continuous use at maximum temperature will affect MTTF.
- MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
- Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.

**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** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

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

Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 70\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	1	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$

**On Characteristics**

Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 400\ \mu\text{Adc}$ )	$V_{GS(th)}$	1.5	2.3	3	Vdc
Gate Quiescent Voltage ( $V_{DD} = 28\text{ Vdc}$ , $I_D = 1700\text{ mAdc}$ , Measured in Functional Test)	$V_{GS(Q)}$	2.4	3.1	3.9	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 4.4\text{ Adc}$ )	$V_{DS(on)}$	0.1	0.2	0.3	Vdc

**Functional Tests** <sup>(1)</sup> (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1700\text{ mA}$ ,  $P_{out} = 75\text{ W Avg.}$ ,  $f = 960\text{ MHz}$ , Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @  $\pm 5\text{ MHz}$  Offset.

Power Gain	$G_{ps}$	17.5	18.6	20.0	dB
Drain Efficiency	$\eta_D$	36.0	38.5	—	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	5.5	5.9	—	dB
Adjacent Channel Power Ratio	ACPR	—	-37.1	-35.0	dBc
Input Return Loss	IRL	—	-14	-9	dB

**Typical Broadband Performance** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ} = 1700\text{ mA}$ ,  $P_{out} = 75\text{ W Avg.}$ , Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 7.5 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @  $\pm 5\text{ MHz}$  Offset.

Frequency	$G_{ps}$ (dB)	$\eta_D$ (%)	Output PAR (dB)	ACPR (dB)	IRL (dB)
920 MHz	18.8	36.0	6.3	-39.5	-16
940 MHz	18.7	37.0	6.2	-38.6	-18
960 MHz	18.6	38.5	5.9	-37.1	-14

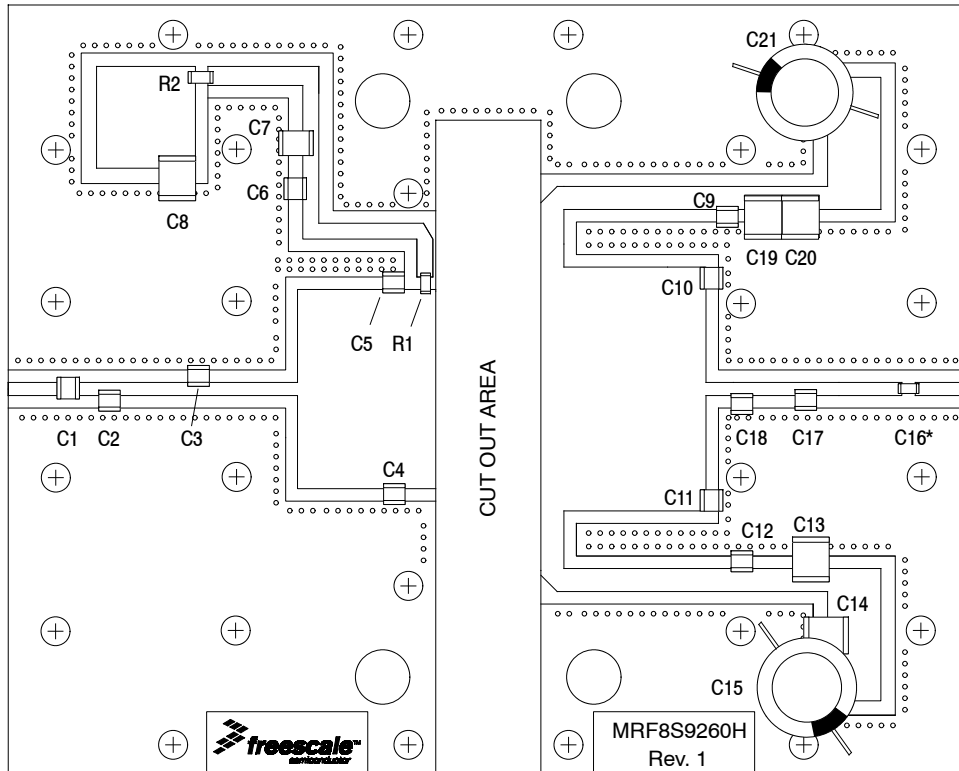
1. Part internally matched both on input and output.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Typical Performance</b> (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$ , $I_{DQ} = 1700\text{ mA}$ , 920-960 MHz Bandwidth					
$P_{out}$ @ 1 dB Compression Point, CW	$P_{1dB}$	—	260	—	W
IMD Symmetry @ 130 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)	$VBW_{res}$	—	50	—	MHz
Gain Flatness in 40 MHz Bandwidth @ $P_{out} = 75\text{ W Avg.}$	$G_F$	—	0.2	—	dB
Gain Variation over Temperature ( $-30^\circ\text{C}$ to $+85^\circ\text{C}$ )	$\Delta G$	—	0.024	—	dB/ $^\circ\text{C}$
Output Power Variation over Temperature ( $-30^\circ\text{C}$ to $+85^\circ\text{C}$ ) (1)	$\Delta P_{1dB}$	—	0.0075	—	dB/ $^\circ\text{C}$

1. Exceeds recommended operating conditions. See CW operation data in Maximum Ratings table.



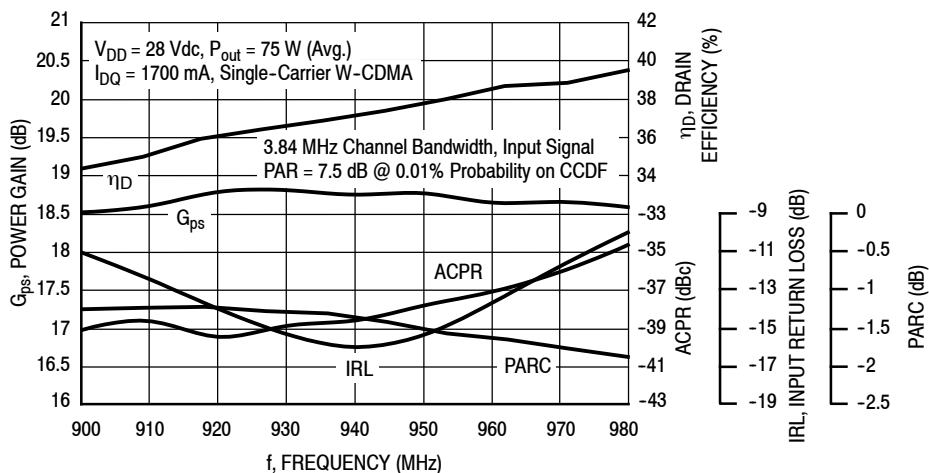
\*C16 is mounted vertically.

**Figure 1. MRF8S9260HR3(HSR3) Test Circuit Component Layout**

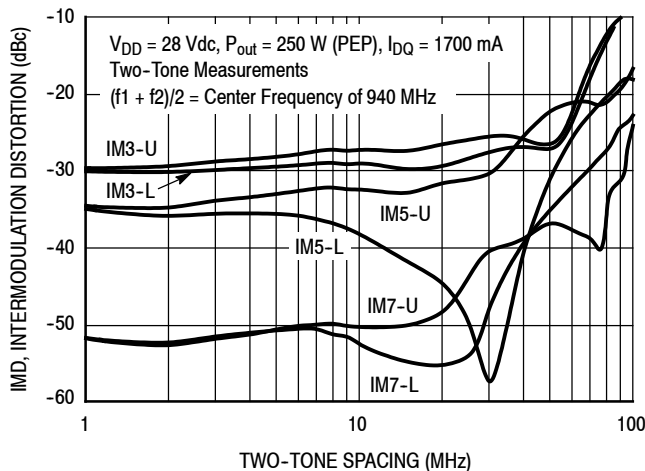
**Table 5. MRF8S9260HR3(HSR3) Test Circuit Component Designations and Values**

Part	Description	Part Number	Manufacturer
C1, C6, C9, C12, C16	36 pF Chip Capacitors	ATC100B360JT500XT	ATC
C2	0.4 pF Chip Capacitor	ATC100B0R4BT500XT	ATC
C3	4.7 pF Chip Capacitor	ATC100B4R7BT500XT	ATC
C4, C5	8.2 pF Chip Capacitors	ATC100B8R2BT500XT	ATC
C7	4.7 $\mu$ F, 50 V Chip Capacitor	C4532X5R1H475MT	TDK
C8, C13, C14, C19, C20	10 $\mu$ F, 50 V Chip Capacitors	C5750X5R1H106MT	TDK
C10, C11	5.6 pF Chip Capacitors	ATC100B5R6BT500XT	ATC
C15, C21	470 $\mu$ F, 63 V Electrolytic Capacitors	477KXM063M	Illinois Capacitor
C17	4.3 pF Chip Capacitor	ATC100B4R3BT500XT	ATC
C18	0.8 pF Chip Capacitor	ATC100B0R8BT500XT	ATC
R1	10 $\Omega$ , 1/4 W Chip Resistor	CRCW120610R0JKEA	Vishay
R2	0 $\Omega$ , 3.5 A Chip Resistor	CRCW12060000Z0EA	Vishay
PCB	0.030", $\epsilon_r = 3.5$	RF-35	Taconic

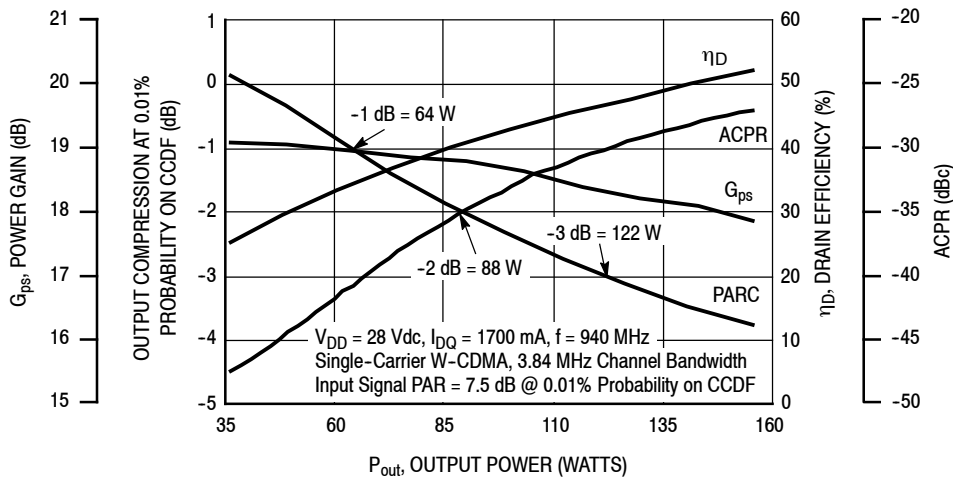
### TYPICAL CHARACTERISTICS



**Figure 2. Output Peak-to-Average Ratio Compression (PARC) Broadband Performance @ P<sub>out</sub> = 75 Watts Avg.**

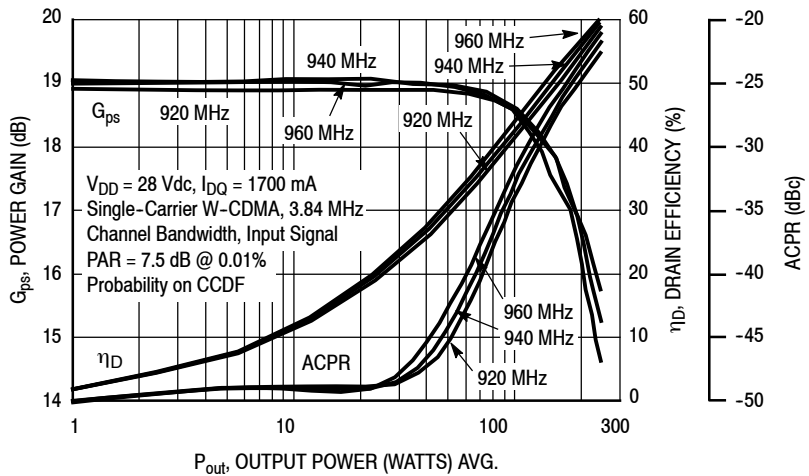


**Figure 3. Intermodulation Distortion Products versus Two-Tone Spacing**

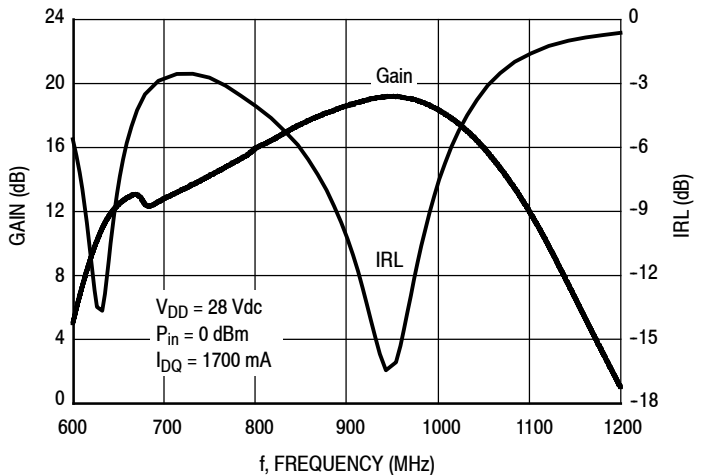


**Figure 4. Output Peak-to-Average Ratio Compression (PARC) versus Output Power**

### TYPICAL CHARACTERISTICS

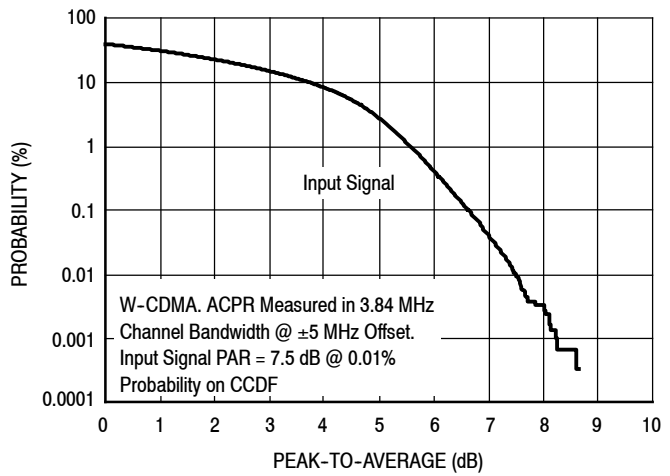


**Figure 5. Single-Carrier W-CDMA Power Gain, Drain Efficiency and ACPR versus Output Power**

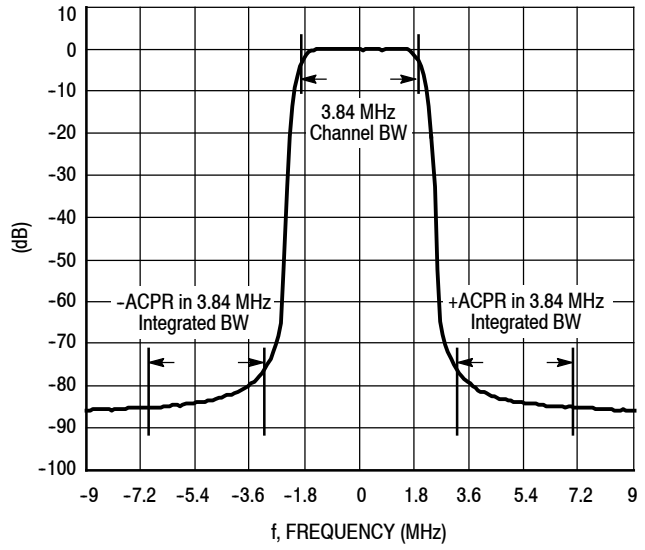


**Figure 6. Broadband Frequency Response**

### W-CDMA TEST SIGNAL



**Figure 7. CCDF W-CDMA IQ Magnitude Clipping, Single-Carrier Test Signal**



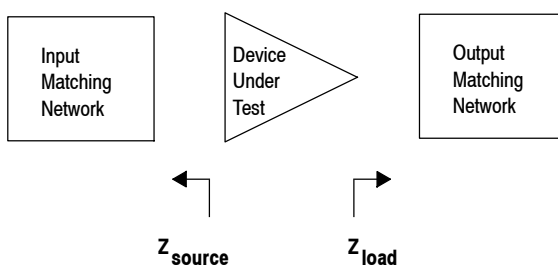
**Figure 8. Single-Carrier W-CDMA Spectrum**

$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 1700 \text{ mA}$ ,  $P_{out} = 75 \text{ W Avg.}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
820	$2.25 - j2.59$	$1.93 - j1.63$
840	$2.21 - j2.51$	$1.91 - j1.45$
860	$2.16 - j2.46$	$1.90 - j1.28$
880	$2.11 - j2.40$	$1.90 - j1.14$
900	$1.98 - j2.37$	$1.91 - j1.02$
920	$1.87 - j2.29$	$1.90 - j0.91$
940	$1.75 - j2.23$	$1.89 - j0.83$
960	$1.61 - j2.14$	$1.87 - j0.76$
980	$1.46 - j2.03$	$1.84 - j0.69$

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

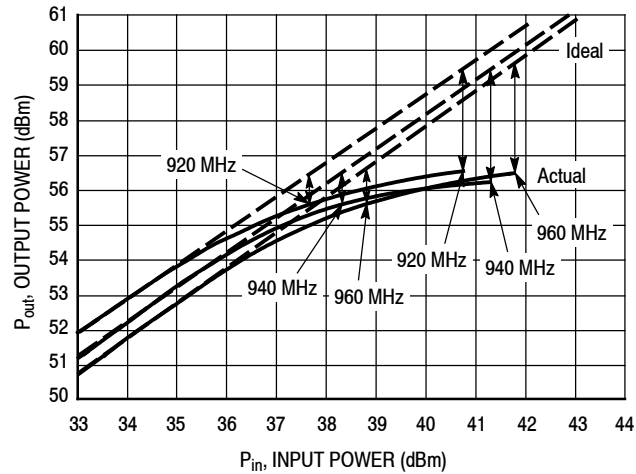
$Z_{load}$  = Test circuit impedance as measured from drain to ground.



**Figure 9. Series Equivalent Source and Load Impedance**

## ALTERNATIVE PEAK TUNE LOAD PULL CHARACTERISTICS

$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 1700 \text{ mA}$ , Pulsed CW, 10  $\mu\text{sec}(\text{on})$ , 10% Duty Cycle



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

f (MHz)	P1dB		P3dB	
	Watts	dBm	Watts	dBm
920	363	55.6	447	56.5
940	363	55.6	417	56.2
960	363	55.6	437	56.4

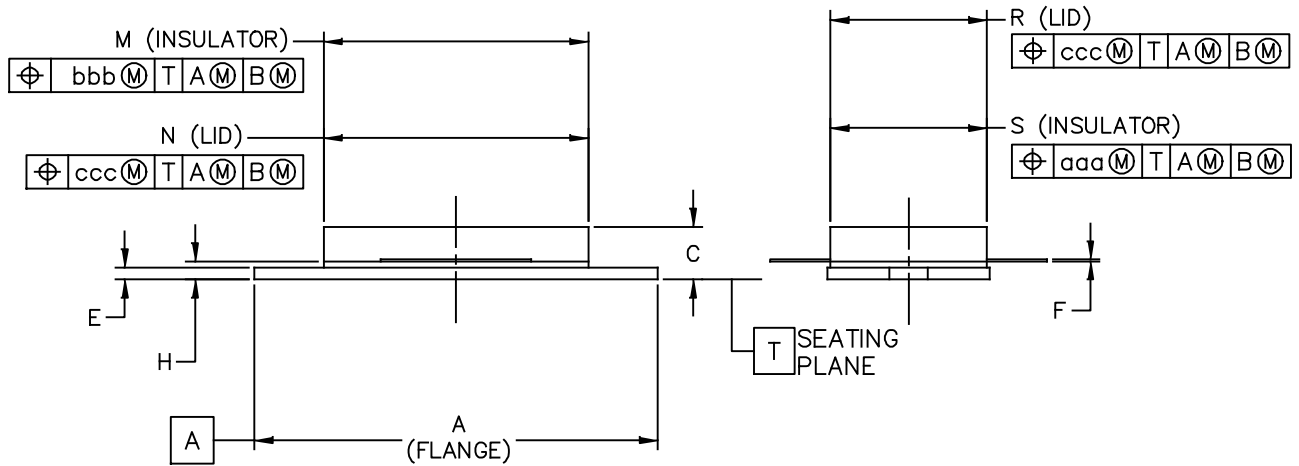
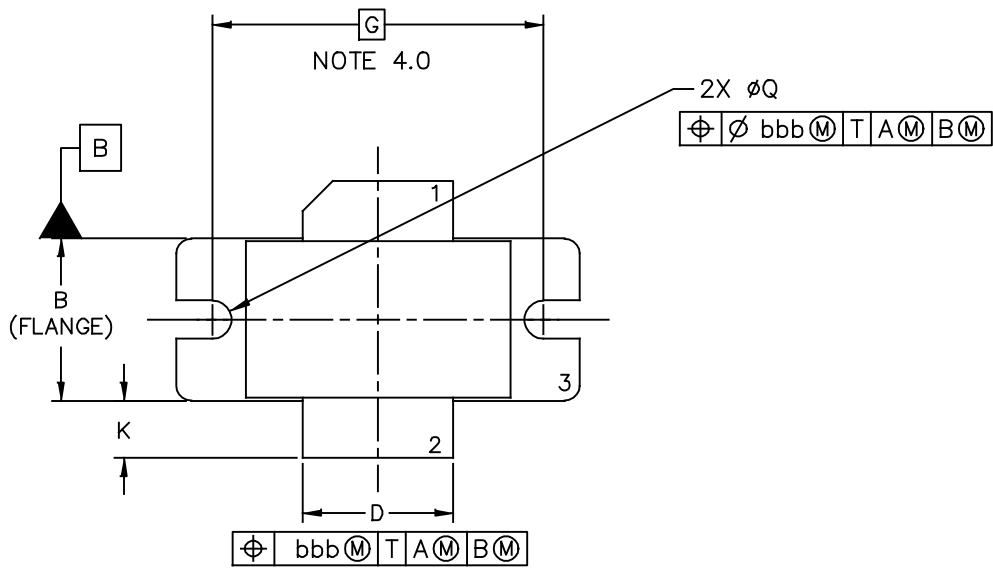
Test Impedances per Compression Level

f (MHz)		$Z_{\text{source}}$ $\Omega$	$Z_{\text{load}}$ $\Omega$
920	P1dB	$0.94 - j2.68$	$2.19 - j2.10$
940	P1dB	$1.18 - j2.65$	$2.18 - j2.52$
960	P1dB	$1.24 - j3.10$	$2.72 - j2.11$

**Figure 10. Pulsed CW Output Power versus Input Power @ 28 V**



### PACKAGE DIMENSIONS

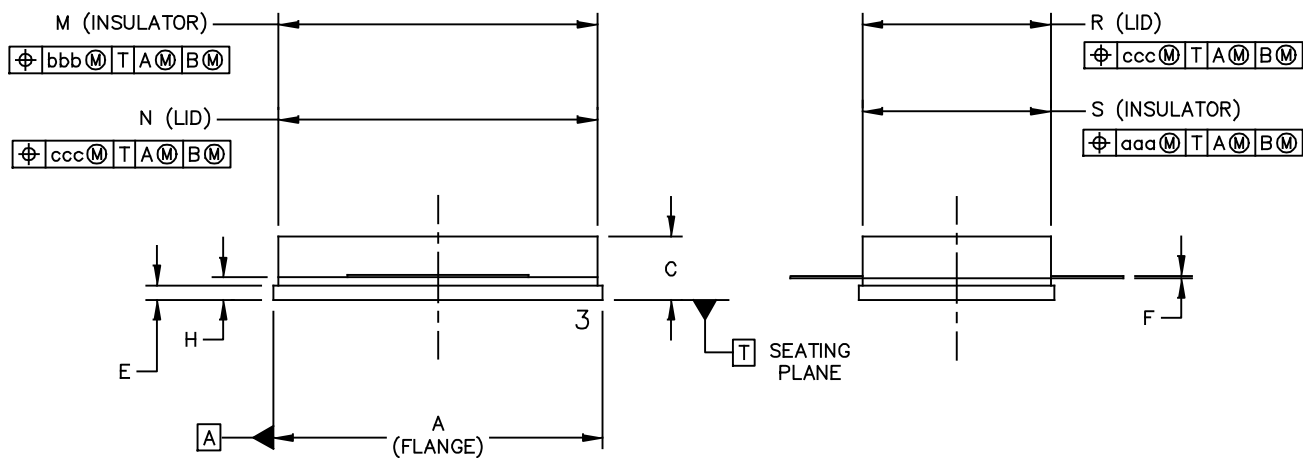
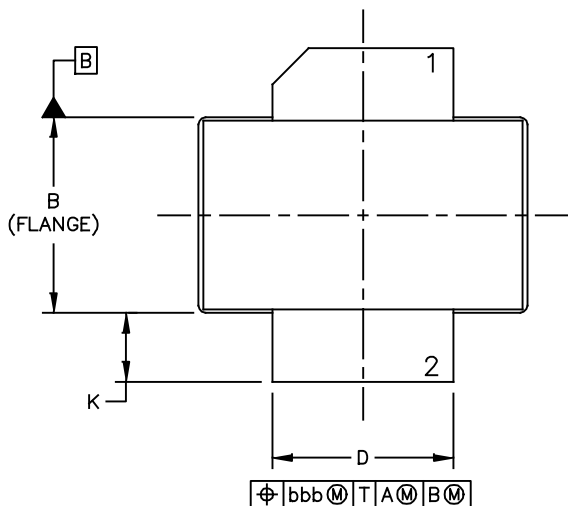


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	CASE NUMBER: 465B-04	26 MAY 2011	
	STANDARD: NON-JEDEC		

NOTES:

- 1.0 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
- 2.0 CONTROLLING DIMENSION: INCH.
- 3.0 DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY.
- 4.0 RECOMMENDED BOLT CENTER DIMENSION OF 1.16 (29.57) BASED ON M3 SCREW.

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	1.335	1.345	33.91	34.16	R	.515	-.525	13.08	- 13.34
B	.535	.545	13.59	13.84	S	.515	-.525	13.08	- 13.34
C	.147	.200	3.73	5.08	aaa	-	.007	-	- 0.178
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	1.70	-	-	-	-	- - -
K	.175	.205	4.45	5.21	-	-	-	-	- - -
M	.872	.888	22.15	22.56	-	-	-	-	- - -
N	.871	.889	22.12	22.58	-	-	-	-	- - -
Q	∅.118	∅.138	∅3.00	∅3.51	-	-	-	-	- - -
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	STANDARD: NON-JEDEC		

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY.

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
A	.905	– .915	22.99	– 23.24	aaa	– .007	–	– 0.178	–
B	.535	– .545	13.59	– 13.84	bbb	– .010	–	– 0.254	–
C	.147	– .200	3.73	– 5.08	ccc	– .015	–	– 0.381	–
D	.495	– .505	12.57	– 12.83	–	–	–	–	–
E	.035	– .045	0.89	– 1.14	–	–	–	–	–
F	.003	– .006	0.08	– 0.15	–	–	–	–	–
H	.057	– .067	1.45	– 1.70	–	–	–	–	–
K	.170	– .210	4.32	– 5.33	–	–	–	–	–
M	.872	– .888	22.15	– 22.56	–	–	–	–	–
N	.871	– .889	22.12	– 22.58	–	–	–	–	–
R	.515	– .525	13.08	– 13.34	–	–	–	–	–
S	.515	– .525	13.08	– 13.34	–	–	–	–	–

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		CASE NUMBER: 465C–03		26 MAY 2011	
		STANDARD: NON–JEDEC			

## PRODUCT DOCUMENTATION, TOOLS 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 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	Dec. 2009	<ul style="list-style-type: none"> <li>• Initial Release of Data Sheet</li> </ul>
1	Feb. 2012	<ul style="list-style-type: none"> <li>• Table 3, ESD Protection Characteristics, removed the word “Minimum” after the ESD class rating. ESD ratings are characterized during new product development but are not 100% tested during production. ESD ratings provided in the data sheet are intended to be used as a guideline when handling ESD sensitive devices, p. 2.</li> <li>• Replaced Case Outline 465B-03, Issue D, with 465B-04, Issue F, p. 1, 9-10. Deleted Style 1 pin note on Sheet 2. On Sheet 2, changed dimension B in mm from 13.6-13.8 to 13.59-13.84, changed dimension H in mm from 1.45-1.7 to 1.45-1.70, changed dimension K in mm from 4.44-5.21 to 4.45-5.21, changed dimension M in mm from 22.15-22.55 to 22.15-22.56, changed dimension N in mm from 19.3-22.6 to 22.12-22.58, changed dimension Q in mm from 3-3.51 to 3.00-3.51, changed dimension R and S in mm from 13.1-13.3 to 13.08-13.34.</li> <li>• Replaced Case Outline 465C-02, Issue D, with 465C-03, Issue E, p. 1, 11-12. Deleted Style 1 pin note on Sheet 2. On Sheet 2, changed dimension B in mm from 13.6-13.8 to 13.59-13.84, changed dimension H in mm from 1.45-1.7 to 1.45-1.70, changed dimension M in mm from 22.15-22.55 to 22.15-22.56, changed dimension N in mm from 19.3-22.6 to 22.12-22.58, changed dimension R and S in mm from 13.1-13.3 to 13.08-13.34.</li> </ul>

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