

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for W-CDMA base station applications with frequencies from 2110 to 2170 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications. To be used in Class AB for PCN-PCS/cellular radio and WLL applications.

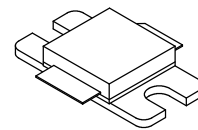
- Typical 2-carrier W-CDMA Performance for  $V_{DD} = 28$  Volts,  $I_{DQ} = 500$  mA,  $f = 2157.5$  MHz, Channel Bandwidth = 3.84 MHz, Adjacent Channels measured over 3.84 MHz Bandwidth at  $f_1 - 5$  MHz and  $f_2 + 5$  MHz, Distortion Products measured over a 3.84 MHz Bandwidth at  $f_1 - 10$  MHz and  $f_2 + 10$  MHz, Peak/Avg. = 8.3 dB @ 0.01% Probability on CCDF.  
Output Power — 10 Watts Avg.  
Efficiency — 23.5%  
Gain — 15 dB  
IM3 — -37.5 dBc  
ACPR — -41 dBc
- Capable of Handling 5:1 VSWR, @ 28 Vdc, 2140 MHz, 45 Watts CW Output Power

### Features

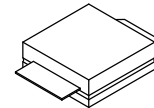
- Internally Matched for Ease of Use
- High Gain, High Efficiency and High Linearity
- Integrated ESD Protection
- Designed for Maximum Gain and Insertion Phase Flatness
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Low Gold Plating Thickness on Leads, 40 $\mu$ m Nominal.
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 32 mm, 13 Inch Reel.

**MRF21045LR3**  
**MRF21045LSR3**

**2110-2170 MHz, 45 W, 28 V**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETs**



**CASE 465E-04, STYLE 1**  
**NI-400**  
**MRF21045LR3**



**CASE 465F-04, STYLE 1**  
**NI-400S**  
**MRF21045LSR3**

**Table 1. Maximum Ratings**

Rating	Symbol	Value	Unit
Drain-Source Voltage	$V_{DSS}$	-0.5, +65	Vdc
Gate-Source Voltage	$V_{GS}$	-0.5, +15	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25 $^\circ\text{C}$	$P_D$	105 0.60	W W/ $^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$
Case Operating Temperature	$T_C$	150	$^\circ\text{C}$
Operating Junction Temperature	$T_J$	200	$^\circ\text{C}$

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value <sup>(1)</sup>	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.65	$^\circ\text{C}/\text{W}$

**Table 3. ESD Protection Characteristics**

Test Conditions	Class
Human Body Model	1 (Minimum)
Machine Model	M2 (Minimum)

1. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>.  
Select Documentation/Application Notes - AN1955.

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Off Characteristics</b>					
Drain-Source Breakdown Voltage ( $V_{GS} = 0 \text{ Vdc}$ , $I_D = 100 \mu\text{Adc}$ )	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ( $V_{DS} = 28 \text{ Vdc}$ , $V_{GS} = 0 \text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5 \text{ Vdc}$ , $V_{DS} = 0 \text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$
<b>On Characteristics (DC)</b>					
Gate Threshold Voltage ( $V_{DS} = 10 \text{ Vdc}$ , $I_D = 100 \mu\text{Adc}$ )	$V_{GS(th)}$	2	—	4	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28 \text{ Vdc}$ , $I_D = 500 \text{ mAdc}$ )	$V_{GS(Q)}$	3	3.9	5	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10 \text{ Vdc}$ , $I_D = 1 \text{ Adc}$ )	$V_{DS(on)}$	—	0.19	0.21	Vdc
Forward Transconductance ( $V_{DS} = 10 \text{ Vdc}$ , $I_D = 1 \text{ Adc}$ )	$g_{fs}$	—	3	—	S
<b>Dynamic Characteristics (1)</b>					
Reverse Transfer Capacitance ( $V_{DS} = 28 \text{ Vdc}$ , $V_{GS} = 0$ , $f = 1 \text{ MHz}$ )	$C_{rss}$	—	1.8	—	pF
<b>Functional Tests</b> (In Freescale Test Fixture, 50 ohm system) 2-carrier W-CDMA. Peak/Avg. = 8.3 dB @ 0.01% Probability on CCDF.					
Common-Source Amplifier Power Gain ( $V_{DD} = 28 \text{ Vdc}$ , $P_{out} = 10 \text{ W Avg.}$ , $I_{DQ} = 500 \text{ mA}$ , $f_1 = 2157.5 \text{ MHz}$ , $f_2 = 2167.5 \text{ MHz}$ )	$G_{ps}$	13.5	15	—	dB
Drain Efficiency ( $V_{DD} = 28 \text{ Vdc}$ , $P_{out} = 10 \text{ W Avg.}$ , $I_{DQ} = 500 \text{ mA}$ , $f_1 = 2157.5 \text{ MHz}$ , $f_2 = 2167.5 \text{ MHz}$ )	$\eta$	21	23.5	—	%
Third Order Intermodulation Distortion ( $V_{DD} = 28 \text{ Vdc}$ , $P_{out} = 10 \text{ W Avg.}$ , $I_{DQ} = 500 \text{ mA}$ , $f_1 = 2157.5 \text{ MHz}$ , $f_2 = 2167.5 \text{ MHz}$ ; IM3 measured over 3.84 MHz Bandwidth at $f_1 - 10 \text{ MHz}$ and $f_2 + 10 \text{ MHz}$ .)	IM3	—	-37.5	-35	dBc
Adjacent Channel Power Ratio ( $V_{DD} = 28 \text{ Vdc}$ , $P_{out} = 10 \text{ W Avg.}$ , $I_{DQ} = 500 \text{ mA}$ , $f_1 = 2157.5 \text{ MHz}$ , $f_2 = 2167.5 \text{ MHz}$ ; ACPR measured over 3.84 MHz Bandwidth at $f_1 - 5 \text{ MHz}$ and $f_2 + 5 \text{ MHz}$ .)	ACPR	—	-41	-38	dBc
Input Return Loss ( $V_{DD} = 28 \text{ Vdc}$ , $P_{out} = 10 \text{ W Avg.}$ , $I_{DQ} = 500 \text{ mA}$ , $f_1 = 2157.5 \text{ MHz}$ , $f_2 = 2167.5 \text{ MHz}$ )	IRL	—	-12	-9	dB

1. Part is internally matched both on input and output.

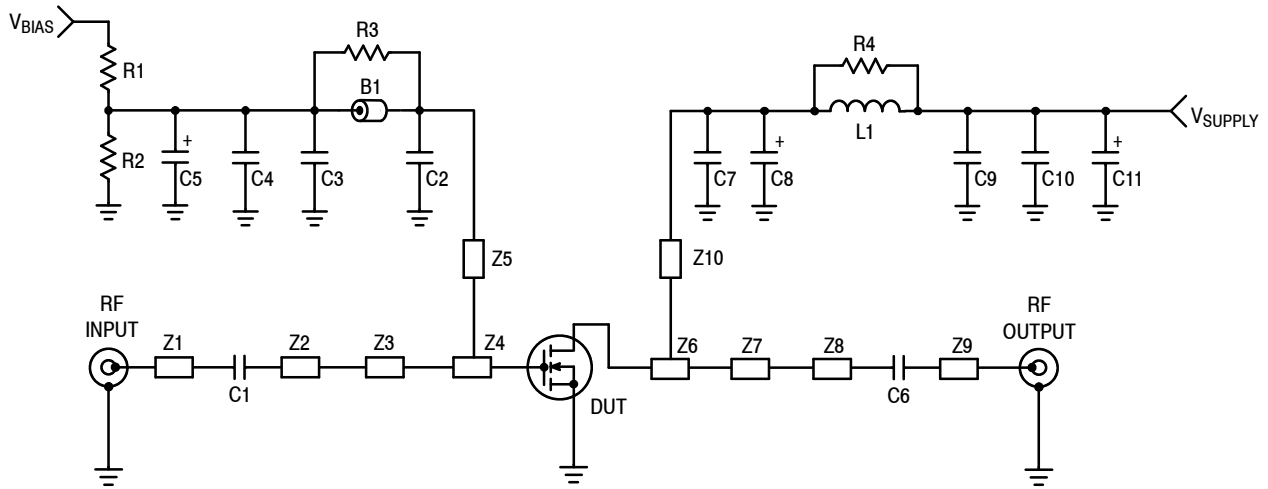
(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Functional Tests</b> (In Freescale Test Fixture, 50 ohm system) — continued					
Two-Tone Common-Source Amplifier Power Gain ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 45\text{ W PEP}$ , $I_{DQ} = 500\text{ mA}$ , $f_1 = 2110\text{ MHz}$ , $f_2 = 2120\text{ MHz}$ and $f_1 = 2160\text{ MHz}$ , $f_2 = 2170\text{ MHz}$ )	$G_{ps}$	—	14.9	—	dB
Two-Tone Drain Efficiency ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 45\text{ W PEP}$ , $I_{DQ} = 500\text{ mA}$ , $f_1 = 2110\text{ MHz}$ , $f_2 = 2120\text{ MHz}$ and $f_1 = 2160\text{ MHz}$ , $f_2 = 2170\text{ MHz}$ )	$\eta$	—	36	—	%
Intermodulation Distortion ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 45\text{ W PEP}$ , $I_{DQ} = 500\text{ mA}$ , $f_1 = 2110\text{ MHz}$ , $f_2 = 2120\text{ MHz}$ and $f_1 = 2160\text{ MHz}$ , $f_2 = 2170\text{ MHz}$ )	IMD	—	-30	—	dBc
Two-Tone Input Return Loss ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 45\text{ W PEP}$ , $I_{DQ} = 500\text{ mA}$ , $f_1 = 2110\text{ MHz}$ , $f_2 = 2120\text{ MHz}$ and $f_1 = 2160\text{ MHz}$ , $f_2 = 2170\text{ MHz}$ )	IRL	—	-12	—	dB
$P_{out, 1\text{ dB}}$ Compression Point ( $V_{DD} = 28\text{ Vdc}$ , $I_{DQ} = 500\text{ mA}$ , $f = 2170\text{ MHz}$ )	$P_{1\text{dB}}$	—	50	—	W

NOT RECOMMENDED FOR NEW DESIGN

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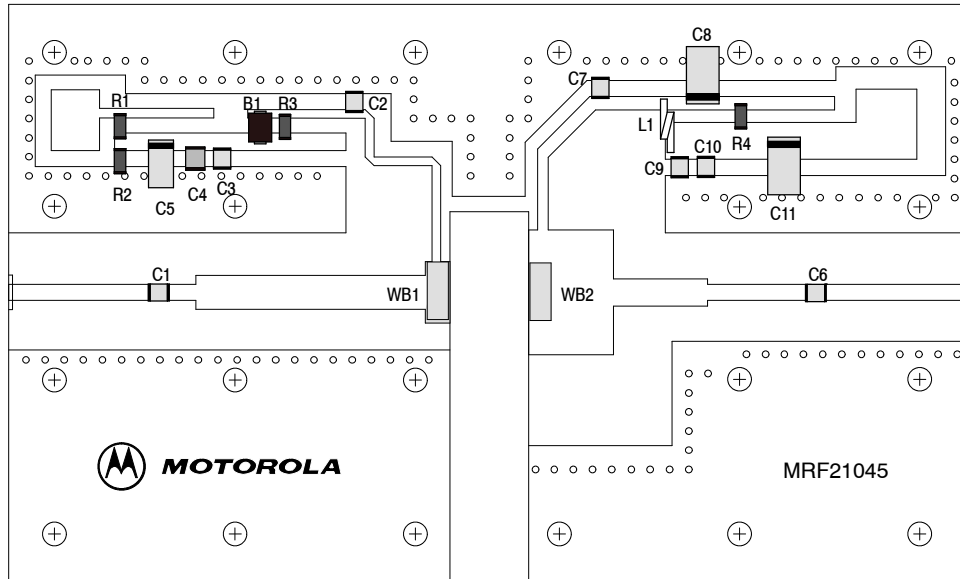


Z1, Z9	0.750" x 0.084" Transmission Line	Board	0.030" Glass Teflon <sup>®</sup> ,
Z2	0.160" x 0.084" Transmission Line	PCB	Keene GX-0300-55-22, $\epsilon_r = 2.55$
Z3	1.195" x 0.176" Transmission Line		Etched Circuit Boards
Z4	0.125" x 0.320" Transmission Line		MRF21045 Rev. 3, CMR
Z5	1.100" x 0.045" Transmission Line		
Z6	0.442" x 0.650" Transmission Line		
Z7	0.490" x 0.140" Transmission Line		
Z8	0.540" x 0.084" Transmission Line		
Z10	0.825" x 0.055" Transmission Line		

**Figure 1. MRF21045LR3(SR3) Test Circuit Schematic**

**Table 5. MRF21045LR3(SR3) Component Designations and Values**

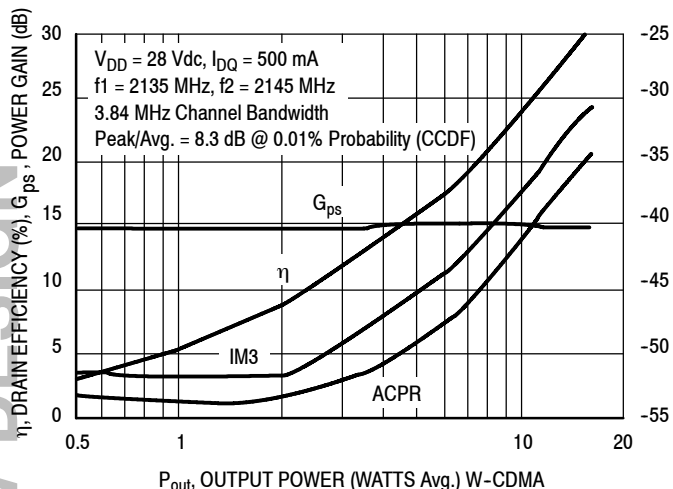
Designators	Description
B1	Short Ferrite Bead, Fair Rite, #2743019447
C1, C2, C6	43 pF Chip Capacitors, ATC #100B430JCA500X
C7	5.6 pF Chip Capacitor, ATC #100B5R6JCA500X
C3, C9	1000 pF Chip Capacitors, ATC #100B102JCA500X
C4, C10	0.1 $\mu$ F Chip Capacitors, Kemet #CDR33BX104AKWS
C5	1.0 $\mu$ F Tantalum Chip Capacitor, Kemet #T491C105M050
C8	10 $\mu$ F Tantalum Chip Capacitor, Kemet #T495X106K035AS4394
C11	22 $\mu$ F Tantalum Chip Capacitor, Kemet #T491X226K035AS4394
L1	1 Turn, #20 AWG, 0.100" ID
N1, N2	Type N Flange Mounts, Omni Spectra #3052-1648-10
R1	1.0 k $\Omega$ , 1/8 W Chip Resistor
R2	180 k $\Omega$ , 1/8 W Chip Resistor
R3, R4	10 $\Omega$ , 1/8 W Chip Resistors



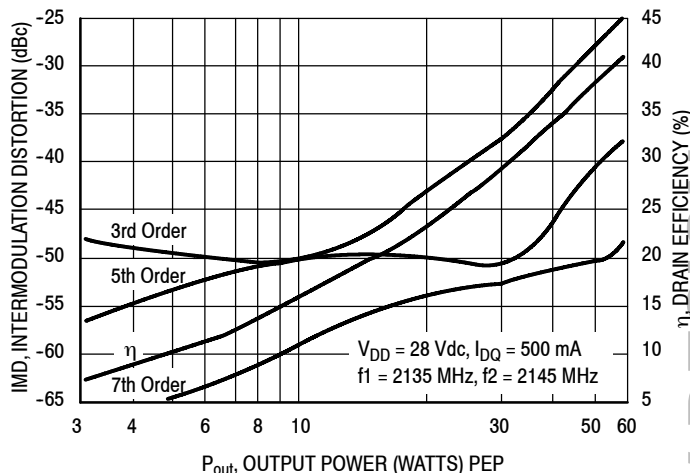
Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

**Figure 2. MRF21045LR3(SR3) Test Circuit Component Layout**

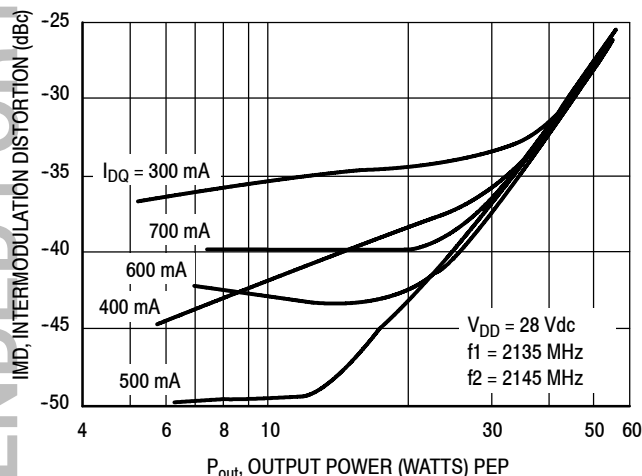
## TYPICAL CHARACTERISTICS



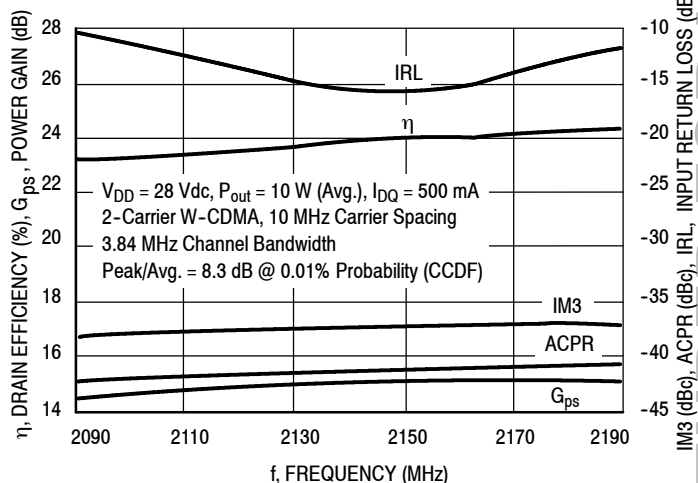
**Figure 3. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**



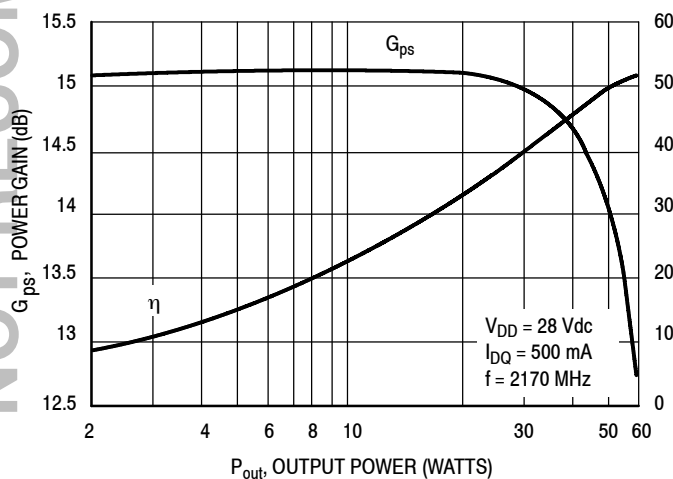
**Figure 4. Intermodulation Distortion Products versus Output Power**



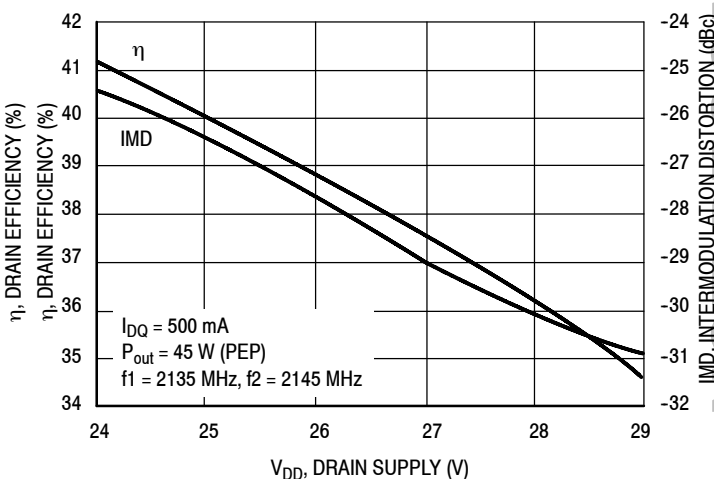
**Figure 5. Intermodulation Distortion versus Output Power**



**Figure 6. 2-Carrier W-CDMA Broadband Performance**

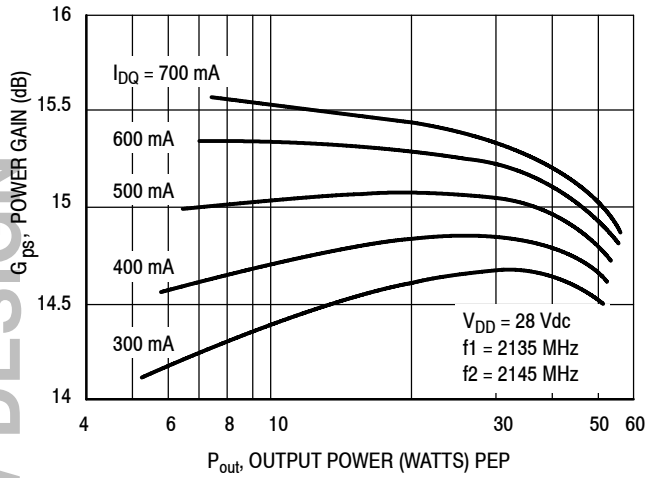


**Figure 7. CW Performance**

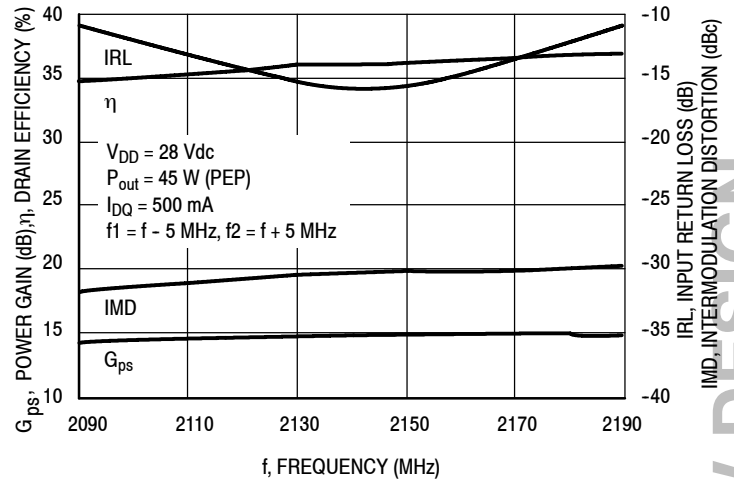


**Figure 8. Two-Tone Intermodulation Distortion and Drain Efficiency versus Drain Supply**

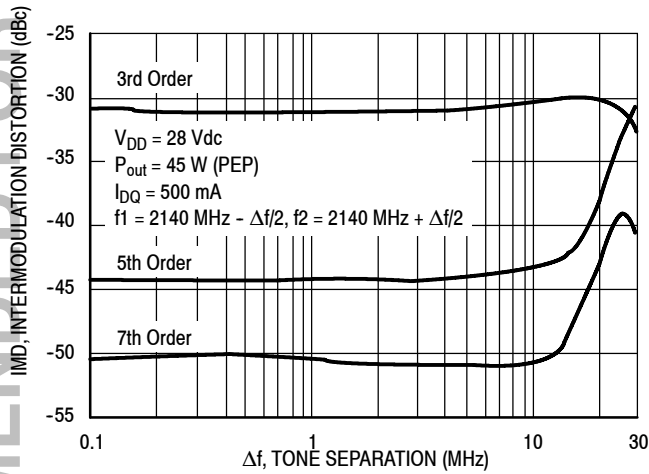
## TYPICAL CHARACTERISTICS



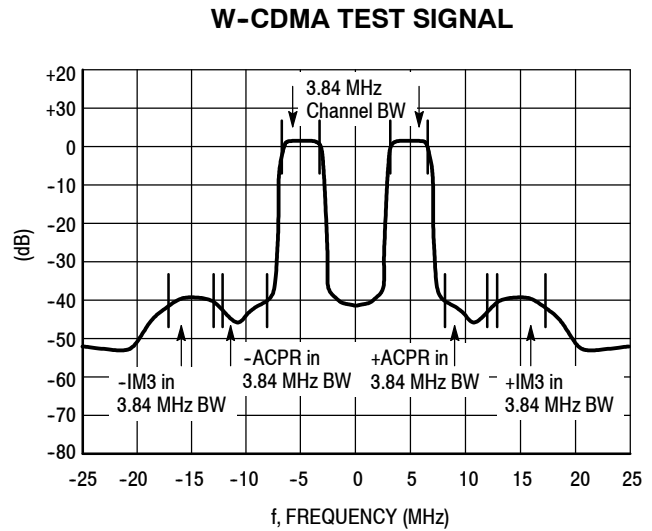
**Figure 9. Two-Tone Power Gain versus Output Power**



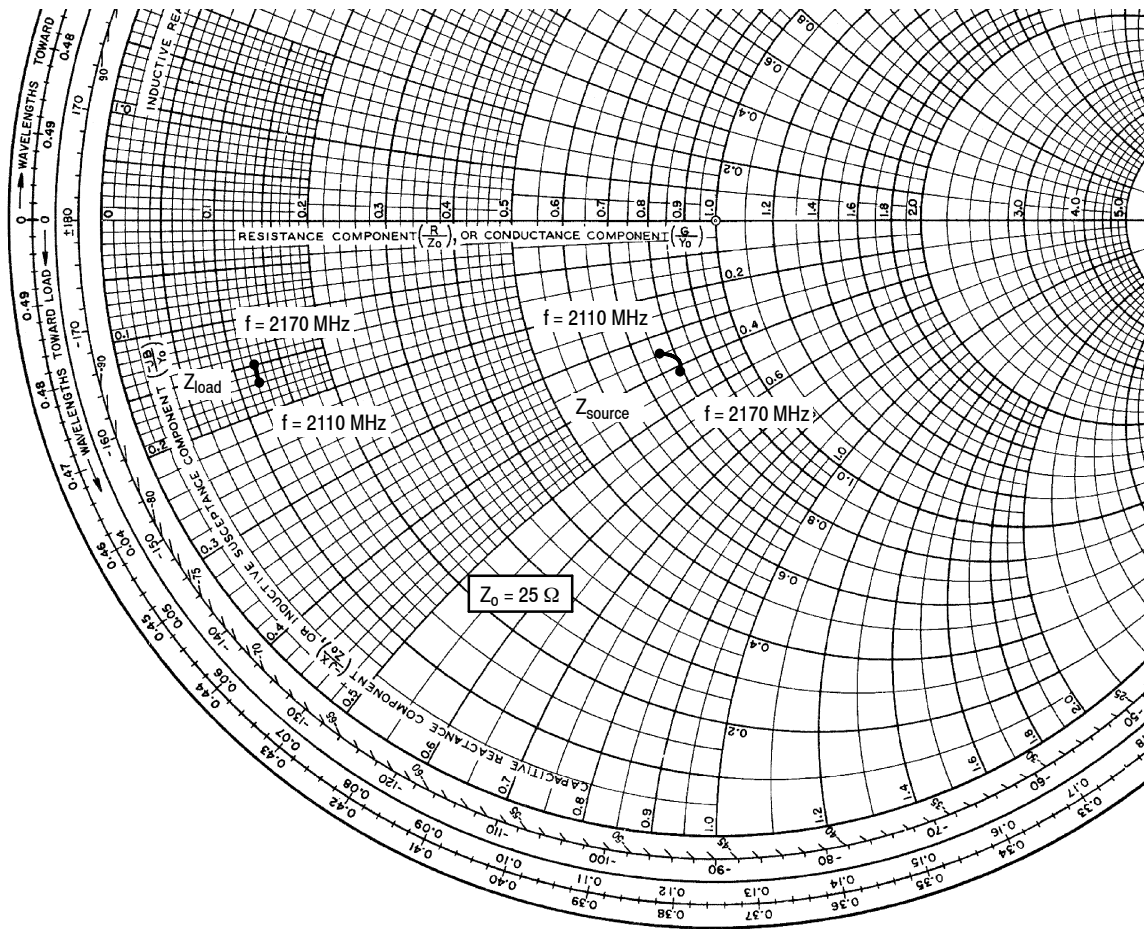
**Figure 10. Two-Tone Broadband Performance**



**Figure 11. Intermodulation Distortion Products versus Two-Tone Spacing**



**Figure 12. 2-Carrier W-CDMA Spectrum**



$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ} = 500 \text{ mA}$ ,  $P_{out} = 10 \text{ W Avg.}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
2110	$18.88 - j8.86$	$3.11 - j4.18$
2140	$19.80 - j9.93$	$3.09 - j3.87$
2170	$19.68 - j10.44$	$3.12 - j3.72$

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

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

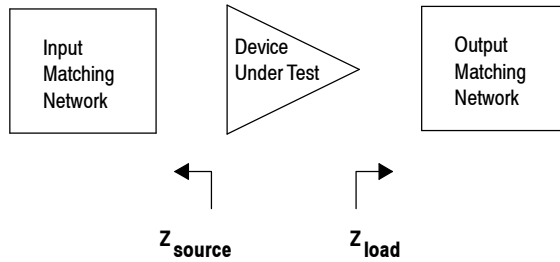
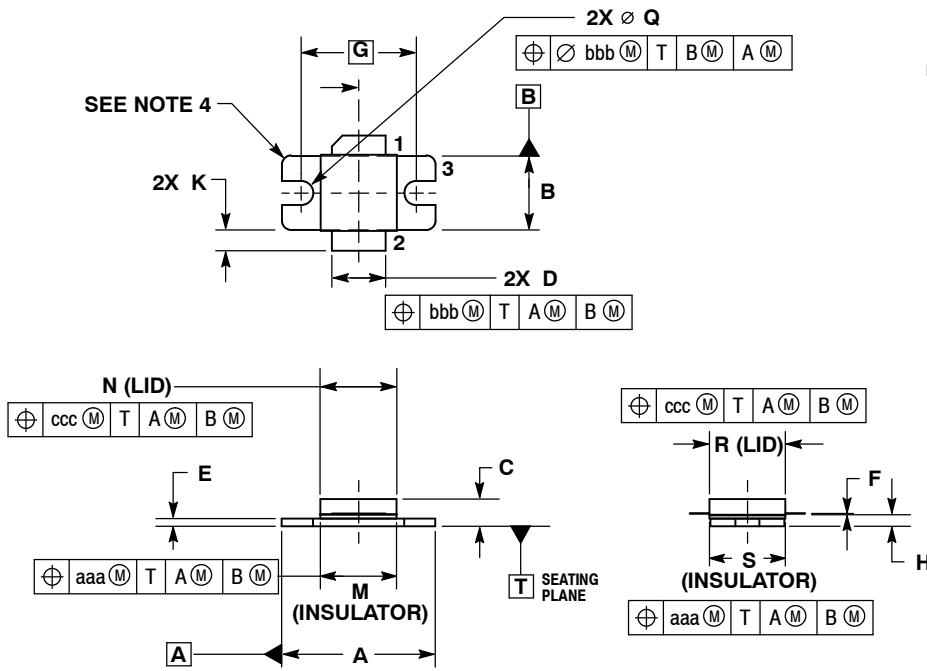


Figure 13. Series Equivalent Source and Load Impedance



**PACKAGE DIMENSIONS**

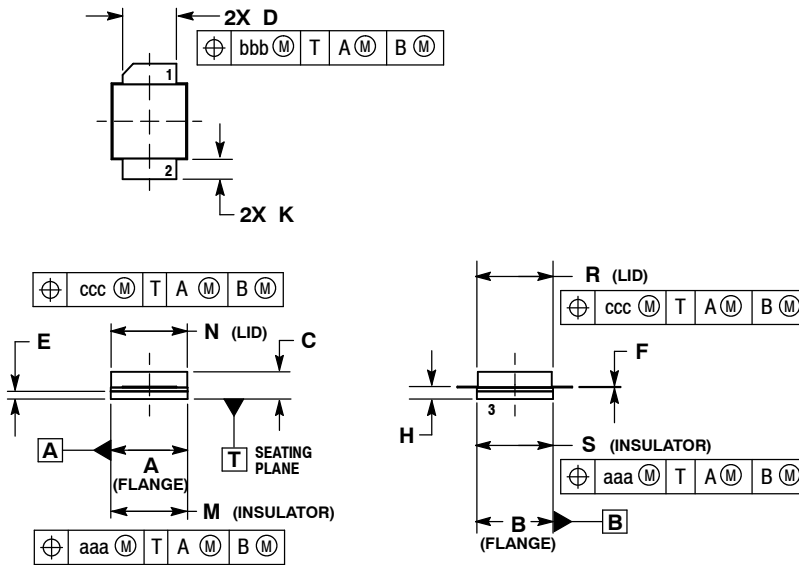


- NOTES:
1. CONTROLLING DIMENSION: INCH.
  2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
  3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
  4. INFORMATION ONLY: CORNER BREAK (4X) TO BE .060±.005 (1.52±0.13) RADIUS OR .06±.005 (1.52±0.13) x 45° CHAMFER.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.795	.805	20.19	20.44
B	.380	.390	9.65	9.9
C	.125	.163	3.17	4.14
D	.275	.285	6.98	7.24
E	.035	.045	0.89	1.14
F	.004	.006	0.10	0.15
G	.600 BSC		15.24 BSC	
H	.057	.067	1.45	1.7
K	.092	.122	2.33	3.1
M	.395	.405	10	10.3
N	.395	.405	10	10.3
Q	$\varnothing$ .120	$\varnothing$ .130	$\varnothing$ 3.05	$\varnothing$ 3.3
R	.395	.405	10	10.3
S	.395	.405	10	10.3
aaa	.005 BSC		0.127 BSC	
bbb	.010 BSC		0.254 BSC	
ccc	.015 BSC		0.381 BSC	

- STYLE 1:
- PIN 1. DRAIN
  - GATE
  - SOURCE

**CASE 465E-04  
ISSUE F  
NI-400  
MRF21045LR3**



- NOTES:
1. CONTROLLING DIMENSION: INCH.
  2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
  3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.395	.405	10.03	10.29
B	.395	.405	10.03	10.29
C	.125	.163	3.18	4.14
D	.275	.285	6.98	7.24
E	.035	.045	0.89	1.14
F	.004	.006	0.10	0.15
H	.057	.067	1.45	1.70
K	.092	.122	2.34	3.10
M	.395	.405	10.03	10.29
N	.395	.405	10.03	10.29
R	.395	.405	10.03	10.29
S	.395	.405	10.03	10.29
aaa	.005 REF		0.127 REF	
bbb	.010 REF		0.254 REF	
ccc	.015 REF		0.38 REF	

- STYLE 1:
- PIN 1. DRAIN
  - GATE
  - SOURCE

**CASE 465F-04  
ISSUE E  
NI-400S  
MRF21045LSR3**

## PRODUCT DOCUMENTATION

Refer to the following documents 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

## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
12	Oct. 2008	<ul style="list-style-type: none"><li>• Data sheet revised to reflect part status change, p. 1, including use of applicable overlay.</li><li>• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN12779, p. 1, 2</li><li>• Added Product Documentation and Revision History, p. 10</li></ul>

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