

# RF Power Field Effect Transistor

## N-Channel Enhancement-Mode Lateral MOSFET

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

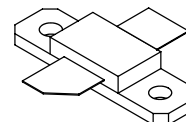
- Typical W-CDMA Performance: -45 dBc ACPR, 2170 MHz, 28 Volts, 5 MHz Offset/4.096 MHz BW, 15 DTCH  
Output Power — 2.1 Watts  
Power Gain — 13.5 dB  
Efficiency — 21%
- Capable of Handling 10:1 VSWR @ 28 Vdc, 2140 MHz, 10 Watts CW Output Power

### Features

- 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. L Suffix Indicates 40μ" Nominal.
- RoHS Compliant.
- In Tape and Reel. R1 Suffix = 500 Units per 32 mm, 13 Inch Reel.

**MRF21010LR1**

**2110-2170 MHz, 10 W, 28 V  
LATERAL N-CHANNEL  
BROADBAND  
RF POWER MOSFET**



**CASE 360B-05, STYLE 1  
NI-360**

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**Table 1. Maximum Ratings**

Rating	Symbol	Value	Unit
Drain-Source Voltage	V <sub>DSS</sub>	-0.5, +65	Vdc
Gate-Source Voltage	V <sub>GS</sub>	- 0.5, +15	Vdc
Total Device Dissipation @ T <sub>C</sub> = 25°C Derate above 25°C	P <sub>D</sub>	43.75 0.25	W W/°C
Storage Temperature Range	T <sub>stg</sub>	- 65 to +150	°C
Case Operating Temperature	T <sub>C</sub>	150	°C
Operating Junction Temperature	T <sub>J</sub>	200	°C

**Table 2. Thermal Characteristics**

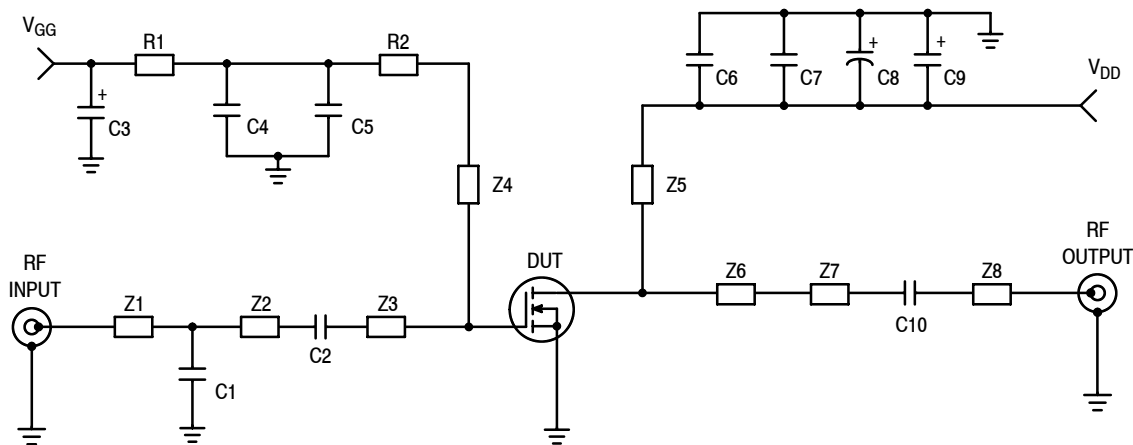
Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction to Case	R <sub>θJC</sub>	5.5	°C/W

**Table 3. ESD Protection Characteristics**

Test Conditions	Class
Human Body Model	1 (Minimum)
Machine Model	M1 (Minimum)

**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 ( $V_{GS} = 0\text{ Vdc}$ , $I_D = 10\ \mu\text{A}$ )	$V_{(BR)DSS}$	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</b>					
Gate Threshold Voltage ( $V_{DS} = 10\text{ V}$ , $I_D = 50\ \mu\text{A}$ )	$V_{GS(th)}$	2.5	3	4	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28\text{ V}$ , $I_D = 100\text{ mA}$ )	$V_{GS(Q)}$	2.5	4	4.5	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ V}$ , $I_D = 0.5\text{ A}$ )	$V_{DS(on)}$	—	0.4	0.5	Vdc
Forward Transconductance ( $V_{DS} = 10\text{ V}$ , $I_D = 1\text{ A}$ )	$g_{fs}$	—	0.95	—	S
<b>Dynamic Characteristics</b>					
Reverse Transfer Capacitance ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0$ , $f = 1\text{ MHz}$ )	$C_{rss}$	—	1	—	pF
<b>Functional Tests</b> (In Freescale Test Fixture, 50 ohm system)					
Two-Tone Common Source Amplifier Power Gain ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 10\text{ W PEP}$ , $I_{DQ} = 100\text{ mA}$ , $f = 2170\text{ MHz}$ , Tone Spacing = 100 KHz)	$G_{ps}$	12	13.5	—	dB
Two-Tone Drain Efficiency ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 10\text{ W PEP}$ , $I_{DQ} = 100\text{ mA}$ , $f = 2170\text{ MHz}$ , Tone Spacing = 100 KHz)	$\eta$	31	35	—	%
Third Order Intermodulation Distortion ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 10\text{ W PEP}$ , $I_{DQ} = 100\text{ mA}$ , $f = 2170\text{ MHz}$ , Tone Spacing = 100 KHz)	IMD	—	-35	-30	dBc
Input Return Loss ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 10\text{ W PEP}$ , $I_{DQ} = 100\text{ mA}$ , $f = 2170\text{ MHz}$ , Tone Spacing = 100 KHz)	IRL	—	-12	-10	dB
Output Power, 1 dB Compression Point, CW ( $V_{DD} = 28\text{ Vdc}$ , $I_{DQ} = 100\text{ mA}$ , $f = 2170\text{ MHz}$ )	P1dB	—	11	—	W
Common-Source Amplifier Power Gain ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 10\text{ W CW}$ , $I_{DQ} = 100\text{ mA}$ , $f = 2170\text{ MHz}$ )	$G_{ps}$	—	12	—	dB
Drain Efficiency ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 10\text{ W CW}$ , $I_{DQ} = 100\text{ mA}$ , $f = 2170\text{ MHz}$ )	$\eta$	—	42	—	%



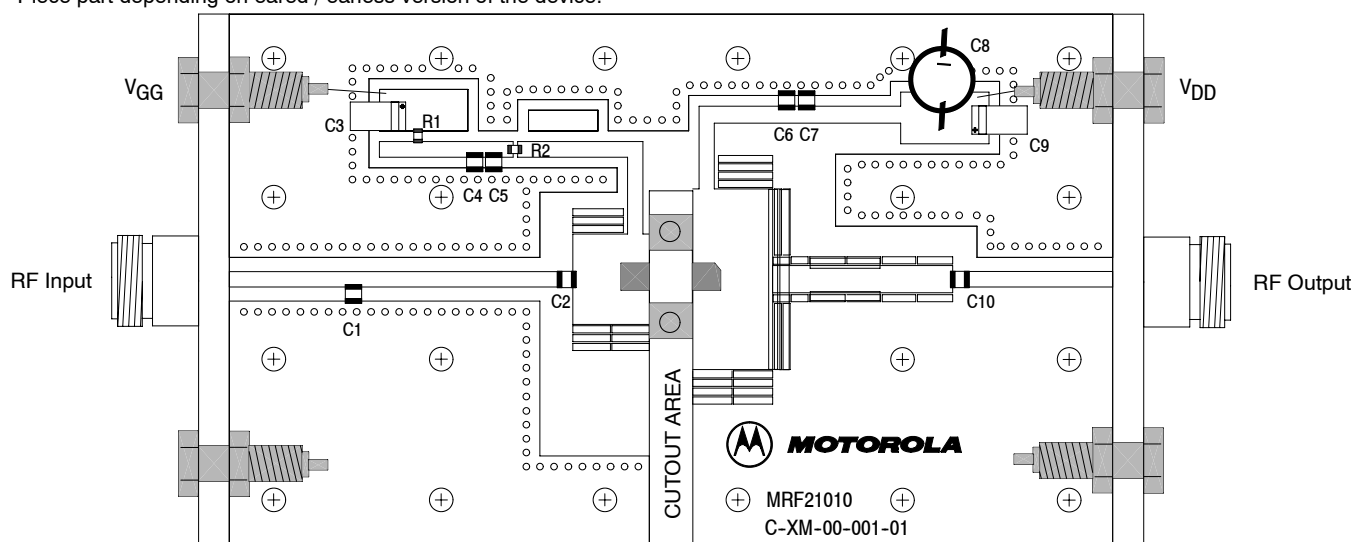
Z1	0.964" x 0.087" Microstrip	Z6	0.453" x 1.118" Microstrip
Z2	0.905" x 0.087" Microstrip	Z7	0.921" x 0.154" Microstrip
Z3	0.433" x 0.512" Microstrip	Z8	0.925" x 0.087" Microstrip
Z4	1.068" x 0.087" Microstrip	PCB	Taconic TLX8-0300, 0.030", $\epsilon_r = 2.55$
Z5	0.752" x 0.087" Microstrip		

**Figure 1. MRF21010L Test Circuit Schematic**

**Table 5. MRF21010L Test Circuit Component Designations and Values**

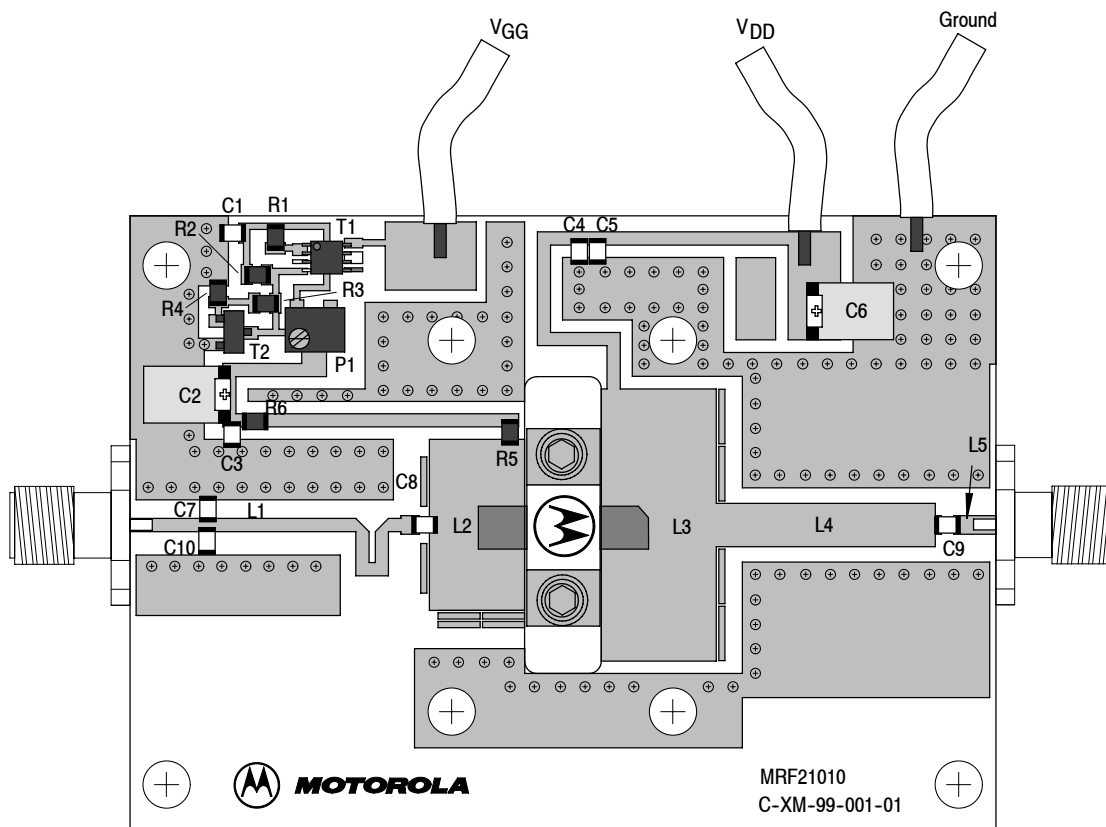
Part	Description	Part Number	Manufacturer
C1 *	(eared) 2.2 pF Chip Capacitor	ATC100B2R2BT500XT	ATC
	(earless) 1.8 pF Chip Capacitor	ATC100B1R8BT500XT	ATC
C2	0.5 pF Chip Capacitor	ATC100B0R5BT500XT	ATC
C3, C9	10 $\mu$ F, 35 V Tantalum Chip Capacitors	T491D106K035AT	Kemet
C4, C7	1 nF Chip Capacitors	ATC100B102JT50XT	ATC
C5, C6	5.6 pF Chip Capacitors	ATC100B5R6BT500XT	ATC
C8	470 $\mu$ F, 63 V Electrolytic Capacitor	EKME630ELL471MK25S	Multicomp
C10	10 pF Chip Capacitor	ATC100B100GT500XT	ATC
R1	1.0 k $\Omega$ , 1/8 W Chip Resistor	CRCW08051001FKEA	Vishay
R2	12 $\Omega$ , 1/8 W Chip Resistor	CRCW080512R0FKEA	Vishay

\* Piece part depending on eared / earless version of the device.



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

**Figure 2. MRF21010L Test Circuit Component Layout**



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 3. MRF21010L Demonstration Board Component Layout**

**Table 6. MRF21010L Demonstration Board Component Designations and Values**

Designators	Description
C1	1 $\mu$ F Chip Capacitor (0805), Kemet C0805C105K5AC
C2, C6	10 $\mu$ F, 35 V Tantalum Capacitors, Kemet T491D106K035AT
C3, C4	6.8 pF Chip Capacitors, ACCU-P (0805), AVX #08051J6R8CBS
C5	10 nF Chip Capacitor (0805), AVX #08055C103KATS
C7	1.5 pF Chip Capacitor, ACCU-P (0805), AVX #08051J2R2BBS
C8, C10	0.5 pF Chip Capacitors, ACCU-P (0805), AVX #08051J0R5BBS
C9	10 pF Chip Capacitor, ACCU-P (0805), AVX #08055J100GBS
L1	19 mm $\times$ 1.07 mm
L2	7.7 mm $\times$ 13.8 mm
L3	9.3 mm $\times$ 22 mm
L4	17.7 mm $\times$ 3.5 mm
L5	3.4 mm $\times$ 1.5 mm
R1, R6	10 $\Omega$ , 1/8 W Chip Resistors (0805) CRCW080510R0FKEA
R2, R3	1 k $\Omega$ , 1/8 W Chip Resistors (0805) CRCW08051001FKEA
R4	2.2 k $\Omega$ , 1/8 W Chip Resistor (0805) CRCW08052201FKEA
R5	0 $\Omega$ , 1/8 W Chip Resistor (0805) CRCW08050000FKEA
P1	5 k $\Omega$ Potentiometer CMS Cermet Multi-Turn, Bourns #3224W
T1	Voltage Regulator, Micro-8, On-Semi #LP2951ACDMR2G
T2	Bipolar NPN Transistor, SOT-23, On-Semi #BC847ALT1G
PCB	Rogers RO4350, 0.5 mm, $\epsilon_r = 3.53$

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### TYPICAL CHARACTERISTICS

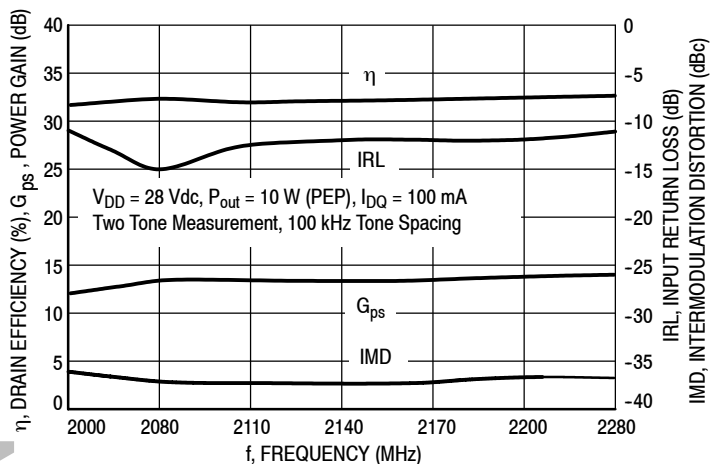


Figure 4. Class AB Broadband Circuit Performance

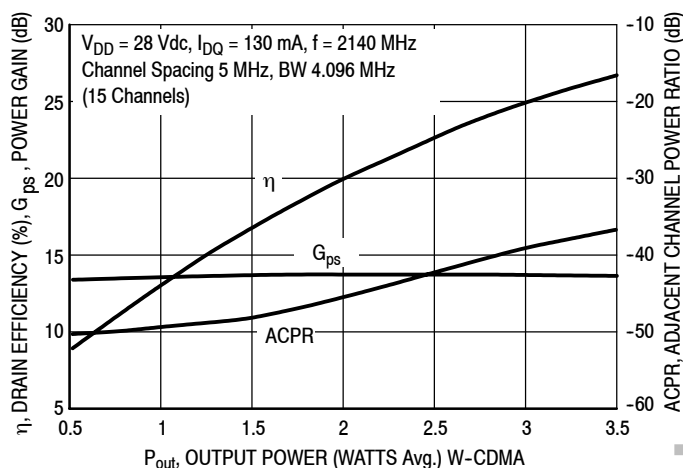


Figure 5. W-CDMA ACPR, Power Gain and Drain Efficiency versus Output Power

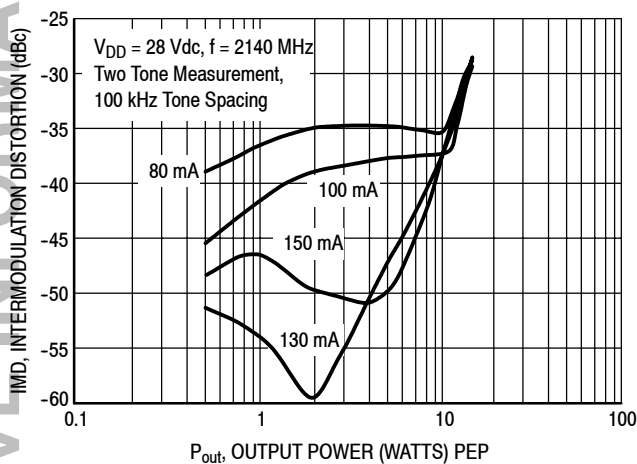


Figure 6. Intermodulation Distortion versus Output Power

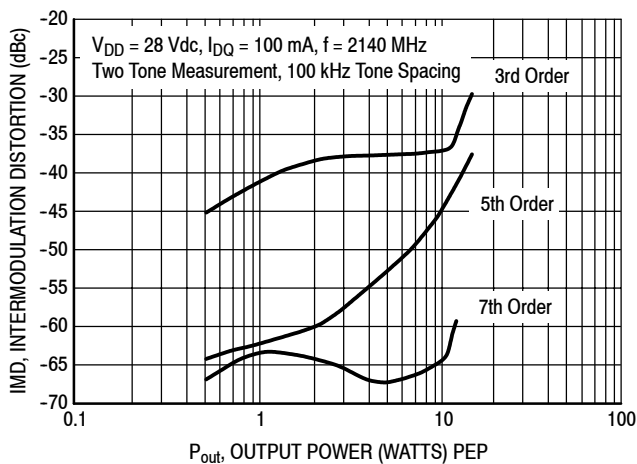


Figure 7. Intermodulation Distortion Products versus Output Power

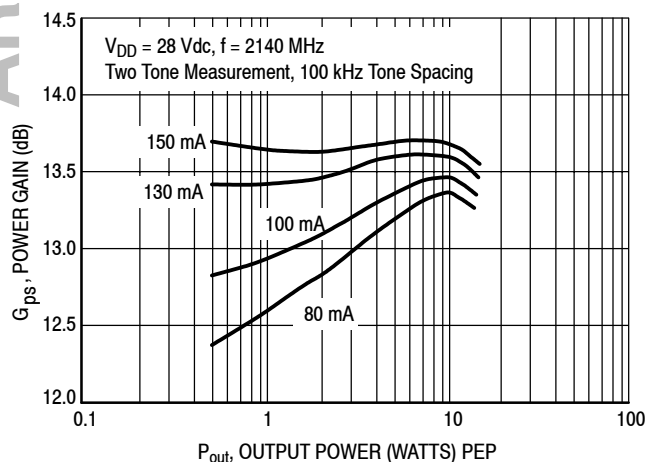


Figure 8. Power Gain versus Output Power

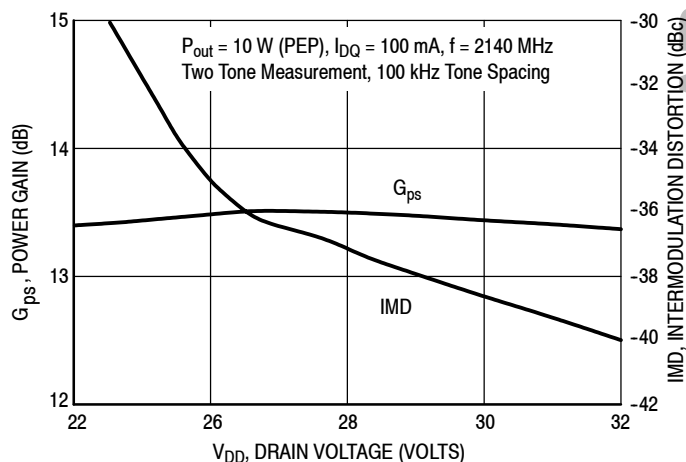
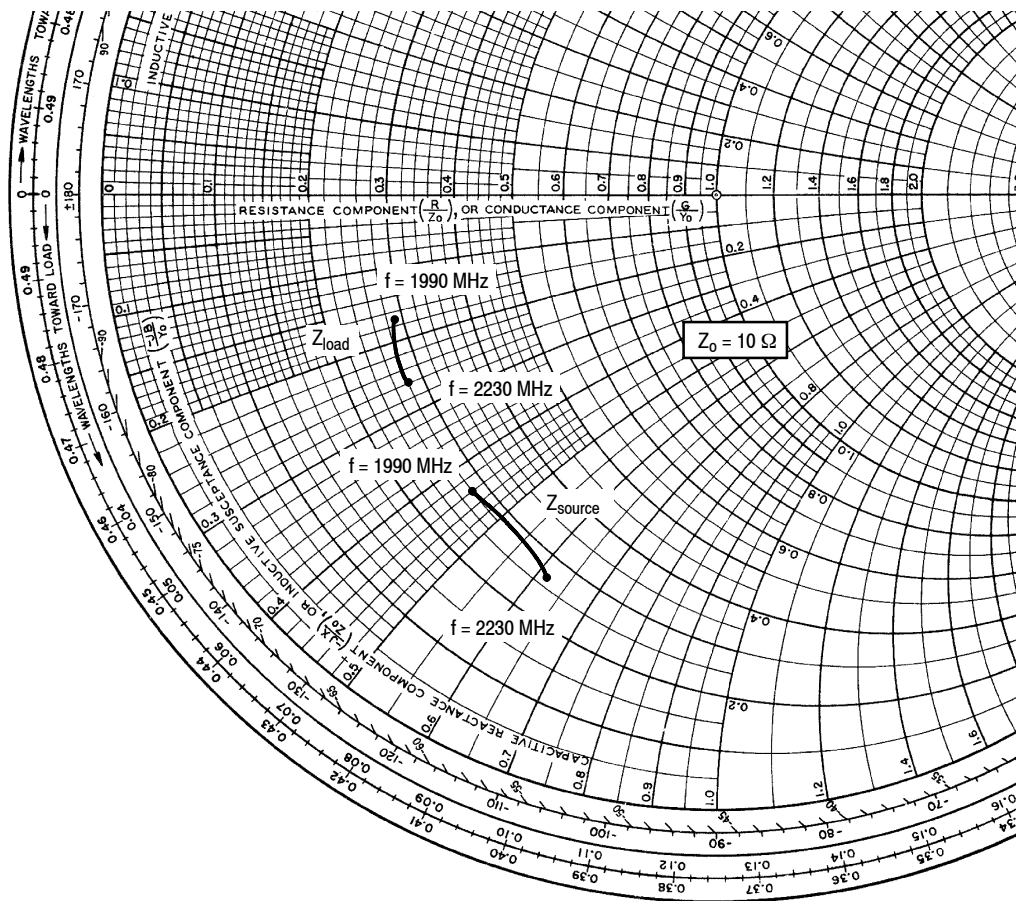


Figure 9. Intermodulation and Gain versus Supply Voltage



$V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$ ,  $P_{out} = 10\text{ W PEP}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
1990	$2.85 - j4.38$	$2.93 - j1.71$
2110	$2.89 - j5.04$	$2.76 - j2.28$
2230	$2.73 - j6.19$	$2.83 - j2.59$

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

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

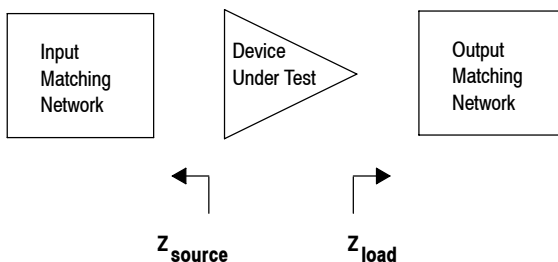
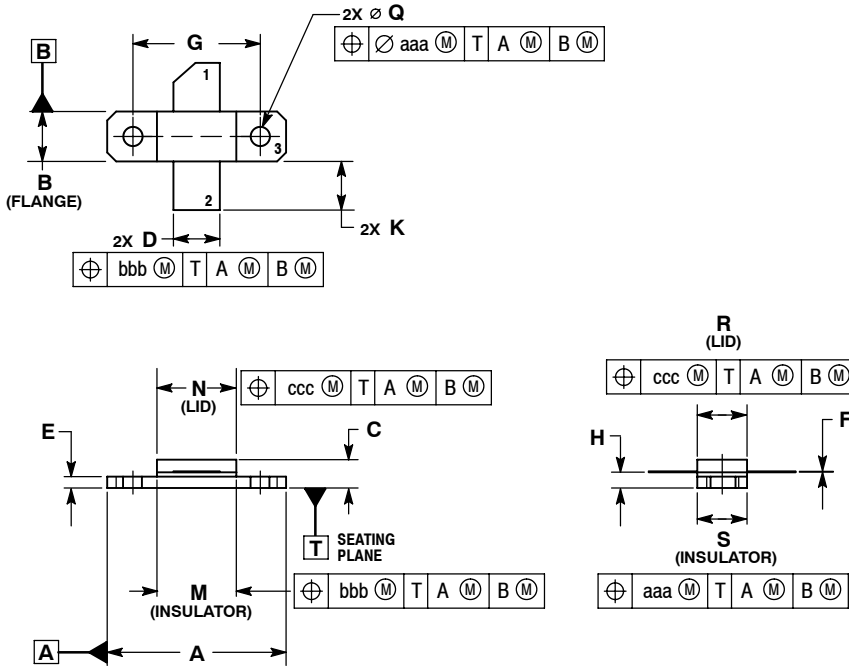


Figure 10. Series Equivalent Source and Load Impedance

## PACKAGE DIMENSIONS



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

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.795	0.805	20.19	20.45
B	0.225	0.235	5.72	5.97
C	0.125	0.175	3.18	4.45
D	0.210	0.220	5.33	5.59
E	0.055	0.065	1.40	1.65
F	0.004	0.006	0.10	0.15
G	0.562 BSC		14.28 BSC	
H	0.077	0.087	1.96	2.21
K	0.220	0.250	5.59	6.35
M	0.355	0.365	9.02	9.27
N	0.357	0.363	9.07	9.22
Q	0.125	0.135	3.18	3.43
R	0.227	0.233	5.77	5.92
S	0.225	0.235	5.72	5.97
aaa	0.005 REF		0.13 REF	
bbb	0.010 REF		0.25 REF	
ccc	0.015 REF		0.38 REF	

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

CASE 360B-05  
 ISSUE G  
 NI-360  
 MRF21010LR1

## PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
10	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>• Updated Part Numbers in Tables 5 and 6, Component Designations and Values, to RoHS compliant part numbers, p. 3, 4</li> <li>• Added Product Documentation and Revision History, p. 8</li> <li>• Data sheet split due to change in part life cycle (-1, -2 added to enable visibility on web).</li> </ul>
	Dec. 2010	<ul style="list-style-type: none"> <li>• MRF21010-1 Rev 10 (MRF21010LR1) data sheet archived. Part no longer manufactured. See MRF21010-2 Rev 11 for MRF21010LSR1.</li> </ul>

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