

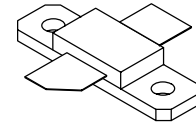
**The RF MOSFET Line**  
**RF Power Field Effect Transistors**  
**N-Channel Enhancement-Mode Lateral MOSFETs**

**MRF21010LR1**  
**MRF21010LSR1**

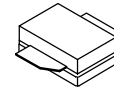
Designed for W-CDMA base station applications with frequencies from 2110 to 2170 MHz. Suitable for FM, TDMA, CDMA and multicarrier amplifier applications. To be used in Class AB for PCN-PCS/cellular radio and WLL applications.

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

- Typical W-CDMA Performance: -45 dBc ACPR, 2140 MHz, 28 Volts, 5 MHz Offset/4.096 MHz BW, 15 DTCH  
 Output Power — 2.1 Watts  
 Power Gain — 13.5 dB  
 Efficiency — 21%
- High Gain, High Efficiency and High Linearity
- Integrated ESD Protection
- Designed for Maximum Gain and Insertion Phase Flatness
- Capable of Handling 10:1 VSWR @ 28 Vdc, 2170 MHz, 10 Watts CW Output Power
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- In Tape and Reel. R1 Suffix = 500 Units per 32 mm, 13 Inch Reel.
- Low Gold Plating Thickness on Leads. L Suffix Indicates 40μ" Nominal.



**CASE 360B-05, STYLE 1**  
**NI-360**  
**MRF21010LR1**



**CASE 360C-05, STYLE 1**  
**NI-360S**  
**MRF21010LSR1**

**MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Drain-Source Voltage	V <sub>DSS</sub>	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
Operating Junction Temperature	T <sub>J</sub>	200	°C

**THERMAL CHARACTERISTICS**

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

**ESD PROTECTION CHARACTERISTICS**

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

**NOTE - CAUTION** - MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

# Freescale Semiconductor, Inc.

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
Drain-Source Breakdown Voltage (V <sub>GS</sub> = 0 Vdc, I <sub>D</sub> = 10 μA)	V <sub>(BR)DSS</sub>	65	—	—	Vdc
Zero Gate Voltage Drain Current (V <sub>DS</sub> = 28 Vdc, V <sub>GS</sub> = 0 Vdc)	I <sub>DSS</sub>	—	—	10	μAdc
Gate-Source Leakage Current (V <sub>GS</sub> = 5 Vdc, V <sub>DS</sub> = 0 Vdc)	I <sub>GSS</sub>	—	—	1	μAdc
<b>ON CHARACTERISTICS</b>					
Gate Threshold Voltage (V <sub>DS</sub> = 10 V, I <sub>D</sub> = 50 μA)	V <sub>GS(th)</sub>	2.5	3	4	Vdc
Gate Quiescent Voltage (V <sub>DS</sub> = 28 V, I <sub>D</sub> = 100 mA)	V <sub>GS(Q)</sub>	2.5	4	4.5	Vdc
Drain-Source On-Voltage (V <sub>GS</sub> = 10 V, I <sub>D</sub> = 0.5 A)	V <sub>DS(on)</sub>	—	0.4	0.5	Vdc
Forward Transconductance (V <sub>DS</sub> = 10 V, I <sub>D</sub> = 1 A)	g <sub>fs</sub>	—	0.95	—	S
<b>DYNAMIC CHARACTERISTICS</b>					
Reverse Transfer Capacitance (V <sub>DS</sub> = 28 Vdc, V <sub>GS</sub> = 0, f = 1 MHz)	C <sub>rss</sub>	—	1	—	pF
<b>FUNCTIONAL TESTS (In Motorola Test Fixture, 50 ohm system)</b>					
Two-Tone Common Source Amplifier Power Gain (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 10 W PEP, I <sub>DQ</sub> = 100 mA, f <sub>1</sub> = 2110 MHz, f <sub>2</sub> = 2170 MHz, Tone Spacing = 100 KHz)	G <sub>ps</sub>	12	13.5	—	dB
Two-Tone Drain Efficiency (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 10 W PEP, I <sub>DQ</sub> = 100 mA, f <sub>1</sub> = 2110 MHz, f <sub>2</sub> = 2170 MHz, Tone Spacing = 100 KHz)	η	31	35	—	%
Third Order Intermodulation Distortion (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 10 W PEP, I <sub>DQ</sub> = 100 mA, f <sub>1</sub> = 2110 MHz, f <sub>2</sub> = 2170 MHz, Tone Spacing = 100 KHz)	IMD	—	-35	-30	dBc
Input Return Loss (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 10 W PEP, I <sub>DQ</sub> = 100 mA, f <sub>1</sub> = 2110 MHz, f <sub>2</sub> = 2170 MHz, Tone Spacing = 100 KHz)	IRL	—	-12	-10	dB
Output Power, 1 dB Compression Point, CW (V <sub>DD</sub> = 28 Vdc, I <sub>DQ</sub> = 100 mA, f = 2170 MHz)	P <sub>1dB</sub>	—	11	—	W
Common-Source Amplifier Power Gain (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 10 W CW, I <sub>DQ</sub> = 100 mA, f = 2170 MHz)	G <sub>ps</sub>	—	12	—	dB
Drain Efficiency (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 10 W CW, I <sub>DQ</sub> = 100 mA, f = 2170 MHz)	η	—	42	—	%
Output Mismatch Stress (V <sub>DD</sub> = 28 Vdc, P <sub>out</sub> = 10 W CW, I <sub>DQ</sub> = 100 mA, f = 2170 MHz, VSWR = 10:1, All Phase Angles at Frequency of Tests)	Ψ	No Degradation In Output Power Before and After Test			

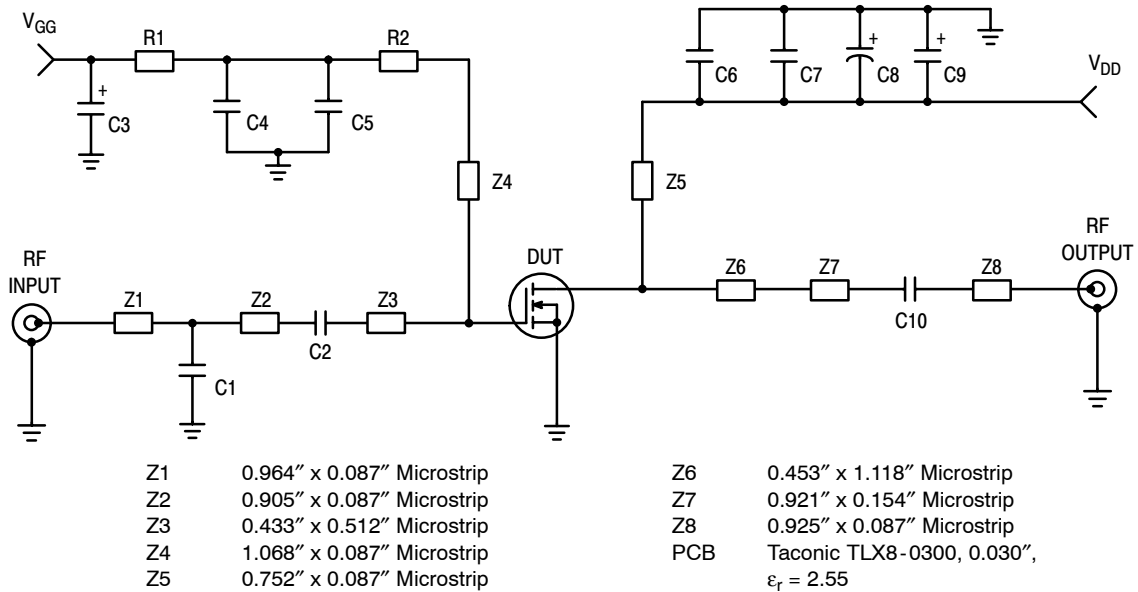


Figure 1. MRF21010L Test Circuit Schematic

Table 1. MRF21010L Test Circuit Component Designations and Values

Part	Description	Value, P/N or DWG	Manufacturer
C1 *	2.2 pF Chip Capacitor, B Case	100B2R2BW	ATC
	(eared)		
	(earless)	100B1R8BW	ATC
C2	0.5 pF Chip Capacitor, B Case	100B0R5BW	ATC
C3, C9	10 $\mu$ F, 35 V Tantalum Chip Capacitors	293D106X9035D2T	Sprague-Vishay
C4, C7	1 nF Chip Capacitors, B Case	100B102JW	ATC
C5, C6	5.6 pF Chip Capacitors, B Case	100B5R6BW	ATC
C8	470 $\mu$ F, 63 V Electrolytic Capacitor		
C10	10 pF Chip Capacitor, B Case	100B100GW	ATC
N1, N2	Type N Connector Flange Mounts	3052-1648-10	Macom
R1	1.0 k $\Omega$ Chip Resistor (0805)		
R2	12 $\Omega$ Chip Resistor (0805)		

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

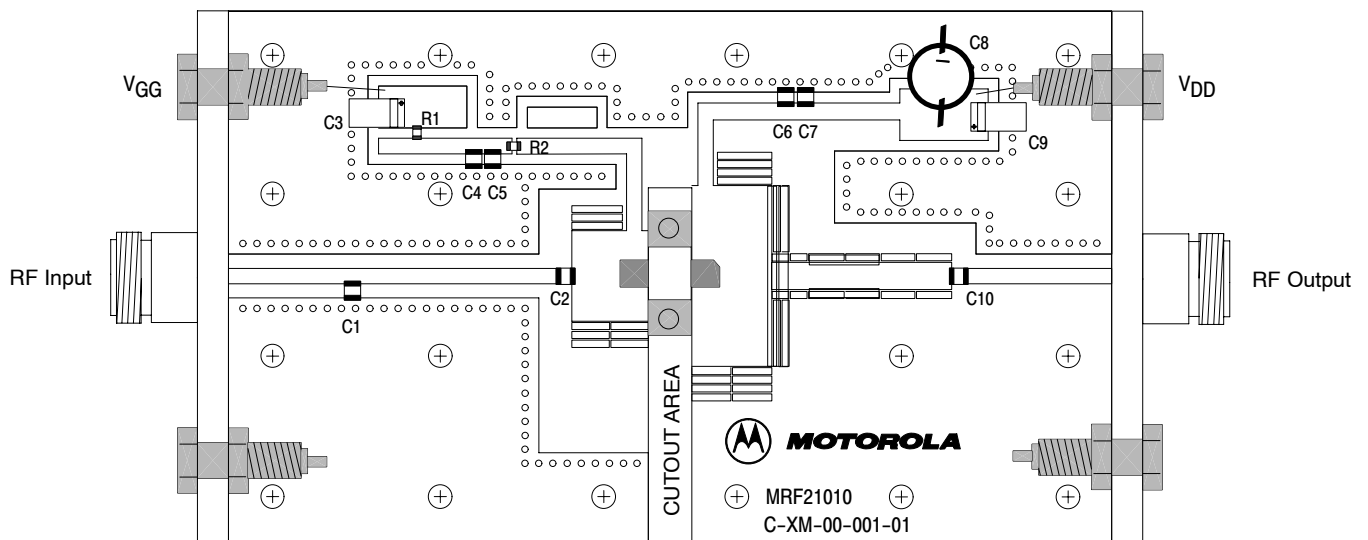


Figure 2. MRF21010L Test Circuit Component Layout

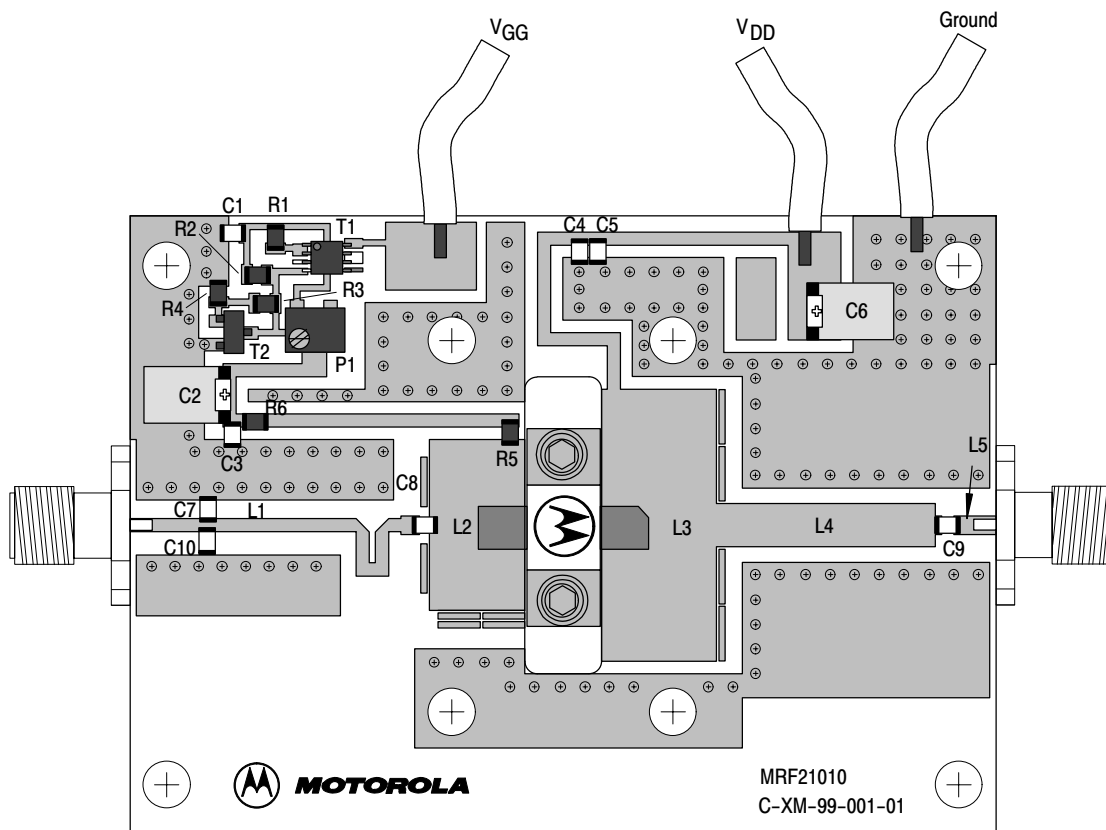


Figure 3. MRF21010L Demonstration Board Component Layout

Table 2. MRF21010L Demonstration Board Component Designations and Values

Designators	Description
C1	1 $\mu$ F Chip Capacitor (0805), AVX #08053G105ZATEA
C2, C6	10 $\mu$ F, 35 V Tantalum Capacitors, Vishay -Sprague #293D106X9035D
C3, C4	6.8 pF Chip Capacitors, ACCU-P (0805), AVX #08051J6R8CBT
C5	10 nF Chip Capacitor (0805), AVX #08055C103KATDA
C7	1.5 pF Chip Capacitor, ACCU-P (0805), AVX #08051J2R2BBT
C8, C10	0.5 pF Chip Capacitors, ACCU-P (0805), AVX #08051J0R5BBT
C9	10 pF Chip Capacitor, ACCU-P (0805), AVX #08055J100GBT
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)
R2, R3	1 k $\Omega$ , 1/8 W Chip Resistors (0805)
R4	2.2 k $\Omega$ , 1/8 W Chip Resistor (0805)
R5	0 $\Omega$ , 1/8 W Chip Resistor (0805)
P1	5 k $\Omega$ Potentiometer CMS Cermet Multi-Turn, Bourns #3224W
T1	Voltage Regulator, Micro-8, Motorola #LP2951
T2	Bipolar NPN Transistor, SOT-23, Motorola #BC847
PCB	Rogers RO4350, 0.5 mm, $\epsilon_r = 3.53$

## TYPICAL CHARACTERISTICS

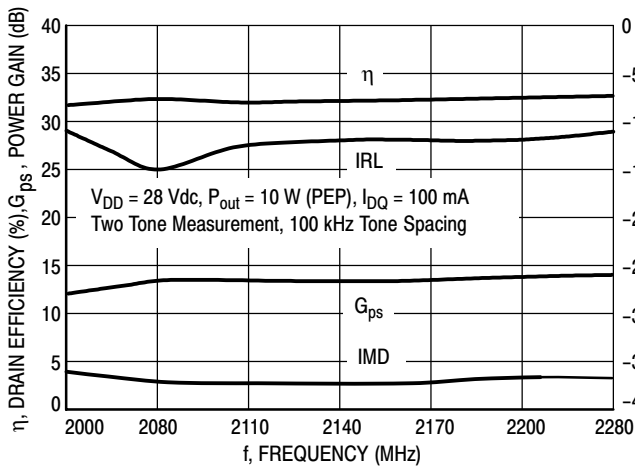


Figure 4. Class AB Broadband Circuit Performance

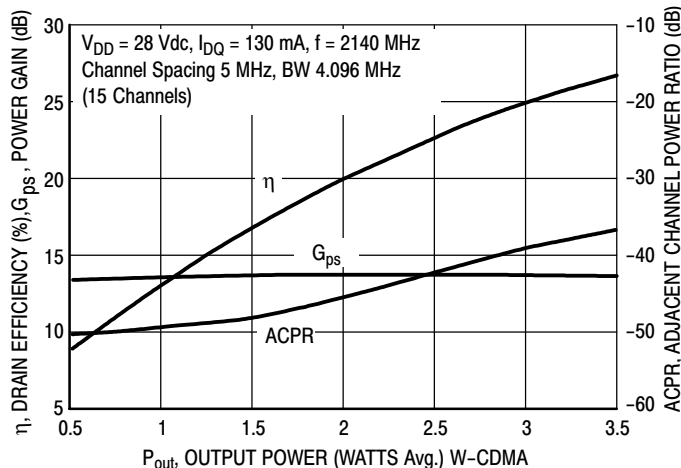


Figure 5. W-CDMA ACPR, Power Gain and Drain Efficiency versus Output Power

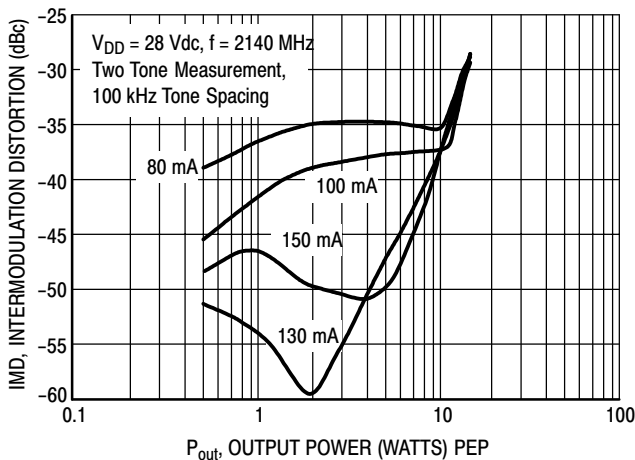


Figure 6. Intermodulation Distortion versus Output Power

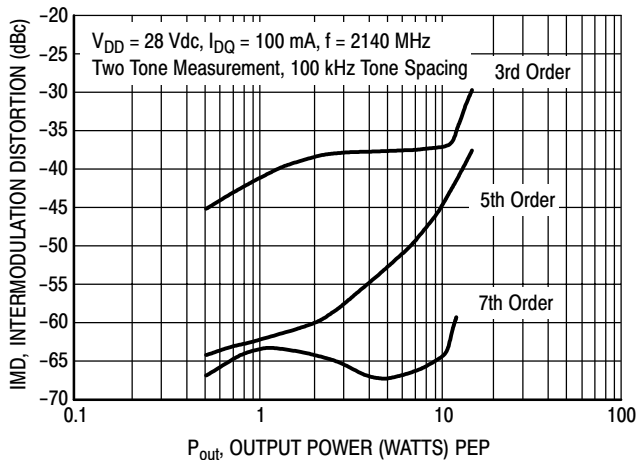


Figure 7. Intermodulation Distortion Products versus Output Power

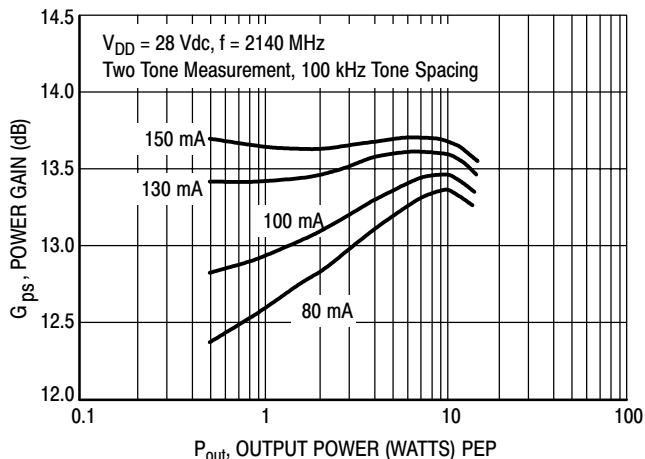


Figure 8. Power Gain versus Output Power

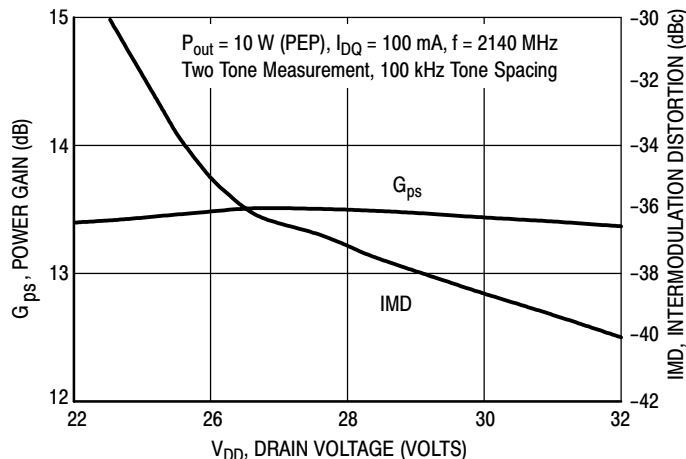
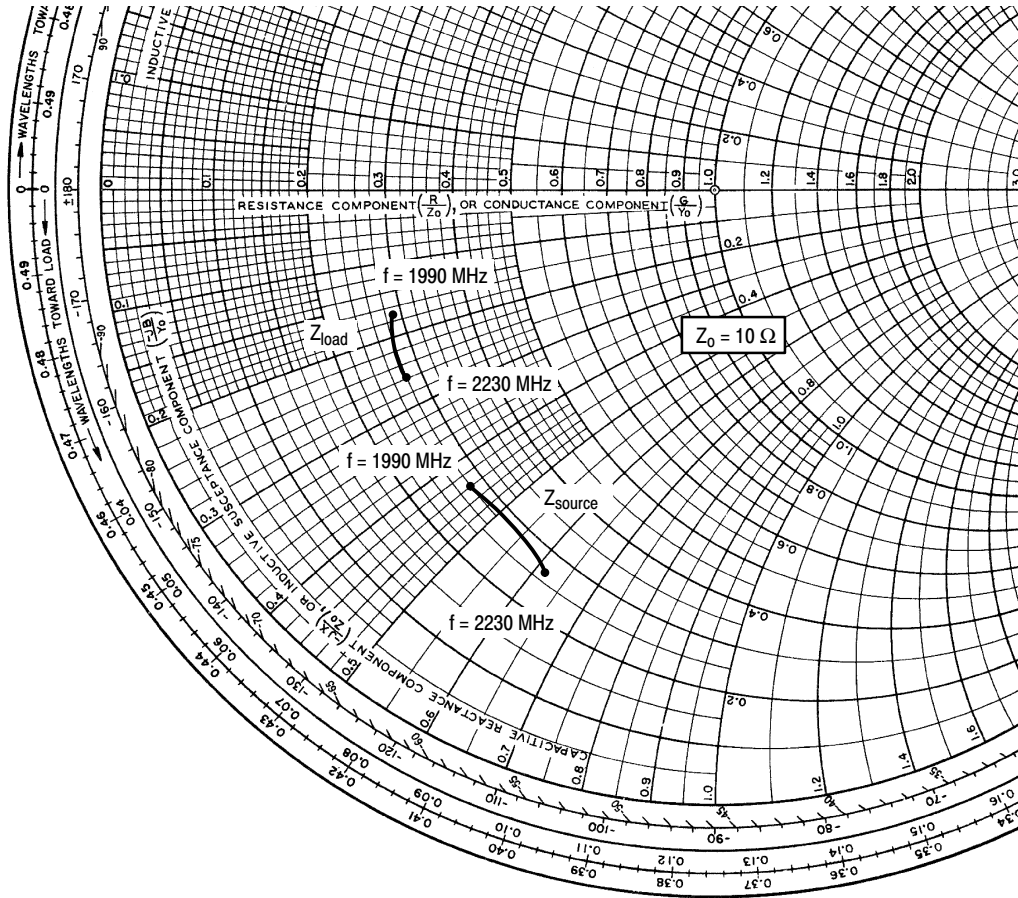


Figure 9. Intermodulation and Gain versus Supply Voltage



$V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$ ,  $P_{out} = P_{1dB\text{ CW}}$

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.

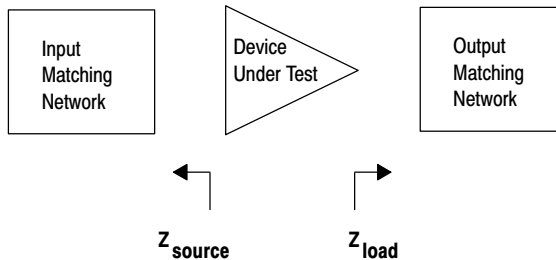


Figure 10. Series Equivalent Input and Output Impedance

# Freescale Semiconductor, Inc.

## PACKAGE DIMENSIONS

**2X  $\varnothing$  Q**  
 $\oplus \varnothing aaa \text{ (M)}$  T A (M) B (M)

**B**  
 (FLANGE)

**G**

**1**

**2**

**2X D**

**2X K**

$\oplus bbb \text{ (M)}$  T A (M) B (M)

**E**

**N**  
 (LID)

**C**

**T**  
 SEATING PLANE

**M**  
 (INSULATOR)

**A**

$\oplus ccc \text{ (M)}$  T A (M) B (M)

**R**  
 (LID)

$\oplus ccc \text{ (M)}$  T A (M) B (M)

**H**

**F**

**S**  
 (INSULATOR)

$\oplus aaa \text{ (M)}$  T A (M) B (M)

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	

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.

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

**CASE 360B-05  
 ISSUE F  
 NI-360  
 MRF21010LR1**

**A**  
 (FLANGE)

**B**  
 (FLANGE)

**1**

**2**

**2X D**

**2X K**

$\oplus bbb \text{ (M)}$  T A (M) B (M)

**E**

**N**  
 (LID)

**C**

**T**  
 SEATING PLANE

**M**  
 (INSULATOR)

**PIN 3**

$\oplus ccc \text{ (M)}$  T A (M) B (M)

**R**  
 (LID)

$\oplus ccc \text{ (M)}$  T A (M) B (M)

**H**

**F**

**S**  
 (INSULATOR)

$\oplus aaa \text{ (M)}$  T A (M) B (M)

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.375	0.385	9.53	9.78
B	0.225	0.235	5.72	5.97
C	0.105	0.155	2.67	3.94
D	0.210	0.220	5.33	5.59
E	0.035	0.045	0.89	1.14
F	0.004	0.006	0.10	0.15
H	0.057	0.067	1.45	1.70
K	0.085	0.115	2.16	2.92
M	0.355	0.365	9.02	9.27
N	0.357	0.363	9.07	9.22
R	0.227	0.23	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	

NOTES:  
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STYLE 1:  
 PIN 1. DRAIN  
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 3. SOURCE

**360C-05  
 ISSUE D  
 NI-360S  
 MRF21010LSR1**

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