

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: $V_{DD} = 28$ Volts, $I_{DQ} = 1050$ mA, $P_{out} = 23$ Watts Avg., $f = 2167.5$ MHz, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
Power Gain — 13.5 dB
Drain Efficiency — 26%
IM3 @ 10 MHz Offset — -37 dBc in 3.84 MHz Channel Bandwidth
ACPR @ 5 MHz Offset — -40 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 MHz, 100 Watts CW Output Power

Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- Lower Thermal Resistance Package
- Low Gold Plating Thickness on Leads, 40 μ m Nominal.
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF5S21100HR3
MRF5S21100HSR3

2110-2170 MHz, 23 W AVG., 28 V
2 x W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs

CASE 465-06, STYLE 1
NI-780
MRF5S21100HR3

CASE 465A-06, STYLE 1
NI-780S
MRF5S21100HSR3

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°C	P_D	273 1.56	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 (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C , 100 W CW Case Temperature 78°C , 23 W CW	$R_{\theta JC}$	0.57 0.64	$^\circ\text{C}/\text{W}$

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.

Table 3. ESD Protection Characteristics

Test Conditions	Class
Human Body Model	2 (Minimum)
Machine Model	M3 (Minimum)
Charge Device Model	C7 (Minimum)

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 ($V_{DS} = 65\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$)	I_{GSS}	—	—	0.5	μAdc

On Characteristics (DC)

Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 250\text{ }\mu\text{Adc}$)	$V_{GS(th)}$	2.5	2.8	3.5	Vdc
Gate Quiescent Voltage ($V_{DS} = 28\text{ Vdc}$, $I_D = 1050\text{ mAdc}$)	$V_{GS(Q)}$	—	3.8	—	Vdc
Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 2.5\text{ Adc}$)	$V_{DS(on)}$	—	0.24	0.3	Vdc
Forward Transconductance ($V_{DS} = 10\text{ Vdc}$, $I_D = 2.5\text{ Adc}$)	g_{fs}	—	6	—	S

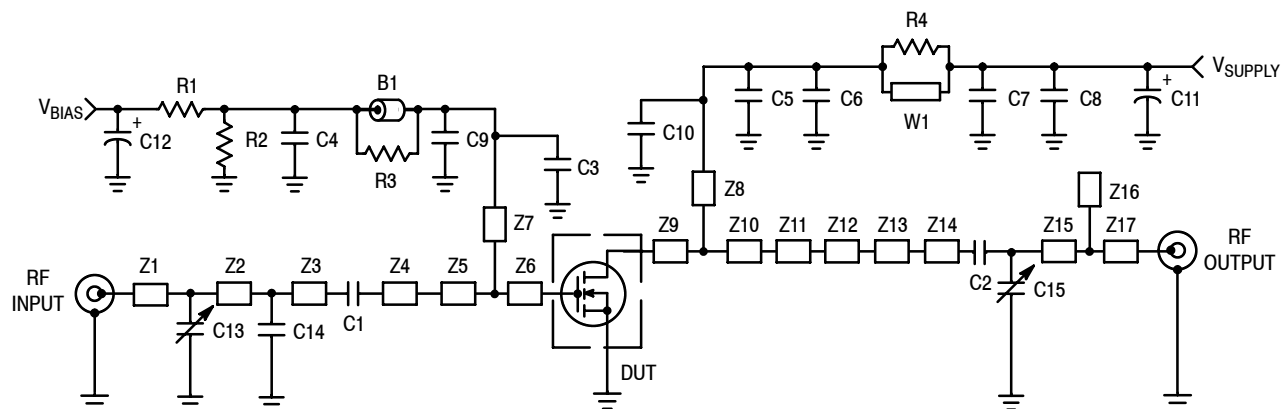
Dynamic Characteristics ⁽¹⁾

Reverse Transfer Capacitance ($V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$)	C_{rss}	—	2.14	—	pF
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Functional Tests (In Freescale Test Fixture, 50 ohm system) $V_{DD} = 28\text{ Vdc}$, $I_{DQ} = 1050\text{ mA}$, $P_{out} = 23\text{ W Avg.}$, $f_1 = 2157.5\text{ MHz}$, $f_2 = 2167.5\text{ MHz}$, 2-carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers. ACPR measured in 3.84 MHz Channel Bandwidth @ $\pm 5\text{ MHz}$ Offset. IM3 measured in 3.84 MHz Bandwidth @ $\pm 10\text{ MHz}$ Offset. PAR = 8.5 dB @ 0.01% Probability on CCDF.

Power Gain	G_{ps}	12.5	13.5	—	dB
Drain Efficiency	η_D	24	26	—	%
Intermodulation Distortion	IM3	—	-37	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-40	-38	dBc
Input Return Loss	IRL	—	-16	-9	dB

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

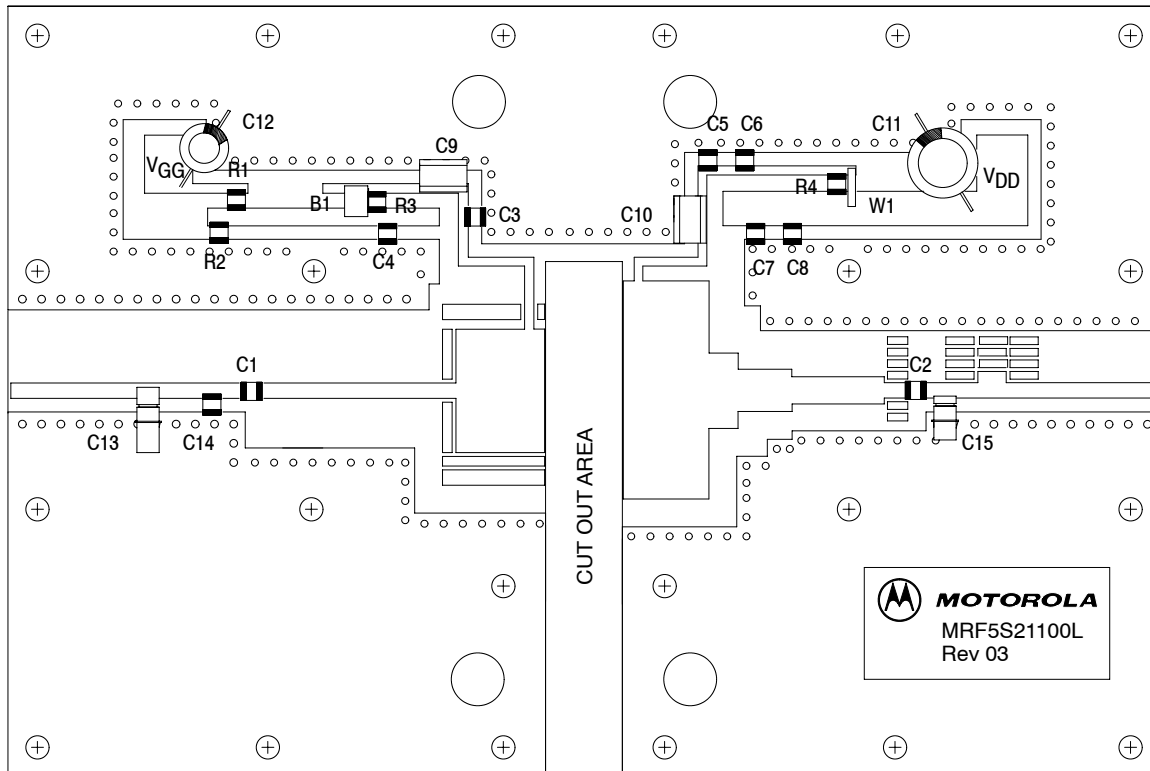


Z1	0.674" x 0.080" Microstrip	Z10	0.368" x 1.136" Microstrip
Z2	0.421" x 0.080" Microstrip	Z11	0.151" x 0.393" Microstrip
Z3	0.140" x 0.080" Microstrip	Z12	0.280" x 0.220" Microstrip
Z4	1.031" x 0.080" Microstrip	Z13	0.481" x 0.142" Microstrip
Z5	0.380" x 0.643" Microstrip	Z14	0.138" x 0.080" Microstrip
Z6	0.080" x 0.643" Microstrip	Z15	0.344" x 0.080" Microstrip
Z7	0.927" x 0.048" Microstrip	Z16	0.147" x 0.099" Microstrip
Z8	0.620" x 0.048" Microstrip	Z17	0.859" x 0.080" Microstrip
Z9	0.079" x 1.136" Microstrip	PCB	Arlon GX-0300-SS-22, 0.030", $\epsilon_r = 2.55$

Figure 1. MRF5S21100HR3(SR3) Test Circuit Schematic

Table 5. MRF5S21100HR3(SR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	Short RF Bead	2743019447	Fair-Rite
C1, C2	8.2 pF Chip Capacitors	ATC100B8R2CT500XT	ATC
C3	5.6 pF Chip Capacitor	ATC100B5R6CT500XT	ATC
C4	0.1 μ F Chip Capacitor	C1210C104J5RAC	Kemet
C5, C7	7.5 pF Chip Capacitors	ATC100B7R5JT500XT	ATC
C6	1.2 pF Chip Capacitor	ATC100B1R2BT500XT	ATC
C8	1K pF Chip Capacitor	ATC100B102JT500XT	ATC
C9, C10	0.56 μ F Chip Capacitors	C1825C564J5RAC	Kemet
C11	470 μ F, 63 V Electrolytic Capacitor	EKME630ELL471MK25S	Multicomp
C12	100 μ F, 50 V Electrolytic Capacitor	MCHT101M1HB-1017-RH	Multicomp
C13	0.6-4.5 pF Gigatrim Variable Capacitor	27271SL	Johanson
C14	2.7 pF Chip Capacitor	ATC100B2R7CT500XT	ATC
C15	0.4-2.5 pF Gigatrim Variable Capacitor	27271SL	Johanson
R1	1 k Ω , 1/4 W Chip Resistor	CRCW12061001FKEA	Vishay
R2	560 k Ω , 1/4 W Chip Resistor	CRCW12065600FKEA	Vishay
R3, R4	12 Ω , 1/4 W Chip Resistors	CRCW120612R0FKEA	Vishay



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. MRF5S21100HR3(SR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

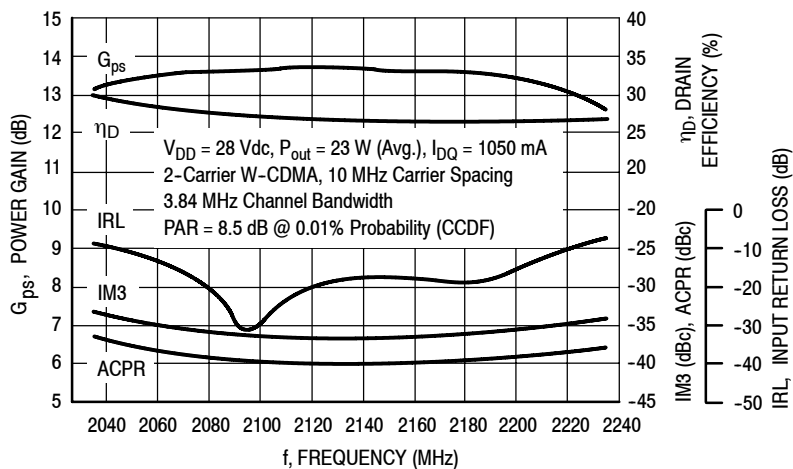


Figure 3. 2-Carrier W-CDMA Broadband Performance

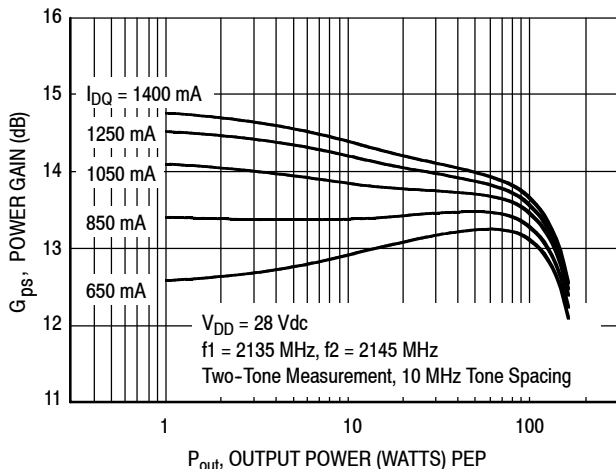


Figure 4. Two-Tone Power Gain versus Output Power

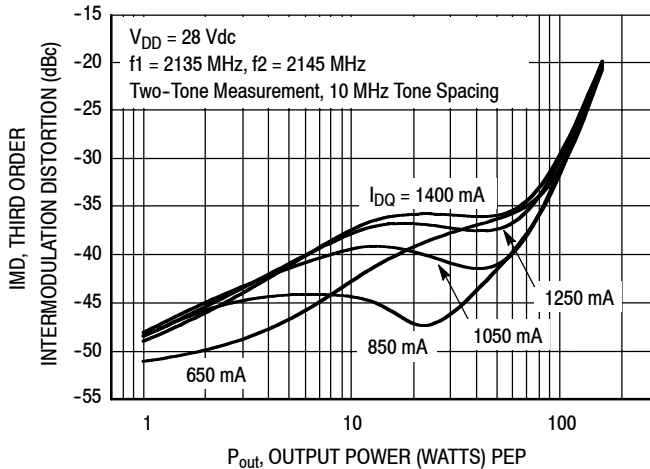


Figure 5. Third Order Intermodulation Distortion versus Output Power

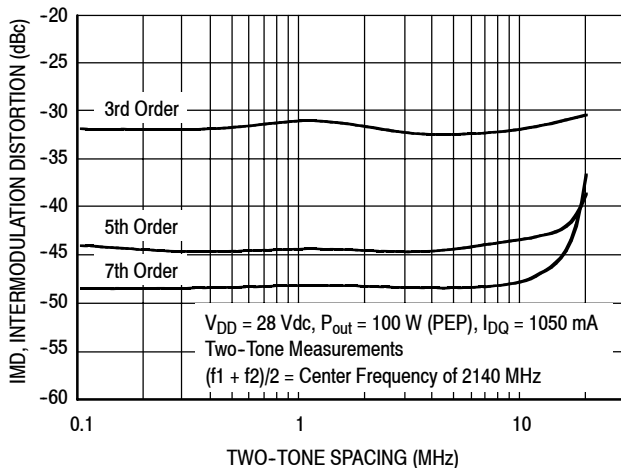


Figure 6. Intermodulation Distortion Products versus Tone Spacing

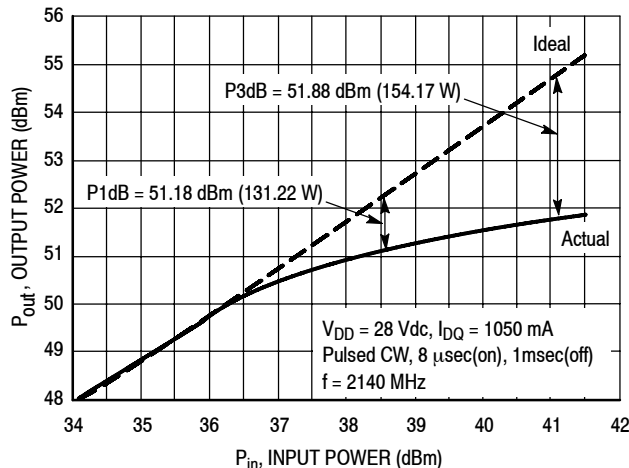


Figure 7. Pulse CW Output Power versus Input Power

TYPICAL CHARACTERISTICS

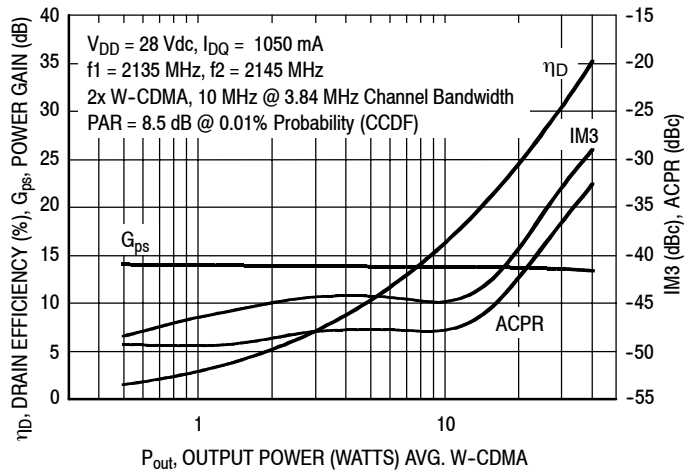
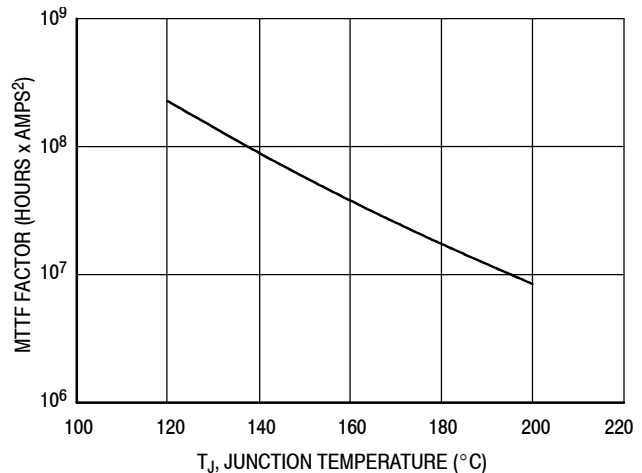


Figure 8. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power



This above graph displays calculated MTTF in hours x ampere² drain current. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ of the theoretical prediction for metal failure. Divide MTTF factor by I_{DQ}^2 for MTTF in a particular application.

Figure 9. MTTF Factor versus Junction Temperature

W-CDMA TEST SIGNAL

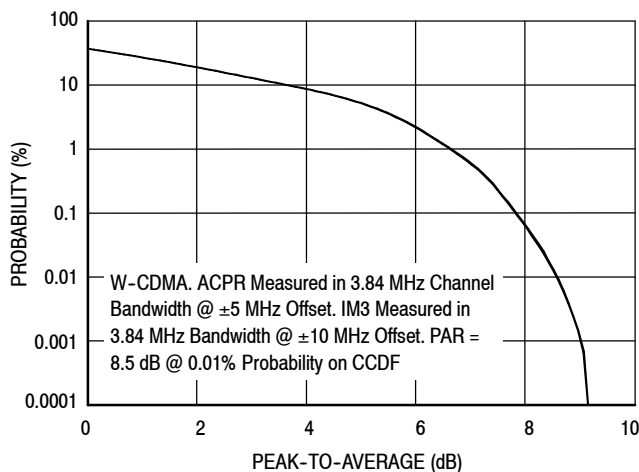


Figure 10. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single Carrier Test Signal

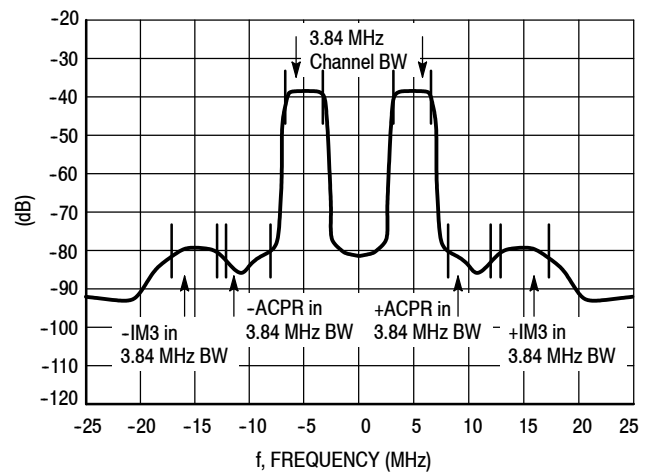
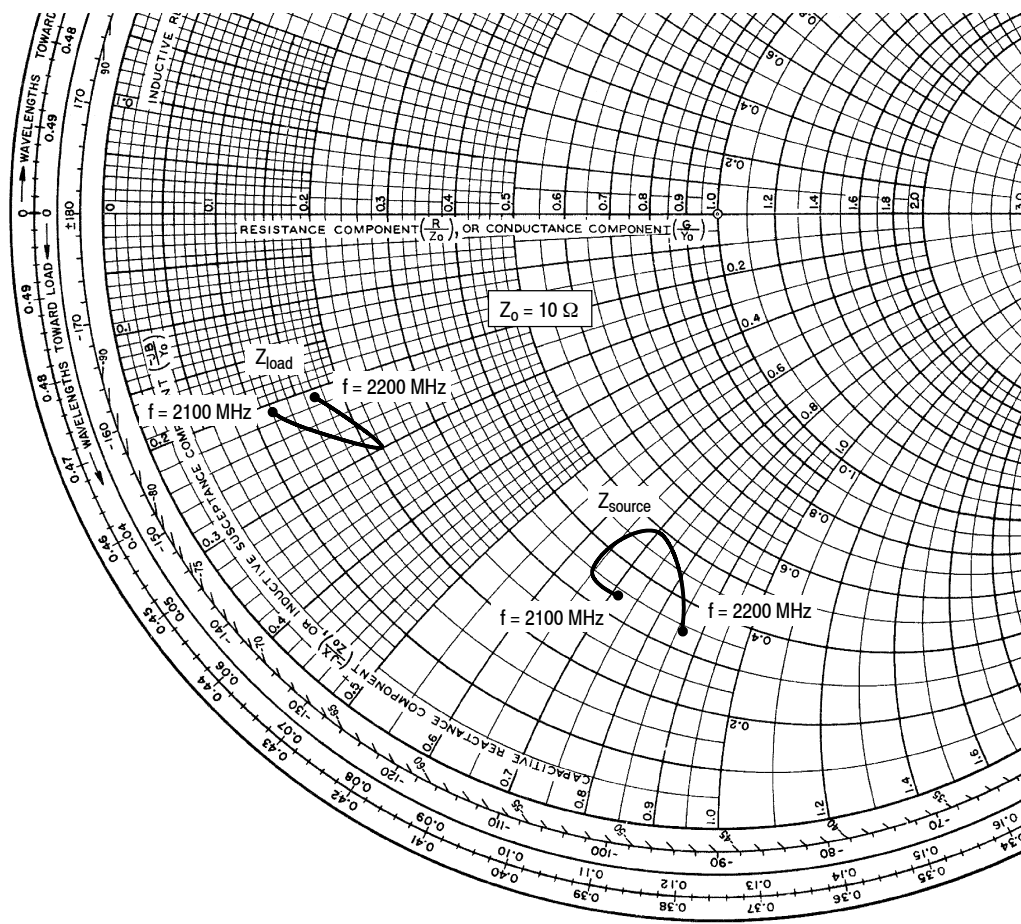


Figure 11. 2-Carrier W-CDMA Spectrum



$V_{DD} = 28 \text{ Vdc}$, $I_{DQ} = 1050 \text{ mA}$, $P_{out} = 23 \text{ W Avg.}$

f MHz	Z_{source} Ω	Z_{load} Ω
2100	$3.4 - j7.2$	$1.2 - j2.1$
2120	$3.4 - j6.5$	$1.4 - j2.3$
2160	$4.9 - j7.0$	$2.2 - j3.0$
2200	$3.4 - j8.6$	$1.7 - j2.1$

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

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

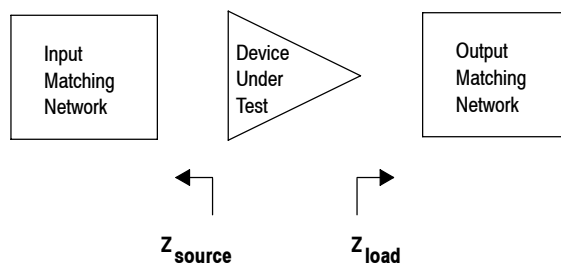
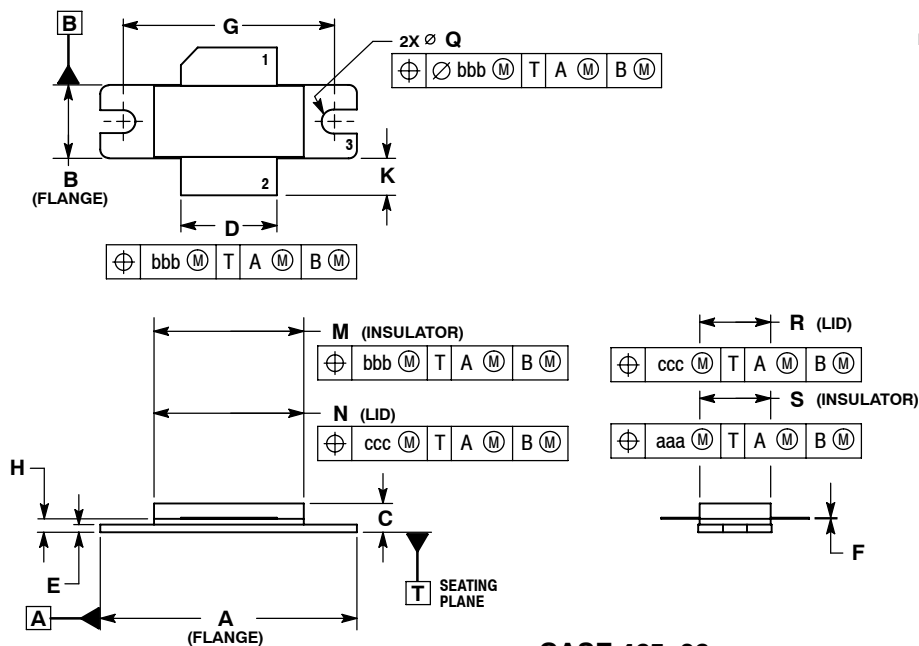


Figure 12. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS



NOTES:

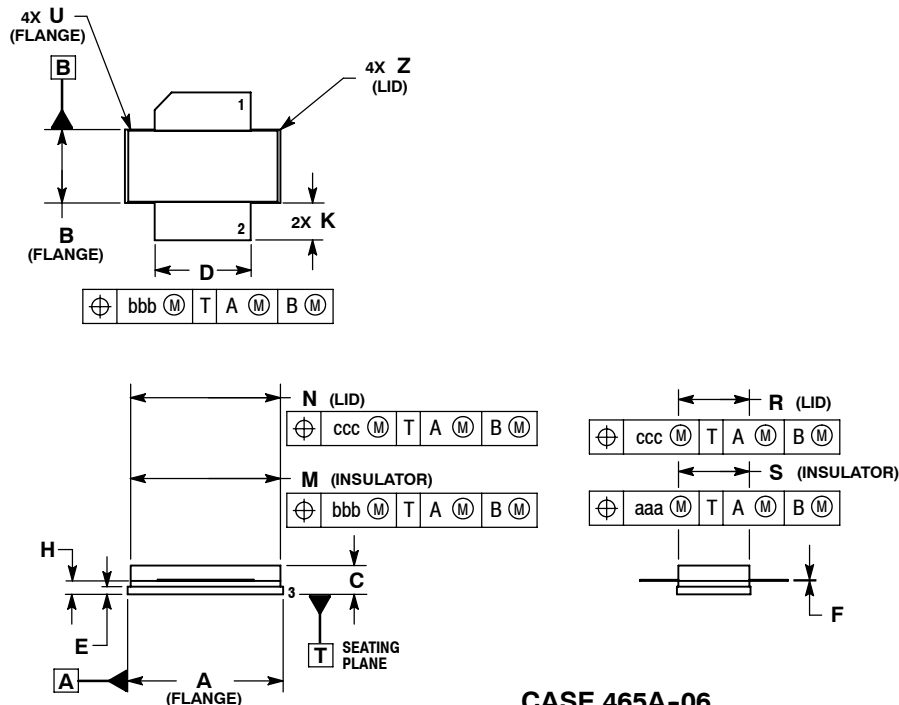
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2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.335	1.345	33.91	34.16
B	0.380	0.390	9.65	9.91
C	0.125	0.170	3.18	4.32
D	0.495	0.505	12.57	12.83
E	0.035	0.045	0.89	1.14
F	0.003	0.006	0.08	0.15
G	1.100 BSC		27.94 BSC	
H	0.057	0.067	1.45	1.70
K	0.170	0.210	4.32	5.33
M	0.774	0.786	19.66	19.96
N	0.772	0.788	19.60	20.00
Q	Ø 1.18	Ø 1.38	Ø 3.00	Ø 3.51
R	0.365	0.375	9.27	9.53
S	0.365	0.375	9.27	9.52
aaa	0.005 REF		0.127 REF	
bbb	0.010 REF		0.254 REF	
ccc	0.015 REF		0.381 REF	

STYLE 1:

- PIN 1. DRAIN
- GATE
- SOURCE

**CASE 465-06
ISSUE G
NI-780
MRF5S21100HR3**



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.805	0.815	20.45	20.70
B	0.380	0.390	9.65	9.91
C	0.125	0.170	3.18	4.32
D	0.495	0.505	12.57	12.83
E	0.035	0.045	0.89	1.14
F	0.003	0.006	0.08	0.15
H	0.057	0.067	1.45	1.70
K	0.170	0.210	4.32	5.33
M	0.774	0.786	19.61	20.02
N	0.772	0.788	19.61	20.02
R	0.365	0.375	9.27	9.53
S	0.365	0.375	9.27	9.52
U	---	0.040	---	1.02
Z	---	0.030	---	0.76
aaa	0.005 REF		0.127 REF	
bbb	0.010 REF		0.254 REF	
ccc	0.015 REF		0.381 REF	

STYLE 1:

- PIN 1. DRAIN
- GATE
- SOURCE

**CASE 465A-06
ISSUE H
NI-780S
MRF5S21100HSR3**

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
4	Dec. 2010	• Data sheet revised to reflect part status change, p. 1, including use of applicable overlay. • Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN12779, p. 1, 2 • Updated Part Numbers in Table 5, Component Designations and Values, to RoHS compliant part numbers, p. 3 • Added Revision History, p. 9 • Data sheet archived. Parts no longer manufactured.

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ARCHIVE INFORMATION

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Japan:

Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:

Freescale Semiconductor China Ltd.
Exchange Building 23F
No. 118 Jianguo Road
Chaoyang District
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China
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