Freescale Semiconductor
Technical Data

Document Number: MRF5S21090H
Rev. 2, 5/2006

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

MRF5S21090HR3
MRF5S21090HSR3

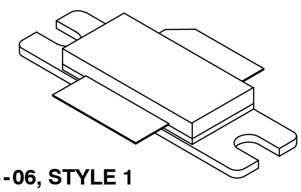
Designed for W-CDMA base station applications with frequencies from 2110 to 2170 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications. To be used in Class AB for PCN-PCS/cellular radio and WLL applications.

- Typical 2-carrier W-CDMA Performance: V_{DD} = 28 Volts, I_{DQ} = 850 mA, P_{out} = 19 Watts Avg., Full Frequency Band, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
  Power Gain — 14.5 dB
  Drain Efficiency — 26%
  IM3 @ 10 MHz Offset — -37.5 dBc in 3.84 MHz Channel Bandwidth
  ACPR @ 5 MHz Offset — -40.5 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 MHz, 90 Watts CW Output Power

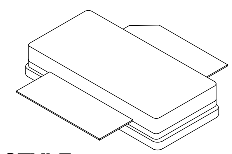
Features

- 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, 40μ″ Nominal.
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

2110-2170 MHz, 19 W AVG., 28 V
2 x W-CDMA
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465-06, STYLE 1
NI-780
MRF5S21090HR3



CASE 465A-06, STYLE 1
NI-780S
MRF5S21090HSR3

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°C Derate above 25°C	P_D	269 1.5	W W/°C
Storage Temperature Range	T_{stg}	- 65 to +150	°C
Case Operating Temperature	T_C	150	°C
Operating Junction Temperature	T_J	200	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 90 W CW Case Temperature 76°C, 19 W CW	$R_{\theta JC}$	 0.65 0.69	°C/W

1. MTTF calculator available at http://www.freescale.com/rf. Select Tools/Software/Application Software/Calculators to access the 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.

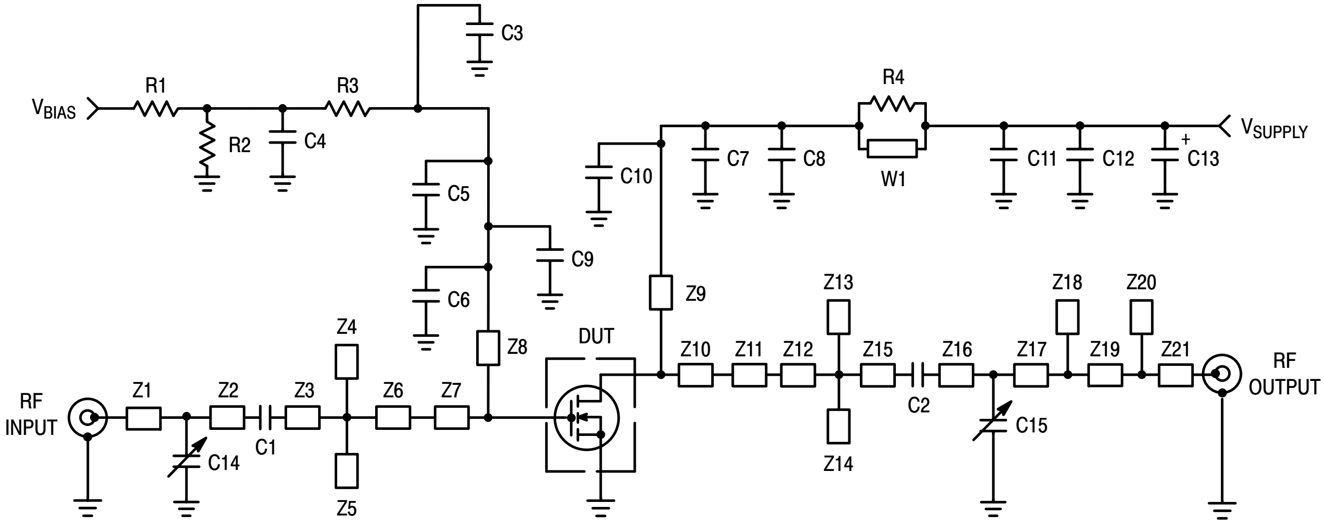
Table 3. ESD Protection Characteristics

Test Conditions	Class
Human Body Model	1 (Minimum)
Machine Model	M3 (Minimum)
Charge Device Model	C7 (Minimum)

Table 4. Electrical Characteristics (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 65 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics (DC)					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 200 μAdc)	$V_{GS(th)}$	2.5	2.9	3.5	Vdc
Gate Quiescent Voltage (V_{DS} = 28 Vdc, I_D = 850 mAdc)	$V_{GS(Q)}$	—	3.9	—	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 2 Adc)	$V_{DS(on)}$	—	0.25	—	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 2 Adc)	g_{fs}	—	5	—	S
Dynamic Characteristics (1)					
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.7	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 850 mA, P_{out} = 19 W Avg., f1 = 2112.5 MHz, f2 = 2122.5 MHz and f1 = 2157.5 MHz, f2 = 2167.5 MHz, 2-carrier W-CDMA, 3.84 MHz Channel Bandwidth Carriers. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset. IM3 measured in 3.84 MHz Bandwidth @ ±10 MHz Offset.. PAR = 8.5 dB @ 0.01% Probability on CCDF					
Power Gain	G_{ps}	12.5	14.5	—	dB
Drain Efficiency	η_D	24	26	—	%
Intermodulation Distortion	IM3	—	-37.5	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-40.5	-38	dBc
Input Return Loss	IRL	—	-15	-9	dB

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

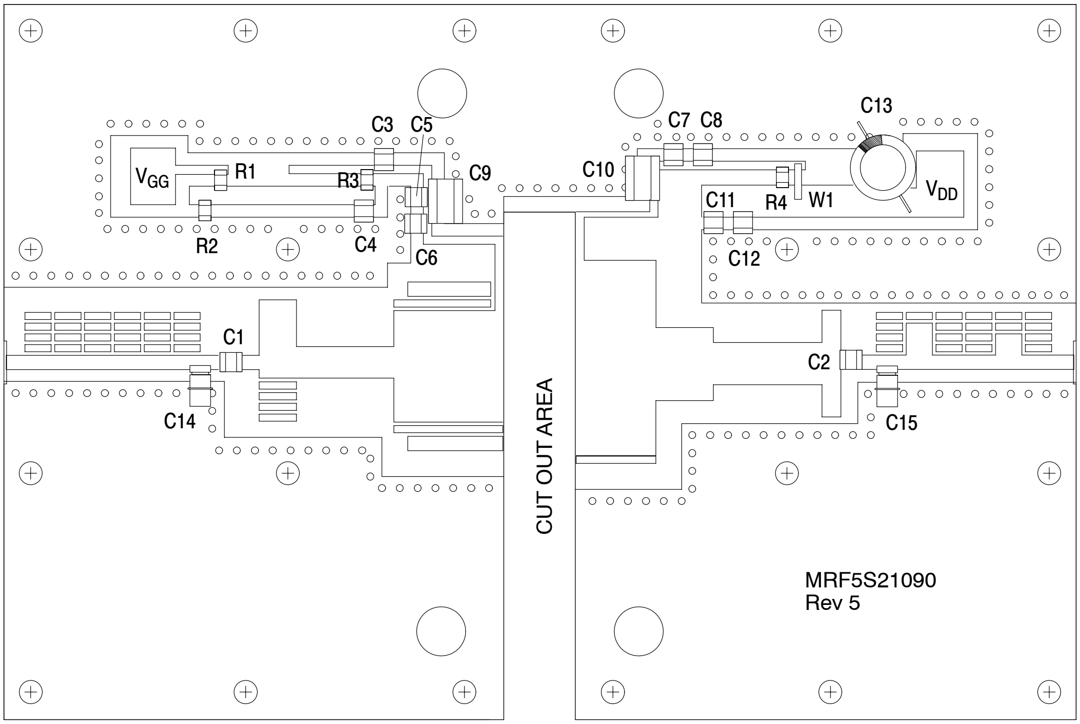


Z1	1.0856″ x 0.080″ Microstrip	Z12	0.609″ x 0.220″ Microstrip
Z2	0.130″ x 0.080″ Microstrip	Z13	0.290″ x 0.106″ Microstrip
Z3	0.230″ x 0.080″ Microstrip	Z14	0.290″ x 0.106″ Microstrip
Z4	0.347″ x 0.208″ Microstrip	Z15	0.080″ x 0.025″ Microstrip
Z5	0.090″ x 0.208″ Microstrip	Z16	1.080″ x 0.160″ Microstrip
Z6	0.650″ x 0.176″ Taper	Z17	0.180″ x 0.080″ Microstrip
Z7	0.623″ x 0.610″ Microstrip	Z18	0.260″ x 0.147″ Microstrip
Z8	0.044″ x 0.881″ Microstrip	Z19	0.500″ x 0.080″ Microstrip
Z9	0.044″ x 0.869″ Microstrip	Z20	0.199″ x 0.147″ Microstrip
Z10	1.076″ x 0.446″ Microstrip	Z21	0.365″ x 0.080″ Microstrip
Z11	0.320″ x 0.393″ Microstrip	PCB	Arlon GX0300-55-22, 0.03″, ε_r = 2.55

Figure 1. MRF5S21090HR3(HSR3) Test Circuit Schematic

Table 5. MRF5S21090HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	9.1 pF Chip Capacitor	100B9R1CP 500X	ATC
C2	8.2 pF Chip Capacitor	100B8R2CP 500X	ATC
C3	2.0 pF Chip Capacitor	100B2R0BP 500X	ATC
C4, C12	0.1 μF Chip Capacitors	CDR33BX104AKWS	Kemet
C5	5.6 pF Chip Capacitor	100B5R6CP 500X	ATC
C6	5.1 pF Chip Capacitor	100B5R1CP 500X	ATC
C7	7.5 pF Chip Capacitor	100B7R5JP 500X	ATC
C8	1.2 pF Chip Capacitor	100B1R2BP 500X	ATC
C9, C10	0.56 μF Chip Capacitors	700A561MP 150X	ATC
C11	1000 pF Chip Capacitor	100B102JP 500X	ATC
C13	470 μF, 35 V Electrolytic Capacitor	95F4579	Newark
C14, C15	0.4 – 2.5 Variable Capacitors, Gigatrim	44F3367	Newark
R1	1 kΩ Chip Resistor	D5534M07B1K00R	Newark
R2	560 kΩ Chip Resistor	CR1206 564JT	Newark
R3, R4	12 Ω Chip Resistors	RM73B2B120JT	Garrett Electronics
W1	Wire Strap		



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. MRF5S21090HR3(HSR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

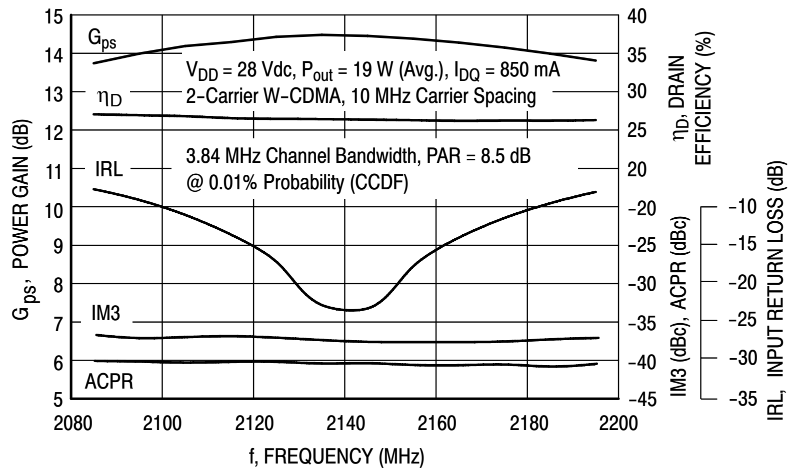


Figure 3. 2-Carrier W-CDMA Broadband Performance

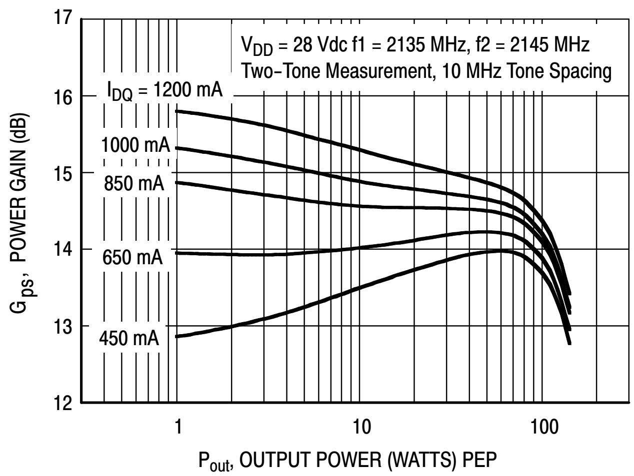


Figure 4. Two-Tone Power Gain versus Output Power

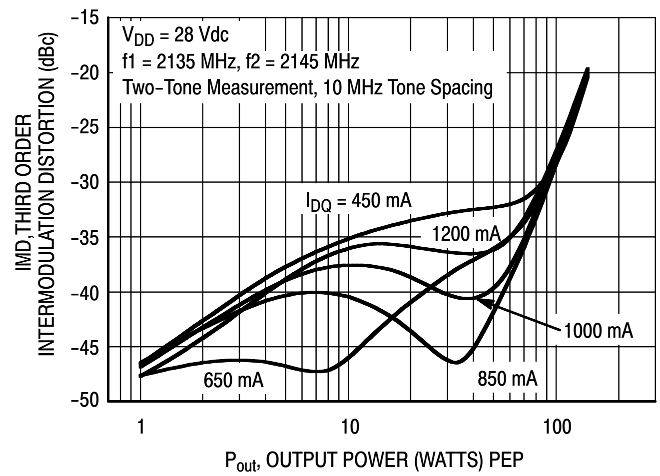


Figure 5. 3rd Order Intermodulation Distortion versus Output Power

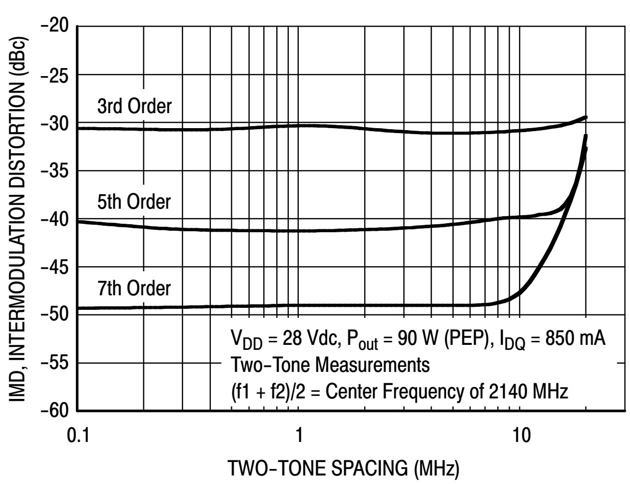


Figure 6. Intermodulation Distortion Products versus Tone Spacing

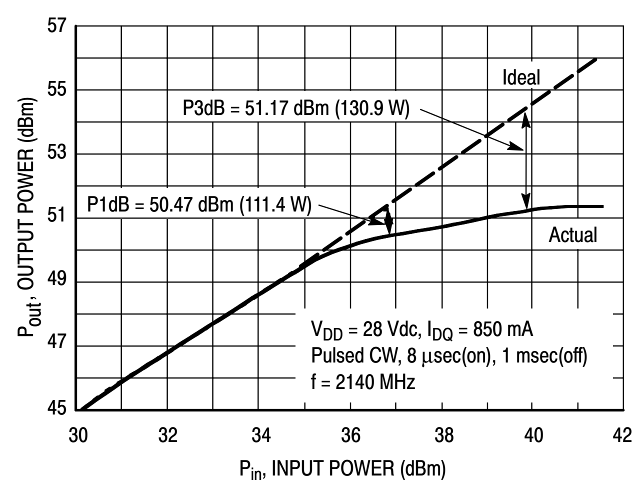


Figure 7. Pulse CW Output Power versus Input Power

TYPICAL CHARACTERISTICS

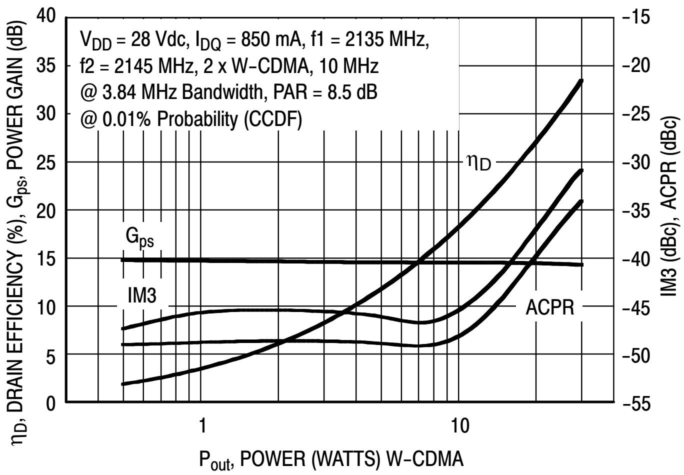
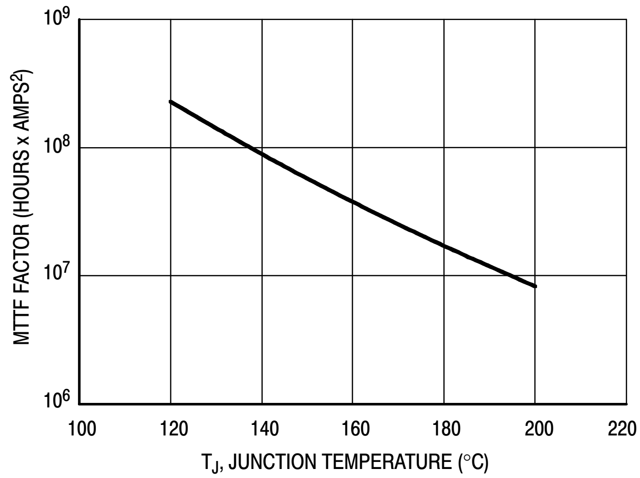


Figure 8. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power



This above graph displays calculated MTTF in hours x ampere^2 drain current. Life tests at elevated temperatures have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTTF factor by I_D^2 for MTTF in a particular application.

Figure 9. MTTF Factor versus Junction Temperature

W-CDMA TEST SIGNAL

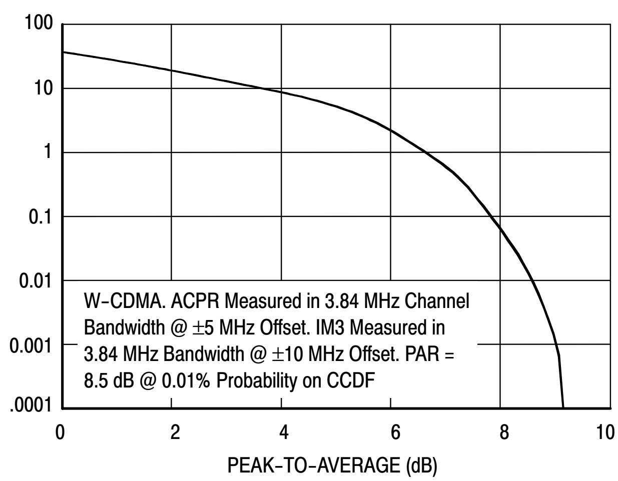


Figure 10. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single Carrier Test Signal

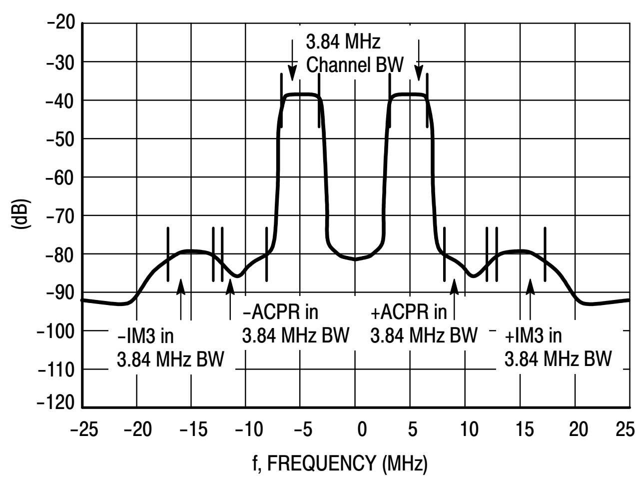
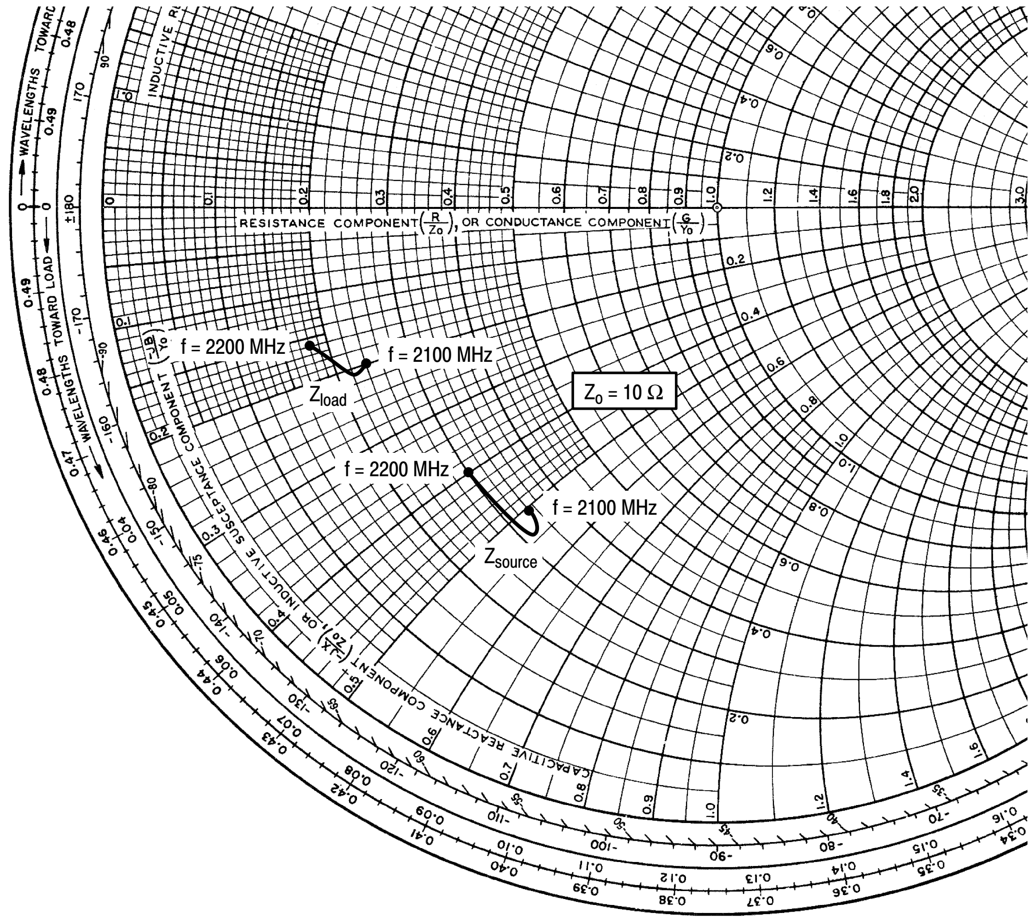


Figure 11. 2-Carrier W-CDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 850 mA, P_{out} = 19 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
2100	3.4 - j5.1	2.4 - j2.0
2120	3.2 - j5.4	2.2 - j2.1
2160	3.0 - j4.4	2.1 - j1.9
2200	3.0 - j4.0	1.8 - j1.6

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

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

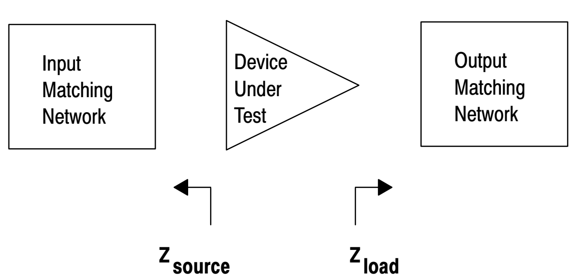


Figure 12. Series Equivalent Source and Load Impedance

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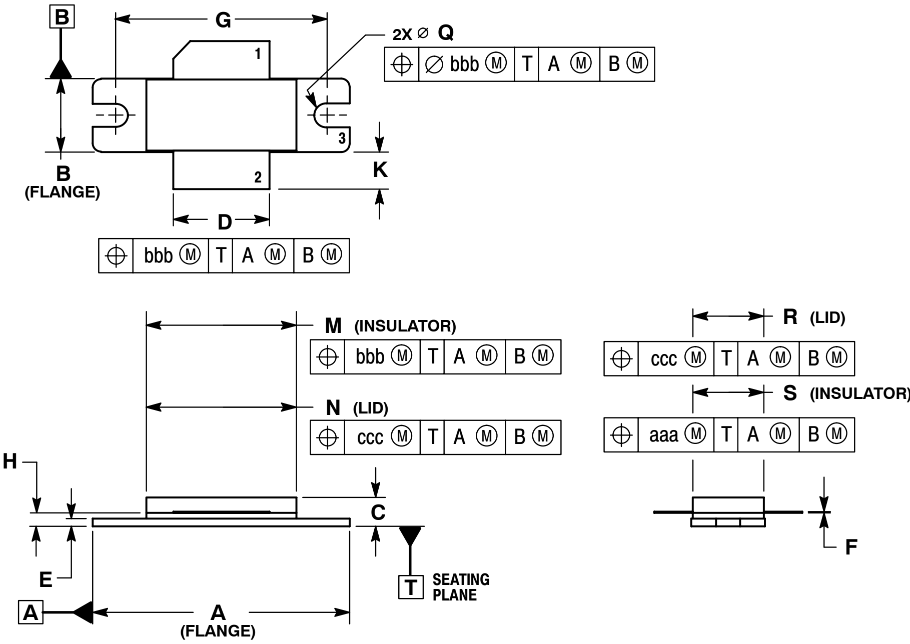
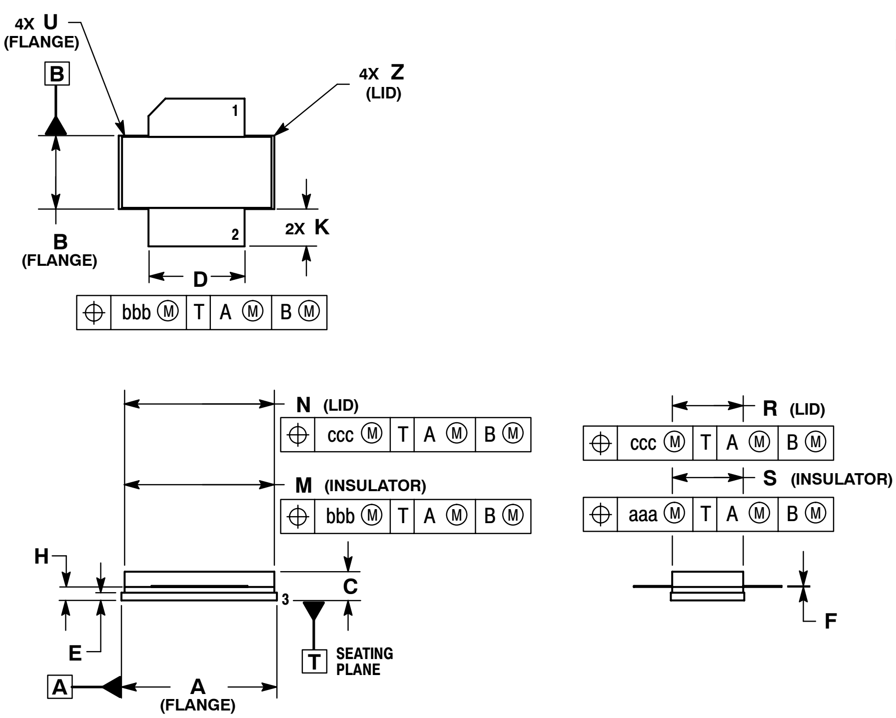


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS 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.118	Ø.138	Ø3.00	Ø3.51
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
2. GATE
3. SOURCE

CASE 465-06
ISSUE G
NI-780
MRF5S21090HR3



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

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS 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
2. GATE
5. SOURCE

CASE 465A-06
ISSUE H
NI-780S
MRF5S21090HSR3

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