Freescale Semiconductor
Technical Data

Document Number: MRF6S21100H
Rev. 7, 1/2007

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, WLL and TD-SCDMA applications.

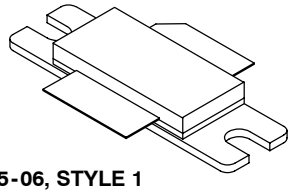
- Typical 2-carrier W-CDMA Performance for V_{DD} = 28 Volts, I_{DQ} = 950 mA, P_{out} = 23 Watts Avg., Full Frequency Band, Channel Bandwidth = 3.84 MHz, PAR = 8.5 dB @ 0.01% Probability on CCDF.
  Power Gain — 15.9 dB
  Drain Efficiency — 27.6%
  IM3 @ 10 MHz Offset — -37 dBc in 3.84 MHz Channel Bandwidth
  ACPR @ 5 MHz Offset — -39.5 dBc in 3.84 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2140 MHz, 100 Watts CW Output Power

Features

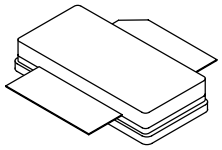
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- Designed for Lower Memory Effects and Wide Instantaneous Bandwidth Applications
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF6S21100HR3
MRF6S21100HSR3

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
MRF6S21100HR3



CASE 465A-06, STYLE 1
NI-780S
MRF6S21100HSR3

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +68	Vdc
Gate-Source Voltage	V_{GS}	-0.5, +12	Vdc
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, 100 W CW Case Temperature 77°C, 23 W CW	$R_{\theta JC}$	 0.45 0.52	°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 Methodology	Class
Human Body Model (per JESD22-A114)	3A (Minimum)
Machine Model (per EIA/JESD22-A115)	A (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

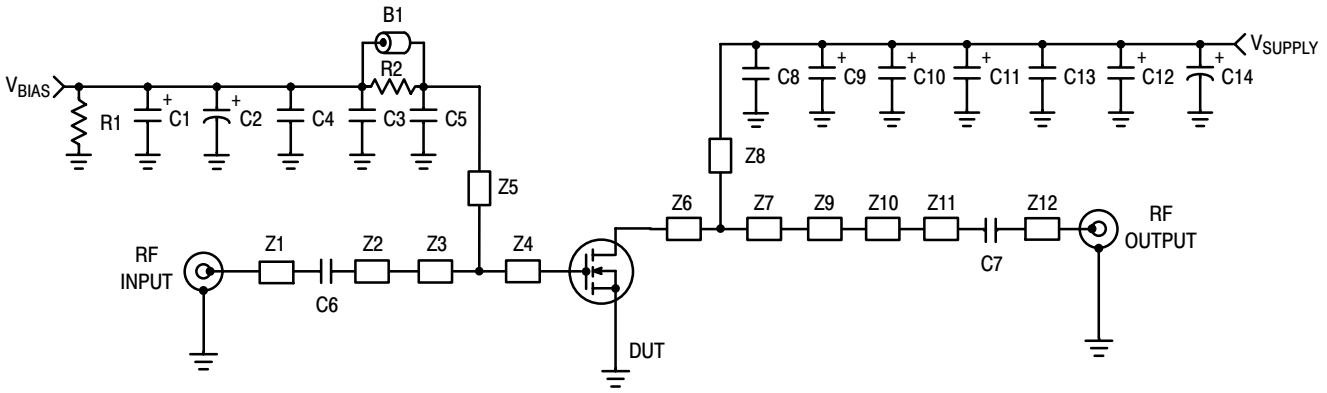
Table 4. Electrical Characteristics (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 68 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					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 250 μAdc)	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage (V_{DS} = 28 Vdc, I_D = 950 mAdc)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 2.2 Adc)	$V_{DS(on)}$	0.1	0.21	0.3	Vdc
Dynamic Characteristics (1)					
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.5	—	pF

Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 950 mA, P_{out} = 23 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 Channel Bandwidth @ ±10 MHz Offset. PAR = 8.5 dB @ 0.01% Probability on CCDF.

Power Gain	G_{ps}	14.5	15.9	17.5	dB
Drain Efficiency	η_D	26	27.6	—	%
Intermodulation Distortion	IM3	—	-37	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-39.5	-38	dBc
Input Return Loss	IRL	—	-16	-9	dB

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



Z1, Z12	1.250″ x 0.084″ Microstrip	Z7	0.320″ x 0.880″ Microstrip
Z2	1.070″ x 0.084″ Microstrip	Z8	0.120″ x 0.820″ Microstrip
Z3	0.330″ x 0.800″ Microstrip	Z9	0.035″ x 0.320″ Microstrip
Z4	0.093″ x 0.800″ Microstrip	Z10	0.335″ x 0.200″ Microstrip
Z5	1.255″ x 0.040″ Microstrip	Z11	0.650″ x 0.084″ Microstrip
Z6	0.160″ x 0.880″ Microstrip	PCB	Arlon GX-0300-55-22, 0.030″, ε_r = 2.55

Figure 1. MRF6S21100HR3(SR3) Test Circuit Schematic

Table 5. MRF6S21100HR3(SR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	Ferrite Bead	2743019447	Fair-Rite
C1	1.0 μF, 50 V Tantalum Capacitor	T491C105M050AT	Kemet
C2	10 μF, 50 V Electrolytic Capacitor	EEV-HB1H100P	Panasonic
C3	1000 pF 100B Chip Capacitor	ATC100B102JT500XT	ATC
C4, C13	0.1 μF 100B Chip Capacitors	CDR33BX104AKWY	Kemet
C5	5.1 pF Chip Capacitor	ATC100B5R1JT500XT	ATC
C6, C7	15 pF Chip Capacitors	ATC100B150JT500XT	ATC
C8	6.8 pF Chip Capacitors	ATC100B6R8JT500XT	ATC
C9, C10, C11, C12	22 μF, 35 V Tantalum Capacitors	T491X226K035AT	Kemet
C14	100 μF, 50 V Electrolytic Capacitor	515D107M050BB6AE3	Vishay/Sprague
R1	1.0 kΩ, 1/8 W Chip Resistor	CRCW08051000FKTA	Vishay
R2	10 Ω, 1/8 W Chip Resistor	CRCW080510R0FKTA	Vishay

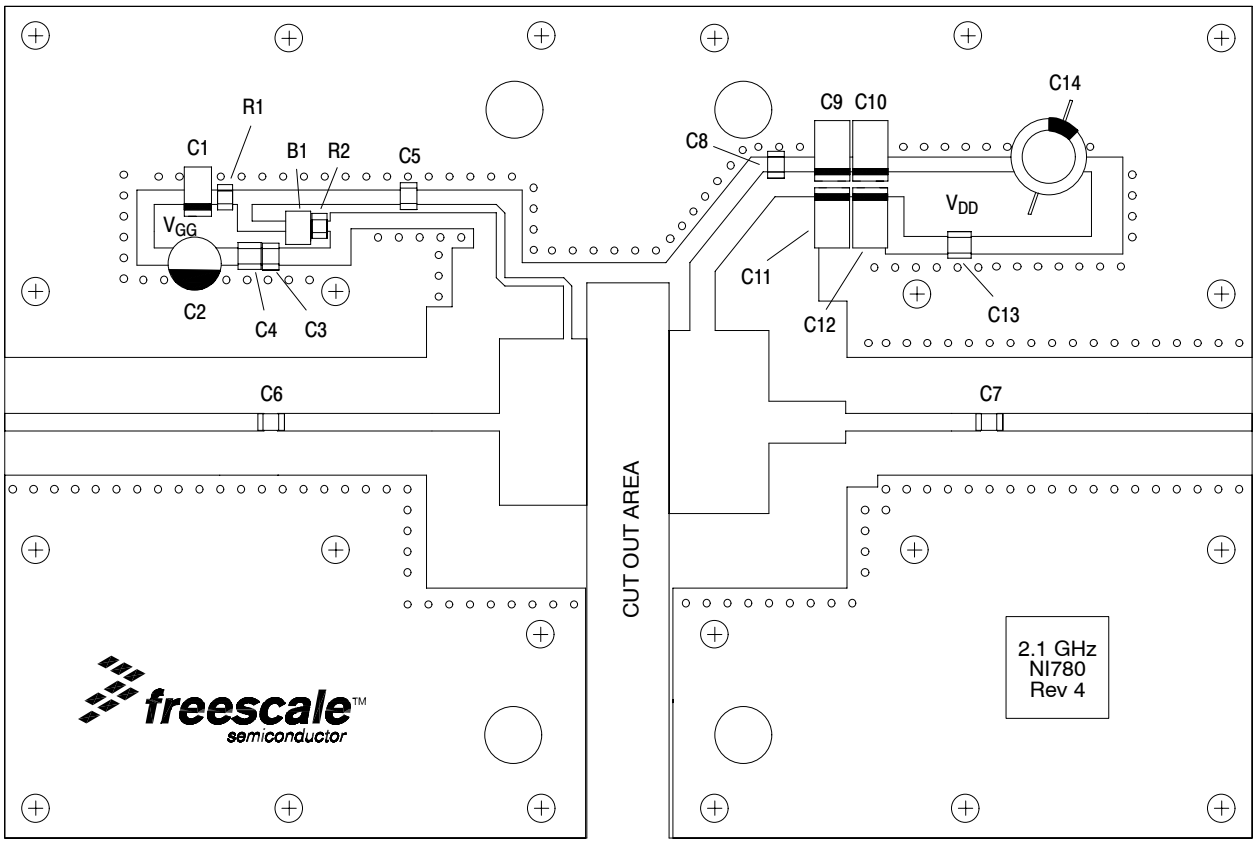


Figure 2. MRF6S21100HR3(SR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

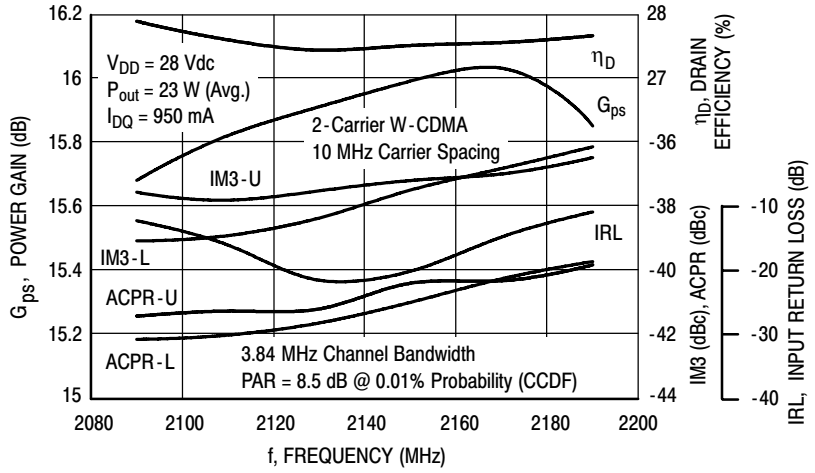


Figure 3. 2-Carrier W-CDMA Broadband Performance @ P_{out} = 23 Watts Avg.

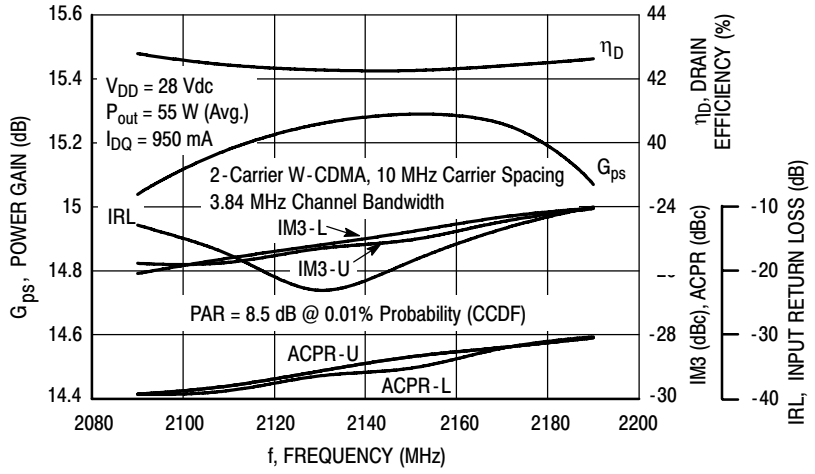


Figure 4. 2-Carrier W-CDMA Broadband Performance @ P_{out} = 55 Watts Avg.

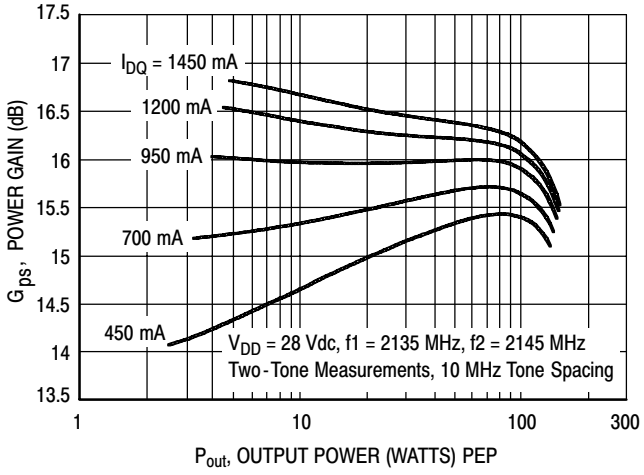


Figure 5. Two-Tone Power Gain versus Output Power

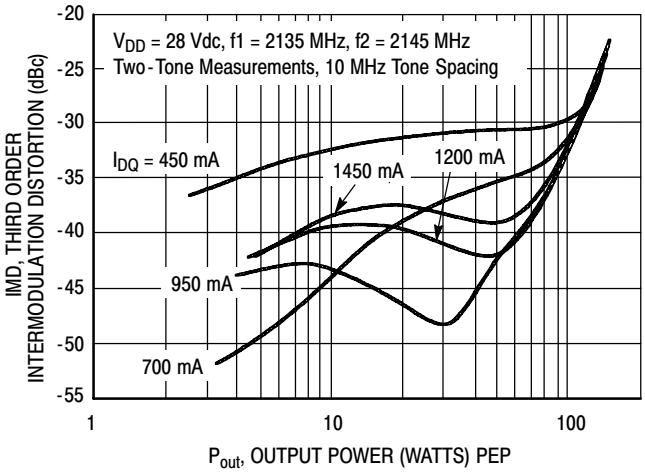


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

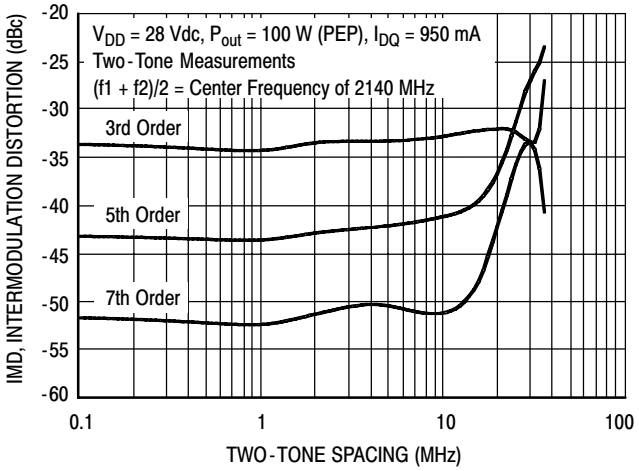


Figure 7. Intermodulation Distortion Products versus Tone Spacing

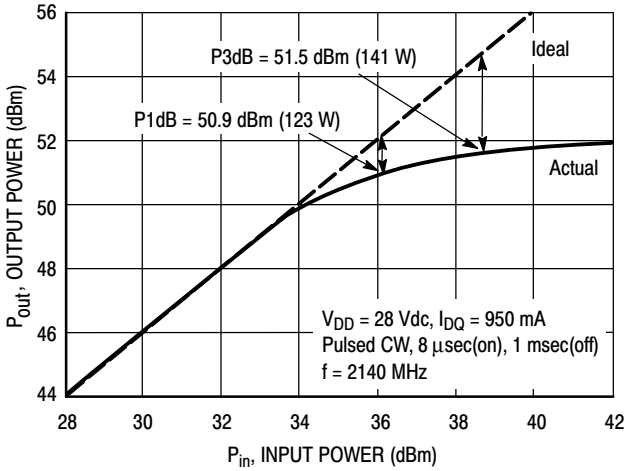


Figure 8. Pulsed CW Output Power versus Input Power

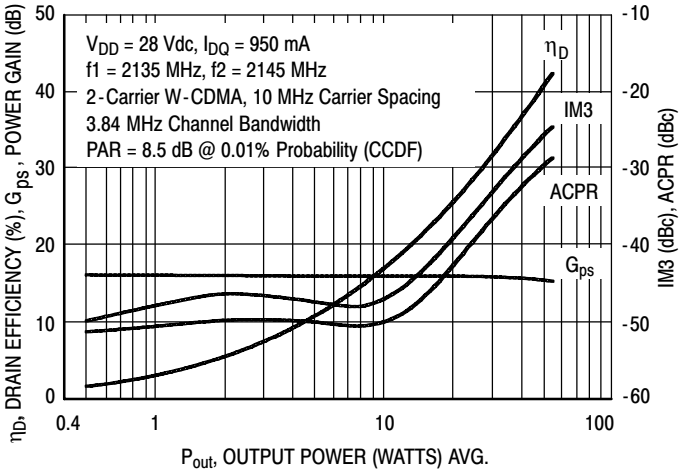


Figure 9. 2-Carrier W-CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power

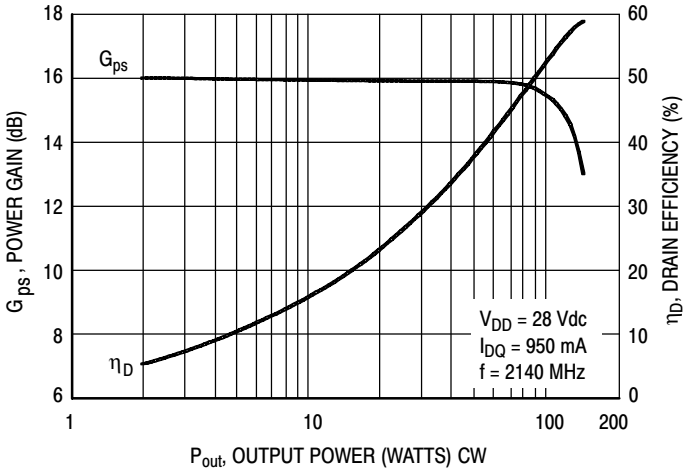


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

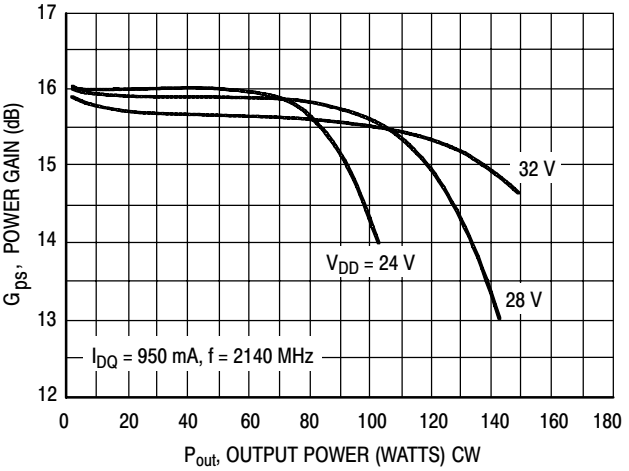
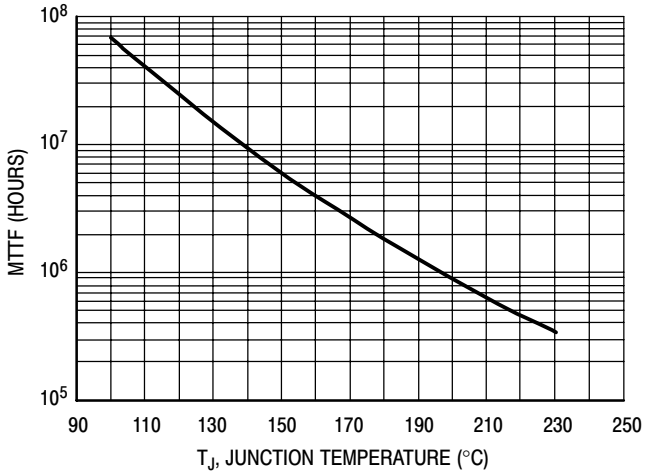


Figure 11. Power Gain versus Output Power

TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours when the device is operated at V_{DD} = 28 Vdc, P_{out} = 23 W Avg., and η_D = 27.6%.

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

Figure 12. MTTF versus Junction Temperature

W-CDMA TEST SIGNAL

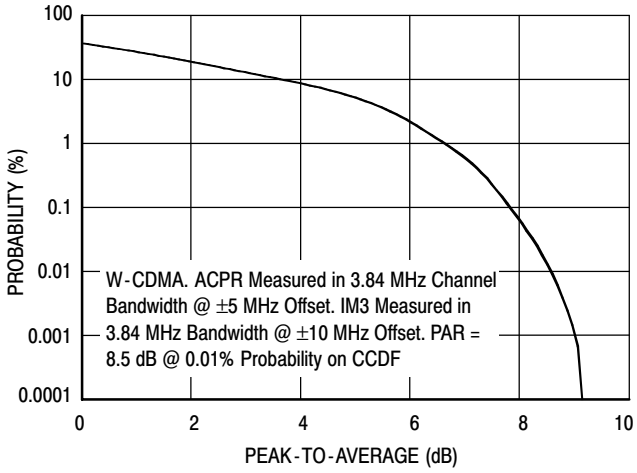


Figure 13. CCDF W-CDMA 3GPP, Test Model 1, 64 DPCH, 67% Clipping, Single-Carrier Test Signal

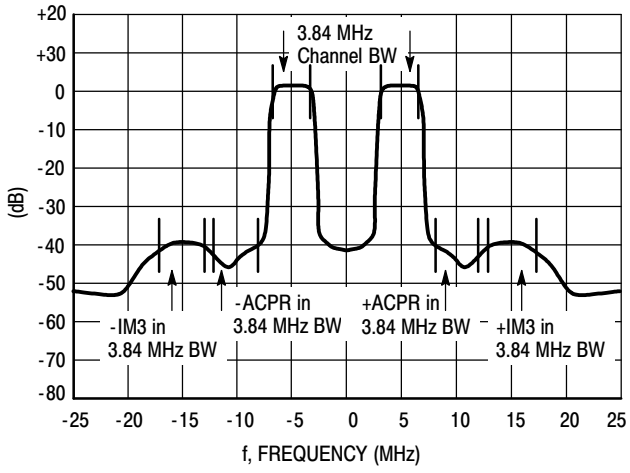
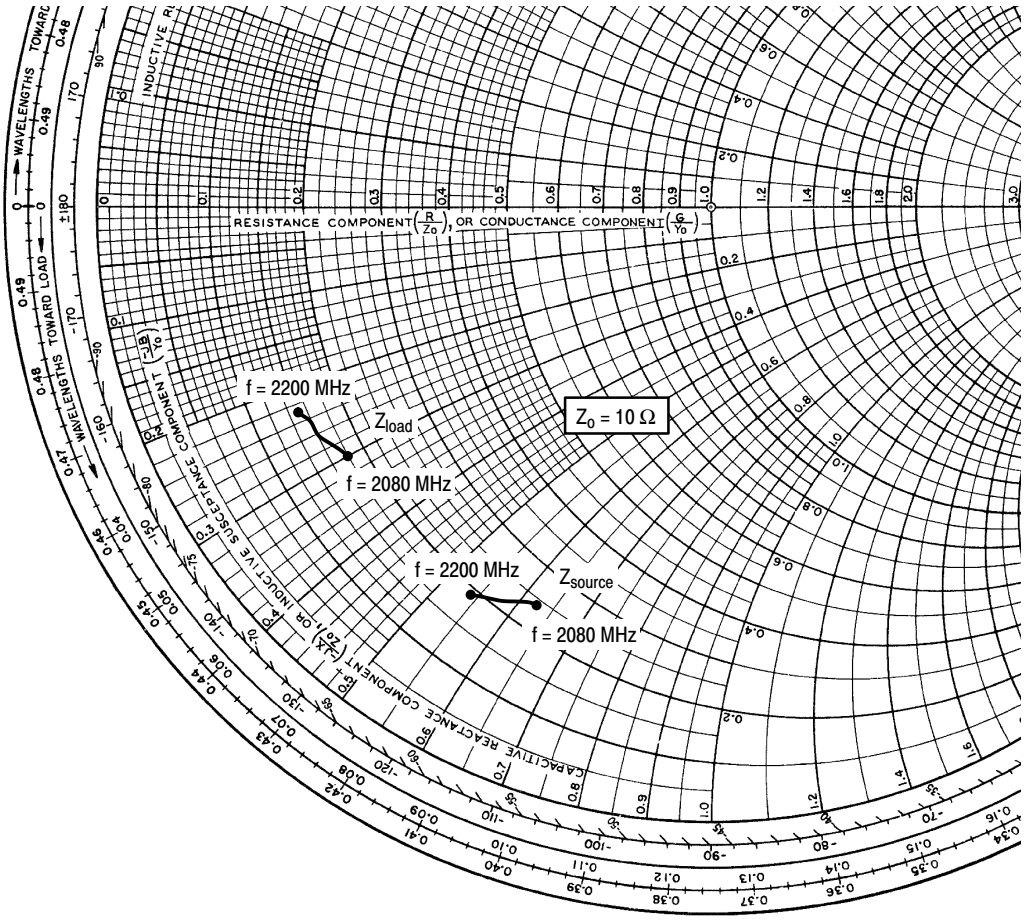


Figure 14. 2-Carrier W-CDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 950 mA, P_{out} = 23 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
2080	2.44 - j6.3	1.83 - j3.0
2110	2.25 - j6.1	1.74 - j2.8
2140	2.09 - j5.8	1.61 - j2.6
2170	1.98 - j5.6	1.59 - j2.5
2200	1.85 - j5.4	1.52 - j2.3

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

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

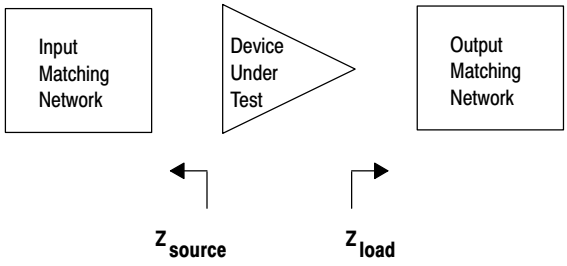
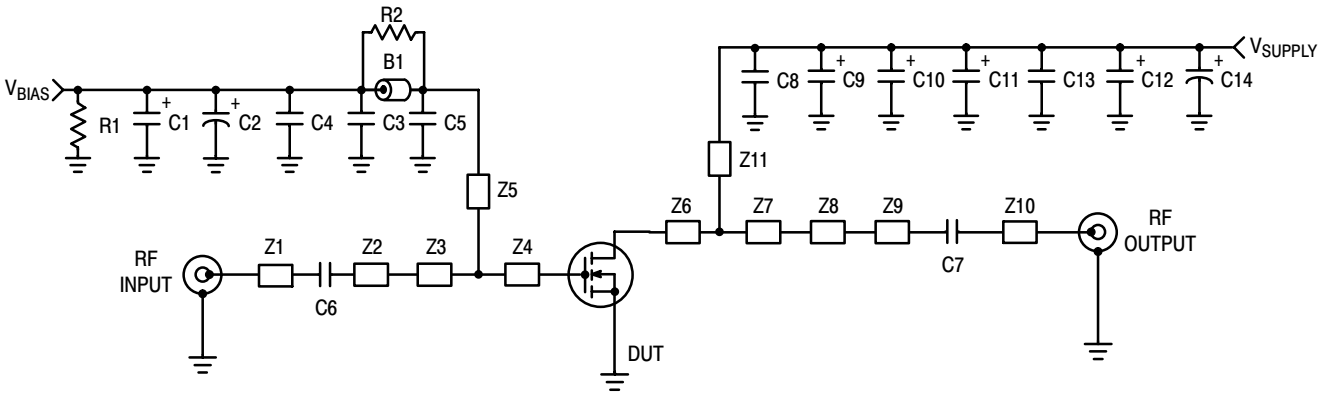


Figure 15. Series Equivalent Source and Load Impedance



Z1	1.250″ x 0.084″ Microstrip	Z7	0.320″ x 0.880″ Microstrip
Z2	0.930″ x 0.084″ Microstrip	Z8	0.370″ x 0.200″ Microstrip
Z3	0.470″ x 0.800″ Microstrip	Z9	0.650″ x 0.084″ Microstrip
Z4	0.090″ x 0.800″ Microstrip	Z10	1.230″ x 0.084″ Microstrip
Z5	1.500″ x 0.040″ Microstrip	Z11	0.870″ x 0.120″ Microstrip
Z6	0.160″ x 0.880″ Microstrip	PCB	Arlon GX-0300-55-22, 0.030″, ε_r = 2.55

Figure 16. MRF6S21100HR3(SR3) Test Circuit Schematic — TD-SCDMA

Table 6. MRF6S21100HR3(SR3) Test Circuit Component Designations and Values — TD-SCDMA

Part	Description	Part Number	Manufacturer
B1	Ferrite Bead	2743019447	Fair-Rite
C1	1.0 μF, 50 V Tantalum Capacitor	T491C105M050AT	Kemet
C2	10 μF, 50 V Electrolytic Capacitor	EEV-HB1H100P	Panasonic
C3	1000 pF 100B Chip Capacitor	ATC100B102JT500XT	ATC
C4, C13	0.1 μF 100B Chip Capacitors	CDR33BX104AKWY	Kemet
C5	5.1 pF Chip Capacitor	ATC100B5R1JT500XT	ATC
C6, C7	15 pF Chip Capacitors	ATC100B150JT500XT	ATC
C8	6.8 pF Chip Capacitors	ATC100B6R8JT500XT	ATC
C9, C10, C11, C12	22 μF, 35 V Tantalum Capacitors	T491X226K035AT	Kemet
C14	100 μF, 50 V Electrolytic Capacitor	515D107M050BB6AE3	Vishay/Sprague
R1	1.0 kΩ, 1/8 W Chip Resistor	CRCW08051000FKTA	Vishay
R2	10 Ω, 1/8 W Chip Resistor	CRCW080510R0FKTA	Vishay

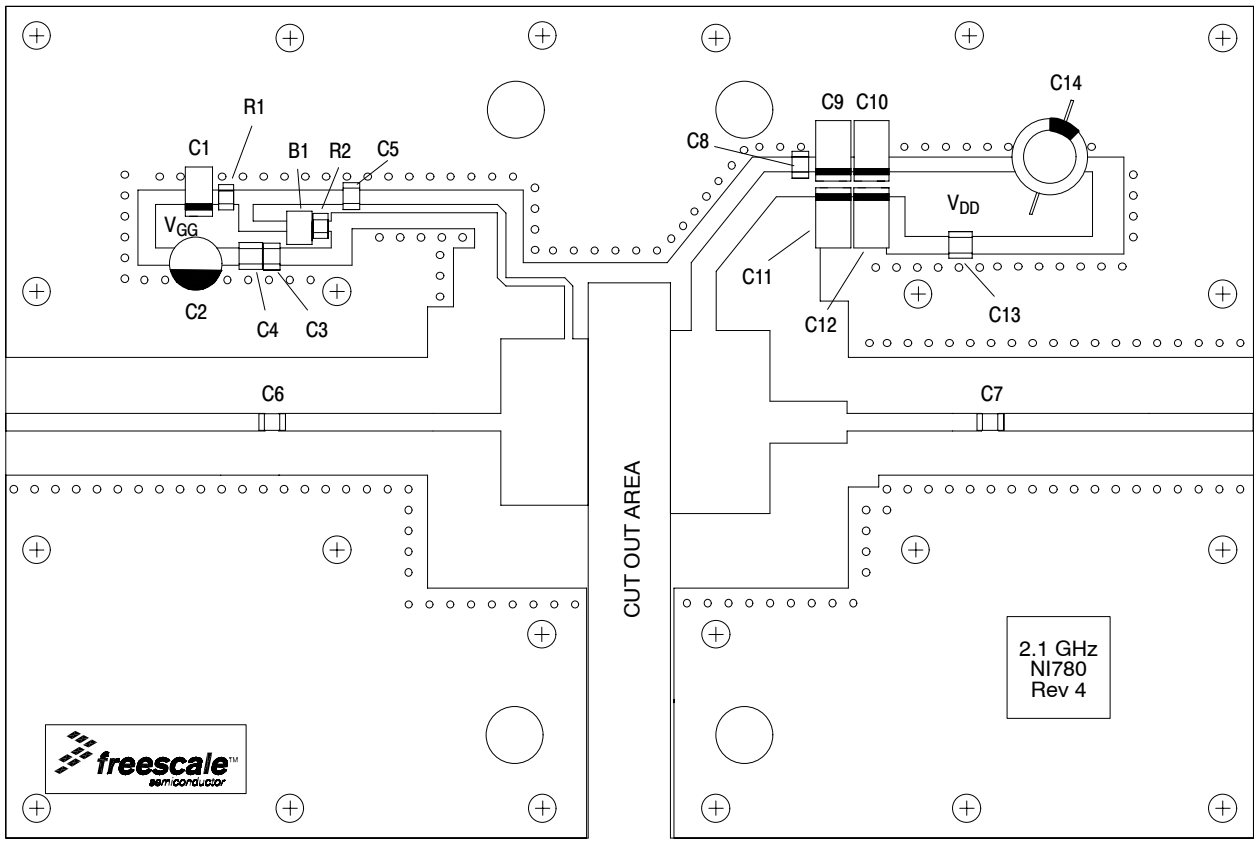


Figure 17. MRF6S21100HR3(SR3) Test Circuit Component Layout — TD-SCDMA

TYPICAL CHARACTERISTICS

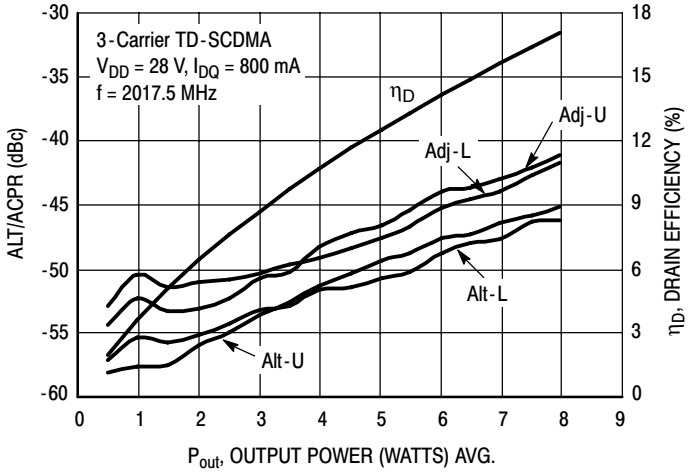


Figure 18. 3-Carrier TD-SCDMA ACPR, ALT and Drain Efficiency versus Output Power

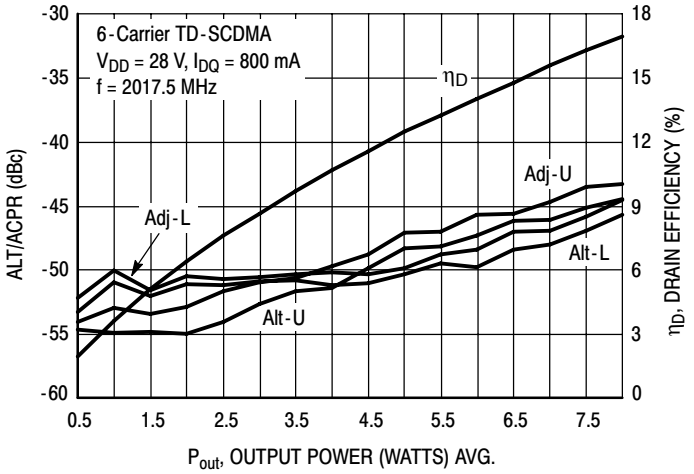


Figure 19. 6-Carrier TD-SCDMA ACPR, ALT and Drain Efficiency versus Output Power

TD-SCDMA TEST SIGNAL

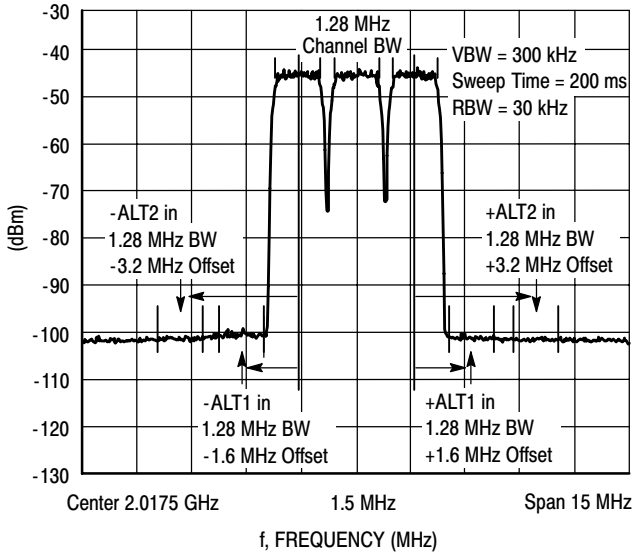


Figure 20. 3-Carrier TD-SCDMA Spectrum

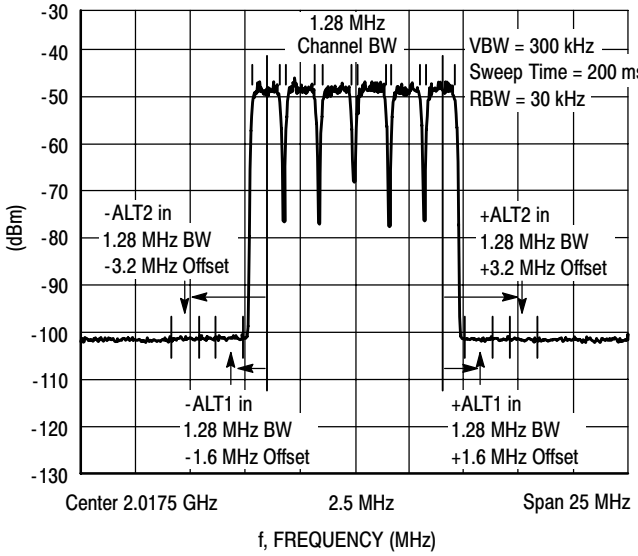
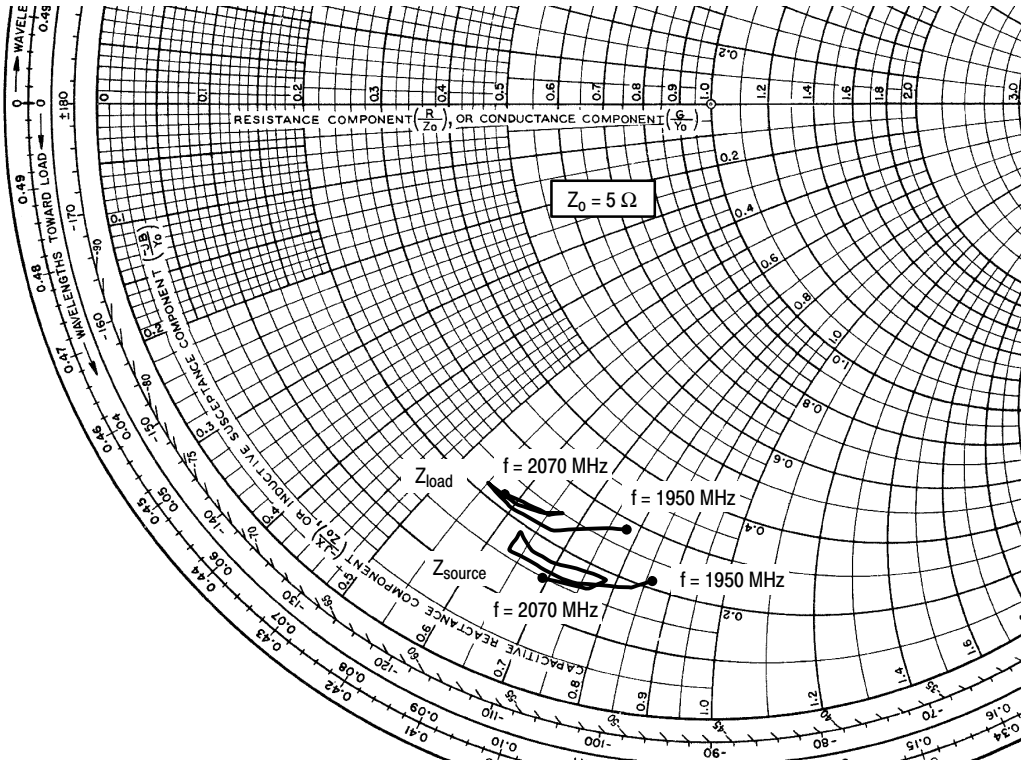


Figure 21. 6-Carrier TD-SCDMA Spectrum



V_{DD} = 28 Vdc, I_{DQ} = 800 mA

f MHz	Z_{source} Ω	Z_{load} Ω
1950	1.04 - j4.28	1.38 - j3.90
1960	1.07 - j4.31	1.41 - j3.92
1970	0.96 - j4.13	1.29 - j3.71
1980	0.82 - j3.71	1.12 - j3.34
1990	0.79 - j3.34	1.07 - j2.96
2000	0.82 - j3.15	1.08 - j2.75
2010	0.88 - j3.16	1.12 - j2.76
2020	0.84 - j3.30	1.11 - j2.86
2030	0.83 - j3.47	1.12 - j3.01
2040	0.91 - j3.71	1.22 - j3.20
2050	0.91 - j3.90	1.25 - j3.34
2060	0.81 - j3.81	1.15 - j3.27
2070	0.76 - j3.45	1.09 - j2.92

Z_{source} = Device input impedance as measured from gate to ground.

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

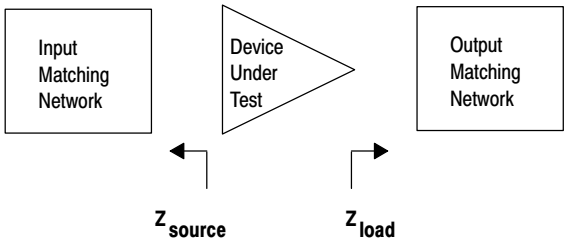
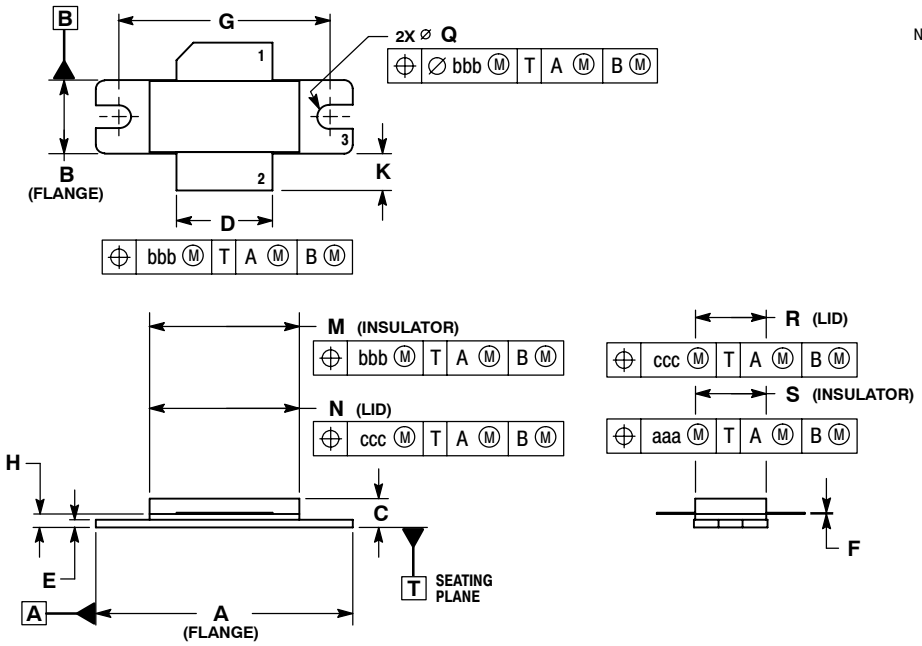


Figure 22. Series Equivalent Source and Load Impedance — TD-SCDMA

PACKAGE DIMENSIONS

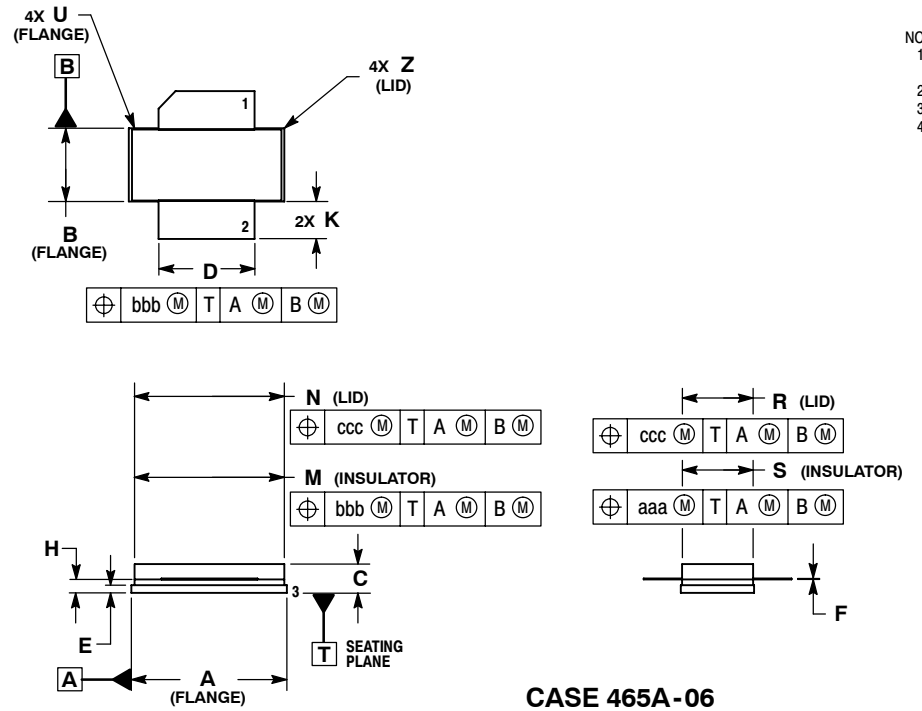


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

	INCHES		MILLIMETERS	
DIM	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.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
MRF6S21100HR3



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

	INCHES		MILLIMETERS	
DIM	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
2. GATE
5. SOURCE

CASE 465A-06
ISSUE H
NI-780S
MRF6S21100HSR3

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
7	Jan. 2007	• Added “TD-SCDMA” to data sheet description paragraph, p. 1 • Removed Lower Thermal Resistance and Low Gold Plating bullets from Features section as functionality is standard, p. 1 • Removed Forward Transconductance from On Characteristics table as it no longer provided usable information, p. 2 • Updated Part Numbers in Table 5, Component Designations and Values, to RoHS compliant part numbers, p. 3 • Adjusted scale for Fig. 5, Two-Tone Power Gain versus Output Power, to better match the device’s capabilities, p. 5 • Removed lower voltage tests from Fig. 11, Power Gain versus Output Power, due to fixed tuned fixture limitations, p. 6 • Replaced Fig. 12, MTTF versus Junction Temperature with updated graph. Removed $Amps^2$ and listed operating characteristics and location of MTTF calculator for device, p. 7 • Added TD-SCDMA test circuit schematic, component designations and values, component layout, typical characteristic curves, test signal and series impedance, p. 9-12 • Added Product Documentation and Revision History, p. 14

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