Freescale Semiconductor
Technical Data

Document Number: MRF7S27130H
Rev. 0, 9/2007

RoHS

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

MRF7S27130HR3
MRF7S27130HSR3

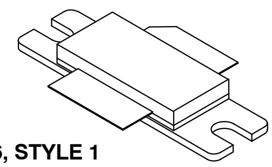
Designed for WiMAX base station applications with frequencies up to 2700 MHz. Suitable for WiMAX, WiBro, BWA, and OFDM multicarrier Class AB and Class C amplifier applications.

- Typical WiMAX Performance: V_{DD} = 28 Volts, I_{DQ} = 1500 mA, P_{out} = 23 Watts Avg., f = 2500 and 2700 MHz, 802.16d, 64 QAM $^3/_4$, 4 bursts, 7 MHz Channel Bandwidth, Input Signal PAR = 9.5 dB @ 0.01% Probability on CCDF.
  Power Gain — 16.5 dB
  Drain Efficiency — 20%
  Device Output Signal PAR — 8.2 dB @ 0.01% Probability on CCDF
  ACPR @ 5.25 MHz Offset — -49 dBc in 0.5 MHz Channel Bandwidth
- Capable of Handling 10:1 VSWR, @ 32 Vdc, 2600 MHz, 105 Watts CW Peak Tuned Output Power

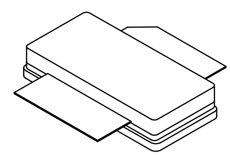
Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

2500-2700 MHz, 23 W AVG., 28 V
WiMAX
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465-06, STYLE 1
NI-780
MRF7S27130HR3



CASE 465A-06, STYLE 1
NI-780S
MRF7S27130HSR3

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	-0.5, +65	Vdc
Gate-Source Voltage	V_{GS}	-6.0, +10	Vdc
Operating Voltage	V_{DD}	32, +0	Vdc
Storage Temperature Range	T_{stg}	- 65 to +150	°C
Case Operating Temperature	T_C	150	°C
Operating Junction Temperature (1,2)	T_J	225	°C
CW Operation @ T_C = 25°C Derate above 25°C	CW	150 0.83	W °C/W

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 104 W CW Case Temperature 69°C, 23 W CW	$R_{\theta JC}$	 0.32 0.36	°C/W

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.freescale.com/rf. Select Design Tools (Software & Tools)/Calculators to access MTTF calculators by product.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1955.

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Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	1B (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} = 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					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 348 μAdc)	$V_{GS(th)}$	1.2	2	2.7	Vdc
Gate Quiescent Voltage (V_{DS} = 28 Vdc, I_D = 1500 mAdc)	$V_{GS(Q)}$	—	2.7	—	Vdc
Fixture Gate Quiescent Voltage (1) (V_{DD} = 28 Vdc, I_D = 1500 mAdc, Measured in Functional Test)	$V_{GG(Q)}$	4	5.4	7	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 3.4 Adc)	$V_{DS(on)}$	0.1	0.24	0.3	Vdc
Dynamic Characteristics (2)					
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	10.4	—	pF
Output Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	711	—	pF
Input Capacitance (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	326	—	pF

Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1500 mA, P_{out} = 23 W Avg., f = 2500 MHz and f = 2700 MHz, WiMAX Signal, 802.16d, 7 MHz Channel Bandwidth, 64 QAM $^3/_4$, 4 Bursts, PAR = 9.5 dB @ 0.01% Probability on CCDF. ACPR measured in 0.5 MHz Channel Bandwidth @ ±5.25 MHz Offset.

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain	G_{ps}	15	16.5	18.5	dB
Drain Efficiency	η_D	18	20	23	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	7.5	8.2	—	dB
Adjacent Channel Power Ratio	ACPR	—	-49	-46	dBc
Input Return Loss	IRL	—	-8	-5	dB

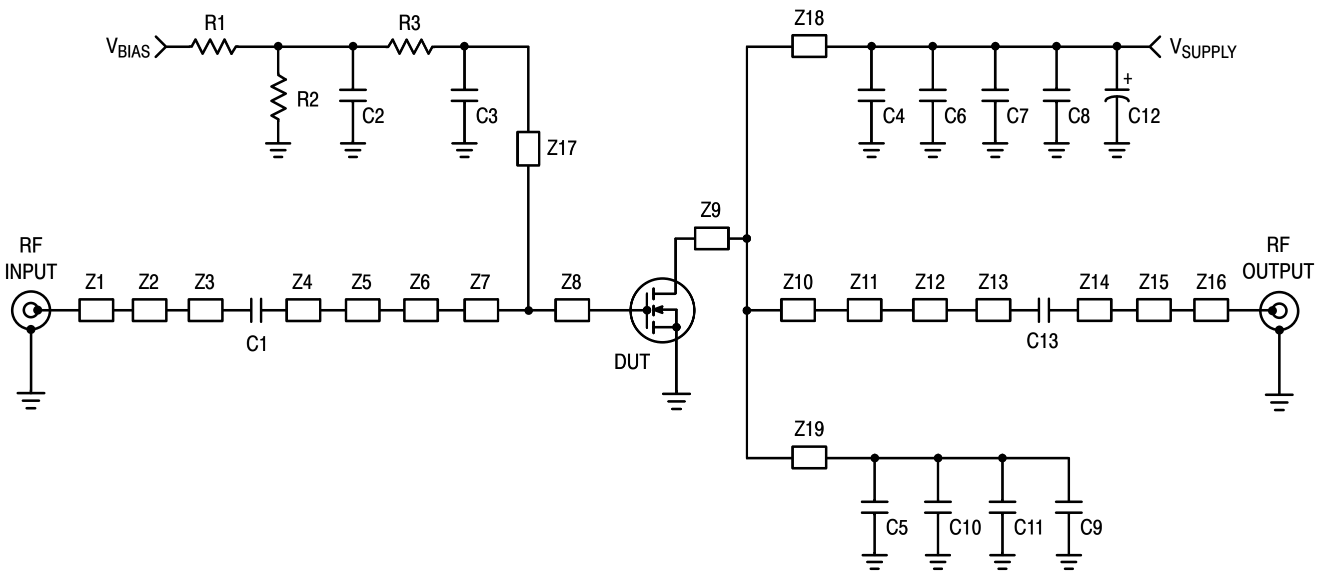
1. V_{GG} = 2 x $V_{GS(Q)}$. Parameter measured on Freescale Test Fixture, due to resistive divider network on the board. Refer to Test Circuit schematic.
2. Part internally matched both on input and output.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
Typical Performances OFDM Signal (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1500 mA, P_{out} = 23 W Avg., f = 2500 MHz and f = 2700 MHz, WiMAX Signal, OFDM Single-Carrier, 7 MHz Channel Bandwidth, 64 QAM $^3/_4$, 4 Bursts, PAR = 9.5 dB @ 0.01% Probability on CCDF.					
Mask System Type G @ P_{out} = 23 W Avg.	Mask				dBc
Point B at 3.5 MHz Offset		—	-27	—	
Point C at 5 MHz Offset		—	-40	—	
Point D at 7.4 MHz Offset		—	-44	—	
Point E at 14 MHz Offset		—	-60	—	
Point F at 17.5 MHz Offset		—	-60	—	
Relative Constellation Error @ P_{out} = 23 W Avg. (1)	RCE	—	-33	—	dB
Error Vector Magnitude (1) (Typical EVM Performance @ P_{out} = 23 W Avg. with OFDM 802.16d Signal Call)	EVM	—	2.2	—	% rms
Typical Performances (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1500 mA, 2500-2700 MHz Bandwidth					
Video Bandwidth @ 130 W PEP P_{out} where IM3 = -30 dBc (Tone Spacing from 100 kHz to VBW) ΔIMD3 = IMD3 @ VBW frequency - IMD3 @ 100 kHz <1 dBc (both sidebands)	VBW	—	40	—	MHz
Gain Flatness in 200 MHz Bandwidth @ P_{out} = 23 W Avg.	G_F	—	1.2	—	dB
Average Deviation from Linear Phase in 200 MHz Bandwidth @ P_{out} = 105 W CW	Φ	—	135	—	°
Average Group Delay @ P_{out} = 105 W CW, f = 2600 MHz	Delay	—	1.5	—	ns
Part-to-Part Insertion Phase Variation @ P_{out} = 105 W CW, f = 2600 MHz, Six Sigma Window	ΔΦ	—	81.3	—	°
Gain Variation over Temperature (-30°C to +85°C)	ΔG	—	0.013	—	dB/°C
Output Power Variation over Temperature (-30°C to +85°C)	ΔP1dB	—	0.01	—	dBm/°C

1. RCE = 20Log(EVM/100)



Z1	0.320″ x 0.084″ Microstrip
Z2	0.380″ x 0.240″ Microstrip
Z3	0.046″ x 0.084″ Microstrip
Z4	0.273″ x 0.084″ Microstrip
Z5	0.360″ x 0.600″ Microstrip
Z6	0.260″ x 0.394″ Microstrip
Z7	0.145″ x 0.922″ Microstrip
Z8	0.455″ x 0.922″ Microstrip
Z9	0.106″ x 0.716″ Microstrip
Z10	0.413″ x 0.716″ Microstrip
Z11	0.251″ x 0.084″ Microstrip
Z12	0.160″ x 0.162″ Microstrip
Z13	0.566″ x 0.084″ Microstrip
Z14	0.059″ x 0.084″ Microstrip
Z15	0.080″ x 0.123″ Microstrip
Z16	0.583″ x 0.084″ Microstrip
Z17*	0.950″ x 0.100″ Microstrip
Z18, Z19*	0.560″ x 0.100″ Microstrip
PCB	Taconix TLX8-0300, 0.030″, ε_r = 2.55

* Variable for tuning

Figure 1. MRF7S27130HR3(HSR3) Test Circuit Schematic

Table 5. MRF7S27130HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	2 pF Chip Capacitor	ATC100B2R0BT500XT	ATC
C2, C6, C7, C8, C9, C10, C11	10 μF, 50 V Chip Capacitors	C5750X5R1H106M	TDK
C3	3 pF Chip Capacitor	ATC100B3R0BT500XT	ATC
C4, C5	3.6 pF Chip Capacitors	ATC100B3R6BT500XT	ATC
C12	470 μF, 63 V Electrolytic Capacitor, Radial	EKME630ELL471MK255	Multicomp
C13	5.6 pF Chip Capacitor	ATC100B5R6BT500XT	ATC
R1, R2	2 KΩ, 1/4 W Chip Resistors	CRCW12062001FKEA	Vishay
R3	10 Ω, 1/4 W Chip Resistor	CRCW120610R1FKEA	Vishay

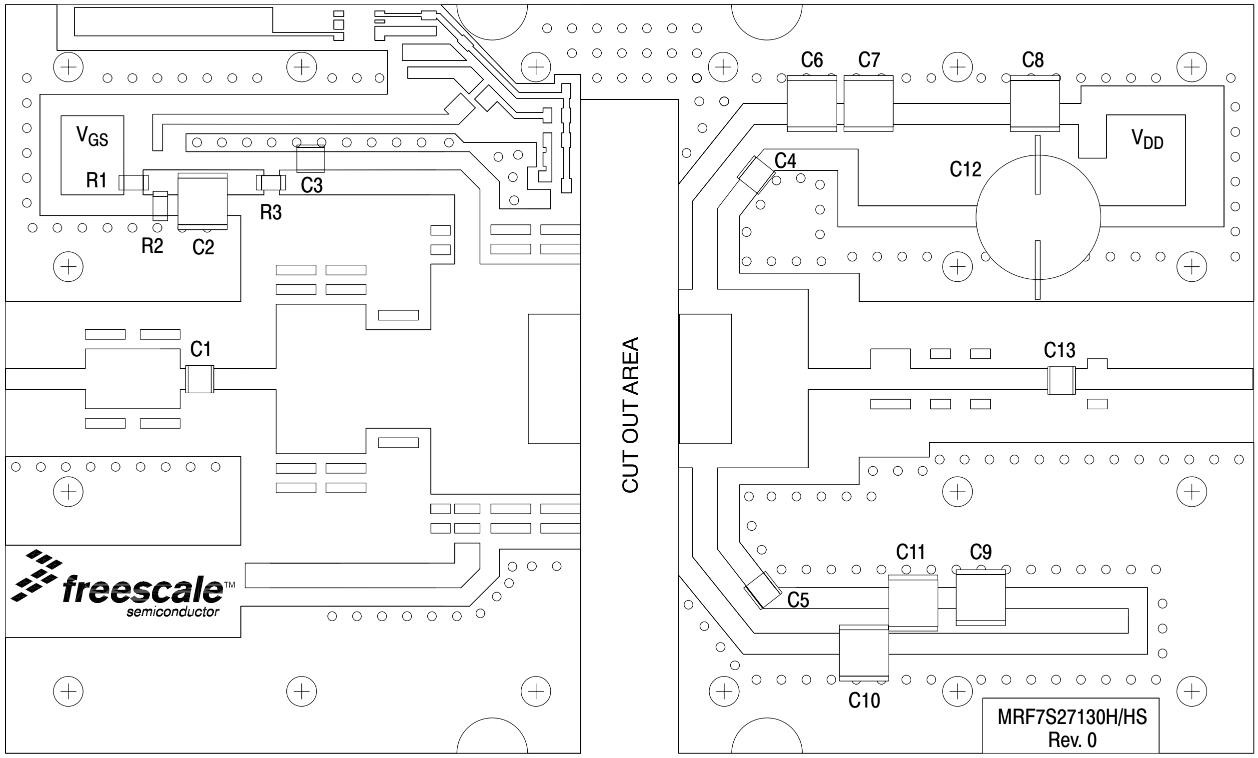


Figure 2. MRF7S27130HR3(HSR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

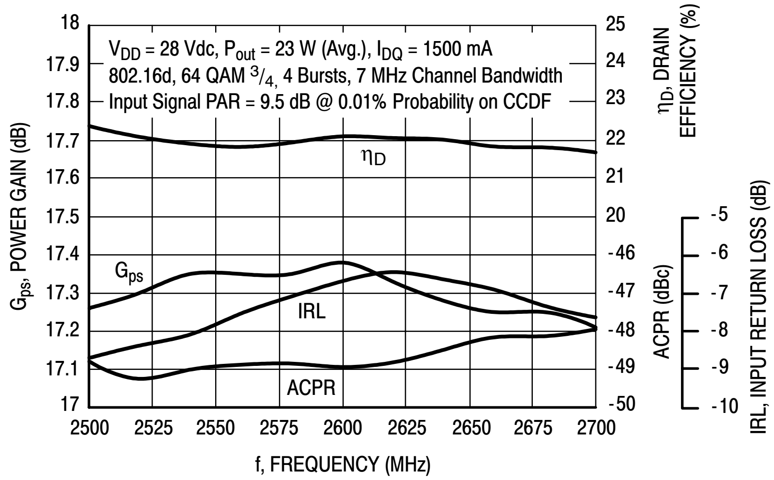


Figure 3. WiMAX Broadband Performance @ P_{out} = 23 Watts Avg.

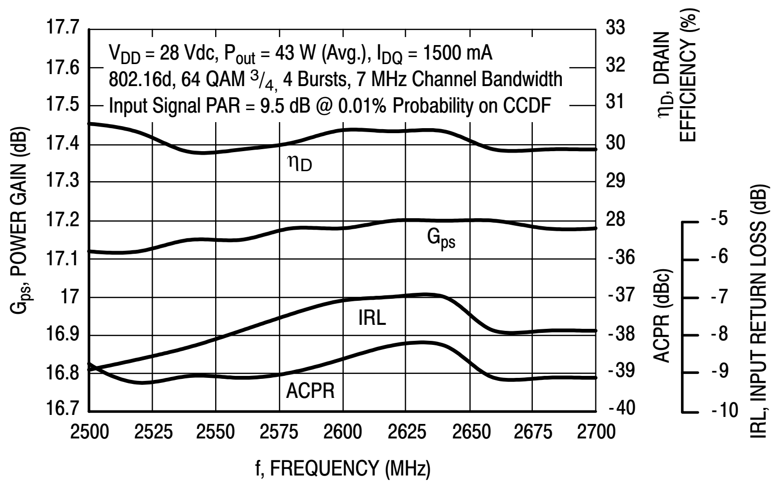


Figure 4. WiMAX Broadband Performance @ P_{out} = 43 Watts Avg.

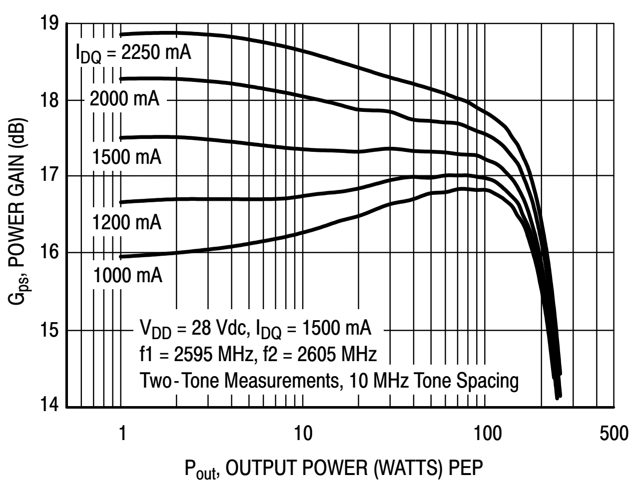


Figure 5. Two-Tone Power Gain versus Output Power

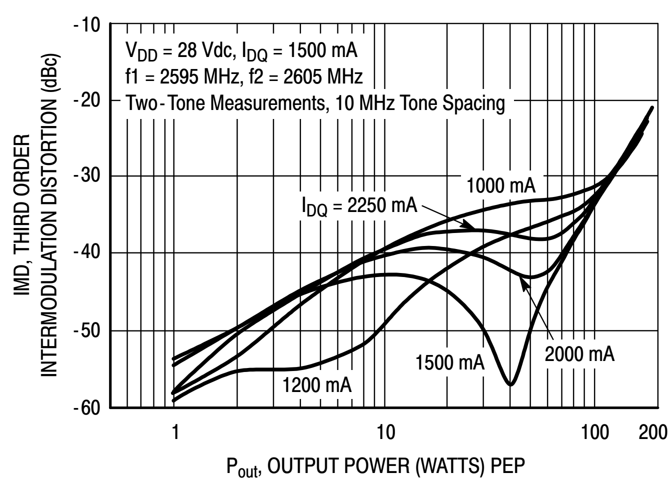


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL CHARACTERISTICS

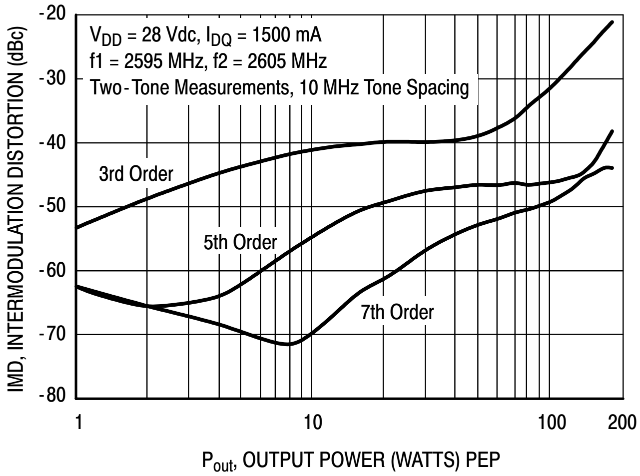


Figure 7. Intermodulation Distortion Products versus Output Power

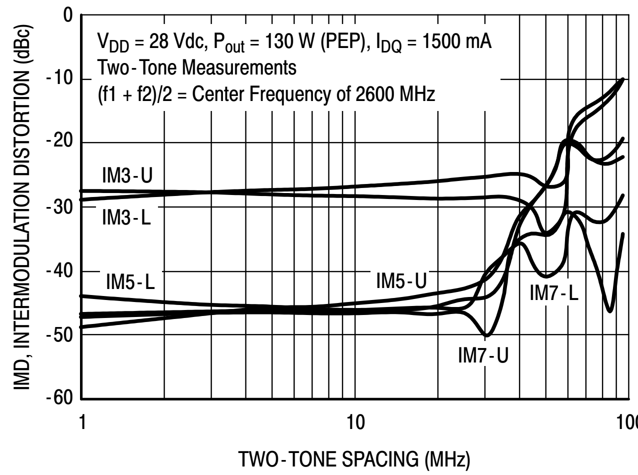


Figure 8. Intermodulation Distortion Products versus Tone Spacing

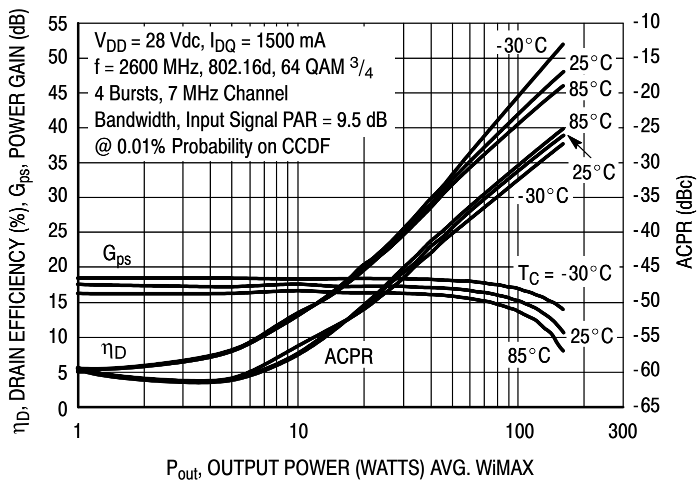


Figure 9. WiMAX, ACPR, Power Gain and Drain Efficiency versus Output Power

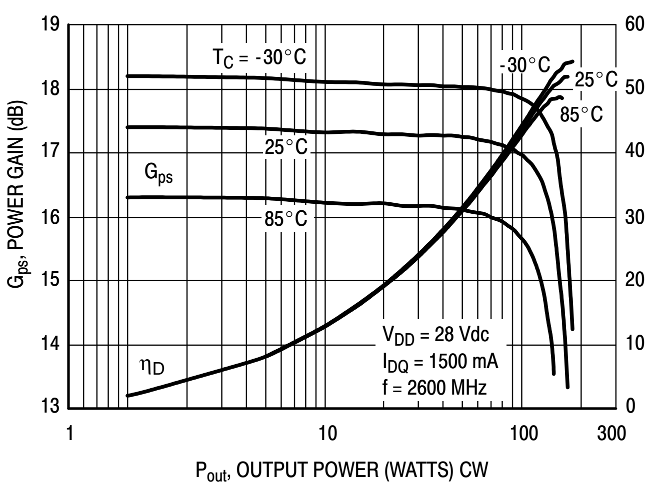


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

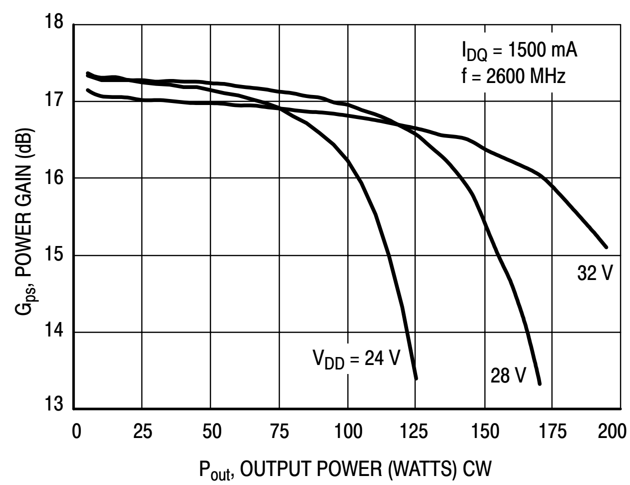
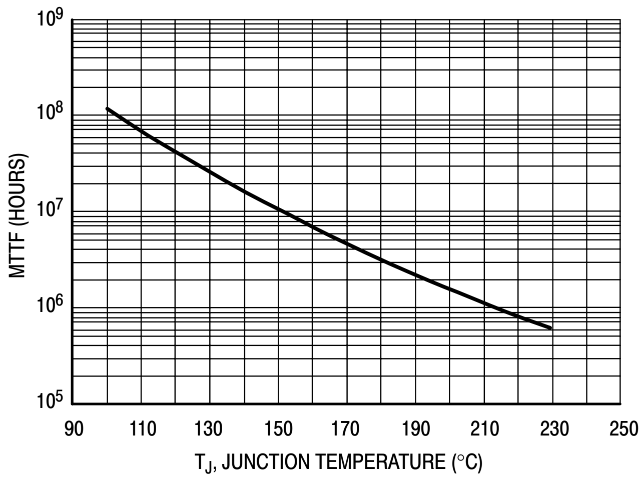


Figure 11. Power Gain versus Output Power

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 = 20%.

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

WiMAX TEST SIGNAL

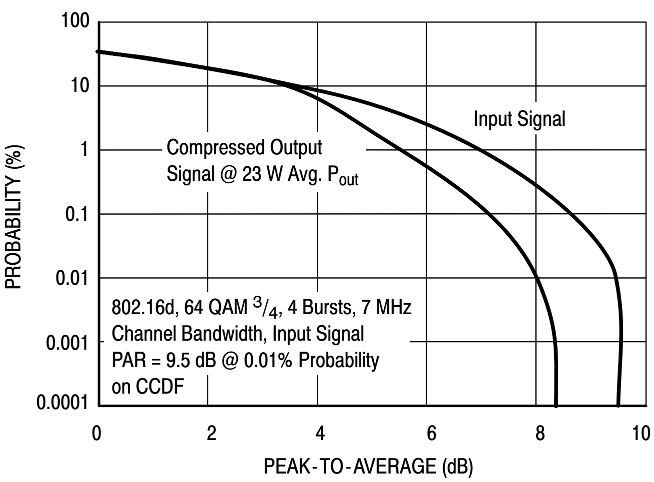


Figure 13. OFDM 802.16d Test Signal

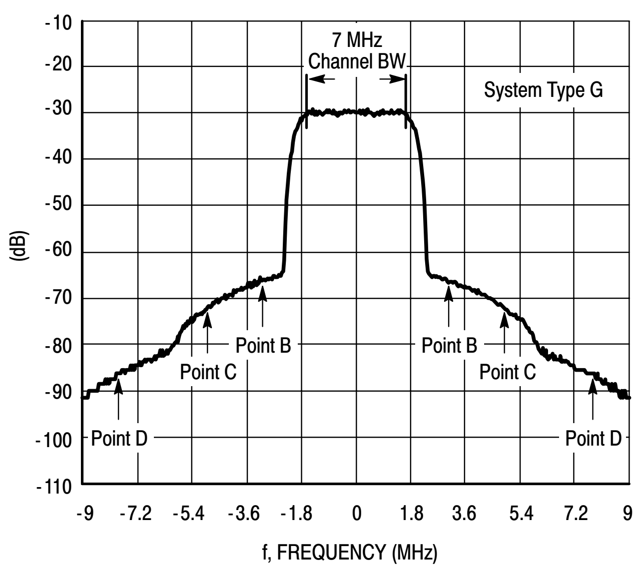
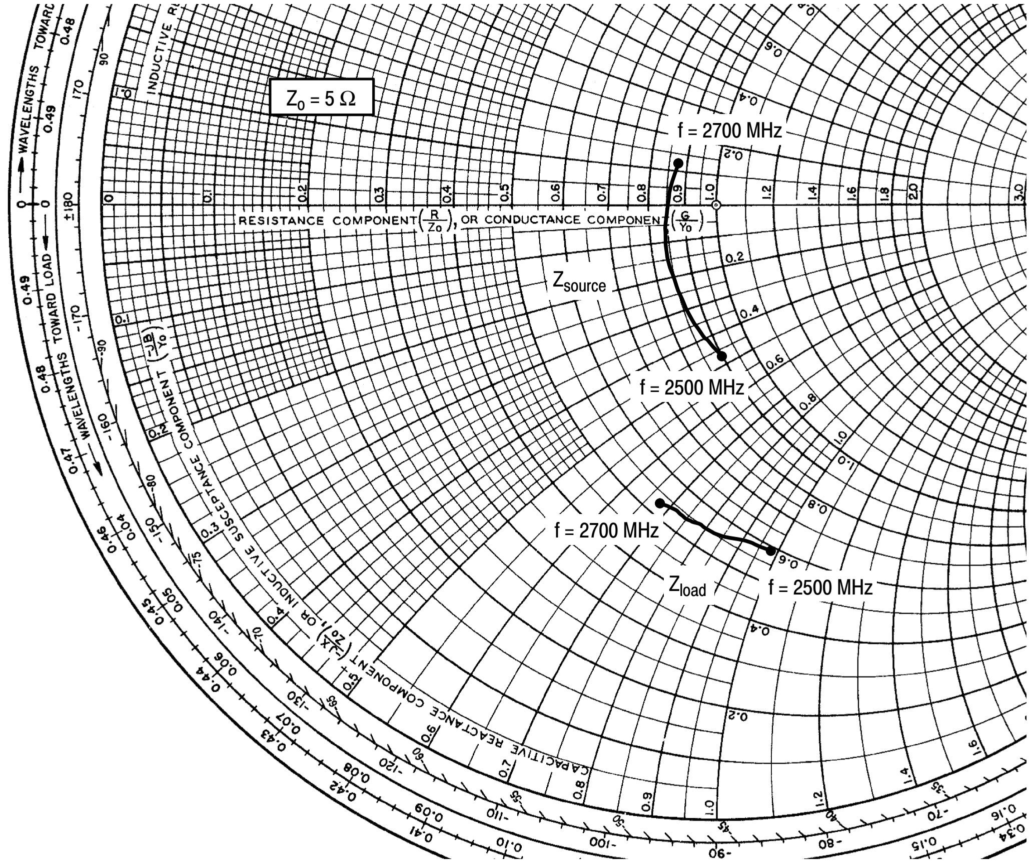


Figure 14. WiMAX Spectrum Mask Specifications



V_{DD} = 28 Vdc, I_{DQ} = 1500 mA, P_{out} = 23 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
2500	4.499 - j2.335	2.936 - j4.876
2525	4.382 - j1.944	2.885 - j4.666
2550	4.294 - j1.567	2.838 - j4.467
2575	4.234 - j1.194	2.797 - j4.273
2600	4.209 - j0.820	2.763 - j4.084
2625	4.219 - j0.447	2.733 - j3.903
2650	4.248 - j0.090	2.706 - j3.732
2675	4.304 + j0.261	2.678 - j3.570
2700	4.390 + j0.612	2.652 - j3.410

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

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

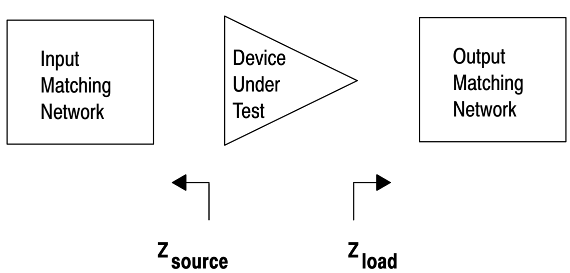
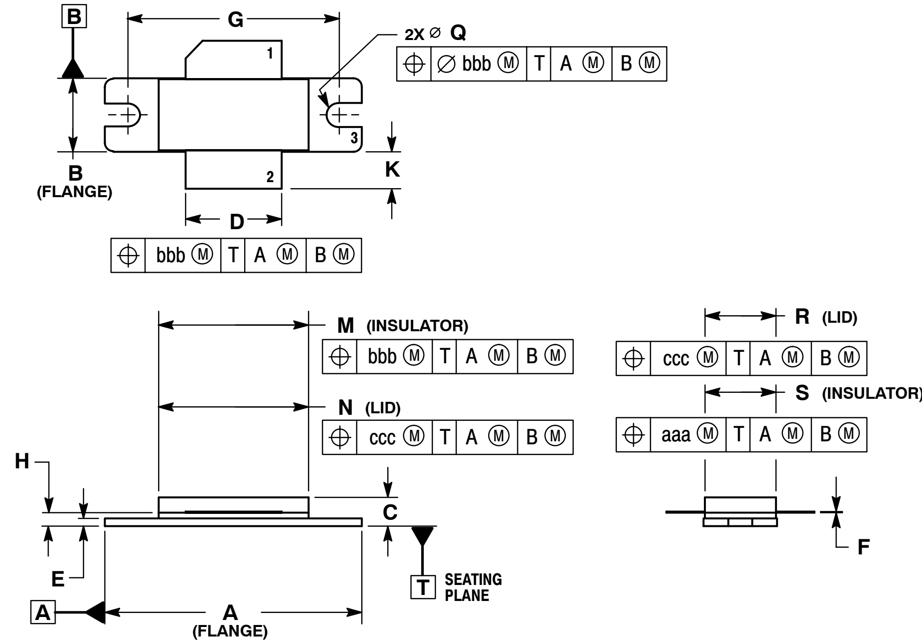


Figure 15. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS

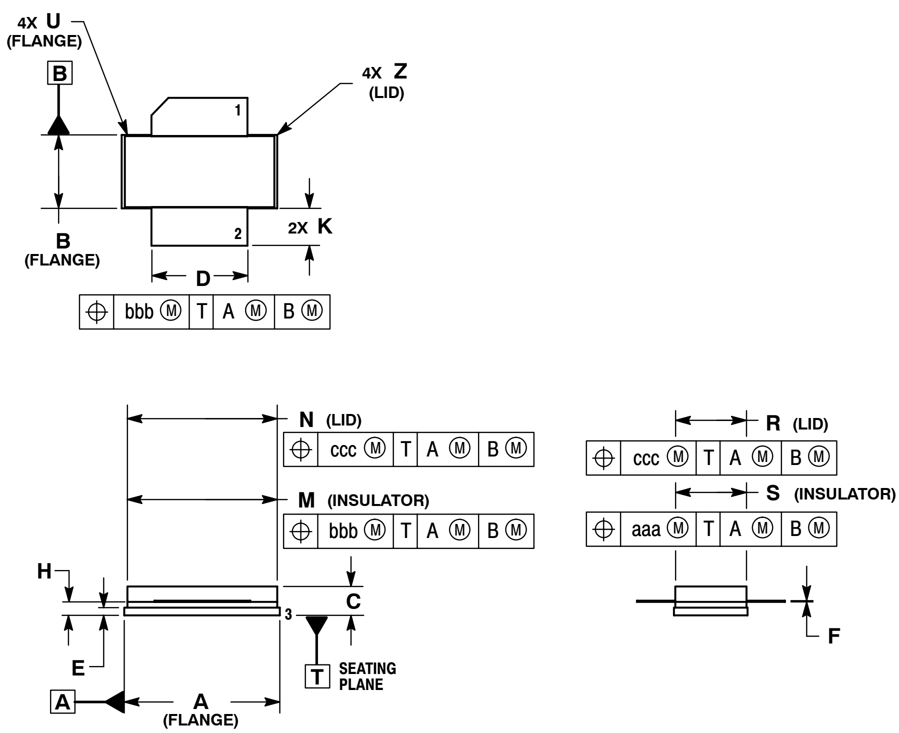


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

	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	∅.118	∅.138	∅3.00	∅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
2. GATE
3. SOURCE

CASE 465-06
ISSUE G
NI-780
MRF7S27130HR3



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	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
MRF7S27130HSR3

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
0	Sept. 2007	• Initial Release of Data Sheet

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