Freescale Semiconductor
Technical Data

Document Number: MRF7S38010H
Rev. 0, 8/2007

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for WiMAX base station applications with frequencies up to 3800 MHz. Suitable for WiMAX, WiBro, BWA, and OFDM multicarrier Class AB and Class C amplifier applications.

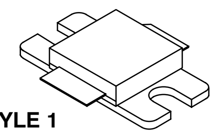
- Typical WiMAX Performance: V_{DD} = 30 Volts, I_{DQ} = 160 mA, P_{out} = 2 Watts Avg., f = 3400-3600 MHz, 802.16d, 64 QAM $^3/_4$, 4 bursts, 7 MHz Channel Bandwidth, Input Signal PAR = 9.5 dB @ 0.01% Probability on CCDF.
  - Power Gain — 15 dB
  - Drain Efficiency — 17%
  - Device Output Signal PAR — 8.5 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, 3500 MHz, 10 Watts CW Peak Tuned Output Power
- P_{out} @ 1 dB Compression Point ≥ 10 Watts CW

Features

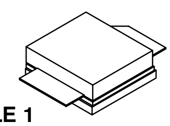
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 32 mm, 13 inch Reel.

MRF7S38010HR3
MRF7S38010HSR3

3400-3600 MHz, 2 W AVG., 30 V
WiMAX
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465I-02, STYLE 1
NI-400-240
MRF7S38010HR3



CASE 465J-02, STYLE 1
NI-400S-240
MRF7S38010HSR3

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

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 80°C, 10 W CW Case Temperature 77°C, 2 W CW	$R_{\theta JC}$	 2.05 2.24	°C/W

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.freescale.com/rf. Select Tools/Software/Application Software/Calculators to access the 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.

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	1C (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 = 33.5 μAdc)	$V_{GS(th)}$	1.2	2	2.7	Vdc
Gate Quiescent Voltage (V_{DD} = 30 Vdc, I_D = 160 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2	2.7	3.5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 335 mAdc)	$V_{DS(on)}$	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}	—	0.13	—	pF
Output Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	68.5	—	pF
Input Capacitance (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	50.6	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 30 Vdc, I_{DQ} = 160 mA, P_{out} = 2 W Avg., f = 3400 MHz and f = 3600 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.					
Power Gain	G_{ps}	13	15	17	dB
Drain Efficiency	η_D	15	17	30	%
Output Peak-to-Average Ratio @ 0.01% Probability on CCDF	PAR	8	8.5	—	dB
Adjacent Channel Power Ratio	ACPR	—	-49	-46	dBc
Input Return Loss	IRL	—	-12	-6	dB

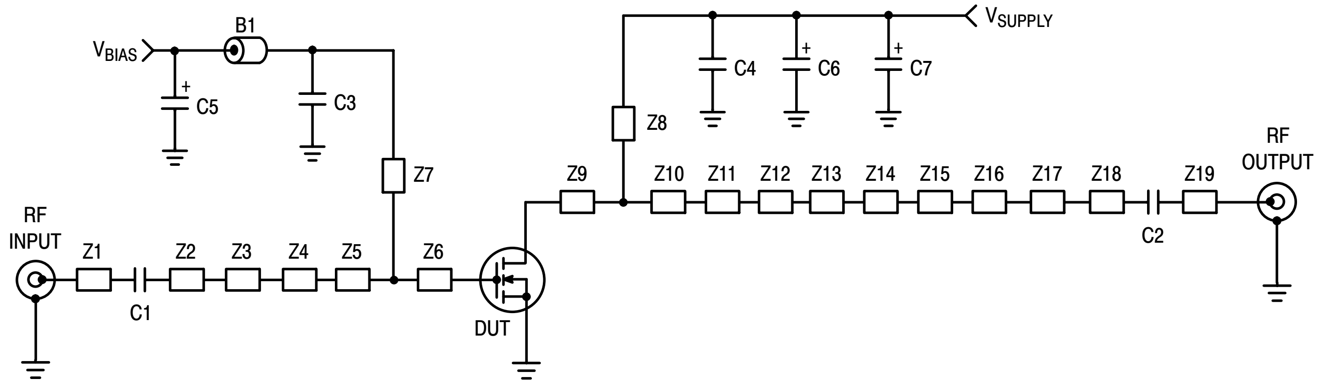
1. Part internally matched both on input and output.

(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} = 30 Vdc, I_{DQ} = 160 mA, P_{out} = 2 W Avg., f = 3400 MHz and f = 3600 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} = 2 W Avg.	Mask				dBc
Point B at 3.5 MHz Offset		—	-26	—	
Point C at 5 MHz Offset		—	-38	—	
Point D at 7.4 MHz Offset		—	-43	—	
Point E at 14 MHz Offset		—	-60	—	
Point F at 17.5 MHz Offset		—	-60	—	
Relative Constellation Error @ P_{out} = 2 W Avg. (1)	RCE	—	-33	—	dB
Error Vector Magnitude (1) (Typical EVM Performance @ P_{out} = 2 W Avg. with OFDM 802.16d Signal Call)	EVM	—	2.3	—	% rms
Typical Performances (In Freescale Test Fixture, 50 ohm system) V_{DD} = 30 Vdc, I_{DQ} = 160 mA, 3400-3600 MHz Bandwidth					
Video Bandwidth @ 12 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	—	20	—	MHz
Gain Flatness in 200 MHz Bandwidth @ P_{out} = 2 W Avg.	G_F	—	1.04	—	dB
Average Deviation from Linear Phase in 200 MHz Bandwidth @ P_{out} = 10 W CW	Φ	—	2.22	—	°
Average Group Delay @ P_{out} = 10 W CW, f = 3500 MHz	Delay	—	1.88	—	ns
Part-to-Part Insertion Phase Variation @ P_{out} = 10 W CW, f = 3500 MHz, Six Sigma Window	ΔΦ	—	25.9	—	°
Gain Variation over Temperature (-30°C to +85°C)	ΔG	—	0.025	—	dB/°C
Output Power Variation over Temperature (-30°C to +85°C)	ΔP1dB	—	0.246	—	dBm/°C

1. RLE = 20Log(EVM/100)



Z1, Z19	0.750″ x 0.084″ Microstrip	Z11	0.032″ x 0.166″ Microstrip
Z2	0.596″ x 0.084″ Microstrip	Z12	0.124″ x 0.538″ Microstrip
Z3	0.288″ x 0.110″ Microstrip	Z13	0.099″ x 0.341″ Microstrip
Z4	0.450″ x 0.084″ Microstrip	Z14	0.220″ x 0.166″ Microstrip
Z5	0.067″ x 0.367″ Microstrip	Z15	0.063″ x 0.240″ Microstrip
Z6	0.083″ x 0.307″ Microstrip	Z16	0.085″ x 0.340″ Microstrip
Z7	0.830″ x 0.058″ Microstrip	Z17	0.037″ x 0.340″ x 0.257″ Taper
Z8	0.567″ x 0.128″ Microstrip	Z18	0.637″ x 0.084″ Microstrip
Z9	0.116″ x 0.367″ Microstrip	PCB	CuClad 250GX-0300-55-22, 0.030″, ε_r = 2.55
Z10	0.064″ x 0.307″ Microstrip		

Figure 1. MRF7S38010HR3(HSR3) Test Circuit Schematic

Table 5. MRF7S38010HR3(HSR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1	95 Ω, 100 MHz Long Ferrite Bead, Surface Mount	2743021447	Fair-Rite
C1	2.2 pF Chip Capacitor	ATC100B2R2JT500XT	ATC
C2	2.7 pF Chip Capacitor	ATC100B2R7BT500XT	ATC
C3, C4	0.8 pF Chip Capacitors	ATC100B0R8BT500XT	ATC
C5, C6, C7	22 μF, 35 V Tantalum Capacitors	T491X226K035AT	Kemet

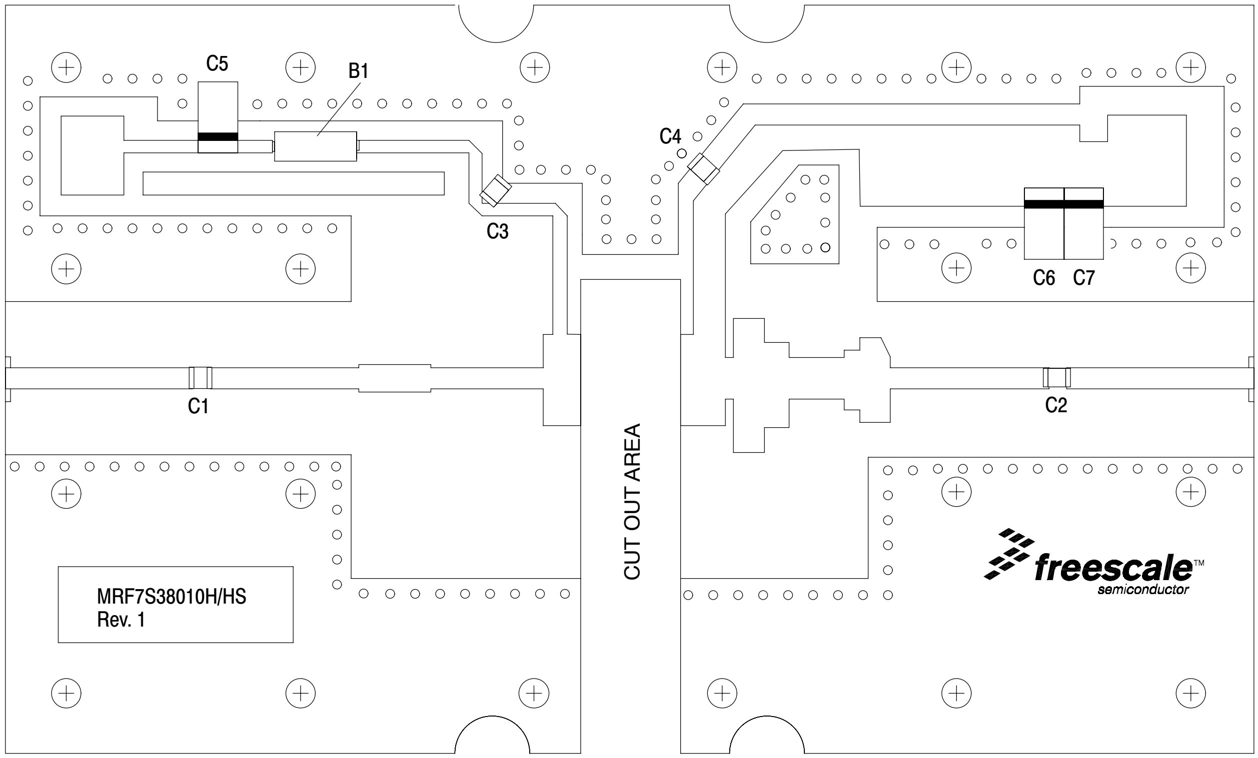


Figure 2. MRF7S38010HR3(HSR3) Test Circuit Component Layout

TYPICAL CHARACTERISTICS

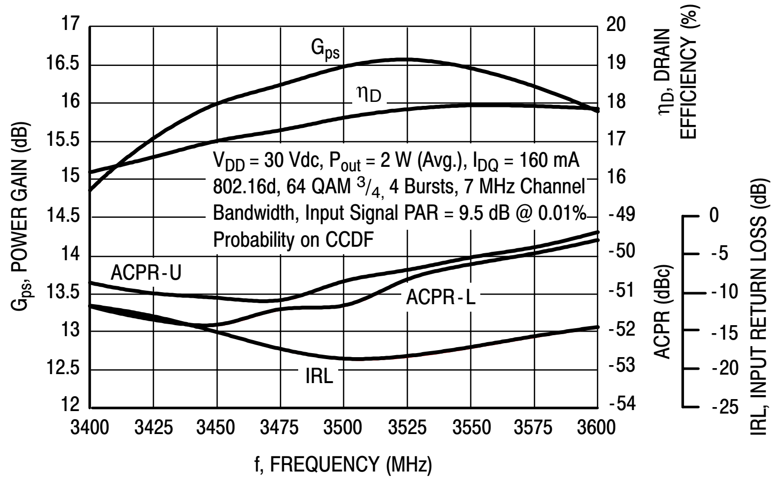


Figure 3. WiMAX Broadband Performance @ P_{out} = 2 Watts Avg.

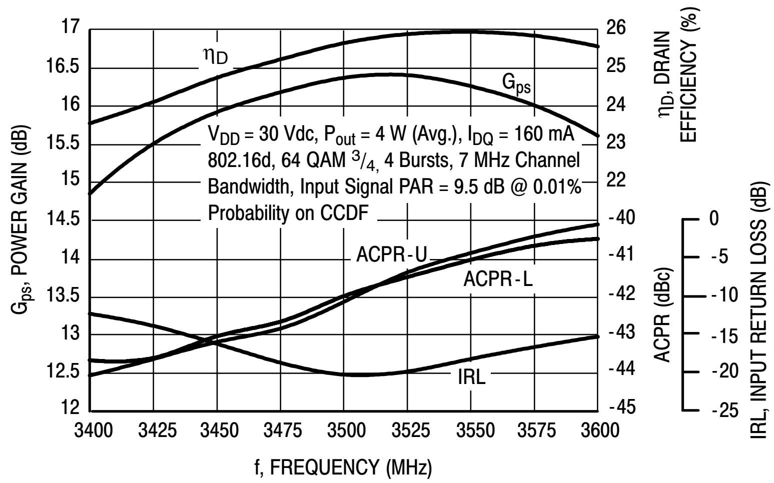


Figure 4. WiMAX Broadband Performance @ P_{out} = 4 Watts Avg.

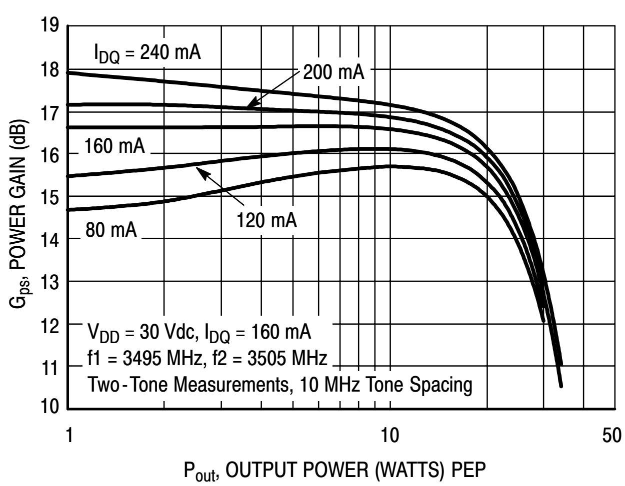


Figure 5. Two-Tone Power Gain versus Output Power

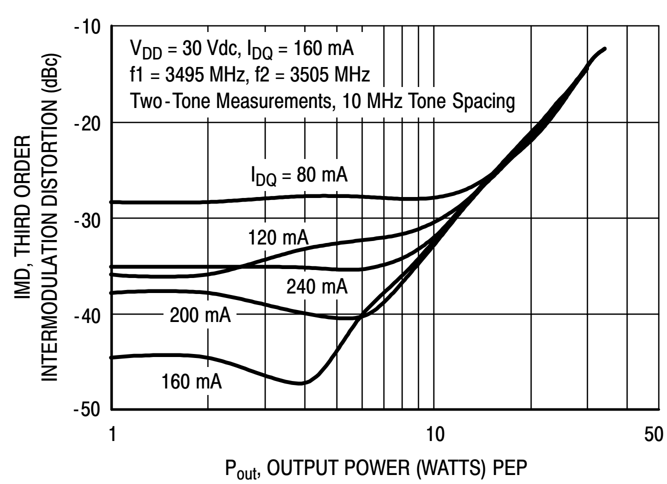


Figure 6. Third Order Intermodulation Distortion versus Output Power

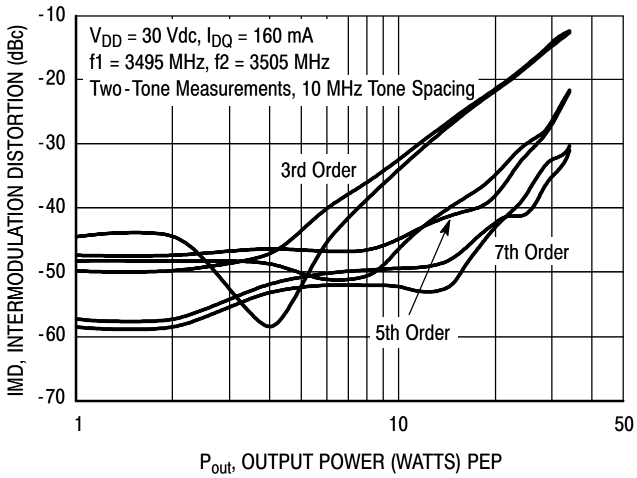


Figure 7. Intermodulation Distortion Products versus Output Power

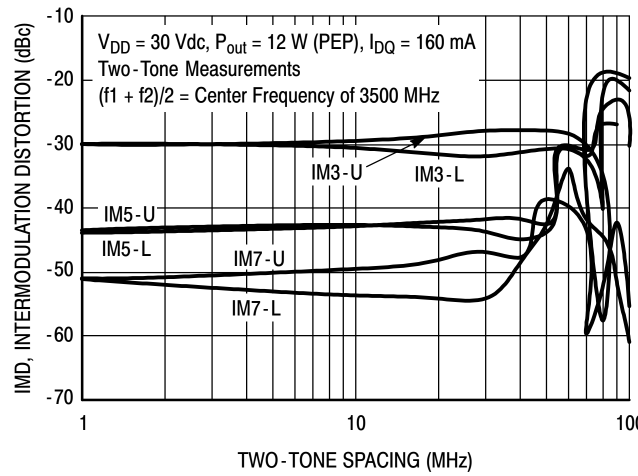


Figure 8. Intermodulation Distortion Products versus Tone Spacing

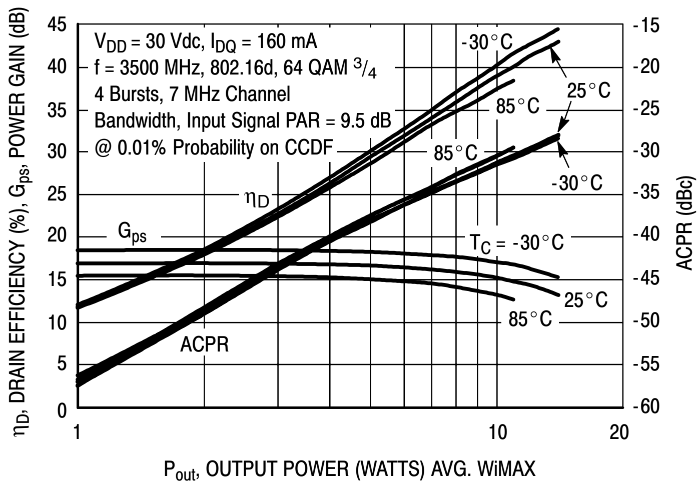


Figure 9. WiMAX, ACPR, Power Gain and Drain Efficiency versus Output Power

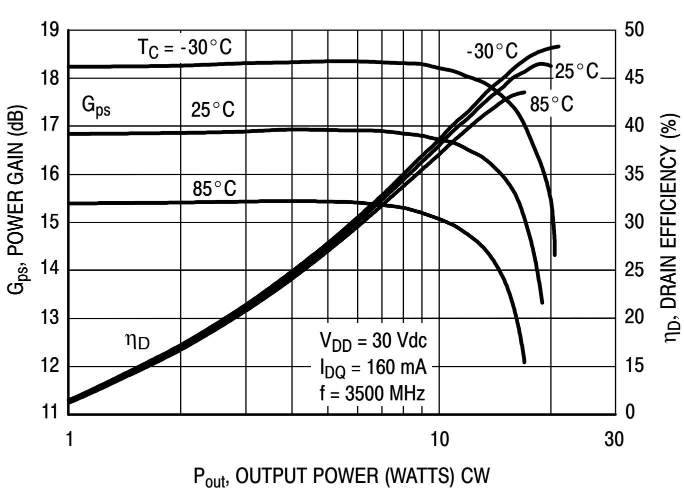


Figure 10. Power Gain and Drain Efficiency versus CW Output Power

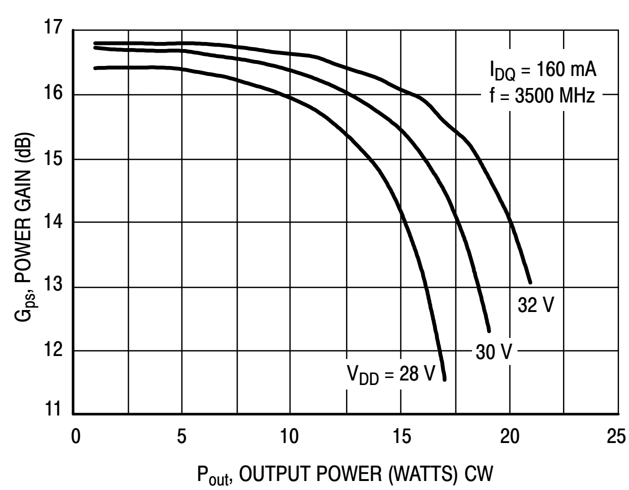
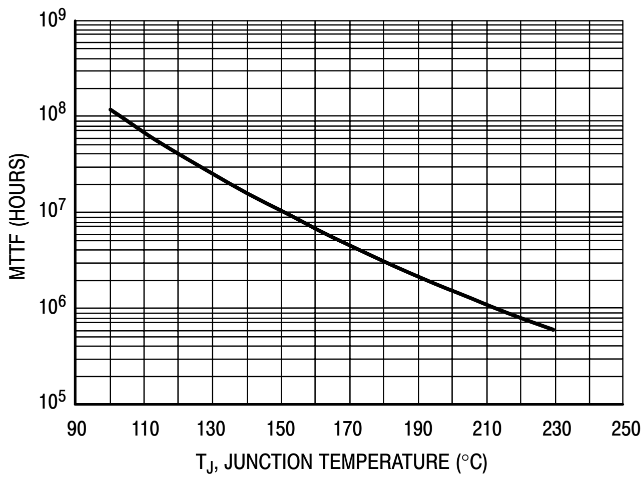


Figure 11. Power Gain versus Output Power

TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours when the device is operated at V_{DD} = 30 Vdc, P_{out} = 2 W Avg., and η_D = 17%.

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

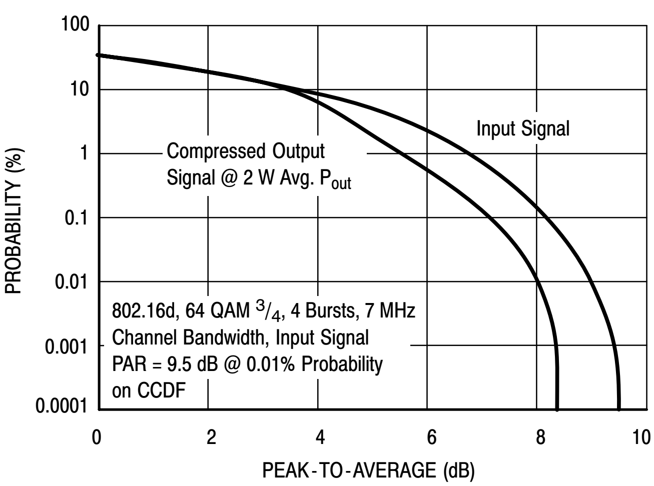


Figure 13. OFDM 802.16d Test Signal

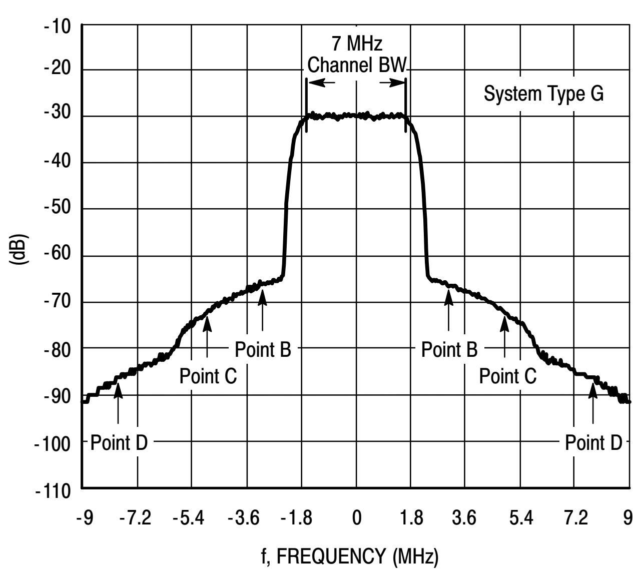
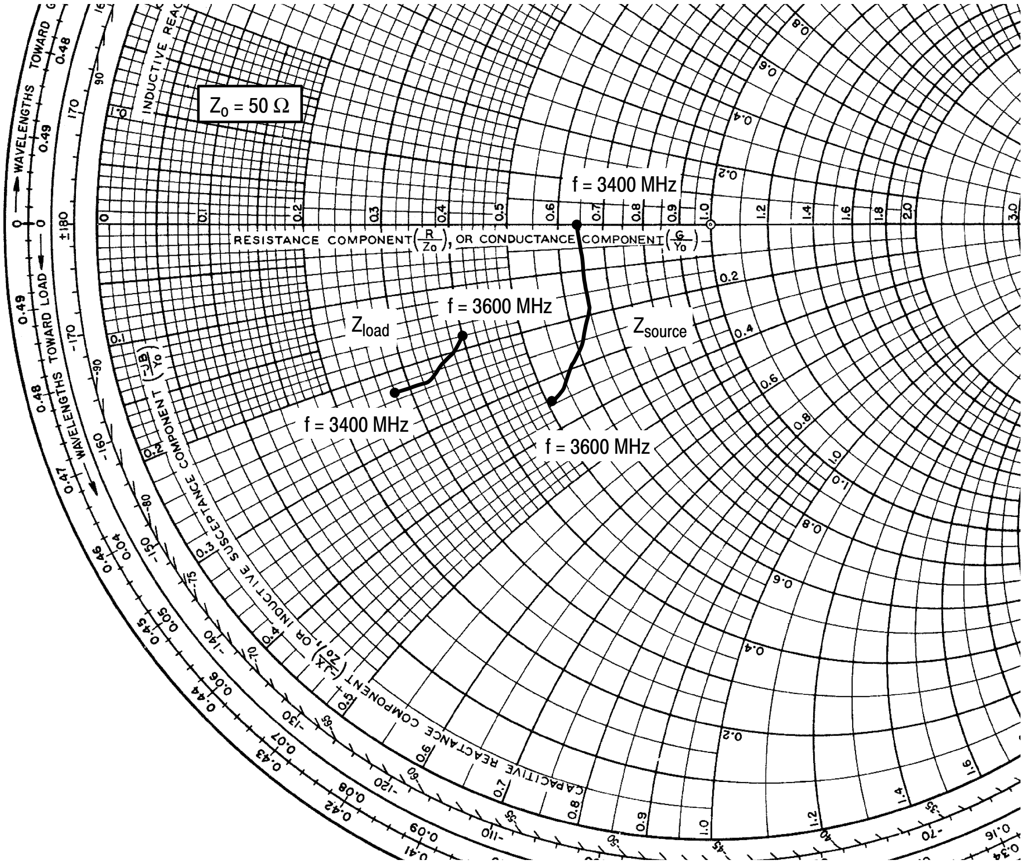


Figure 14. WiMAX Spectrum Mask Specifications



V_{DD} = 30 Vdc, I_{DQ} = 160 mA, P_{out} = 2 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
3400	31.79 - j0.13	13.92 - j11.33
3425	32.46 - j3.62	14.61 - j11.40
3450	32.58 - j6.82	15.53 - j11.36
3475	32.29 - j9.43	16.44 - j11.28
3500	31.32 - j11.63	17.25 - j11.07
3525	30.03 - j13.46	18.11 - j10.64
3550	28.76 - j15.19	18.96 - j10.22
3575	27.24 - j16.25	19.60 - j9.68
3600	25.51 - j17.02	20.17 - j8.99

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

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

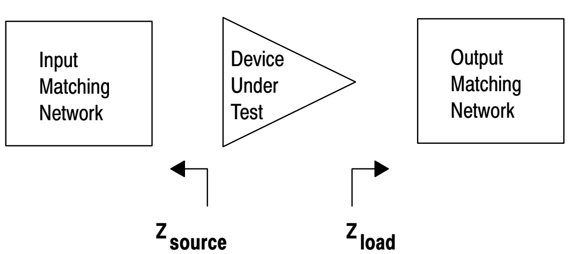
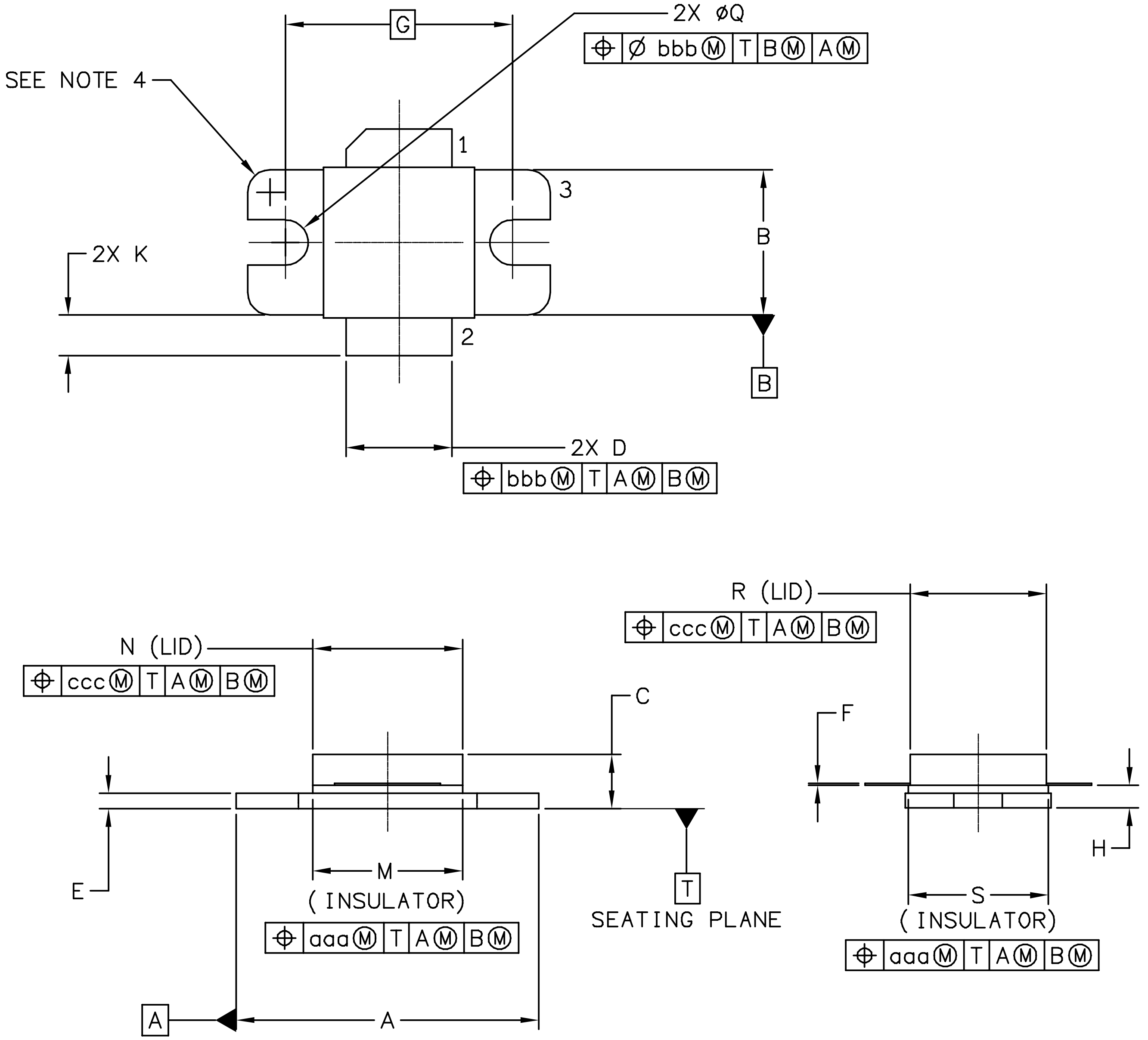


Figure 15. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS



	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE	
TITLE: NI–400–240	DOCUMENT NO: 98ASA10730D	REV: B	
	CASE NUMBER: 465I–02	09 MAY 2006	
	STANDARD: NON–JEDEC		

NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M−1994.
3. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY.
4. INFORMATION ONLY:
   CORNER BREAK (4X) TO BE .060±.005 (1.52±0.13) RADIUS OR
   .06±.005 (1.52±0.13) x 45° CHAMFER.

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

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

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	.795	.805	20.19	20.44	R	.355	.365	9.02	9.27
B	.380	.390	9.65	9.91	S	.365	.375	9.27	9.53
C	.125	.163	3.17	4.14					
D	.275	.285	6.98	7.24	aaa	.005		0.127	
E	.035	.045	0.89	1.14	bbb	.010		0.254	
F	.004	.006	0.10	0.15	ccc	.015		0.381	
G	.600 BSC		15.24 BSC						
H	.057	.067	1.45	1.70					
K	.0995	.1295	2.53	3.29					
M	.395	.405	10.03	10.29					
N	.385	.395	9.78	10.03					
Q	ø.120	ø.130	ø3.05	ø3.30					

MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE	
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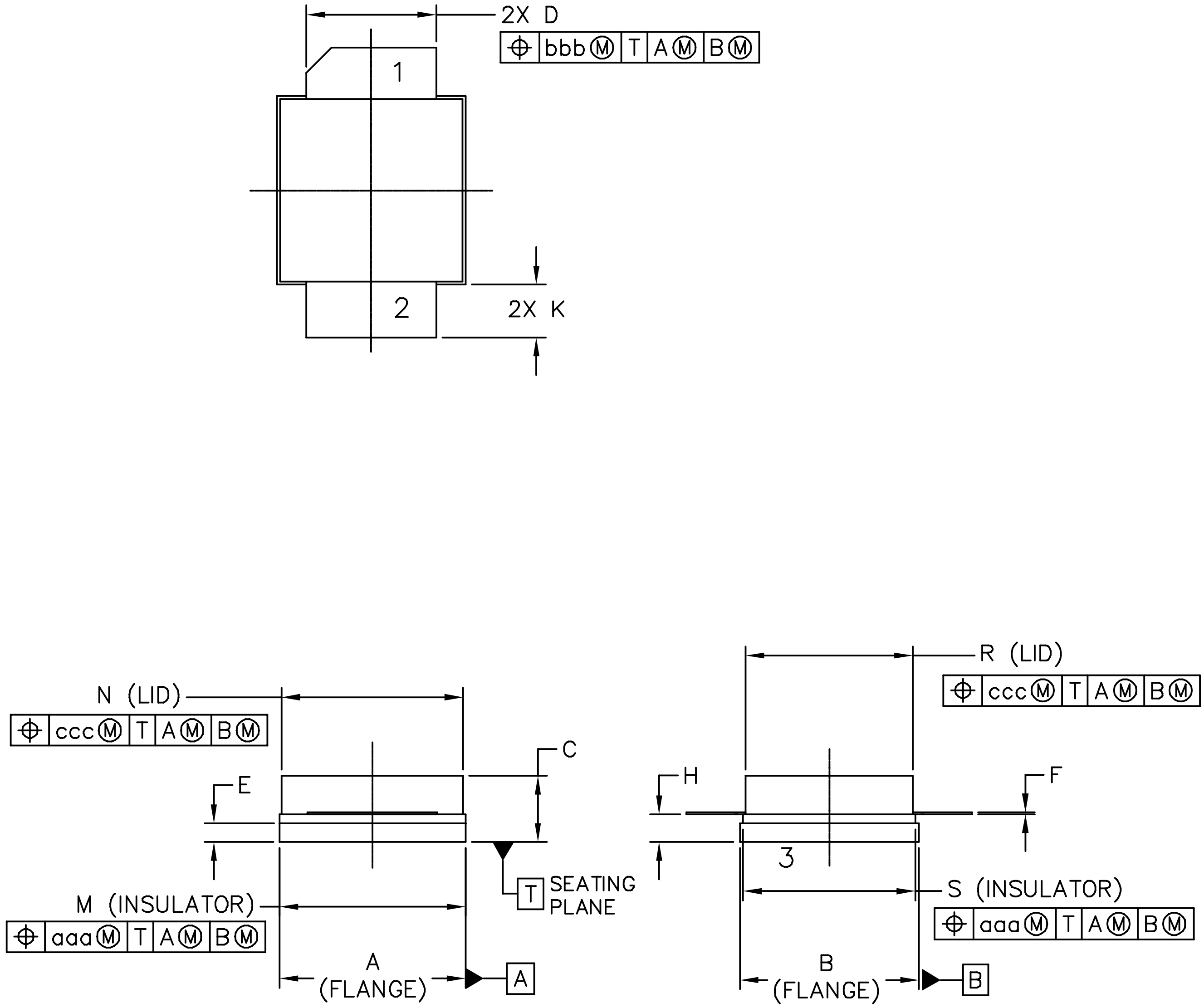
	CASE NUMBER: 465I−02	09 MAY 2006
	STANDARD: NON−JEDEC	



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TITLE: NI–400S–240	DOCUMENT NO: 98ASA10732D	REV: A
	CASE NUMBER: 465J–02	09 MAY 2006
	STANDARD: NON–JEDEC	

NOTES:

1. CONTROLLING DIMENSION: INCH

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M—1994.

3. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY

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

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

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	.395	.405	10.03	10.29	aaa	.005		0.127	
B	.380	.390	9.65	9.91	bbb	.010		0.254	
C	.125	.163	3.18	4.14	ccc	.015		0.381	
D	.275	.285	6.98	7.24					
E	.035	.045	0.89	1.14					
F	.004	.006	0.10	0.15					
H	.057	.067	1.45	1.70					
K	.0995	.1295	2.53	3.29					
M	.395	.405	10.03	10.29					
N	.385	.395	9.78	10.03					
R	.355	.365	9.02	9.27					
S	.365	.375	9.27	9.53					

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
TITLE: NI—400S—240	DOCUMENT NO: 98ASA10732D	REV: A
	CASE NUMBER: 465J—02	09 MAY 2006
	STANDARD: NON—JEDEC	

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	Aug. 2007	• Initial Release of Data Sheet

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