Freescale Semiconductor
Technical Data

Document Number: MRFE6P3300H
Rev. 2, 12/2009

RoHS

RF Power Field Effect Transistor

N-Channel Enhancement-Mode Lateral MOSFET

MRFE6P3300HR3

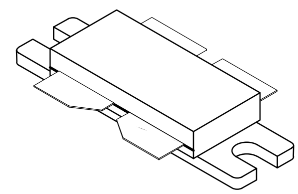
860 MHz, 300 W, 32 V
LATERAL N-CHANNEL
RF POWER MOSFET

Designed for broadband commercial and industrial applications with frequencies from 470 to 860 MHz. The high gain and broadband performance of this device make it ideal for large-signal, common-source amplifier applications in 32 volt analog or digital television transmitter equipment.

- Typical Narrowband Two-Tone Performance @ 860 MHz: V_{DD} = 32 Volts, I_{DQ} = 1600 mA, P_{out} = 270 Watts PEP
  Power Gain — 20.4 dB
  Drain Efficiency — 44.8%
  IMD — -28.8 dBc
- Capable of Handling 10:1 VSWR, @ 32 Vdc, 860 MHz, 3 dB Overdrive, Designed for Enhanced Ruggedness

Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Designed for Push-Pull Operation Only
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel. R5 Suffix = 50 Units per 56 mm, 13 inch Reel.



CASE 375G-04, STYLE 1
NI-860C3

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +66	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 (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, 300 W CW Case Temperature 82°C, 220 W CW Case Temperature 79°C, 100 W CW Case Temperature 81°C, 60 W CW	$R_{\theta JC}$	 0.23 0.24 0.27 0.27	°C/W

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.freescale.com/rf. Select Software & Tools/Development 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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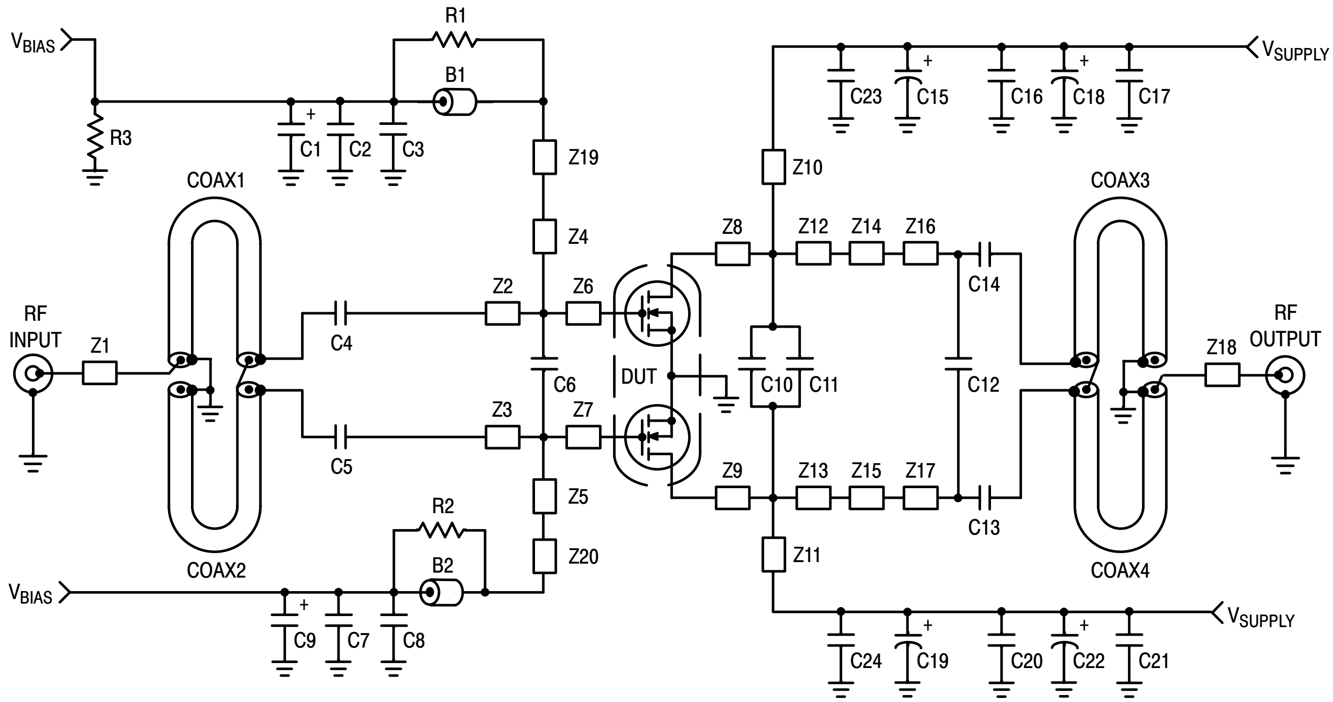
Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	3B (Minimum)
Machine Model (per EIA/JESD22-A115)	C (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

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

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics (1)					
Zero Gate Voltage Drain Leakage Current (4) (V_{DS} = 66 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (4) (V_{DS} = 32 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 (1)					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 350 μAdc)	$V_{GS(th)}$	1	2.2	3	Vdc
Gate Quiescent Voltage (3) (V_{DD} = 32 Vdc, I_D = 1600 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 2.4 Adc)	$V_{DS(on)}$	—	0.22	0.3	Vdc
Dynamic Characteristics (1,2)					
Reverse Transfer Capacitance (4) (V_{DS} = 32 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.22	—	pF
Output Capacitance (4) (V_{DS} = 32 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	217	—	pF
Input Capacitance (1) (V_{DS} = 32 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	1060	—	pF
Functional Tests (3) (In Freescale Narrowband Test Fixture, 50 ohm system) V_{DD} = 32 Vdc, I_{DQ} = 1600 mA, P_{out} = 270 W PEP, f1 = 857 MHz, f2 = 863 MHz					
Power Gain	G_{ps}	19	20.4	23	dB
Drain Efficiency	η_D	41	44.8	—	%
Intermodulation Distortion	IMD	—	-28.8	-27	dBc
Input Return Loss	IRL	—	-18.4	-9	dB

1. Each side of the device measured separately.
2. Part internally matched both on input and output.
3. Measurement made with device in push-pull configuration.
4. Drains are tied together internally as this is a total device value.



Z1	0.401″ x 0.081″ Microstrip	Z12, Z13	0.225″ x 0.507″ Microstrip
Z2, Z3	0.563″ x 0.101″ Microstrip	Z14, Z15	0.440″ x 0.435″ Microstrip
Z4, Z5	1.186″ x 0.058″ Microstrip	Z16, Z17	0.123″ x 0.215″ Microstrip
Z6, Z7	0.416″ x 0.727″ Microstrip	Z18	0.401″ x 0.081″ Microstrip
Z8, Z9	0.191″ x 0.507″ Microstrip	Z19, Z20	0.339″ x 0.165″ Microstrip
Z10, Z11	1.306″ x 0.150″ Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030″, ε_r = 2.5

Figure 1. 820-900 MHz Narrowband Test Circuit Schematic

Table 5. 820-900 MHz Narrowband Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1, B2	Ferrite Beads, Short	2743019447	Fair-Rite
C1, C9	1.0 μF, 50 V Tantulum Chip Capacitors	T491C105K050AT	Kemet
C2, C7, C17, C21	0.1 μF, 50 V Chip Capacitors	CDR33BX104AKYS	Kemet
C3, C8, C16, C20	1000 pF Chip Capacitors	ATC100B102JT50XT	ATC
C4, C5, C13, C14	100 pF Chip Capacitors	ATC100B101JT500XT	ATC
C6, C12	8.2 pF Chip Capacitors	ATC100B8R2JT500XT	ATC
C10	9.1 pF Chip Capacitor	ATC100B9R1BT500XT	ATC
C11	1.8 pF Chip Capacitor	ATC100B1R8BT500XT	ATC
C15, C19	47 μF, 50 V Electrolytic Capacitors	EMVY500ADA470MF80G	Nippon
C18, C22	470 μF, 63 V Electrolytic Capacitors	ESME630ELL471MK25S	United Chemi-Con
C23, C24	22 pF Chip Capacitors	ATC100B220FT500XT	ATC
Coax1, 2, 3, 4	50 Ω, Semi Rigid Coax, 2.06″ Long	UT-141A-TP	Micro-Coax
R1, R2	10 Ω, 1/4 W Chip Resistors	CRCW120610R0FKEA	Vishay
R3	1 kΩ, 1/4 W Chip Resistor	CRCW12061001FKEA	Vishay

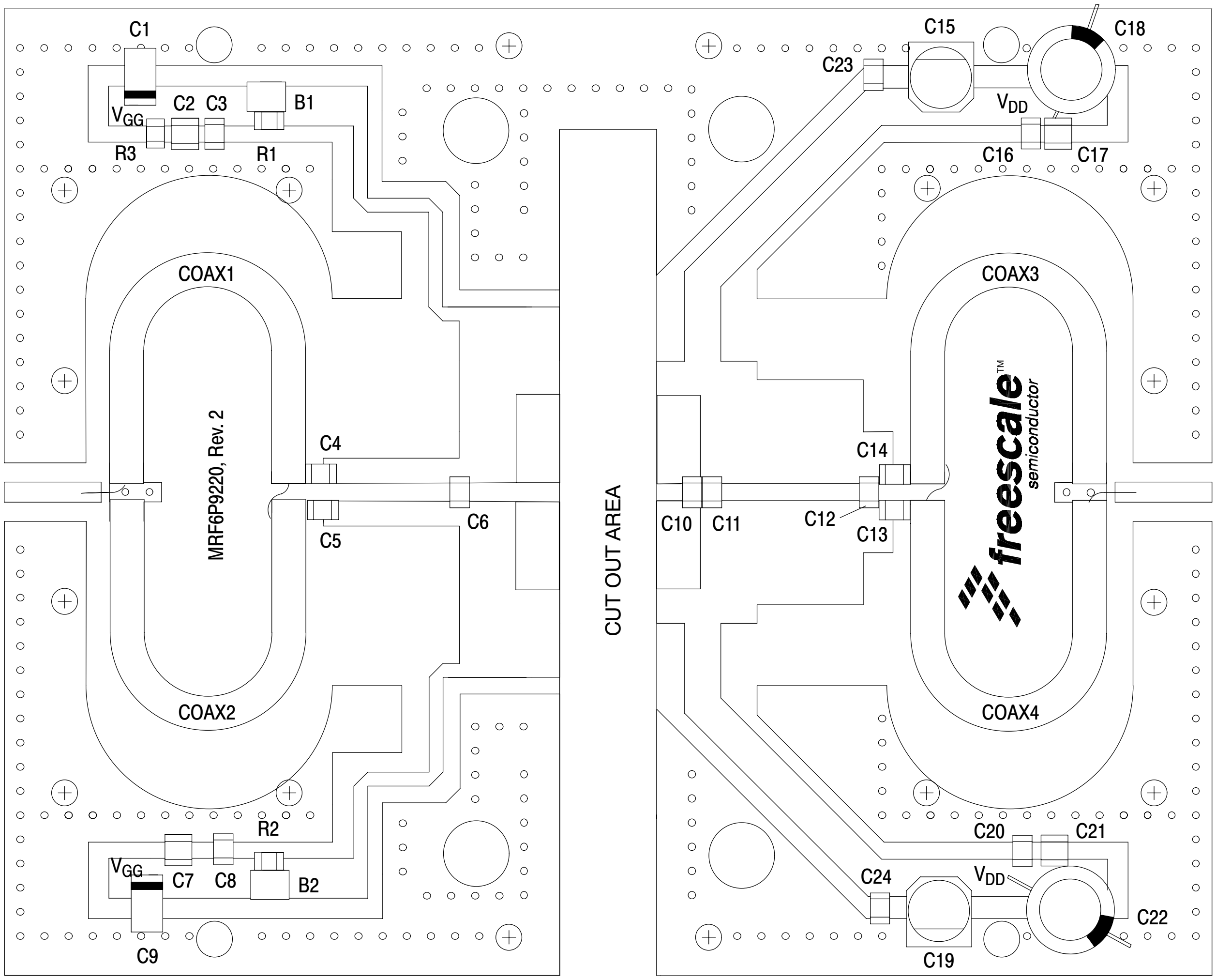


Figure 2. 820-900 MHz Narrowband Test Circuit Component Layout

TYPICAL NARROWBAND CHARACTERISTICS

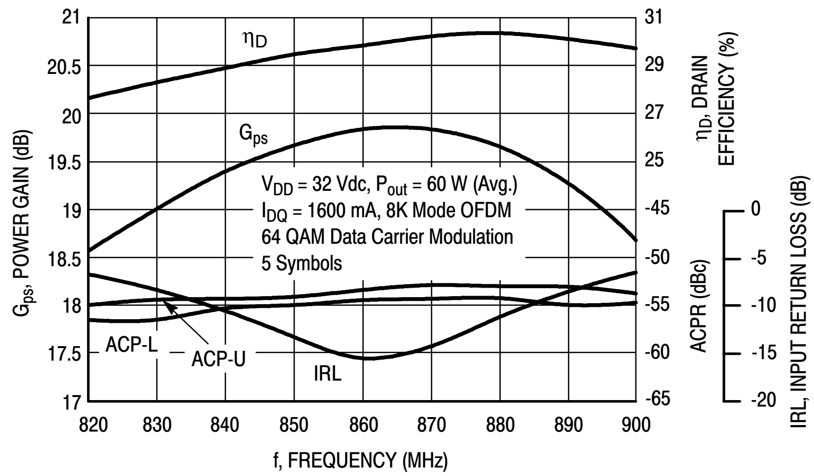


Figure 3. Single-Carrier OFDM Broadband Performance @ 60 Watts Avg.

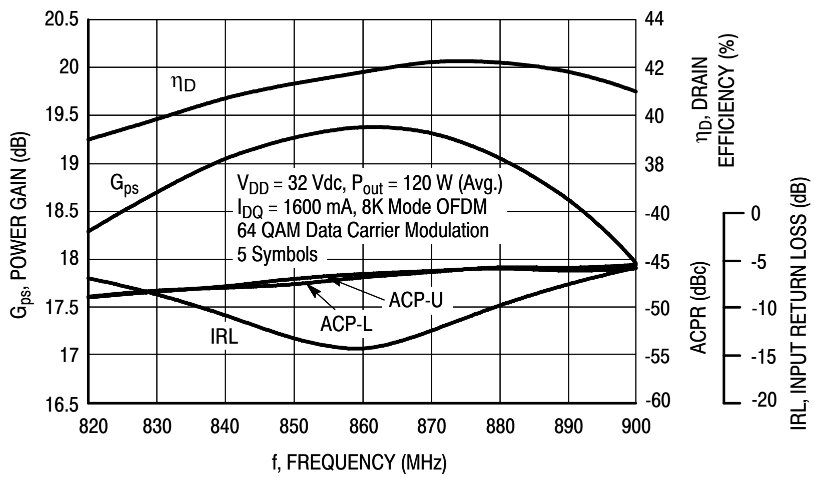


Figure 4. Single-Carrier OFDM Broadband Performance @ 120 Watts Avg.

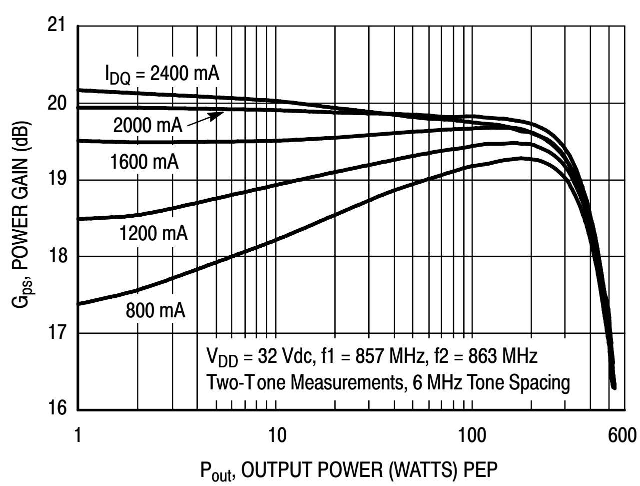


Figure 5. Two-Tone Power Gain versus Output Power

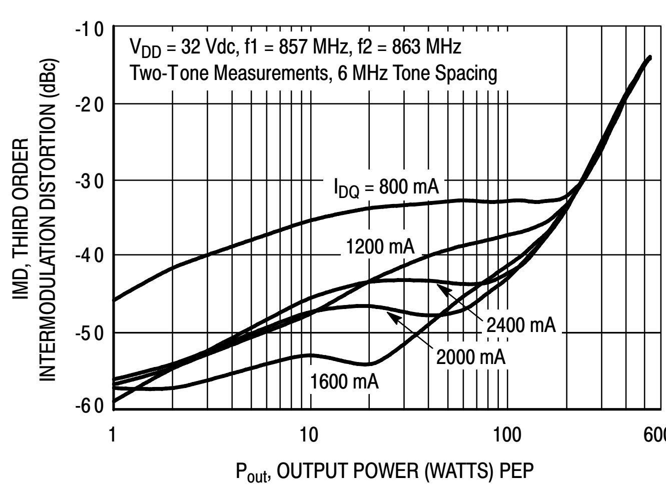


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL NARROWBAND CHARACTERISTICS

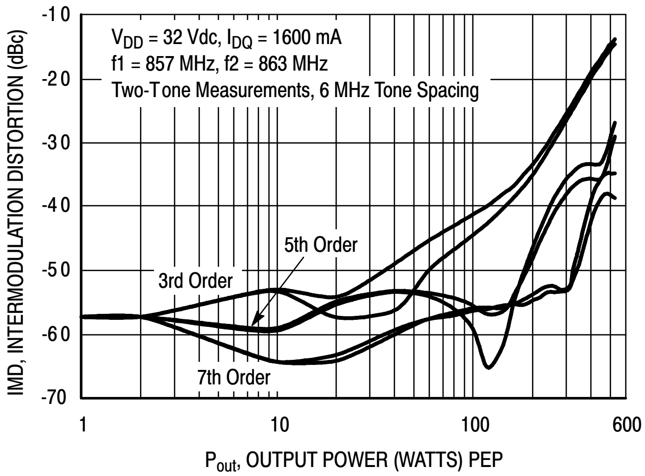


Figure 7. Intermodulation Distortion Products versus Output Power

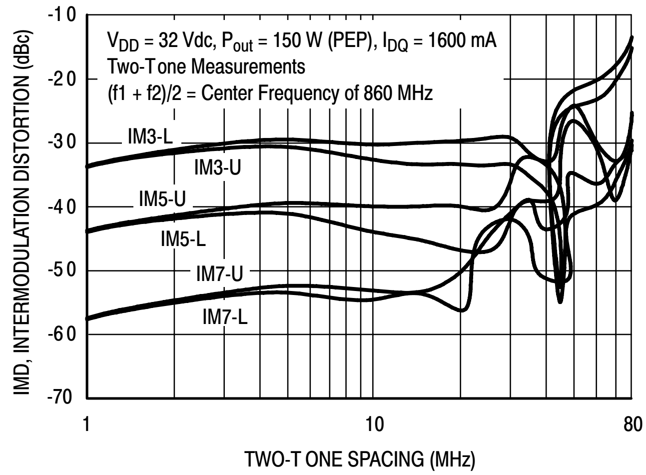


Figure 8. Intermodulation Distortion Products versus Tone Spacing

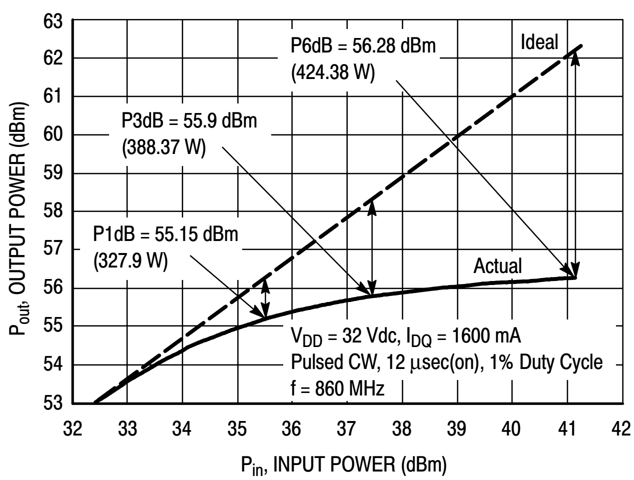


Figure 9. Pulsed CW Output Power versus Input Power

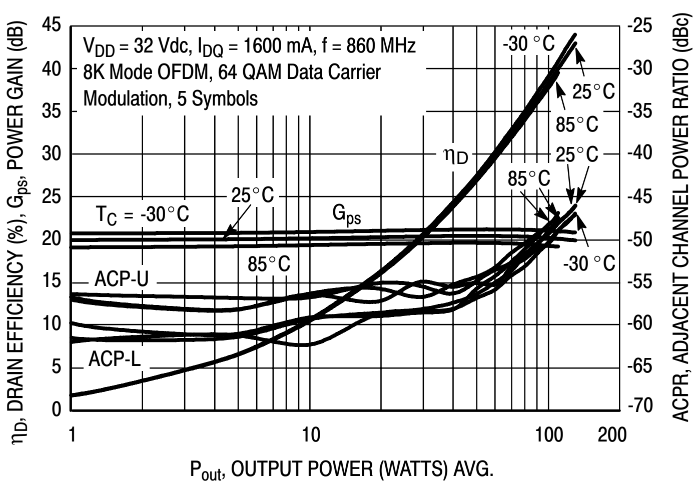


Figure 10. Single-Carrier DVBT OFDM ACPR, Power Gain and Drain Efficiency versus Output Power

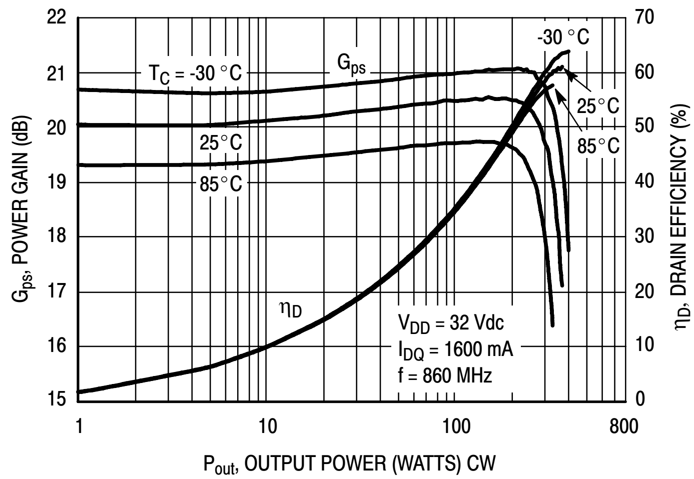


Figure 11. Power Gain and Drain Efficiency versus CW Output Power

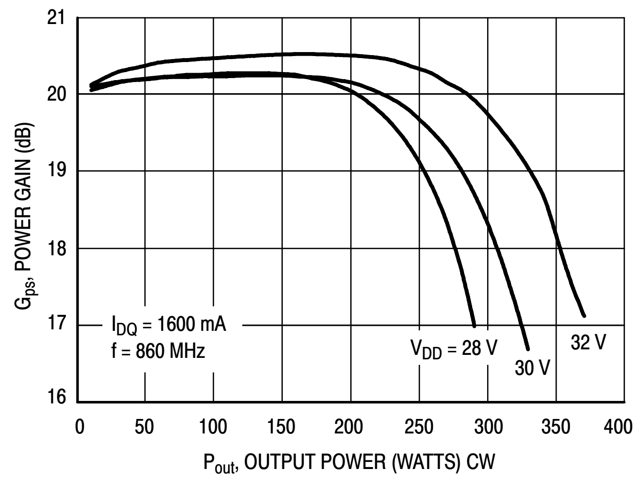
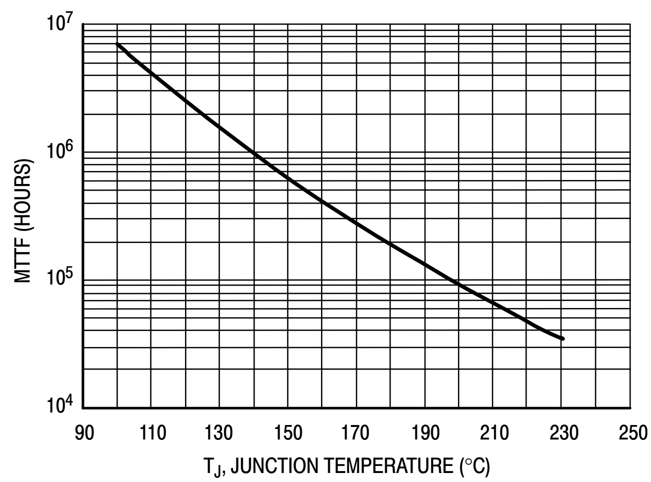


Figure 12. Power Gain versus Output Power



This above graph displays calculated MTTF in hours when the device is operated at V_{DD} = 32 Vdc, P_{out} = 270 W PEP, and η_D = 44.8%.

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

Figure 13. MTTF versus Junction Temperature

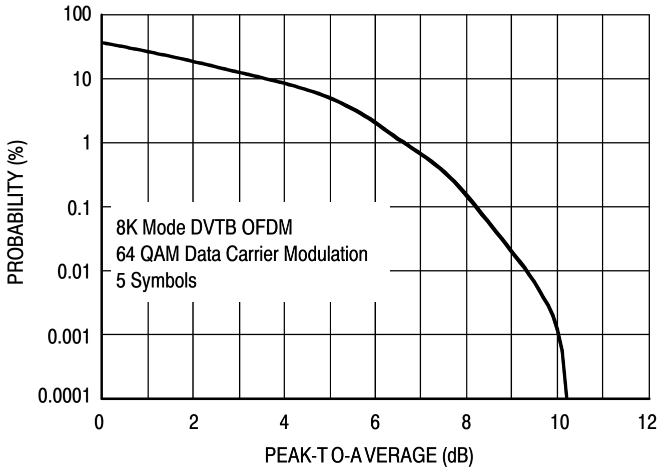


Figure 14. Single-Carrier DVTB OFDM

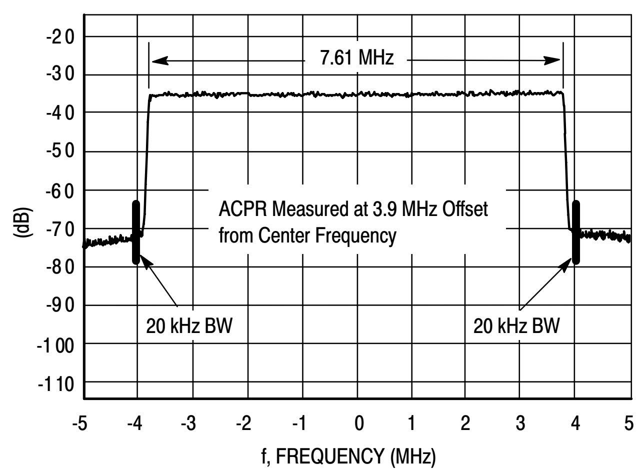
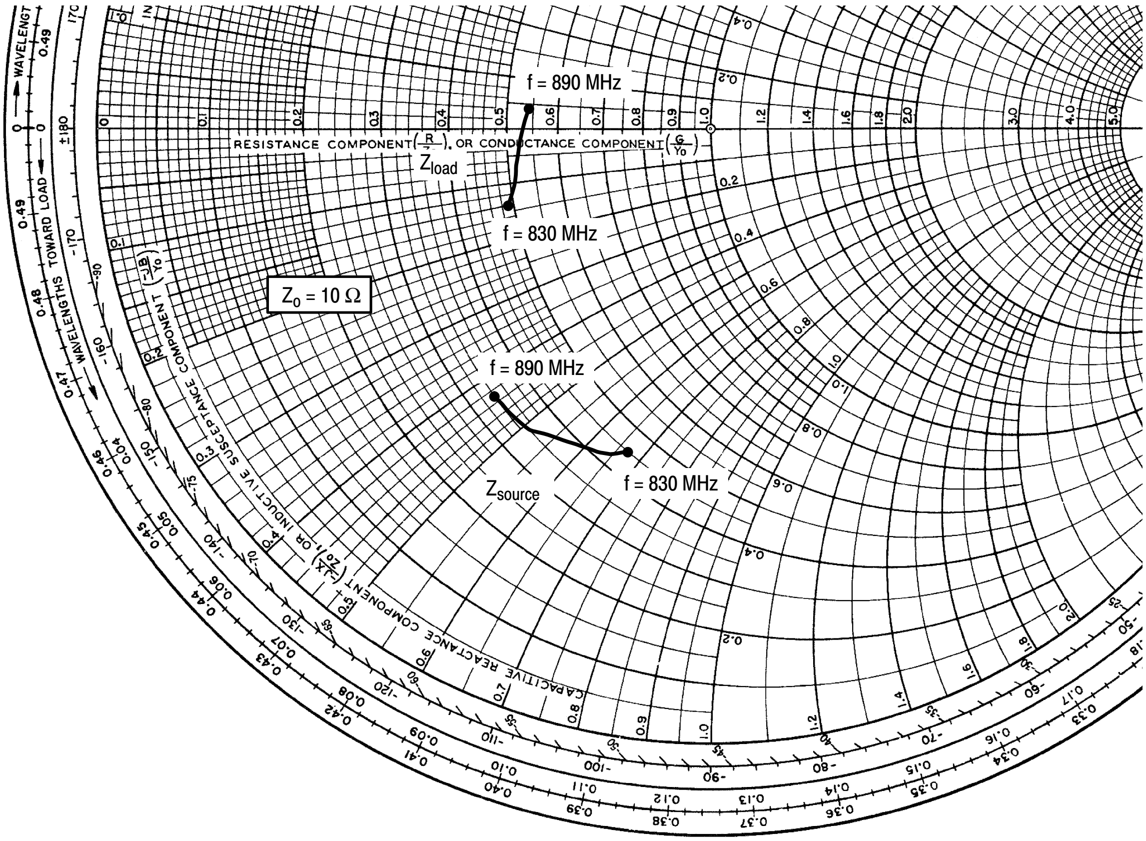


Figure 15. 8K Mode DVBT OFDM Spectrum



V_{DD} = 32 Vdc, I_{DQ} = 1600 mA, P_{out} = 270 W PEP

f MHz	Z_{source} Ω	Z_{load} Ω
830	4.52 - j6.73	4.89 - j1.35
845	4.22 - j6.38	5.06 - j1.01
860	3.89 - j5.81	5.18 - j0.58
875	3.54 - j5.10	5.27 - j0.11
890	3.39 - j4.32	5.36 + j0.43

Z_{source} = Test circuit impedance as measured from gate to gate, balanced configuration.

Z_{load} = Test circuit impedance as measured from drain to drain, balanced configuration.

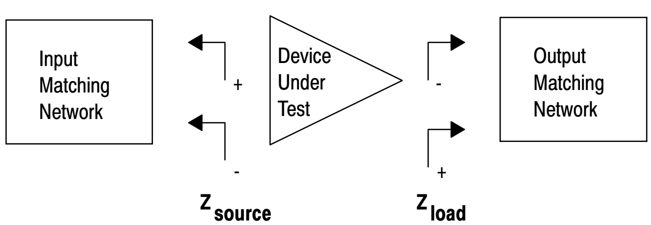
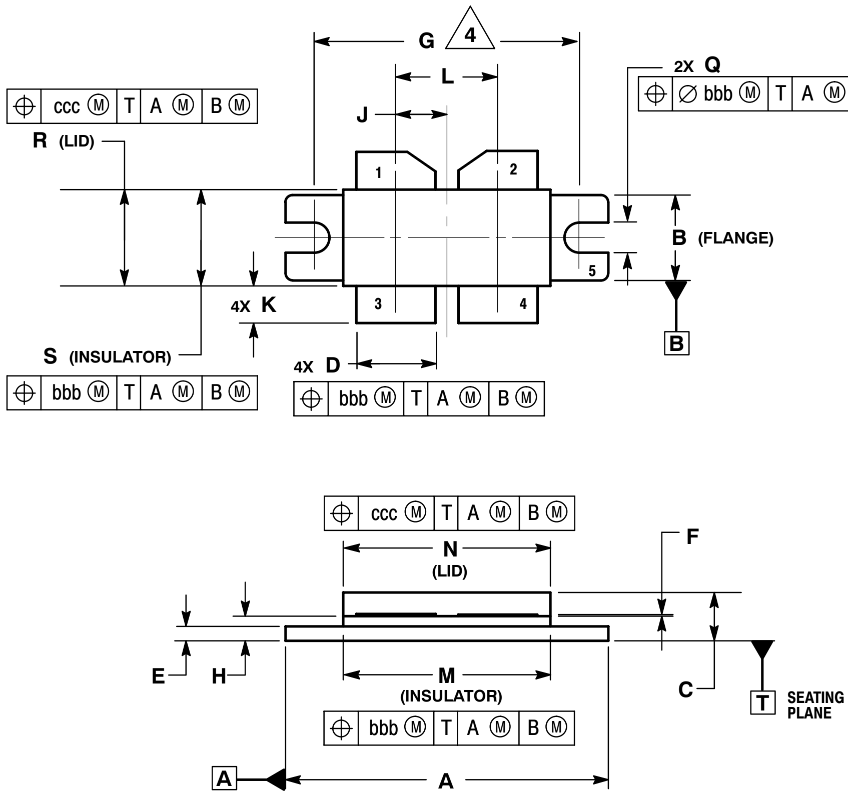


Figure 16. 820-900 MHz Narrowband Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS



NOTES:
1. CONTROLLING DIMENSION: INCH.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
3. DIMENSION H TO BE MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
4. RECOMMENDED BOLT CENTER DIMENSION OF 1.140 (28.96) BASED ON 3M SCREW.

	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	0.180	0.224	4.57	5.69
D	0.325	0.335	8.26	8.51
E	0.060	0.070	1.52	1.78
F	0.004	0.006	0.10	0.15
G	1.100 BSC		27.94 BSC	
H	0.097	0.107	2.46	2.72
J	0.2125 BSC		5.397 BSC	
K	0.135	0.165	3.43	4.19
L	0.425 BSC		10.8 BSC	
M	0.852	0.868	21.64	22.05
N	0.851	0.869	21.62	22.07
Q	0.118	0.138	3.00	3.30
R	0.395	0.405	10.03	10.29
S	0.394	0.406	10.01	10.31
bbb	0.010 REF		0.25 REF	
ccc	0.015 REF		0.38 REF	

STYLE 1:
PIN 1. DRAIN
2. DRAIN
3. GATE
4. GATE
5. SOURCE

CASE 375G-04
ISSUE G
NI-860C3

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	May 2007	• Initial Release of Data Sheet
1	Dec. 2008	• Table 4, Dynamic Characteristics, corrected C_{iss} test condition to indicate AC stimulus on the V_{GS} connection versus the V_{DS} connection, corrected Typ value from 106 to 1060 pF, p. 2 • Fig. 1, Test Circuit Schematic, Z-list, changed Z4, Z5 from 1.013″ x 0.058″ Microstrip to 1.186″ x 0.058″ Microstrip; Z10, Z11 from 1.054″ x 0.150″ Microstrip to 1.306″ x 0.150″ Microstrip; and Z19, Z20 from 0.165″ x 0.339″ Microstrip to 0.339″ x 0.165″ Microstrip; also separated Z1 and Z18 into two lines in Z-list, p. 3 • Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3 • Updated Part Numbers in Table 5, Component Designations and Values, to latest RoHS compliant part numbers, p. 3
2	Dec. 2009	• Data sheet revised to reflect part status change, removing MRFE6P3300HR5. Refer to PCN13420. (See Rev. 1 data sheet for MRFE6P3300HR5.)

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