Document Number: MRFE6VP5600H
Rev. 1, 1/2011

RoHS

RF Power Field Effect Transistors

High Ruggedness N-Channel Enhancement-Mode Lateral MOSFETs

These high ruggedness devices are designed for use in high VSWR industrial (including laser and plasma exciters), broadcast (analog and digital), aerospace and radio/land mobile applications. They are unmatched input and output designs allowing wide frequency range utilization, between 1.8 and 600 MHz.

- Typical Performance: V_{DD} = 50 Volts, I_{DQ} = 100 mA

Signal Type	P_{out} (W)	f (MHz)	G_{ps} (dB)	η_D (%)	IRL (dB)
Pulsed (100 μsec, 20% Duty Cycle)	600 Peak	230	25.0	74.6	-18
CW	600 Avg.	230	24.6	75.2	-17

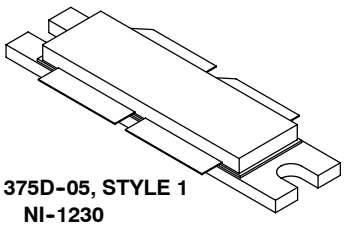
- Capable of Handling a Load Mismatch of 65:1 VSWR, @ 50 Vdc, 230 MHz, at all Phase Angles, Designed for Enhanced Ruggedness
  - 600 Watts Pulsed Peak Power, 20% Duty Cycle, 100 μsec

Features

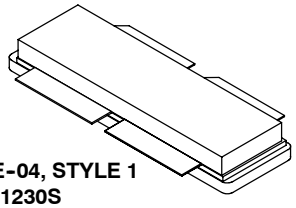
- Unmatched Input and Output Allowing Wide Frequency Range Utilization
- Device can be used Single-Ended or in a Push-Pull Configuration
- Qualified Up to a Maximum of 50 V_{DD} Operation
- Characterized from 30 V to 50 V for Extended Power Range
- Suitable for Linear Application with Appropriate Biasing
- Integrated ESD Protection with Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- RoHS Compliant
- In Tape and Reel. R6 Suffix = 150 Units, 56 mm Tape Width, 13 inch Reel. For R5 Tape and Reel options, see p. 12.

MRFE6VP5600HR6
MRFE6VP5600HSR6

1.8-600 MHz, 600 W CW, 50 V
LATERAL N-CHANNEL
BROADBAND
RF POWER MOSFETs



CASE 375D-05, STYLE 1
NI-1230
MRFE6VP5600HR6

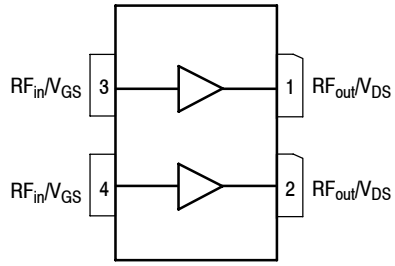


CASE 375E-04, STYLE 1
NI-1230S
MRFE6VP5600HSR6

PARTS ARE PUSH-PULL

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	-0.5, +130	Vdc
Gate-Source Voltage	V_{GS}	-6.0, +10	Vdc
Storage Temperature Range	T_{stg}	-65 to +150	°C
Case Operating Temperature	T_C	150	°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1667 8.33	W W/°C
Operating Junction Temperature (1,2)	T_J	225	°C



(Top View)

Figure 1. Pin Connections

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 68°C, 600 W Pulsed, 100 μsec Pulse Width, 20% Duty Cycle, 100 mA, 230 MHz Case Temperature 60°C, 600 W CW, 100 mA, 230 MHz	 $Z_{\theta JC}$ $R_{\theta JC}$	 0.022 0.12	°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.

freescale semiconductor

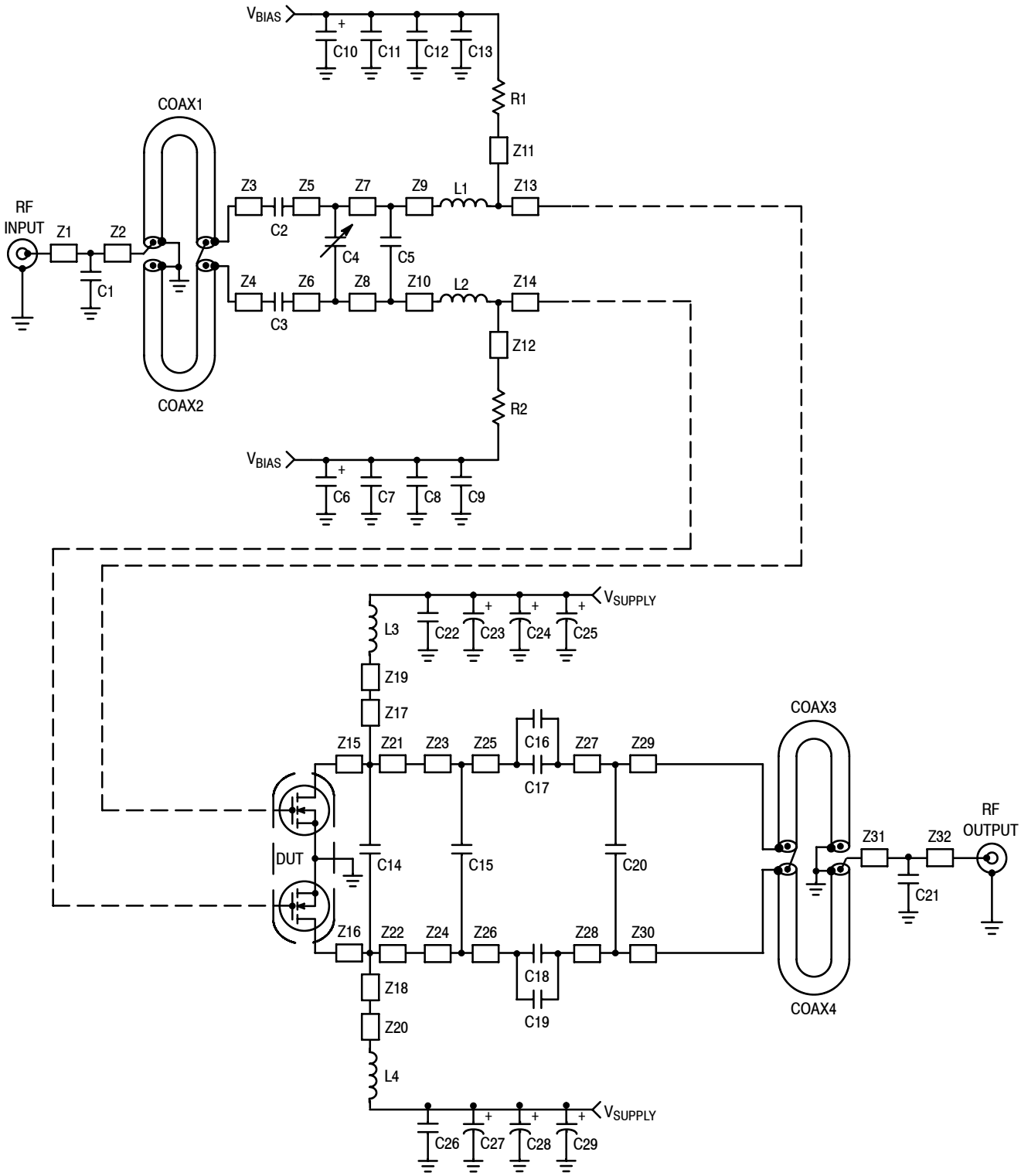
Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	2 (Minimum)
Machine Model (per EIA/JESD22-A115)	B (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)					
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
Drain-Source Breakdown Voltage (V_{GS} = 0 Vdc, I_D = 100 mA)	$V_{(BR)DSS}$	130	—	—	Vdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 50 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 100 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	20	μAdc
On Characteristics					
Gate Threshold Voltage (1) (V_{DS} = 10 Vdc, I_D = 960 μAdc)	$V_{GS(th)}$	1.7	2.2	2.7	Vdc
Gate Quiescent Voltage (V_{DD} = 50 Vdc, I_D = 100 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2.0	2.5	3.0	Vdc
Drain-Source On-Voltage (1) (V_{GS} = 10 Vdc, I_D = 2 Adc)	$V_{DS(on)}$	—	0.26	—	Vdc
Dynamic Characteristics (1)					
Reverse Transfer Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.60	—	pF
Output Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	129	—	pF
Input Capacitance (V_{DS} = 50 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	342	—	pF
Functional Tests (In Freescale Test Fixture, 50 ohm system) V_{DD} = 50 Vdc, I_{DQ} = 100 mA, P_{out} = 600 W Peak (120 W Avg.), f = 230 MHz, Pulsed, 100 μsec Pulse Width, 20% Duty Cycle					
Power Gain	G_{ps}	23.5	25.0	26.5	dB
Drain Efficiency	η_D	73.5	74.6	—	%
Input Return Loss	IRL	—	-18	-12	dB

1. Each side of device measured separately.



Z1	0.192″ x 0.082″ Microstrip	Z11*, Z12*	0.872″ x 0.058″ Microstrip	Z23, Z24	1.251″ x 0.300″ Microstrip
Z2	0.175″ x 0.082″ Microstrip	Z13, Z14	0.412″ x 0.726″ Microstrip	Z25, Z26	0.127″ x 0.300″ Microstrip
Z3, Z4	0.170″ x 0.100″ Microstrip	Z15, Z16	0.371″ x 0.507″ Microstrip	Z27, Z28	0.058″ x 0.300″ Microstrip
Z5, Z6	0.116″ x 0.285″ Microstrip	Z17*, Z18*	0.466″ x 0.363″ Microstrip	Z29, Z30	0.058″ x 0.300″ Microstrip
Z7, Z8	0.116″ x 0.285″ Microstrip	Z19*, Z20*	1.187″ x 0.154″ Microstrip	Z31	0.186″ x 0.082″ Microstrip
Z9, Z10	0.108″ x 0.285″ Microstrip	Z21, Z22	0.104″ x 0.507″ Microstrip	Z32	0.179″ x 0.082″ Microstrip

* Line length includes microstrip bends

Figure 1. MRFE6VP5600HR6(HSR6) Test Circuit Schematic – Pulsed

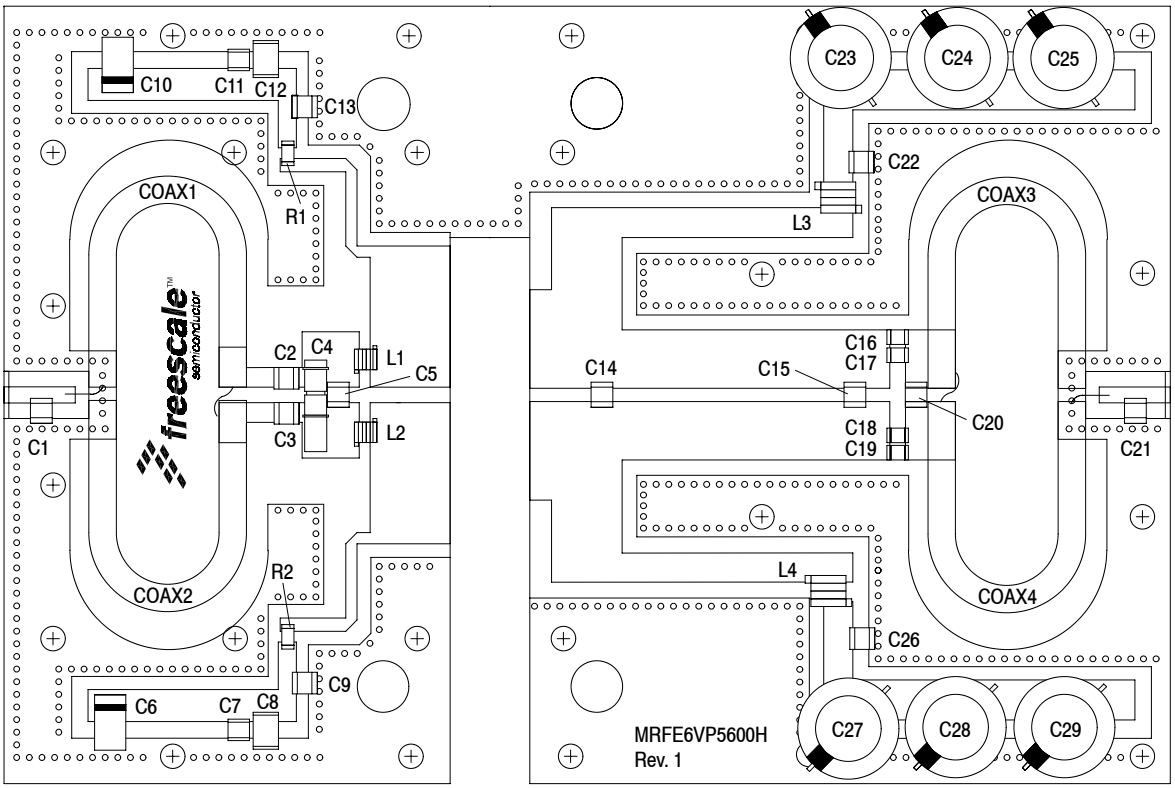
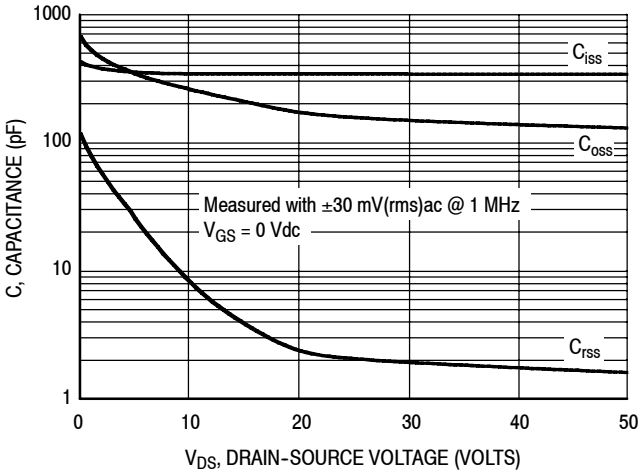


Figure 2. MRFE6VP5600HR6(HSR6) Test Circuit Component Layout – Pulsed

Table 5. MRFE6VP5600HR6(HSR6) Test Circuit Component Designations and Values – Pulsed

Part	Description	Part Number	Manufacturer
C1	12 pF Chip Capacitor	ATC100B120JT500XT	ATC
C2, C3	27 pF Chip Capacitors	ATC100B270JT500XT	ATC
C4	0.8–8.0 pF Variable Capacitor, Gigatrim	27291SL	Johanson
C5	33 pF Chip Capacitor	ATC100B330JT500XT	ATC
C6, C10	22 μF, 35 V Tantalum Capacitors	T491X226K035AT	Kemet
C7, C11	0.1 μF Chip Capacitors	CDR33BX104AKYS	AVX
C8, C12	220 nF Chip Capacitors	C1812C224K5RACTU	Kemet
C9, C13, C22, C26	1000 pF Chip Capacitors	ATC100B102JT50XT	ATC
C14	36 pF Chip Capacitor	ATC100B360JT500XT	ATC
C15	51 pF Chip Capacitor	ATC100B510GT500XT	ATC
C16, C17, C18, C19	240 pF Chip Capacitors	ATC100B241JT200XT	ATC
C20	39 pF Chip Capacitor	ATC100B390JT500XT	ATC
C21	10 pF Chip Capacitor	ATC100B100JT500XT	ATC
C23, C24, C25, C27, C28, C29	470 μF, 63 V Electrolytic Capacitors	MCGPR63V477M13X26-RH	Multicomp
Coax1, 2, 3, 4	25 Ω Semi Rigid Coax, 2.2″ Long	UT-141C-25	Micro Coax
L1, L2	5 nH Inductors	A02TKLC	Coilcraft
L3, L4	6.6 nH Inductors	GA3093-ALC	Coilcraft
R1, R2	10 Ω Chip Resistors	CRCW120610R0JNEA	Vishay
PCB	0.030″, ε_r = 2.55	AD255A	Arlon

TYPICAL CHARACTERISTICS



Note: Each side of device measured separately.

Figure 3. Capacitance versus Drain-Source Voltage

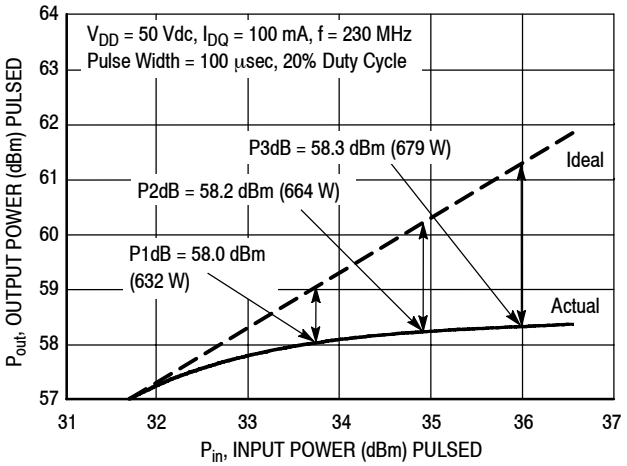


Figure 4. Pulsed Output Power versus Input Power

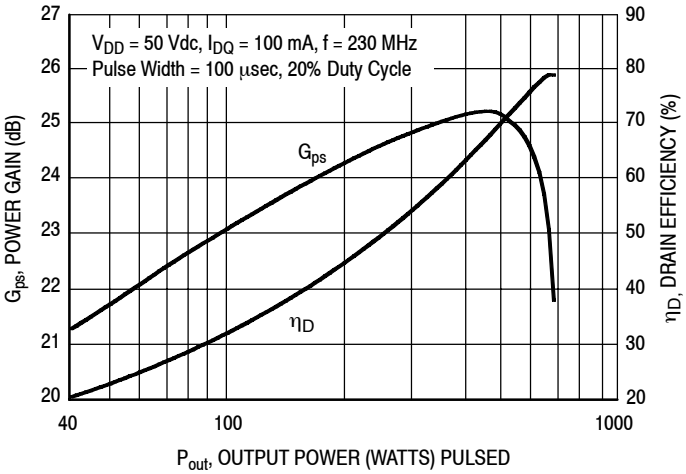


Figure 5. Pulsed Power Gain and Drain Efficiency versus Output Power

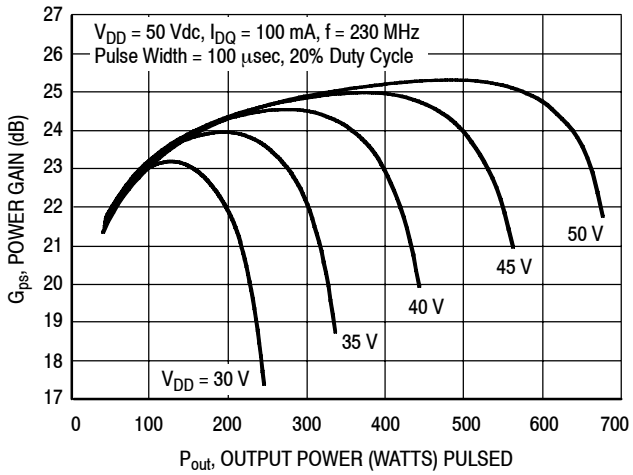


Figure 6. Pulsed Power Gain versus Output Power

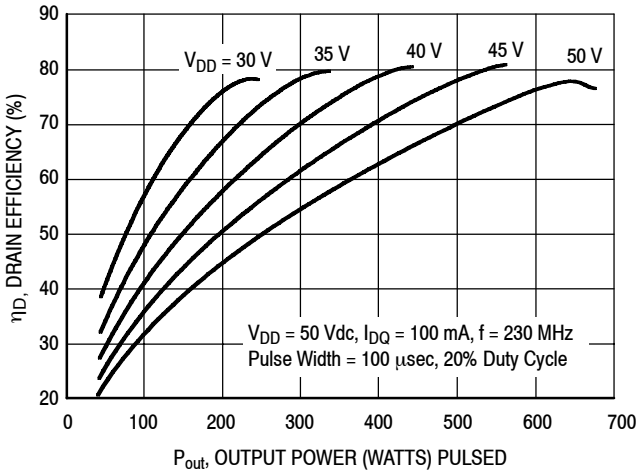


Figure 7. Pulsed Drain Efficiency versus Output Power

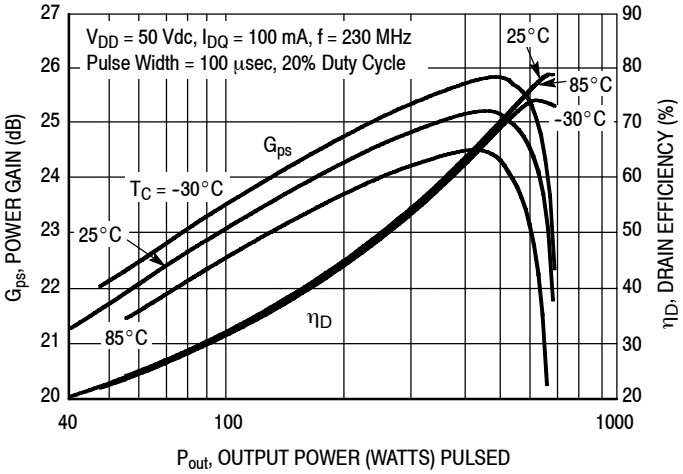
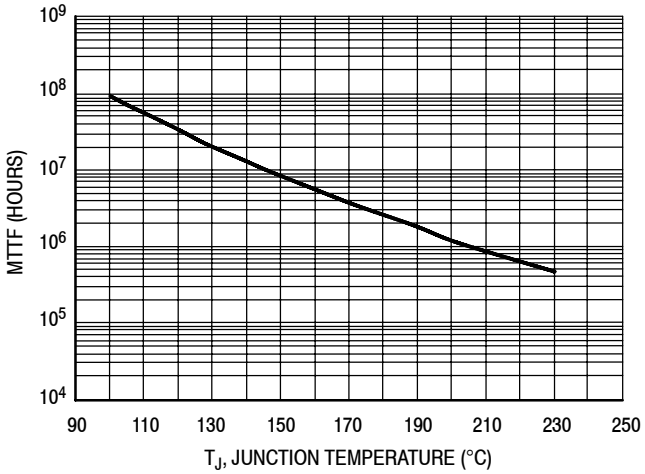


Figure 8. Pulsed Power Gain and Drain Efficiency versus Output Power

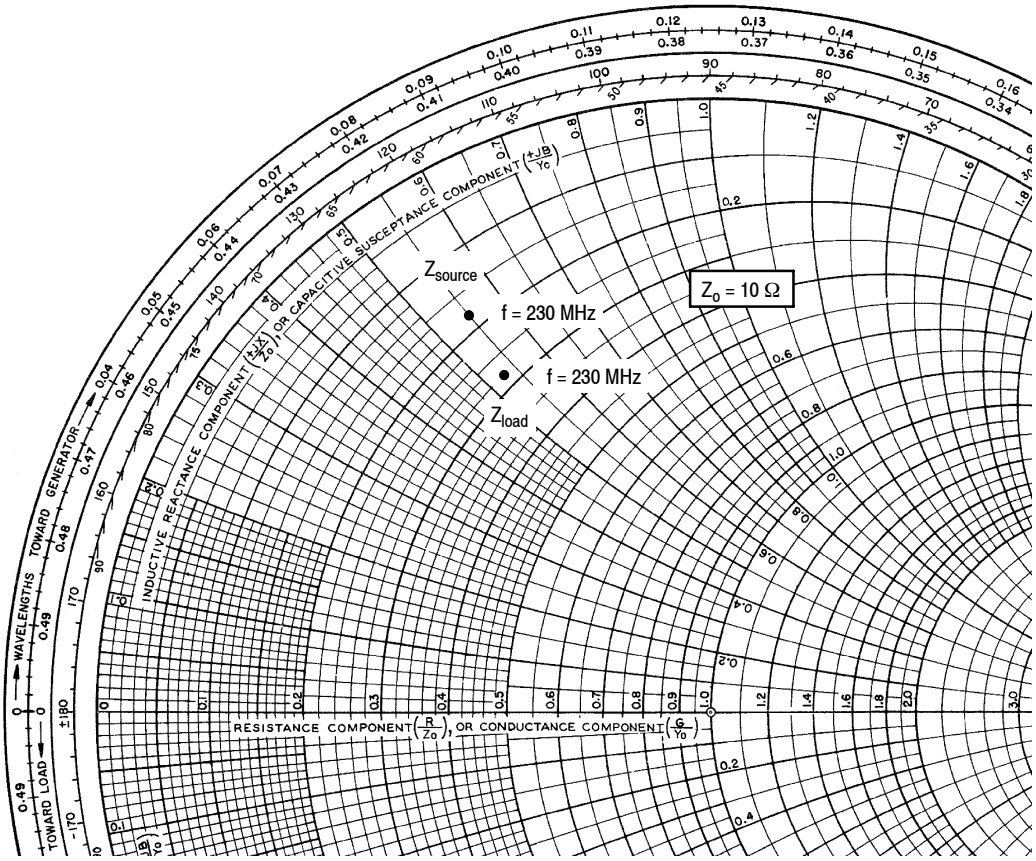
TYPICAL CHARACTERISTICS



This above graph displays calculated MTTF in hours when the device is operated at V_{DD} = 50 Vdc, P_{out} = 600 W Avg., and η_D = 75.2%.

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

Figure 9. MTTF versus Junction Temperature — CW



V_{DD} = 50 Vdc, I_{DQ} = 100 mA, P_{out} = 600 W Peak

f MHz	Z_{source} Ω	Z_{load} Ω
230	1.78 + j5.45	2.75 + j5.30

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.

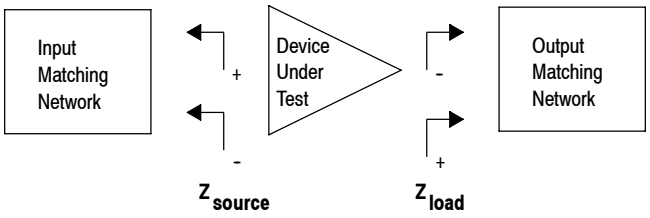
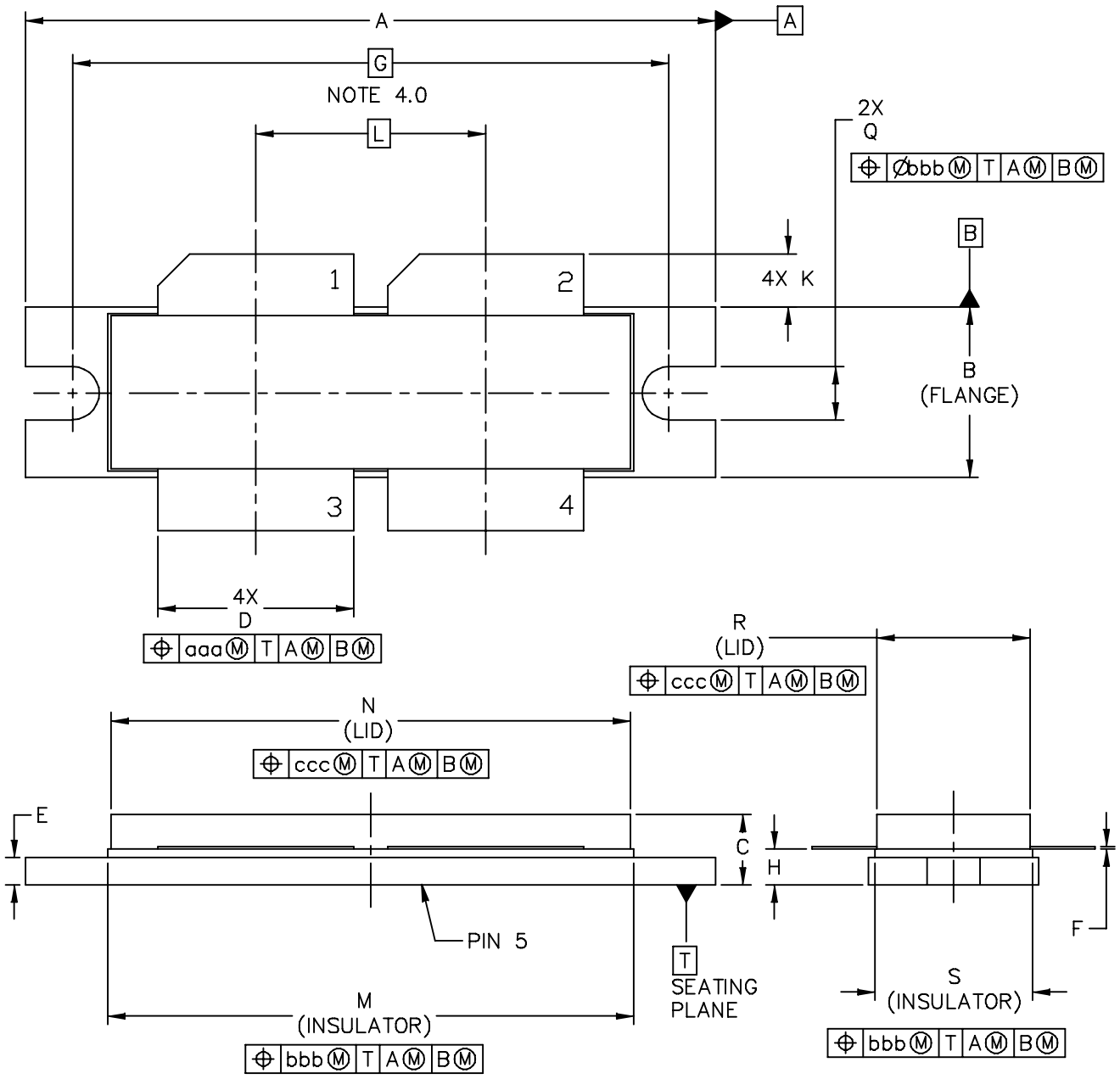


Figure 10. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS



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TITLE: NI−1230	DOCUMENT NO: 98ASB16977C	REV: E
	CASE NUMBER: 375D−05	31 MAR 2005
	STANDARD: NON−JEDEC	

NOTES:

1. 0 INTERPRET DIMENSIONS AND TOLERANCES
PER ASME Y14. 5M–1994.

2. 0 CONTROLLING DIMENSION: INCH

3. 0 DIMENSION H IS MEASURED . 030 (0. 762)
AWAY FROM PACKAGE BODY.

4. 0 RECOMMENDED BOLT CENTER DIMENSION OF
1. 52 (38. 61) BASED ON M3 SCREW.

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

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	1.615	1.625	41.02	41.28	N	1.218	1.242	30.94	31.55
B	.395	.405	10.03	10.29	Q	.120	.130	3.05	3.3
C	.150	.200	3.81	5.08	R	.355	.365	9.01	9.27
D	.455	.465	11.56	11.81	S	.365	.375	9.27	9.53
E	.062	.066	1.57	1.68					
F	.004	.007	0.1	0.18					
G	1.400 BSC		35.56 BSC		aaa	.013		0.33	
H	.082	.090	2.08	2.29	bbb	.010		0.25	
K	.117	.137	2.97	3.48	ccc	.020		0.51	
L	.540 BSC		13.72 BSC						
M	1.219	1.241	30.96	31.52					

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NI–1230	CASE NUMBER: 375D–05	31 MAR 2005
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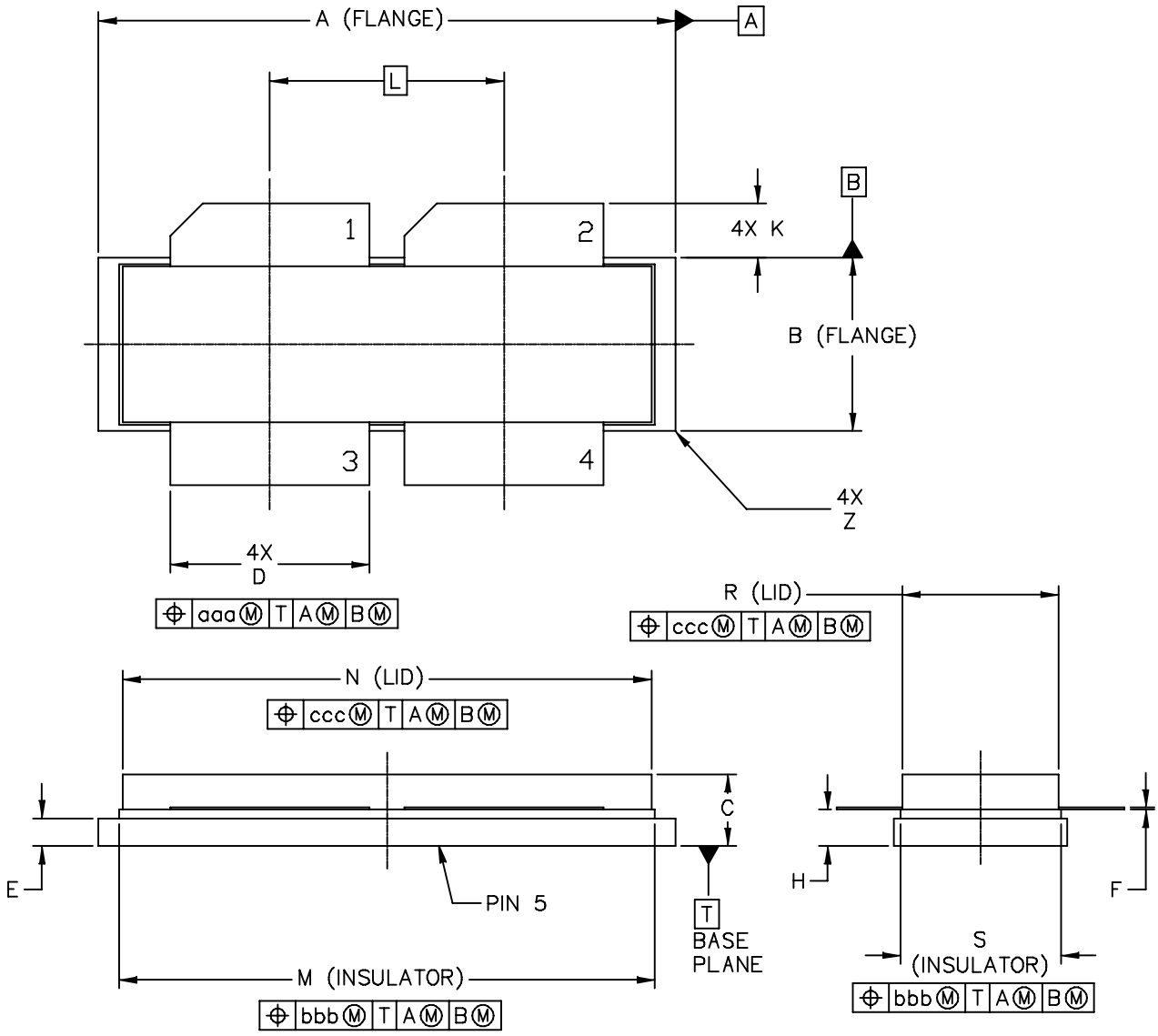

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	CASE NUMBER: 375E−04	05 AUG 2005
	STANDARD: NON−JEDEC	

NOTES:

1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.

2. CONTROLLING DIMENSION: INCH

3. DIMENSION H IS MEASURED .030 AWAY FROM PACKAGE BODY

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

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX	DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.265	1.275	32.13	32.38	R	.355	.365	9.01	9.27
B	.395	.405	10.03	10.29	S	.365	.375	9.27	9.53
C	.150	.200	3.81	5.08	Z	---	.040	---	1.02
D	.455	.465	11.56	11.81					
E	.062	.066	1.57	1.68	aaa		.013		0.33
F	.004	.007	0.1	0.18	bbb		.010		0.25
H	.082	.090	2.08	2.29	ccc		.020		0.51
K	.117	.137	2.97	3.48					
L	.540 BSC		13.72 BSC						
M	1.219	1.241	30.96	31.52					
N	1.218	1.242	30.94	31.55					

MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE

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NI–1230S	CASE NUMBER: 375E–04	05 AUG 2005
	STANDARD: NON–JEDEC	

PRODUCT DOCUMENTATION AND SOFTWARE

Refer to the following documents and software 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

Software

- Electromigration MTTF Calculator
- RF High Power Model
- .s2p File

For Software, do a Part Number search at http://www.freescale.com, and select the “Part Number” link. Go to the Software & Tools tab on the part’s Product Summary page to download the respective tool.

R5 TAPE AND REEL OPTION

R5 Suffix = 50 Units, 56 mm Tape Width, 13 inch Reel.

The R5 tape and reel option for MRFE6VP5600H and MRFE6VP5600HS parts will be available for 2 years after release of MRFE6VP5600H and MRFE6VP5600HS. Freescale Semiconductor, Inc. reserves the right to limit the quantities that will be delivered in the R5 tape and reel option. At the end of the 2 year period customers who have purchased these devices in the R5 tape and reel option will be offered MRFE6VP5600H and MRFE6VP5600HS in the R6 tape and reel option.

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Dec. 2010	• Initial Release of Data Sheet
1	Jan. 2011	• Fig. 1, Pin Connections, corrected pin 4 label from RF_{out}/V_{GS} to RF_{in}/V_{GS}, p. 1

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Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor China Ltd.
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No. 118 Jianguo Road
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