Freescale Semiconductor
Technical Data

Document Number: MRF6S24140H
Rev. 4, 2/2012

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed primarily for large-signal output applications at 2450 MHz. Devices are suitable for use in industrial, medical and scientific applications.

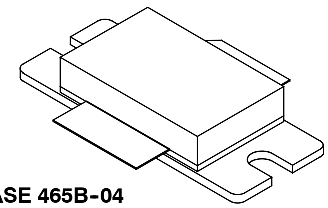
- Typical CW Performance at 2450 MHz, V_{DD} = 28 Volts, I_{DQ} = 1200 mA, P_{out} = 140 Watts
  - Power Gain — 13.2 dB
  - Drain Efficiency — 45%
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2390 MHz, 140 Watts CW Output Power

Features

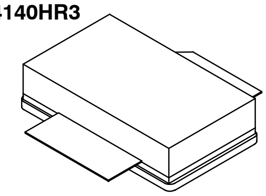
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF6S24140HR3
MRF6S24140HSR3

2450 MHz, 140 W, 28 V
CW
LATERAL N-CHANNEL
RF POWER MOSFETs



CASE 465B-04
NI-880
MRF6S24140HR3



CASE 465C-03
NI-880S
MRF6S24140HSR3

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 (1,2)	T_J	225	°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case Case Temperature 82°C, 140 W CW Case Temperature 75°C, 28 W CW	$R_{\theta JC}$	 0.29 0.33	°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)	2
Machine Model (per EIA/JESD22-A115)	A
Charge Device Model (per JESD22-C101)	IV

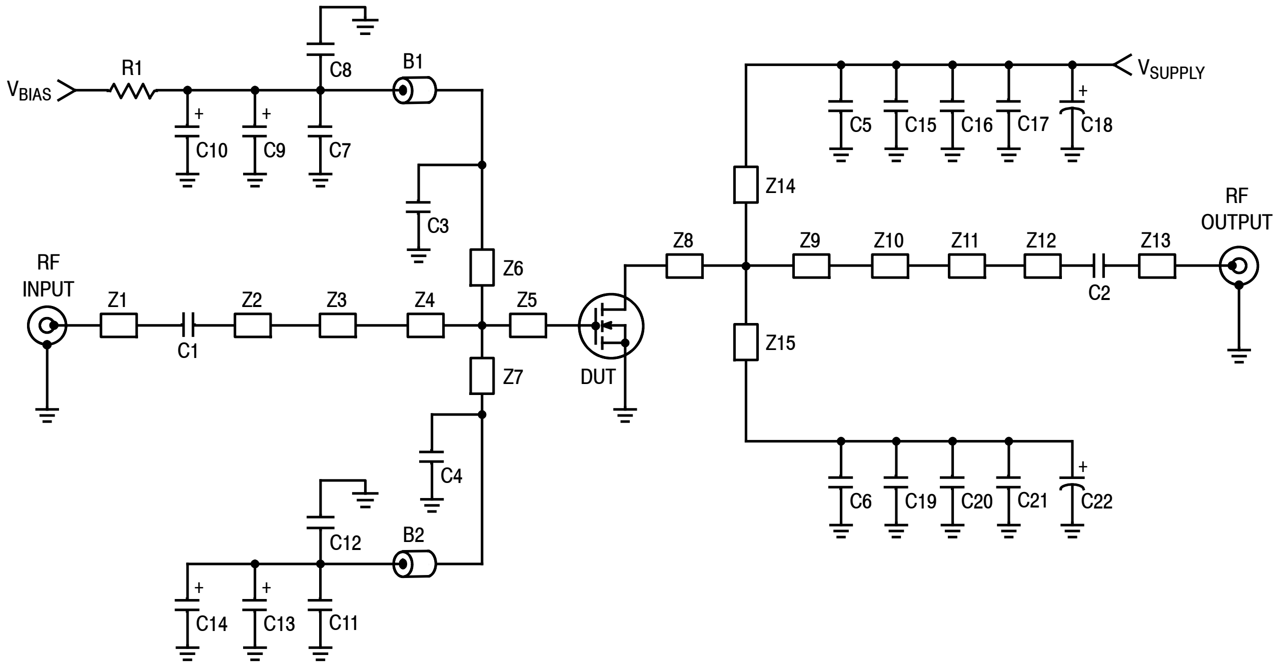
Table 4. Electrical Characteristics (T_A = 25°C unless otherwise noted)

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}	—	—	500	nAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 300 μAdc)	$V_{GS(th)}$	1	2	3	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 1300 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 3 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}	—	2	—	pF

Functional Tests (In Freescale Test Fifxture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ} = 1300 mA, P_{out} = 28 W Avg., f = 2390 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 Bandwidth @ ±10 MHz Offset. Input Signal PAR = 8.5 dB @ 0.01% Probability on CCDF.

Characteristic	Symbol	Min	Typ	Max	Unit
Power Gain	G_{ps}	13	15.2	17	dB
Drain Efficiency	η_D	23	25	—	%
Intermodulation Distortion	IM3	—	-37	-35	dBc
Adjacent Channel Power Ratio	ACPR	—	-40	-38	dBc
Input Return Loss	IRL	—	-15	—	dB

1. Part internally matched both on input and output.

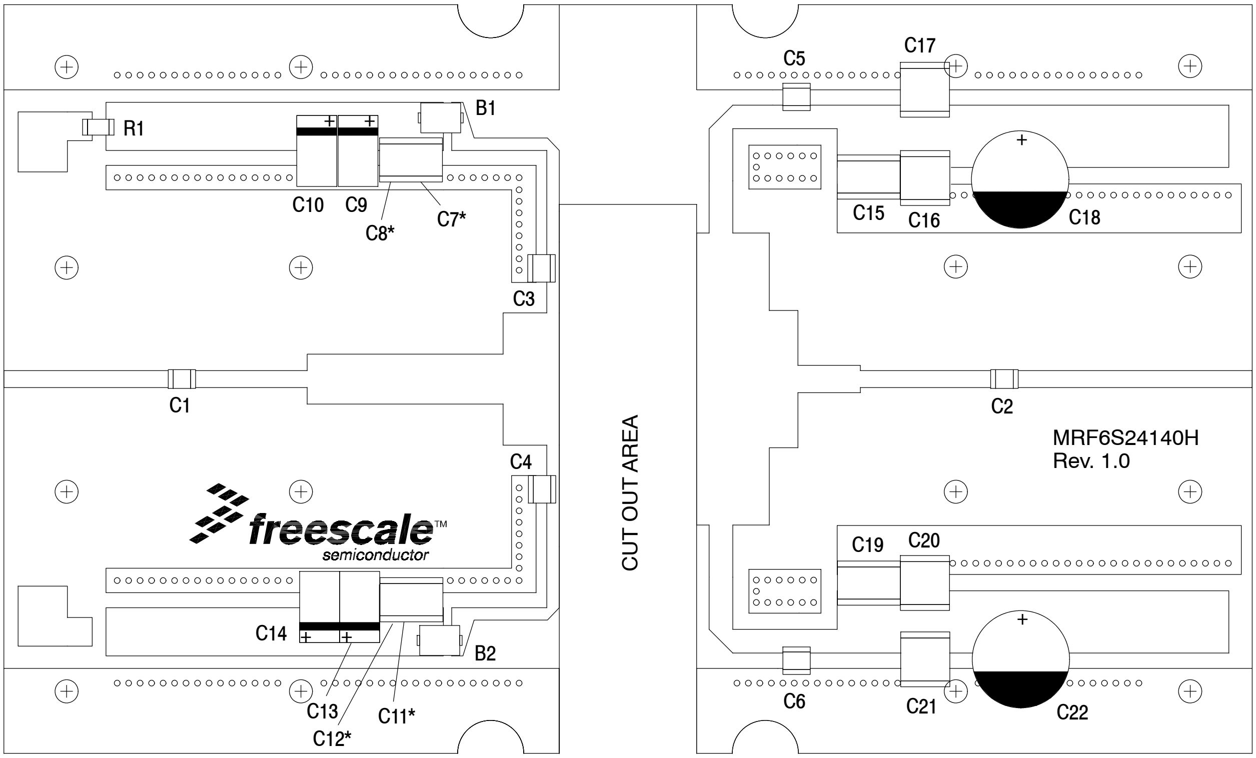


Z1	0.678″ x 0.068″ Microstrip	Z9	0.193″ x 1.170″ Microstrip
Z2	0.466″ x 0.068″ Microstrip	Z10	0.115″ x 0.550″ Microstrip
Z3	0.785″ x 0.200″ Microstrip	Z11	0.250″ x 0.110″ Microstrip
Z4	0.200″ x 0.530″ Microstrip	Z12	0.538″ x 0.068″ Microstrip
Z5	0.025″ x 0.530″ Microstrip	Z13	0.957″ x 0.068″ Microstrip
Z6, Z7	0.178″ x 0.050″ Microstrip	Z14, Z15	0.673″ x 0.095″ Microstrip
Z8	0.097″ x 1.170″ Microstrip	PCB	Taconic RF-35, 0.030″, ε_r = 3.5

Figure 1. MRF6S24140HR3(SR3) Test Circuit Schematic — 2450 MHz

Table 5. MRF6S24140HR3(SR3) Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1, B2	47 Ω, 100 MHz Short Ferrite Beads, Surface Mount	2743019447	Fair-Rite
C1, C2, C3, C4, C5, C6	5.6 pF Chip Capacitors	ATC600B5R6BT500XT	ATC
C7, C11	0.01 μF, 100 V Chip Capacitors	C1825C103J1RAC	Kemet
C8, C12, C15, C19	2.2 μF, 50 V Chip Capacitors	C1825C225J5RAC	Kemet
C9, C13	22 μF, 25 V Tantalum Capacitors	T491D226M025AT	Kemet
C10, C14	47 μF, 16 V Tantalum Capacitors	T491D476K016AT	Kemet
C16, C17, C20, C21	10 μF, 50 V Chip Capacitors	GRM55DR61H106KA88B	Murata
C18, C22	220 μF, 50 V Electrolytic Capacitors	2222-150-95102	Vishay
R1	240 Ω, 1/4 W Chip Resistor	CRC12062400FKEA	Vishay



* Stacked

Figure 2. MRF6S24140HR3(SR3) Test Circuit Component Layout — 2450 MHz

TYPICAL CHARACTERISTICS — 2450 MHz

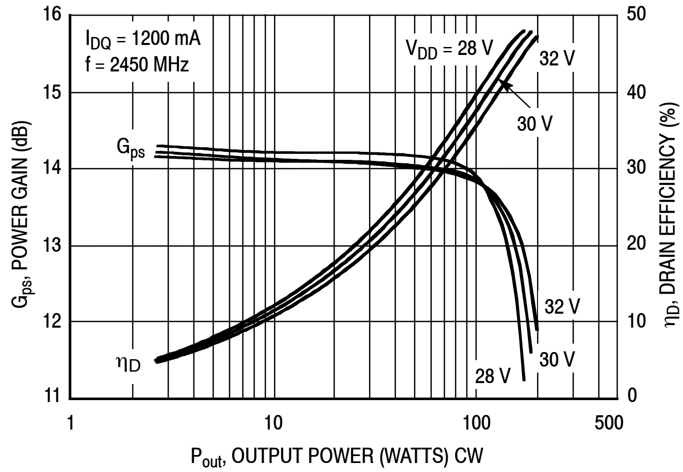


Figure 3. Power Gain and Drain Efficiency versus CW Output Power as a Function of V_{DD}

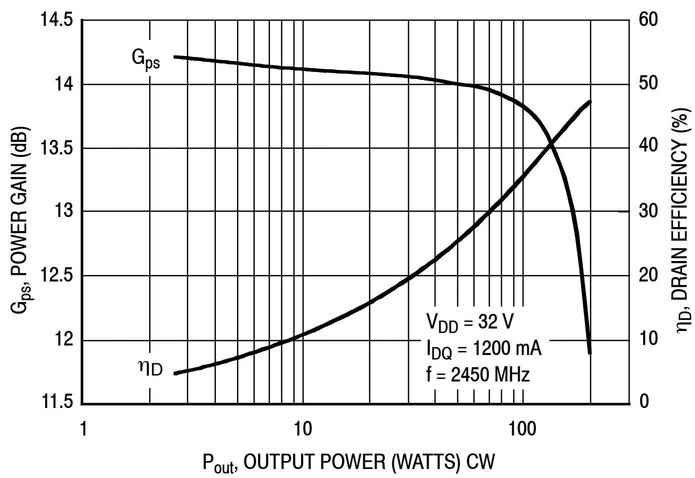


Figure 4. Power Gain and Drain Efficiency versus CW Output Power

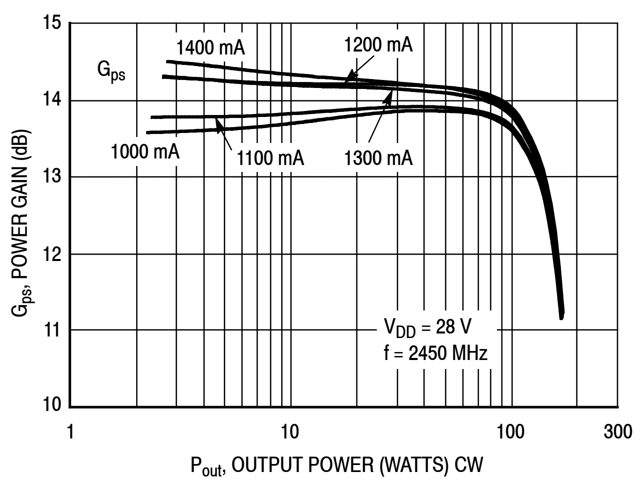
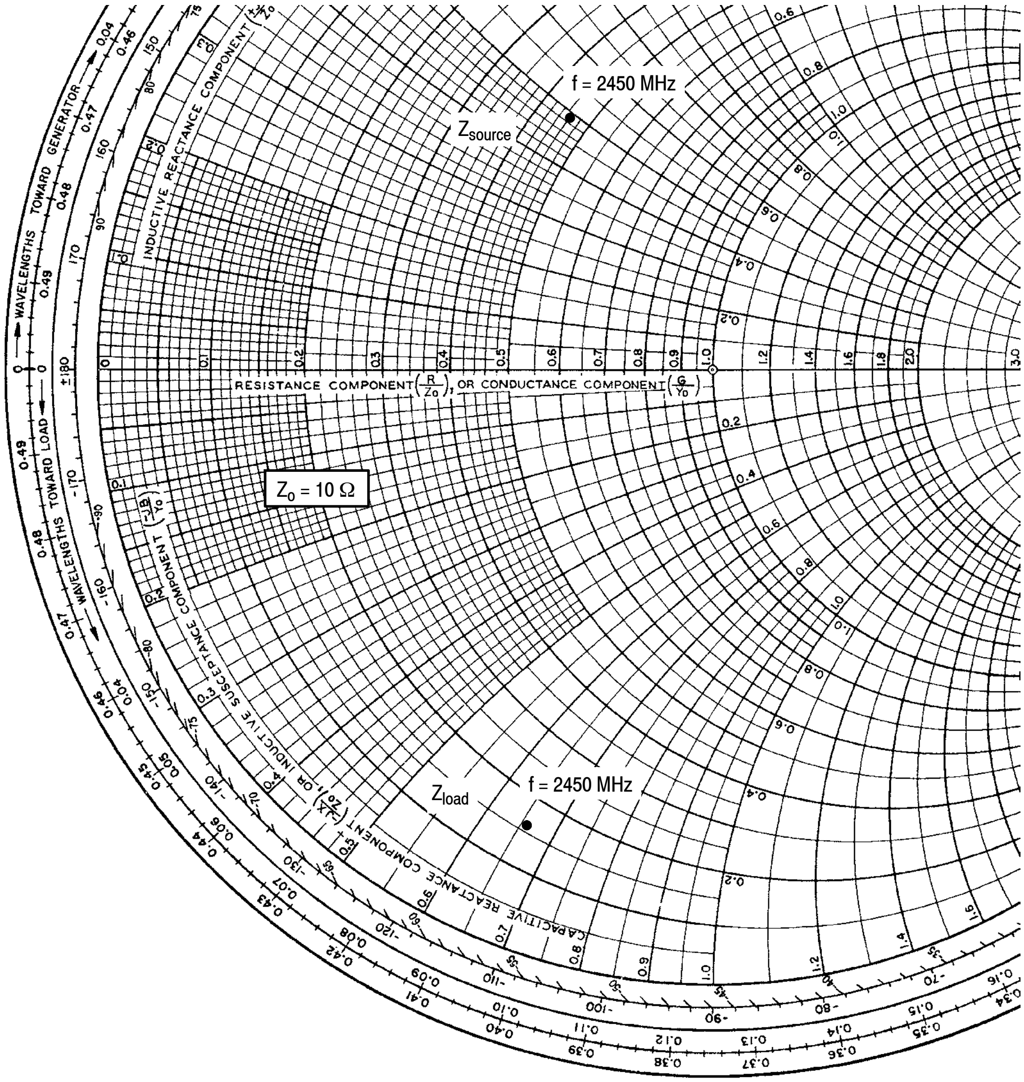


Figure 5. Power Gain and Drain Efficiency versus CW Output Power as a Function of Total I_{DQ}



V_{DD} = 28 Vdc, I_{DQ} = 1200 mA, P_{out} = 140 W CW

f MHz	Z_{source} Ω	Z_{load} Ω
2450	4.55 + j4.9	1.64 – j6.57

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

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

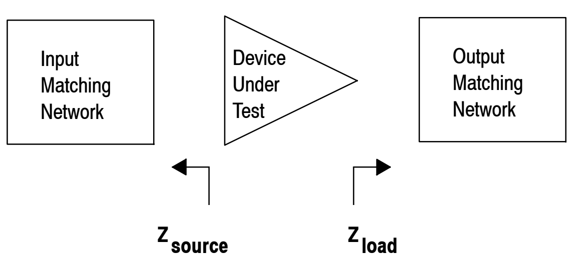
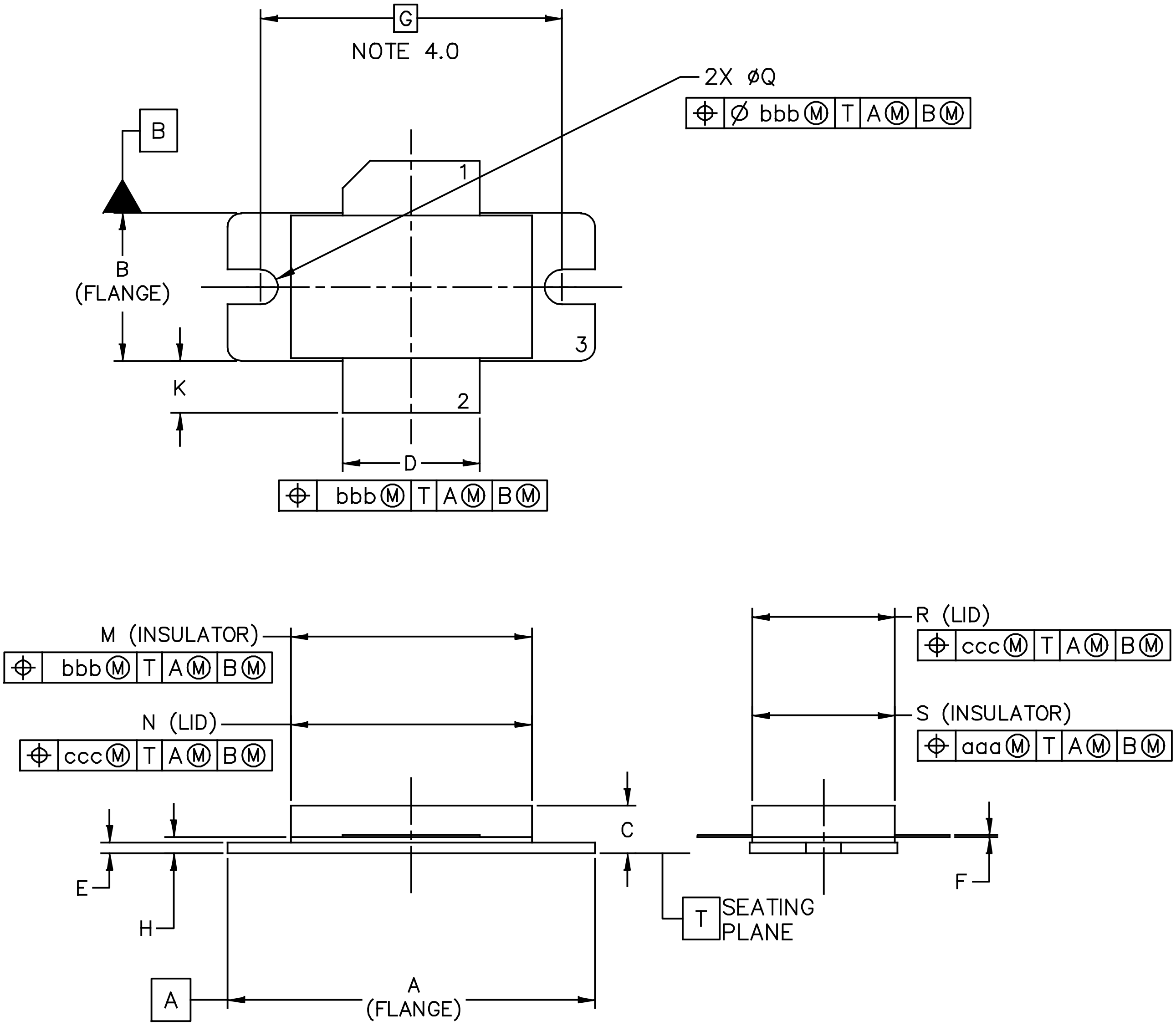


Figure 6. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS



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TITLE: NI–880	DOCUMENT NO: 98ARB18493C		REV: F
	CASE NUMBER: 465B–04		26 MAY 2011
	STANDARD: NON–JEDEC		

NOTES:
1.0 DIMENSIONING AND TOLERANCING PER ANSI 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 1.16 (29.57) BASED ON M3 SCREW.

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN		INCH MAX	MILLIMETER MIN		MILLIMETER MAX
A	1.335	1.345	33.91	34.16	R	.515	−	.525	13.08	−	13.34
B	.535	.545	13.59	13.84	S	.515	−	.525	13.08	−	13.34
C	.147	.200	3.73	5.08	aaa	−	.007	−	−	0.178	−
D	.495	.505	12.57	12.83	bbb	−	.010	−	−	0.254	−
E	.035	.045	0.89	1.14	ccc	−	.015	−	−	0.381	−
F	.003	.006	0.08	0.15	−	−	−	−	−	−	−
G	1.100 BSC		27.94 BSC		−	−	−	−	−	−	−
H	.057	.067	1.45	1.70	−	−	−	−	−	−	−
K	.175	.205	4.45	5.21	−	−	−	−	−	−	−
M	.872	.888	22.15	22.56	−	−	−	−	−	−	−
N	.871	.889	22.12	22.58	−	−	−	−	−	−	−
Q	ø.118	ø.138	ø3.00	ø3.51	−	−	−	−	−	−	−

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
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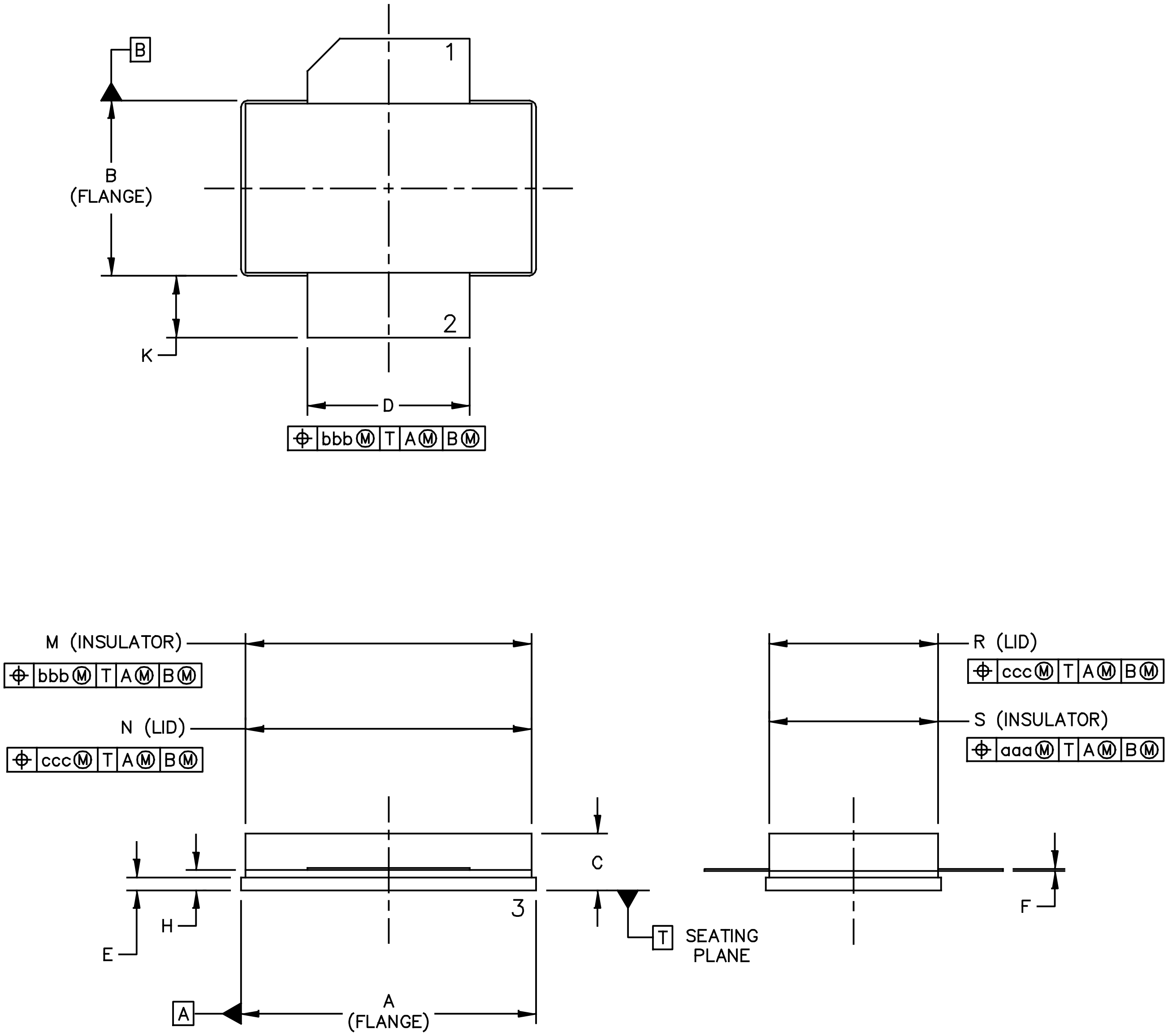

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	CASE NUMBER: 465C–03		26 MAY 2011
	STANDARD: NON–JEDEC		

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1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY.

DIM	INCH MIN		INCH MAX	MILLIMETER MIN		MILLIMETER MAX	DIM	INCH MIN		INCH MAX	MILLIMETER MIN		MILLIMETER MAX
A	.905	–	.915	22.99	–	23.24	aaa	–	.007	–	–	0.178	–
B	.535	–	.545	13.59	–	13.84	bbb	–	.010	–	–	0.254	–
C	.147	–	.200	3.73	–	5.08	ccc	–	.015	–	–	0.381	–
D	.495	–	.505	12.57	–	12.83	–	–	–	–	–	–	–
E	.035	–	.045	0.89	–	1.14	–	–	–	–	–	–	–
F	.003	–	.006	0.08	–	0.15	–	–	–	–	–	–	–
H	.057		.067	1.45		1.70	–	–	–	–	–	–	–
K	.170	–	.210	4.32	–	5.33	–	–	–	–	–	–	–
M	.872	–	.888	22.15	–	22.56	–	–	–	–	–	–	–
N	.871	–	.889	22.12	–	22.58	–	–	–	–	–	–	–
R	.515	–	.525	13.08	–	13.34	–	–	–	–	–	–	–
S	.515	–	.525	13.08	–	13.34	–	–	–	–	–	–	–

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	CASE NUMBER: 465C–03	26 MAY 2011
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PRODUCT DOCUMENTATION, TOOLS AND SOFTWARE

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

Software

- Electromigration MTTF Calculator
- RF High Power Model

For Software and Tools, 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.

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Mar. 2007	• Initial Release of Data Sheet
1	Apr. 2008	• Operating Junction Temperature increased from 200°C to 225°C in Maximum Ratings table and related "Continuous use at maximum temperature will affect MTTF" footnote added, p. 1 • Corrected V_{DS} to V_{DD} in the RF test condition voltage callout for $V_{GS(Q)}$, and added "Measured in Functional Test", On Characteristics table, p. 2 • Updated PCB information to show more specific material details, Fig. 1, Test Circuit Schematic, p. 3
2	Feb. 2009	• Modified data sheet to reflect RF Test Reduction described in Product and Process Change Notification number, PCN13232, p. 2
3	Mar. 2010	• Fig. 1, Test Circuit Schematic, Z-list, corrected PCB information to reflect Taconic as manufacturer, p. 3 • Fig. 4, Power Gain and Drain Efficiency versus CW Output Power, corrected 28 V to read 32 V, p. 5 • Added Electromigration MTTF Calculator and RF High Power Model availability to Product Software, p. 8
4	Feb. 2012	• Table 3, ESD Protection Characteristics, removed the word "Minimum" after the ESD class rating. ESD ratings are characterized during new product development but are not 100% tested during production. ESD ratings provided in the data sheet are intended to be used as a guideline when handling ESD sensitive devices, p. 2. • Fig. 6, MTTF versus Junction Temperature removed, p. 5. Refer to the device's MTTF Calculator available at freescale.com/RFpower. Go to Design Resources > Software and Tools. • Replaced Case Outline 465B-03, Issue D, with 465B-04, Issue F, p. 1, 7-8. Deleted Style 1 pin note on Sheet 2. On Sheet 2, changed dimension B in mm from 13.6-13.8 to 13.59-13.84, changed dimension H in mm from 1.45-1.7 to 1.45-1.70, changed dimension K in mm from 4.44-5.21 to 4.45-5.21, changed dimension M in mm from 22.15-22.55 to 22.15-22.56, changed dimension N in mm from 19.3-22.6 to 22.12-22.58, changed dimension Q in mm from 3-3.51 to 3.00-3.51, changed dimension R and S in mm from 13.1-13.3 to 13.08-13.34. • Replaced Case Outline 465C-02, Issue D, with 465C-03, Issue E, p. 1, 9-10. Deleted Style 1 pin note on Sheet 2. On Sheet 2, changed dimension B in mm from 13.6-13.8 to 13.59-13.84, changed dimension H in mm from 1.45-1.7 to 1.45-1.70, changed dimension M in mm from 22.15-22.55 to 22.15-22.56, changed dimension N in mm from 19.3-22.6 to 22.12-22.58, changed dimension R and S in mm from 13.1-13.3 to 13.08-13.34.

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