Freescale Semiconductor
Technical Data

Document Number: MRF6S24140H
Rev. 1, 4/2008

RoHS

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.

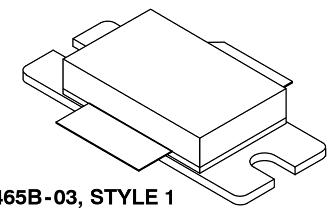
- Typical CW Performance at 2450 MHz, V_{DD} = 28 Volts, I_{DQ} = 1200 mA, P_{out} = 140 Watts
  - Power Gain — 13.2 dB
  - Drain Efficiency — 45%
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 2390 MHz, 140 Watts CW Output Power

Features

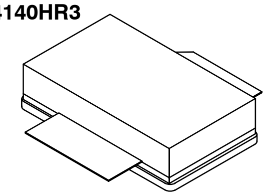
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 32 V_{DD} Operation
- Integrated ESD Protection
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.

MRF6S24140HR3
MRF6S24140HSR3

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



CASE 465B-03, STYLE 1
NI-880
MRF6S24140HR3



CASE 465C-02, STYLE 1
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.

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	2 (Minimum)
Machine Model (per EIA/JESD22-A115)	A (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

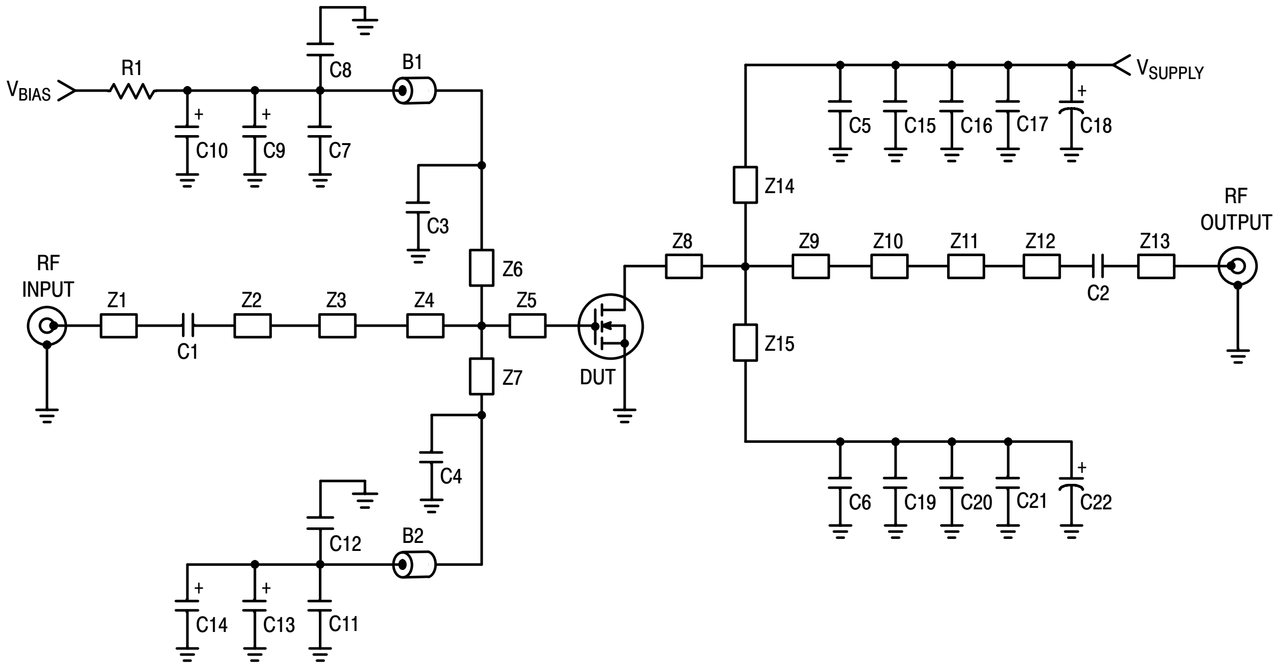
Table 4. Electrical Characteristics (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 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., f1 = 2300 MHz, f2 = 2310 MHz and f1 = 2390 MHz, f2 = 2400 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.

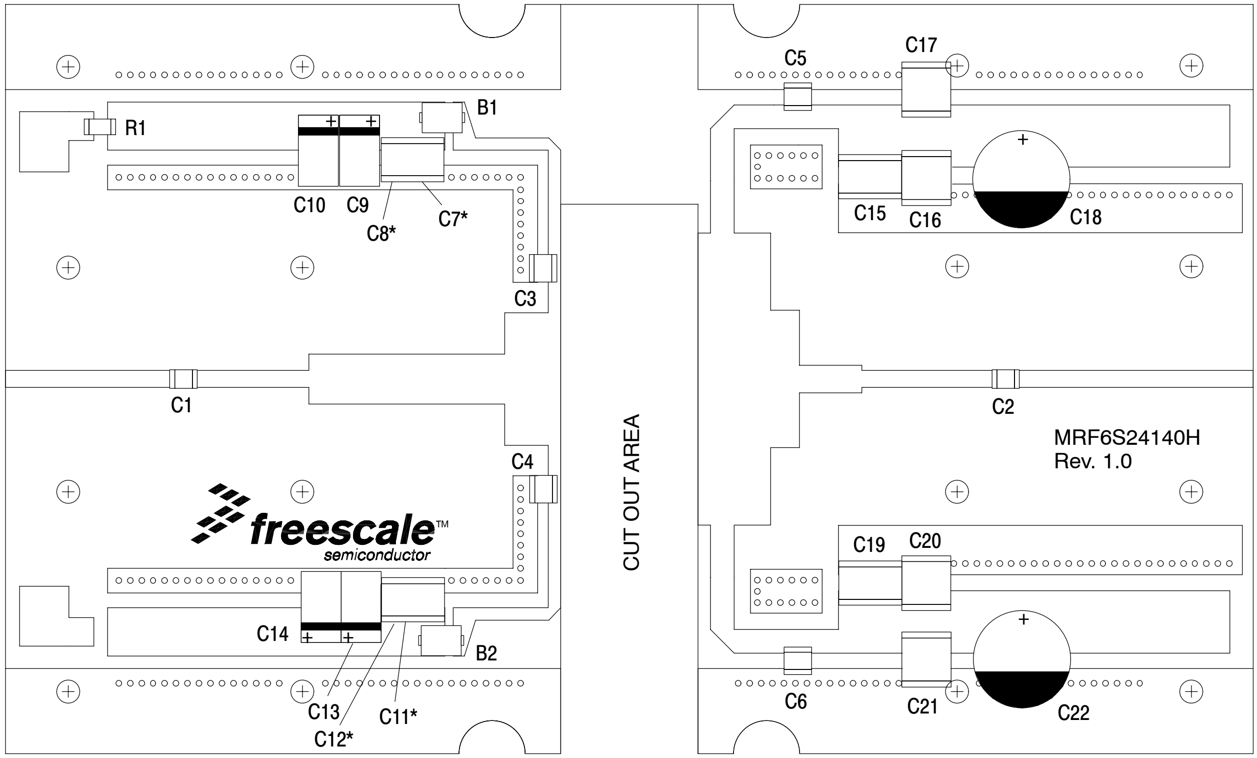


Z1	0.678″ x 0.068″ Microstrip	Z9	0.193″ x 1.170″ Microstrip
Z2	0.466″ x 0.068″ Microstrip	Z10	0.115″ x 0.550″ Microstrip
Z3	0.785″ x 0.200″ Microstrip	Z11	0.250″ x 0.110″ Microstrip
Z4	0.200″ x 0.530″ Microstrip	Z12	0.538″ x 0.068″ Microstrip
Z5	0.025″ x 0.530″ Microstrip	Z13	0.957″ x 0.068″ Microstrip
Z6, Z7	0.178″ x 0.050″ Microstrip	Z14, Z15	0.673″ x 0.095″ Microstrip
Z8	0.097″ x 1.170″ Microstrip	PCB	Arlon CuClad 250GX-0300-55-22, 0.030″, ε_r = 2.55

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

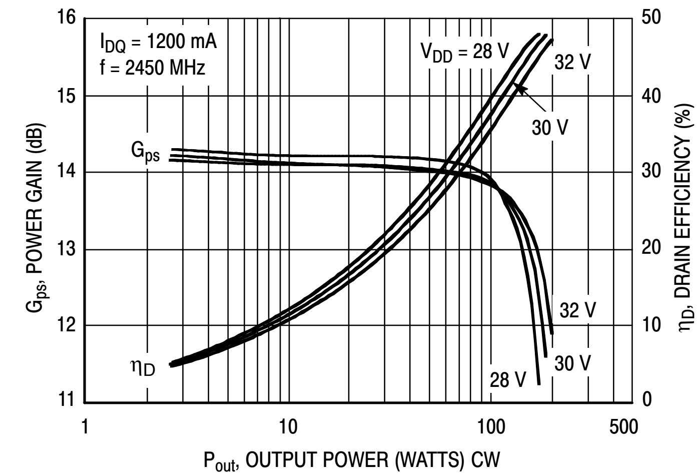


Figure 3. Power Gain and Drain Efficiency versus CW Output Power as a Function of V_{DD}

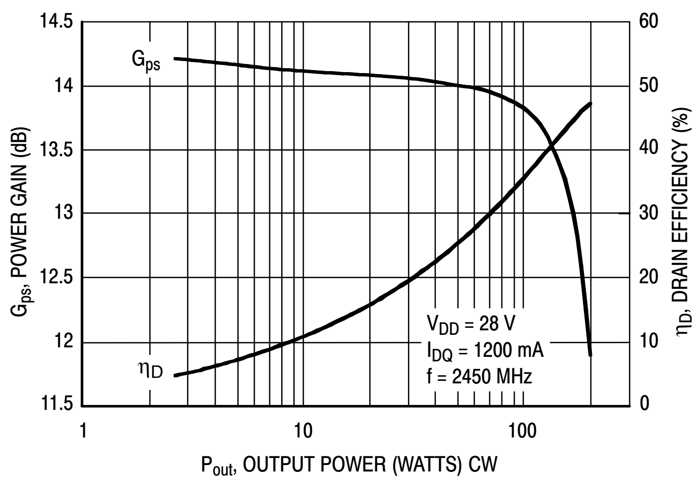


Figure 4. Power Gain and Drain Efficiency versus CW Output Power

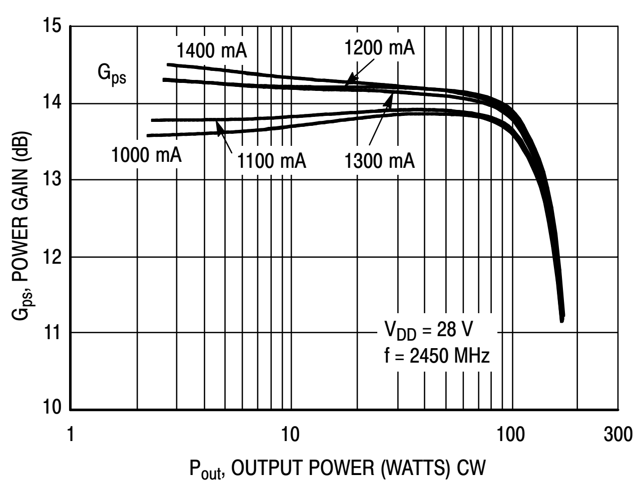
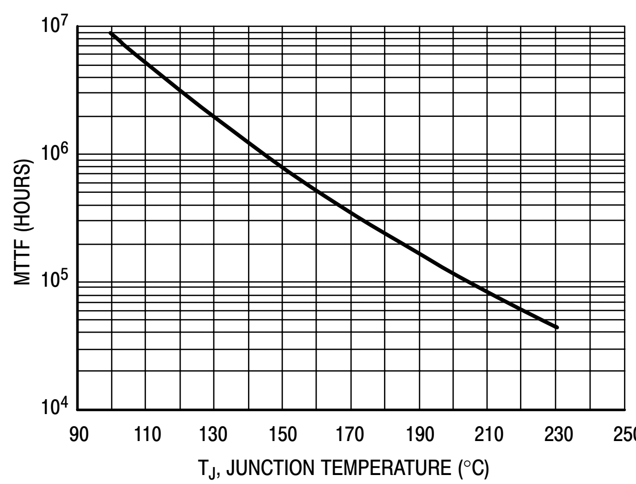


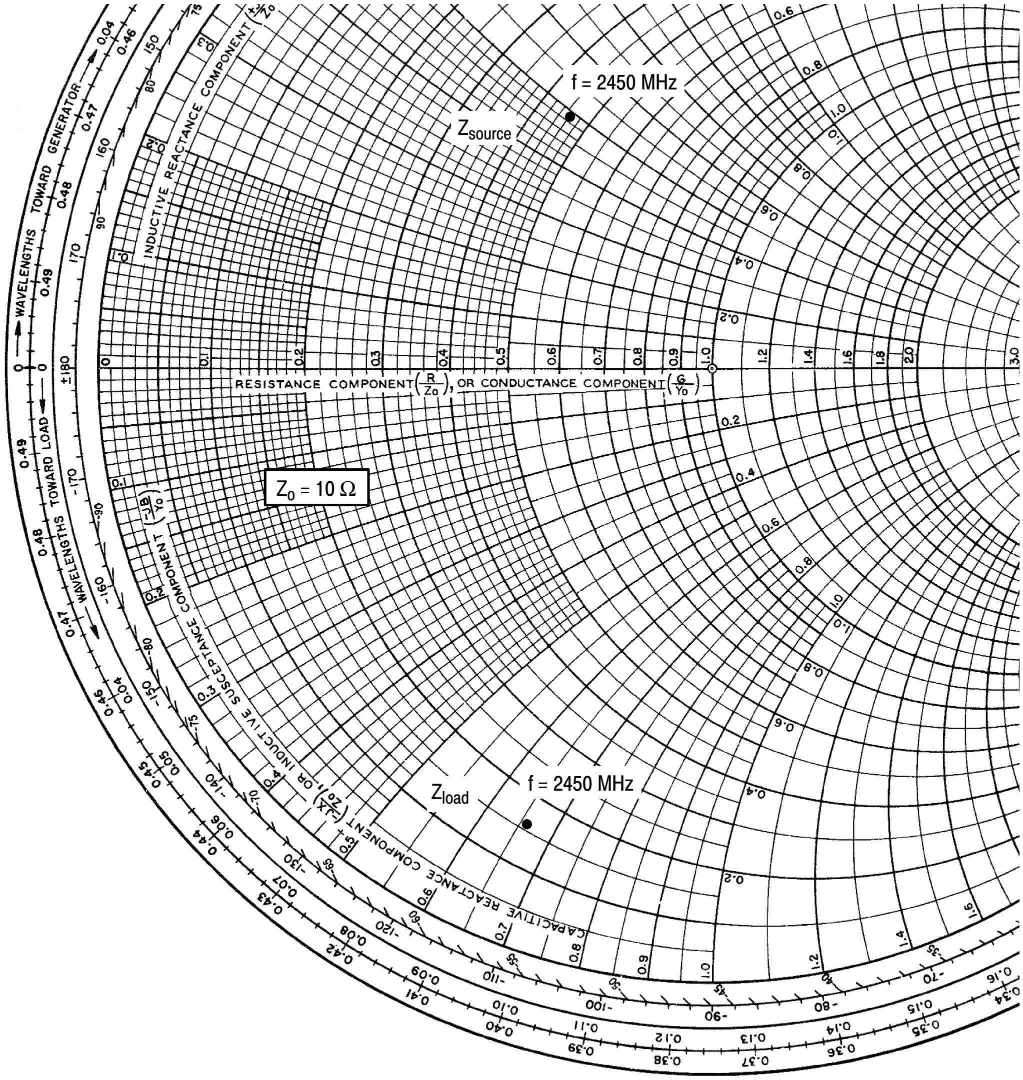
Figure 5. Power Gain and Drain Efficiency versus CW Output Power as a Function of Total I_{DQ}



This above graph displays calculated MTTF in hours when the device is operated at V_{DD} = 28 Vdc, P_{out} = 140 W CW, and η_D = 45%.

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

Figure 6. MTTF versus Junction Temperature



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.

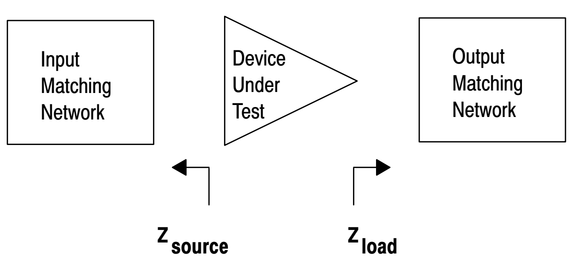
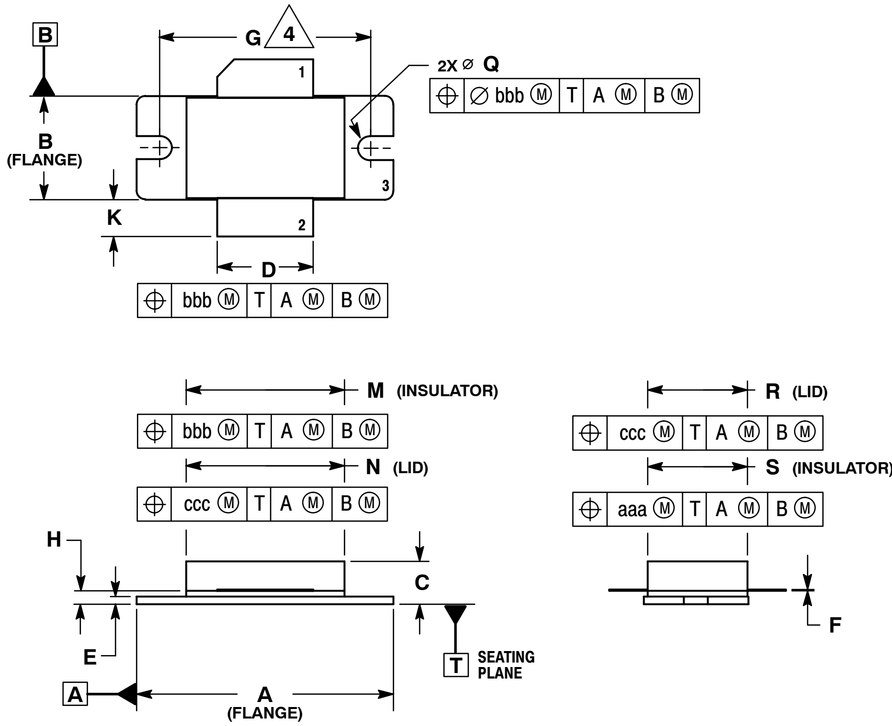


Figure 7. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS

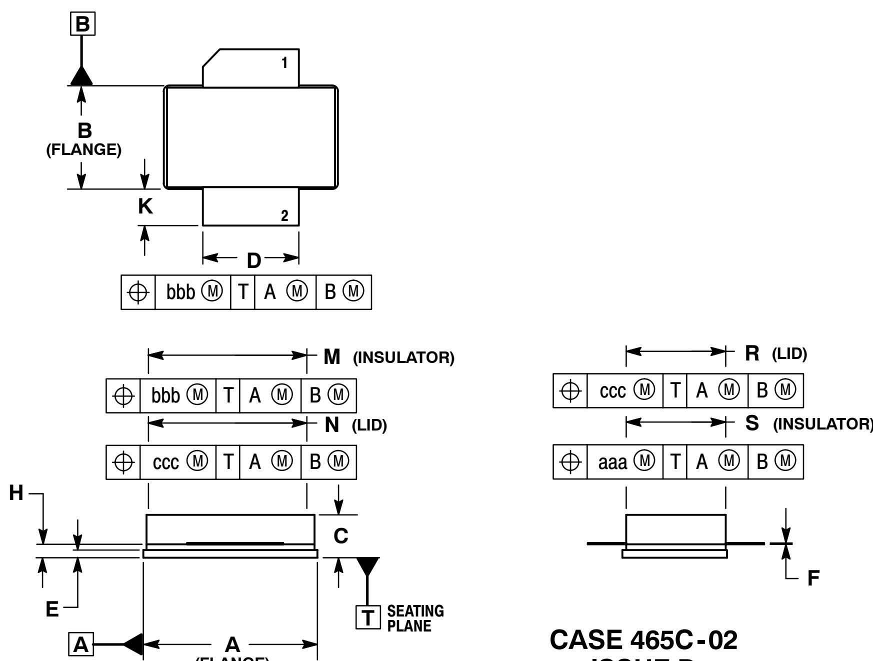


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
4. RECOMMENDED BOLT CENTER DIMENSION OF 1.16 (29.57) BASED ON M3 SCREW.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	1.335	1.345	33.91	34.16
B	0.535	0.545	13.6	13.8
C	0.147	0.200	3.73	5.08
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	0.175	0.205	4.44	5.21
M	0.872	0.888	22.15	22.55
N	0.871	0.889	19.30	22.60
Q	Ø.118	Ø.138	Ø3.00	Ø3.51
R	0.515	0.525	13.10	13.30
S	0.515	0.525	13.10	13.30
aaa	0.007 REF		0.178 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 465B-03
ISSUE D
NI-880
MRF6S24140HR3



NOTES:
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3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.905	0.915	22.99	23.24
B	0.535	0.545	13.60	13.80
C	0.147	0.200	3.73	5.08
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	0.872	0.888	22.15	22.55
N	0.871	0.889	19.30	22.60
R	0.515	0.525	13.10	13.30
S	0.515	0.525	13.10	13.30
aaa	0.007 REF		0.178 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 465C-02
ISSUE D
NI-880S
MRF6S24140HSR3

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	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

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