Freescale Semiconductor
Technical Data

Document Number: MRF9045
Rev. 11, 9/2008

RoHS

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

Designed for broadband commercial and industrial applications with frequencies up to 1000 MHz. The high gain and broadband performance of these devices make them ideal for large-signal, common-source amplifier applications in 28 volt base station equipment.

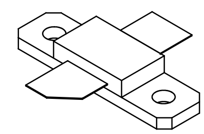
- Typical Two-Tone Performance at 945 MHz, 28 Volts
  Output Power — 45 Watts PEP
  Power Gain — 18.8 dB
  Efficiency — 42%
  IMD — -32 dBc
- Capable of Handling 10:1 VSWR, @ 28 Vdc, 945 MHz, 45 Watts CW Output Power

Features

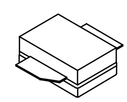
- Integrated ESD Protection
- Designed for Maximum Gain and Insertion Phase Flatness
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Low Gold Plating Thickness on Leads. L Suffix Indicates 40μ″ Nominal.
- RoHS Compliant
- In Tape and Reel. R1 Suffix = 500 Units per 32 mm, 13 inch Reel.

MRF9045LR1
MRF9045LSR1

945 MHz, 45 W, 28 V
LATERAL N-CHANNEL
BROADBAND
RF POWER MOSFETs



CASE 360B-05, STYLE 1
NI-360
MRF9045LR1



CASE 360C-05, STYLE 1
NI-360S
MRF9045LSR1

Table 1. Maximum Ratings

Rating		Symbol	Value	Unit
Drain-Source Voltage		V_{DSS}	-0.5, +65	Vdc
Gate-Source Voltage		V_{GS}	-0.5, +15	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	MRF9045LR1 MRF9045LSR1	P_D	125 0.71 175 1	W W/°C
Storage Temperature Range		T_{stg}	-65 to +150	°C
Case Operating Temperature		T_C	150	°C
Operating Junction Temperature		T_J	200	°C

Table 2. Thermal Characteristics

Characteristic		Symbol	Value	Unit
Thermal Resistance, Junction to Case	MRF9045LR1 MRF9045LSR1	$R_{\theta JC}$	1.4 1.0	°C/W

Table 3. ESD Protection Characteristics

Test Conditions	Class
Human Body Model	1 (Minimum)
Machine Model	M1 (Minimum)

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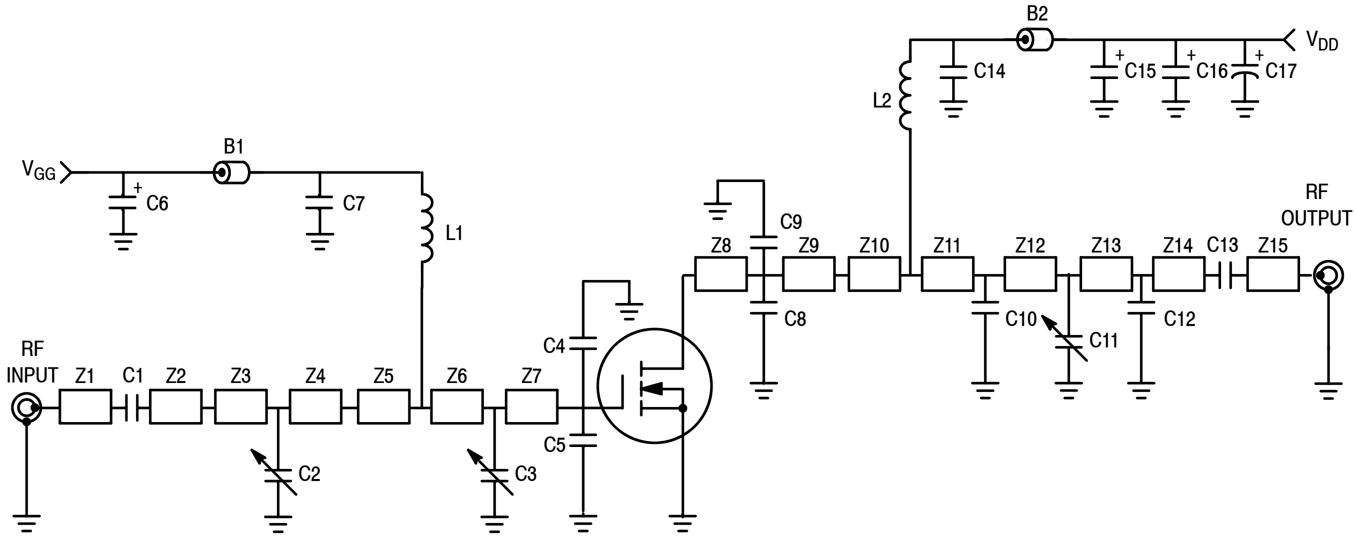
Table 4. Electrical Characteristics (T_C = 25°C unless otherwise noted)

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 = 150 μAdc)	$V_{GS(th)}$	2	3	4	Vdc
Gate Quiescent Voltage (V_{DS} = 28 Vdc, I_D = 350 mAdc)	$V_{GS(Q)}$	—	3.7	—	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 1 Adc)	$V_{DS(on)}$	—	0.19	0.4	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 3 Adc)	g_{fs}	—	4	—	S
Dynamic Characteristics					
Input Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{iss}	—	69	—	pF
Output Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	37	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.5	—	pF

(continued)

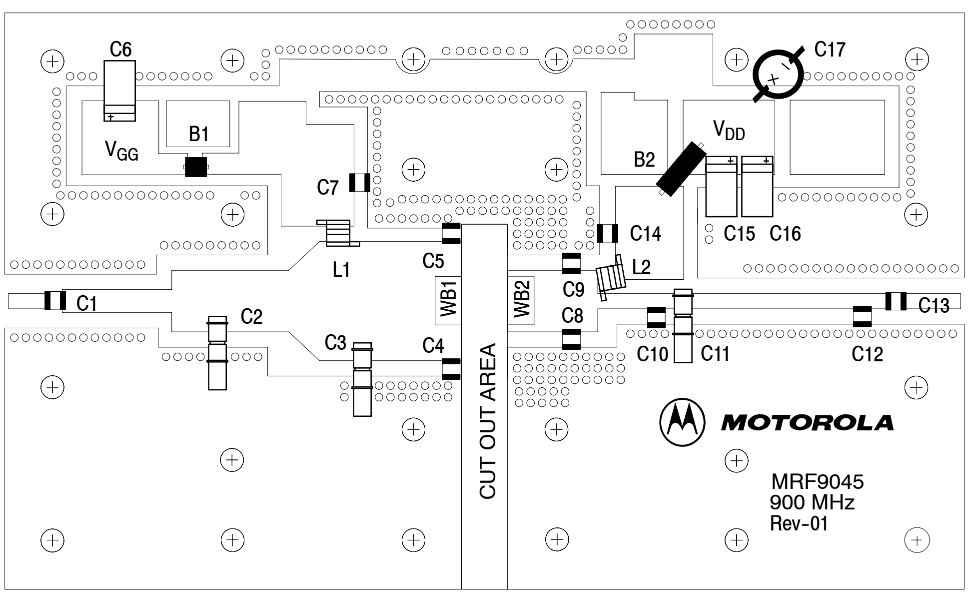
Table 4. Electrical Characteristics (T_C = 25°C unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Functional Tests (In Freescale Test Fixture, 50 ohm system)					
Two-Tone Common-Source Amplifier Power Gain (V_{DD} = 28 Vdc, P_{out} = 45 W PEP, I_{DQ} = 350 mA, f1 = 945.0 MHz, f2 = 945.1 MHz)	G_{ps}	17	18.8	—	dB
Two-Tone Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 45 W PEP, I_{DQ} = 350 mA, f1 = 945.0 MHz, f2 = 945.1 MHz)	η	38	42	—	%
3rd Order Intermodulation Distortion (V_{DD} = 28 Vdc, P_{out} = 45 W PEP, I_{DQ} = 350 mA, f1 = 945.0 MHz, f2 = 945.1 MHz)	IMD	—	-32	-28	dBc
Input Return Loss (V_{DD} = 28 Vdc, P_{out} = 45 W PEP, I_{DQ} = 350 mA, f1 = 945.0 MHz, f2 = 945.1 MHz)	IRL	—	-14	-9	dB
Two-Tone Common-Source Amplifier Power Gain (V_{DD} = 28 Vdc, P_{out} = 45 W PEP, I_{DQ} = 350 mA, f1 = 930.0 MHz, f2 = 930.1 MHz and f1 = 960.0 MHz, f2 = 960.1 MHz)	G_{ps}	—	18.5	—	dB
Two-Tone Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 45 W PEP, I_{DQ} = 350 mA, f1 = 930.0 MHz, f2 = 930.1 MHz and f1 = 960.0 MHz, f2 = 960.1 MHz)	η	—	41	—	%
3rd Order Intermodulation Distortion (V_{DD} = 28 Vdc, P_{out} = 45 W PEP, I_{DQ} = 350 mA, f1 = 930.0 MHz, f2 = 930.1 MHz and f1 = 960.0 MHz, f2 = 960.1 MHz)	IMD	—	-33	—	dBc
Input Return Loss (V_{DD} = 28 Vdc, P_{out} = 45 W PEP, I_{DQ} = 350 mA, f1 = 930.0 MHz, f2 = 930.1 MHz and f1 = 960.0 MHz, f2 = 960.1 MHz)	IRL	—	13	—	dB
Power Output, 1 dB Compression Point (V_{DD} = 28 Vdc, P_{out} = 45 W CW, I_{DQ} = 350 mA, f1 = 945.0 MHz)	P_{1dB}	—	55	—	W
Common-Source Amplifier Power Gain (V_{DD} = 28 Vdc, P_{out} = 45 W CW, I_{DQ} = 350 mA, f1 = 945.0 MHz)	G_{ps}	—	18	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 45 W CW, I_{DQ} = 350 mA, f1 = 945.0 MHz)	η	—	60	—	%



B1	Short Ferrite Bead Surface Mount	Z4	0.360″ x 0.320″ Microstrip
B2	Long Ferrite Bead Surface Mount	Z5	0.240″ x 0.320″ x 0.620″, Taper
C1, C7, C13, C14	47 pF Chip Capacitors	Z6	0.140″ x 0.620″ Microstrip
C2, C3, C11	0.8-8.0 pF Gigatrim Variable Trim Capacitors	Z7	0.510″ x 0.620″ Microstrip
C4, C5, C8, C9	10 pF Chip Capacitors	Z8	0.330″ x 0.320″ Microstrip
C6, C15, C16	10 μF, 35 V Tantalum Surface Mount Chip Capacitors	Z9	0.140″ x 0.320″ Microstrip
C10	2.2 pF Chip Capacitor	Z10	0.070″ x 0.080″ Microstrip
C12	0.7 pF Chip Capacitor - MRF9045LS	Z11	0.240″ x 0.080″ Microstrip
	1.3 pF Chip Capacitor - MRF9045	Z12	0.140″ x 0.080″ Microstrip
C17	220 μF, 50 V Electrolytic Capacitor	Z13	0.930″ x 0.080″ Microstrip
L1, L2	12.5 nH Surface Mount Inductors, Coilcraft	Z14	0.180″ x 0.080″ Microstrip
Z1	0.260″ x 0.080″ Microstrip	Z15	0.350″ x 0.080″ Microstrip
Z2	0.610″ x 0.120″ Microstrip	PCB	Arlon GX-0300-55-22, 0.03″, ε_r = 2.55
Z3	0.260″ x 0.320″ Microstrip		

Figure 1. 930 - 960 MHz Broadband Test Circuit Schematic



Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/-logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

Figure 2. 930 - 960 MHz Broadband Test Circuit Component Layout

TYPICAL CHARACTERISTICS

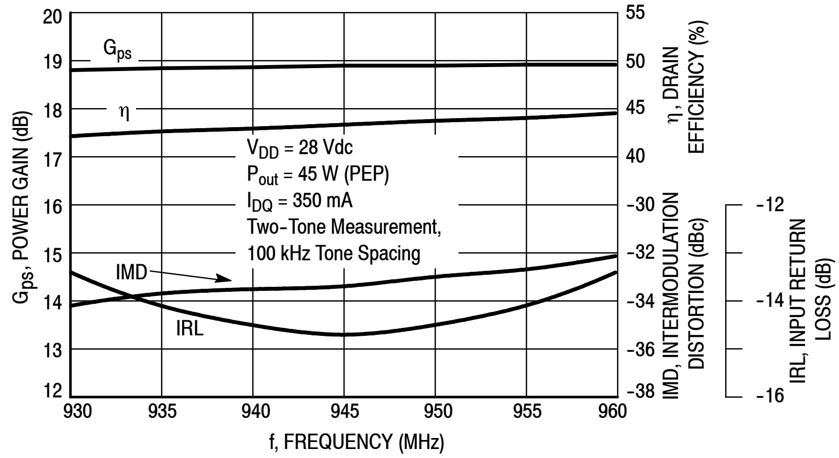


Figure 3. Class AB Broadband Circuit Performance

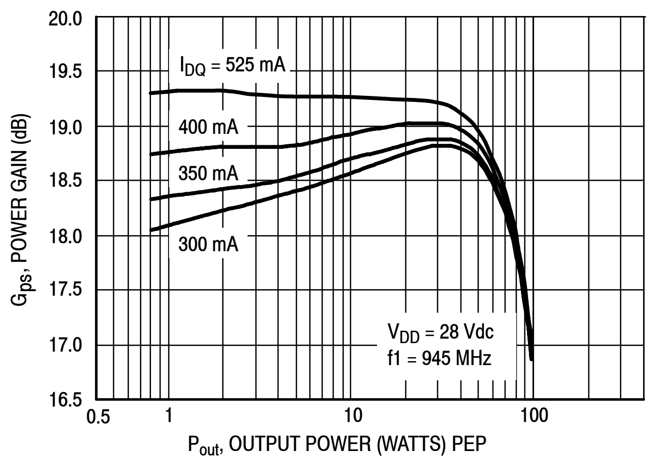


Figure 4. Power Gain versus Output Power

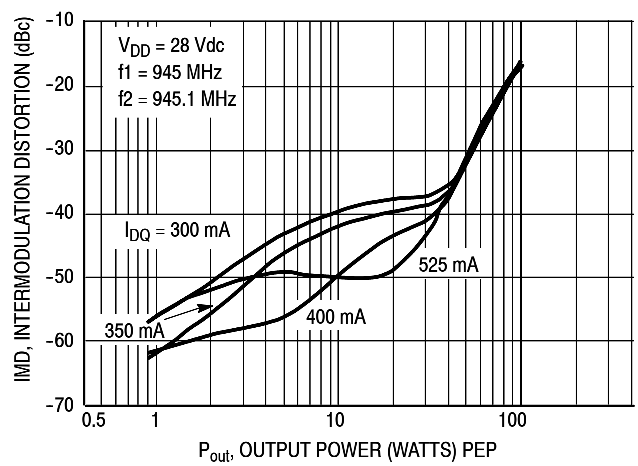


Figure 5. Intermodulation Distortion versus Output Power

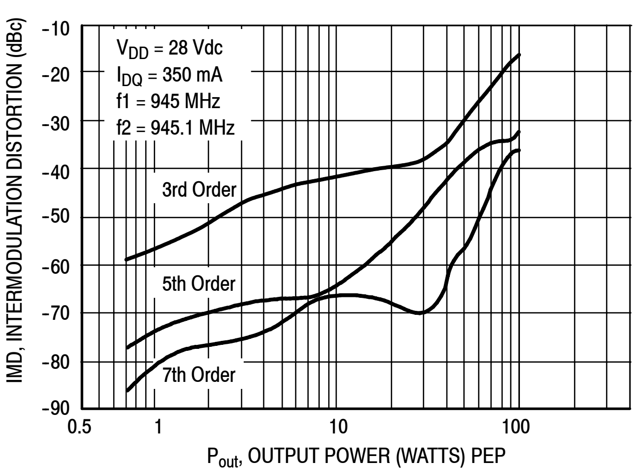


Figure 6. Intermodulation Distortion Products versus Output Power

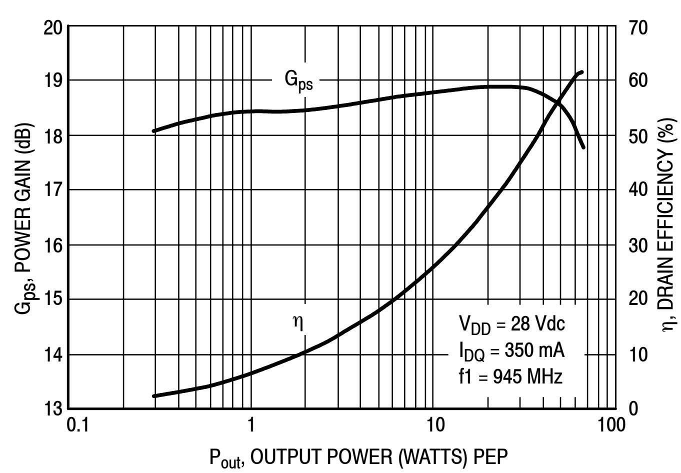
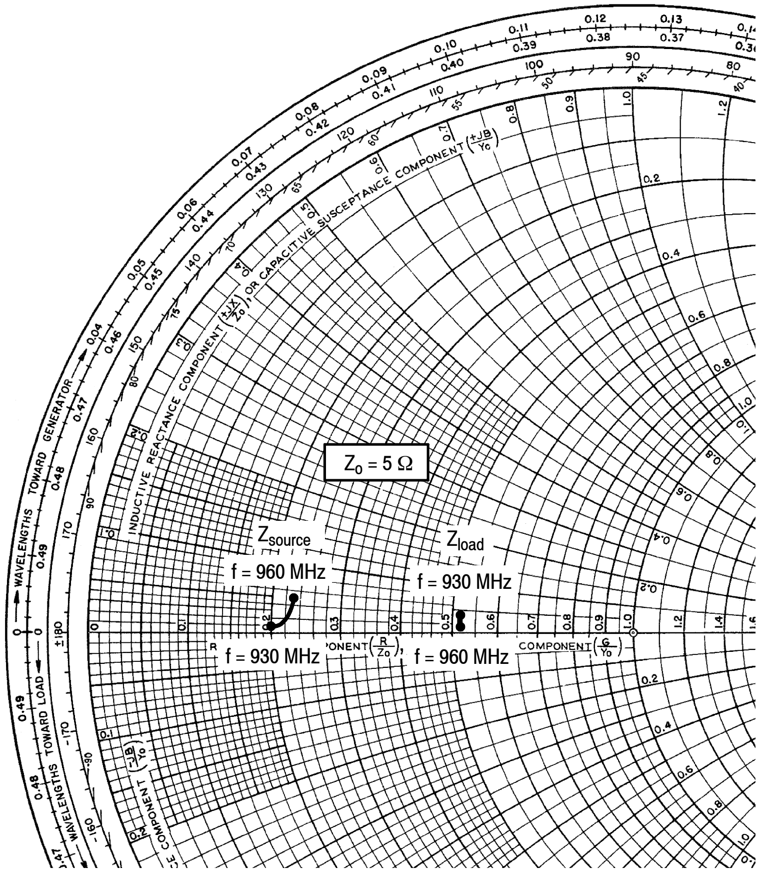


Figure 7. Power Gain, Efficiency versus Output Power



V_{DD} = 28 V, I_{DQ} = 350 mA, P_{out} = 45 W PEP

f MHz	Z_{source} Ω	Z_{load} Ω
930	1.02 + j0.06	2.6 + j0.20
945	1.10 + j0.11	2.6 + j0.16
960	1.15 + j0.25	2.6 + j0.10

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

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

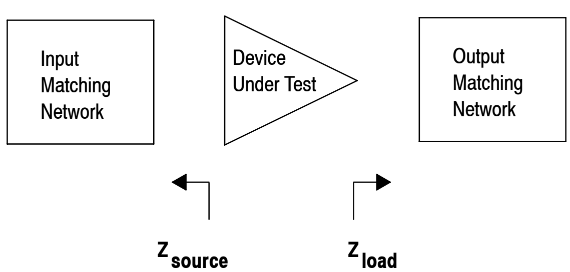
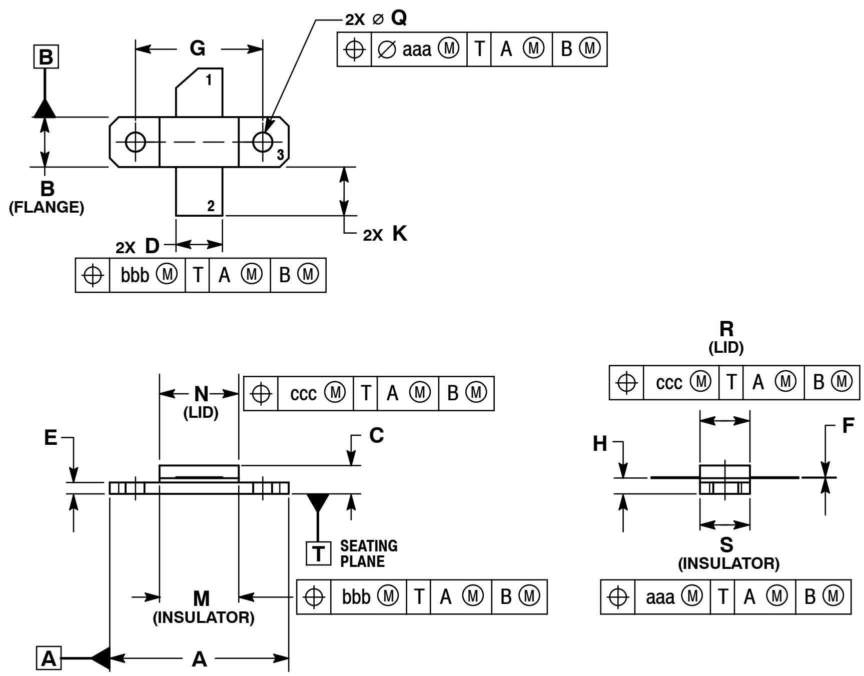


Figure 8. Series Equivalent Source and Load Impedance

PACKAGE DIMENSIONS

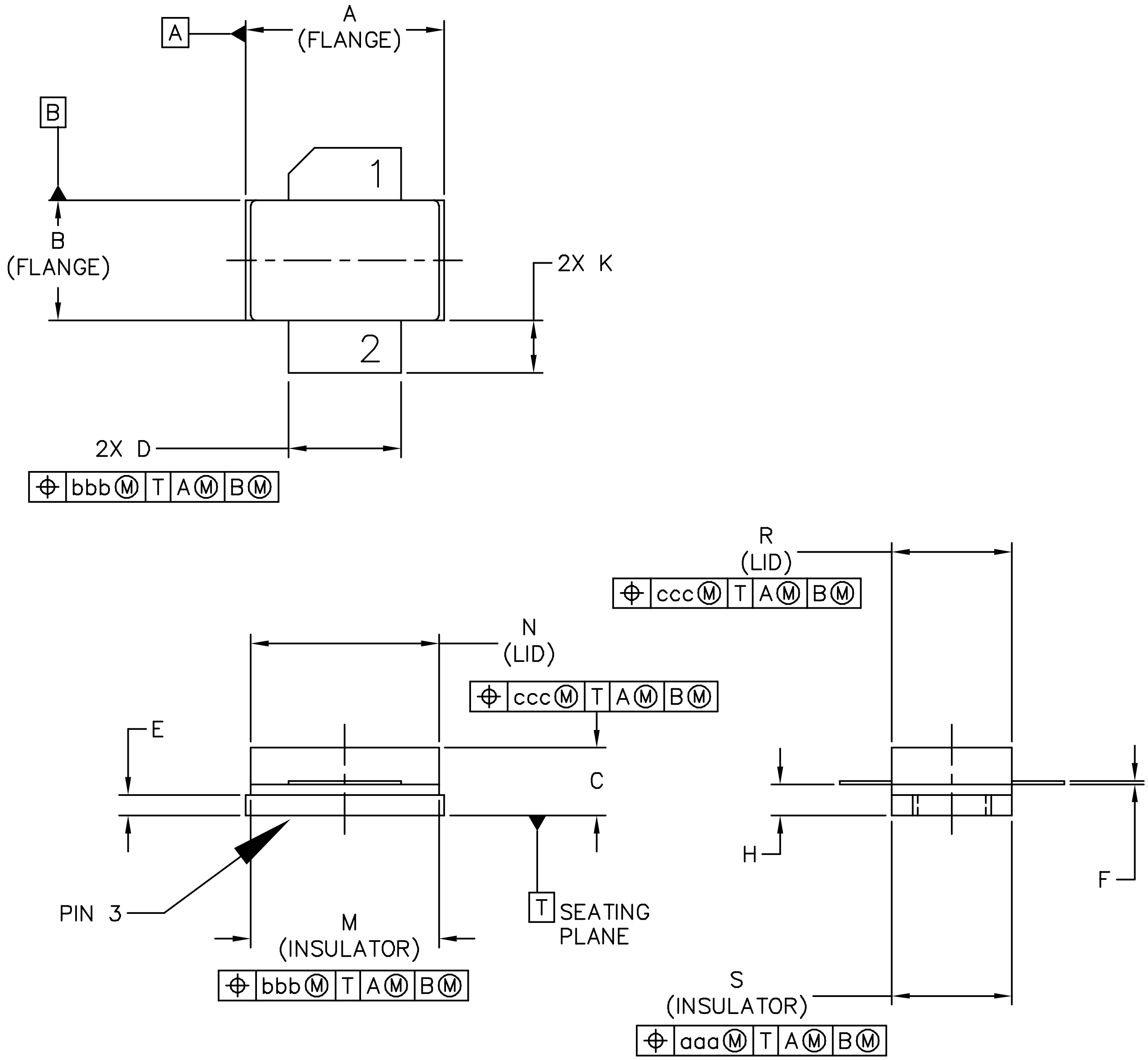


NOTES:
1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.795	0.805	20.19	20.45
B	0.225	0.235	5.72	5.97
C	0.125	0.175	3.18	4.45
D	0.210	0.220	5.33	5.59
E	0.055	0.065	1.40	1.65
F	0.004	0.006	0.10	0.15
G	0.562 BSC		14.28 BSC	
H	0.077	0.087	1.96	2.21
K	0.220	0.250	5.59	6.35
M	0.355	0.365	9.02	9.27
N	0.357	0.363	9.07	9.22
Q	0.125	0.135	3.18	3.43
R	0.227	0.233	5.77	5.92
S	0.225	0.235	5.72	5.97
aaa	0.005 REF		0.13 REF	
bbb	0.010 REF		0.25 REF	
ccc	0.015 REF		0.38 REF	

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

CASE 360B-05
ISSUE G
NI-360
MRF9045LR1



	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE	
TITLE: NI–360S SURFACE MOUNT	DOCUMENT NO: 98ASB14516C		REV: F
	CASE NUMBER: 360C–05		10 MAR 2006
	STANDARD: NON–JEDEC		

NOTES:

1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH
3. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM PACKAGE BODY

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

DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX	DIM	INCH MIN	INCH MAX	MILLIMETER MIN	MILLIMETER MAX
A	.375	.385	9.53	9.78	N	.357	.363	9.07	9.22
B	.225	.235	5.72	5.97	R	.227	.233	5.77	5.92
C	.105	.155	2.67	3.94	S	.225	.235	5.72	5.97
D	.210	.220	5.33	5.59					
E	.035	.045	0.89	1.14	aaa	.005		0.13	
F	.004	.006	0.1	0.15	bbb	.010		0.25	
H	.057	.067	1.45	1.7	ccc	.015		0.38	
K	.085	.115	2.16	2.92					
M	.355	.365	9.02	9.27					

MECHANICAL OUTLINE PRINT VERSION NOT TO SCALE

TITLE:
NI–360S
SURFACE MOUNT

DOCUMENT NO: 98ASB14516C REV: F
CASE NUMBER: 360C–05 10 MAR 2006
STANDARD: NON–JEDEC

PRODUCT DOCUMENTATION

Refer to the following documents to aid your design process.

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
11	Sept. 2008	• Replaced Case Outline 360C-05, Issue E with Issue F, p. 8-9. • Added Product Documentation and Revision History, p. 10

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Japan:
Freescale Semiconductor Japan Ltd.
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.
Exchange Building 23F
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Chaoyang District
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