MOTOROLA **Freescale Semiconductor, Inc.**
SEMICONDUCTOR TECHNICAL DATA

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by MRF284/D

The RF Sub-Micron MOSFET Line

RF Power Field Effect Transistors

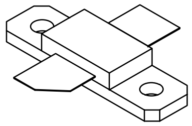
N-Channel Enhancement-Mode Lateral MOSFETs

MRF284LR1
MRF284LSR1

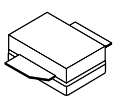
2000 MHz, 30 W, 26 V
LATERAL N-CHANNEL
BROADBAND
RF POWER MOSFETs

Designed for PCN and PCS base station applications with frequencies from 1000 to 2600 MHz. Suitable for FM, TDMA, CDMA, and multicarrier amplifier applications. To be used in Class A and Class AB for PCN-PCS/cellular radio and wireless local loop.

- Specified Two-Tone Performance @ 2000 MHz, 26 Volts
  Output Power = 30 Watts PEP
  Power Gain = 9 dB
  Efficiency = 30%
  Intermodulation Distortion = -29 dBc
- Typical Single-Tone Performance at 2000 MHz, 26 Volts
  Output Power = 30 Watts CW
  Power Gain = 9.5 dB
  Efficiency = 45%
- Capable of Handling 10:1 VSWR, @ 26 Vdc, 2000 MHz, 30 Watts CW Output Power
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- In Tape and Reel. R1 Suffix = 500 Units per 32 mm, 13 inch Reel.
- Low Gold Plating Thickness on Leads. L Suffix Indicates 40μ″ Nominal.



CASE 360B-05, STYLE 1
NI-360
MRF284LR1



CASE 360C-05, STYLE 1
NI-360S
MRF284LSR1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	87.5 0.5	Watts W/°C
Storage Temperature Range	T_{stg}	- 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 μAdc)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 20 Vdc, V_{GS} = 0)	I_{DSS}	—	—	1.0	μAdc
Gate-Source Leakage Current (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSS}	—	—	10	μAdc

NOTE - **CAUTION** - MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

REV 14

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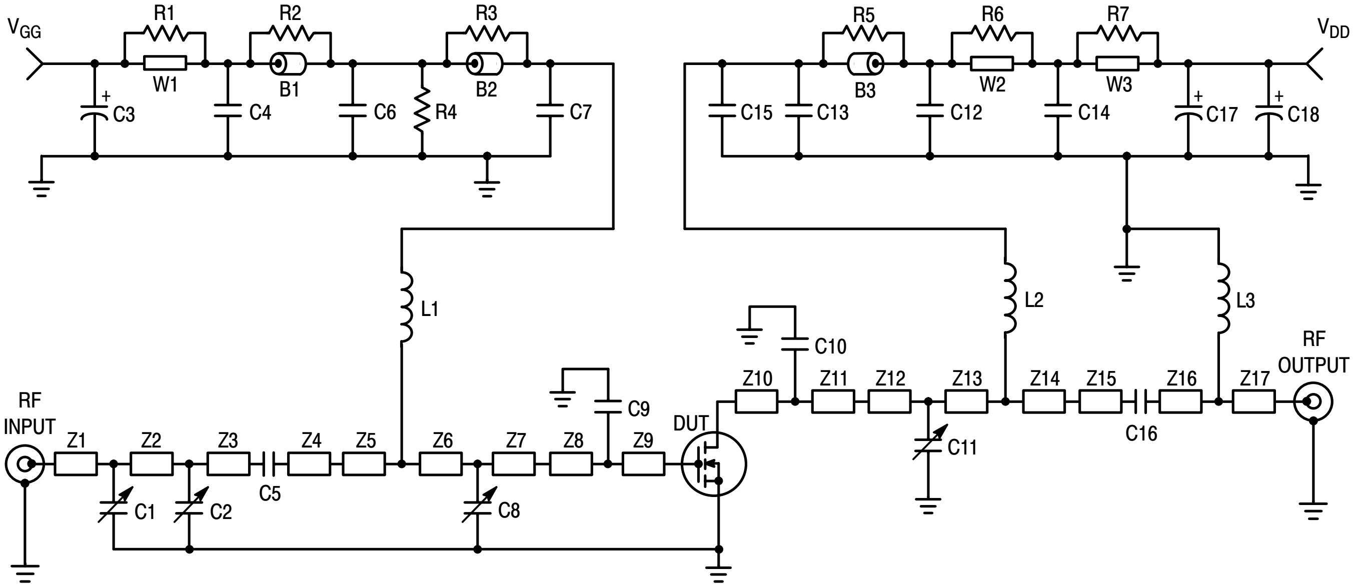
ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 150 μAdc)	$V_{GS(th)}$	2.0	3.0	4.0	Vdc
Gate Quiescent Voltage (V_{DS} = 26 Vdc, I_D = 200 mAdc)	$V_{GS(q)}$	3.0	4.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 1.0 Adc)	$V_{DS(on)}$	—	0.3	0.6	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 1.0 Adc)	g_{fs}	—	1.5	—	S
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 26 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	43	—	pF
Output Capacitance (V_{DS} = 26 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	23	—	pF
Reverse Transfer Capacitance (V_{DS} = 26 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	1.4	—	pF
FUNCTIONAL TESTS (in Motorola Test Fixture, 50 ohm system)					
Common-Source Power Gain (V_{DD} = 26 Vdc, P_{out} = 30 W, I_{DQ} = 200 mA, f1 = 2000.0 MHz, f2 = 2000.1 MHz)	G_{ps}	9	10.5	—	dB
Drain Efficiency (V_{DD} = 26 Vdc, P_{out} = 30 W, I_{DQ} = 200 mA, f1 = 2000.0 MHz, f2 = 2000.1 MHz)	η	30	35	—	%
Intermodulation Distortion (V_{DD} = 26 Vdc, P_{out} = 30 W, I_{DQ} = 200 mA, f1 = 2000.0 MHz, f2 = 2000.1 MHz)	IMD	—	-32	-29	dBc
Input Return Loss (V_{DD} = 26 Vdc, P_{out} = 30 W, I_{DQ} = 200 mA, f1 = 2000.0 MHz, f2 = 2000.1 MHz)	IRL	—	-15	-9	dB
Common-Source Amplifier Power Gain (V_{DD} = 26 Vdc, P_{out} = 30 W PEP, I_{DQ} = 200 mA, f1 = 1930.0 MHz, f2 = 1930.1 MHz)	G_{ps}	9	10.4	—	dB
Drain Efficiency (V_{DD} = 26 Vdc, P_{out} = 30 W PEP, I_{DQ} = 200 mA, f1 = 1930.0 MHz, f2 = 1930.1 MHz)	η	—	35	—	%
Intermodulation Distortion (V_{DD} = 26 Vdc, P_{out} = 30 W PEP, I_{DQ} = 200 mA, f1 = 1930.0 MHz, f2 = 1930.1 MHz)	IMD	—	-34	—	dBc
Input Return Loss (V_{DD} = 26 Vdc, P_{out} = 30 W PEP, I_{DQ} = 200 mA, f1 = 1930.0 MHz, f2 = 1930.1 MHz)	IRL	—	-15	-9	dB
Common-Source Amplifier Power Gain (V_{DD} = 26 Vdc, P_{out} = 30 W CW, I_{DQ} = 200 mA, f1 = 2000.0 MHz)	G_{ps}	8.5	9.5	—	dB
Drain Efficiency (V_{DD} = 26 Vdc, P_{out} = 30 W CW, I_{DQ} = 200 mA, f1 = 2000.0 MHz)	η	35	45	—	%
Output Mismatch Stress (V_{DD} = 26 Vdc, P_{out} = 30 W CW, I_{DQ} = 200 mA, f1 = 2000.0 MHz, VSWR = 10:1, at All Phase Angles)	Ψ	No Degradation In Output Power			



Z1	0.530″ x 0.080″ Microstrip
Z2	0.255″ x 0.080″ Microstrip
Z3	0.600″ x 0.080″ Microstrip
Z4	0.525″ x 0.080″ Microstrip
Z5	0.015″ x 0.325″ Microstrip
Z6	0.085″ x 0.325″ Microstrip
Z7	0.165″ x 0.325″ Microstrip
Z8	0.110″ x 0.515″ Microstrip
Z9	0.095″ x 0.515″ Microstrip
Z10	0.050″ x 0.515″ Microstrip
Z11	0.155″ x 0.515″ Microstrip
Z12	0.120″ x 0.325″ Microstrip
Z13	0.150″ x 0.325″ Microstrip
Z14	0.010″ x 0.325″ Microstrip
Z15	0.505″ x 0.080″ Microstrip
Z16	0.865″ x 0.080″ Microstrip
Z17	0.525″ x 0.080″ Microstrip
PCB	Arlon GX0300-55-22, 0.030″, ε_r = 2.55

Figure 1. 1.93-2.0 GHz Broadband Test Circuit Schematic

Table 1. 1.93 - 2.0 GHz Broadband Test Circuit Component Designations and Values

Designators	Description
B1 - B3	Ferrite Beads, Round, Ferroxcube #56-590-65-3B
C1, C2, C8	0.8-8.0 pF Gigatrim Variable Capacitors, Johanson #27291SL
C3, C17	22 μF, 35 V Tantalum Surface Mount Chip Capacitors, Kemet #T491X226K035AS4394
C4, C14	0.1 μF Chip Capacitors, Kemet #CDR33BX104AKWS
C5	220 pF Chip Capacitor, B Case, ATC #100B221KP500X
C6, C12	1000 pF Chip Capacitors, B Case, ATC #100B102JCA50X
C7, C13	5.1 pF Chip Capacitors, B Case, ATC #100B5R1CCA500X
C9	1.2 pF Chip Capacitor, B Case, ATC #100B1R2CCA500X
C10	2.7 pF Chip Capacitor, B Case, ATC #100B2R7CCA500X
C11	0.6-4.5 pF Gigatrim Variable Capacitors, Johanson #27271SL
C15, C16	200 pF Chip Capacitors, B Case, ATC #100B201KP500X
C18	10 μF, 35 V Tantalum Surface Mount Chip Capacitor, Kemet #T495X106K035AS4394
L1, L2	4 Turns, #24 AWG, 0.120″ OD, 0.140″ Long, (12.5 nH), Coilcraft #A04T-5
L3	2 Turns, #24 AWG, 0.120″ OD, 0.140″ Long, (5.0 nH), Coilcraft #A02T-5
R1, R2, R3, R5, R6, R7	12 Ω, 1/4 W Chip Resistors, 0.08″ x 0.13″, Garrett Instruments #RM73B2B120JT
R4	560 kΩ, 1/4 W Chip Resistor, 0.08″ x 0.13″
W1, W2, W3	Solid Copper Buss Wire, 16 AWG
WS1, WS2	Beryllium Copper Wear Blocks 0.005″ x 0.250″ x 0.250″

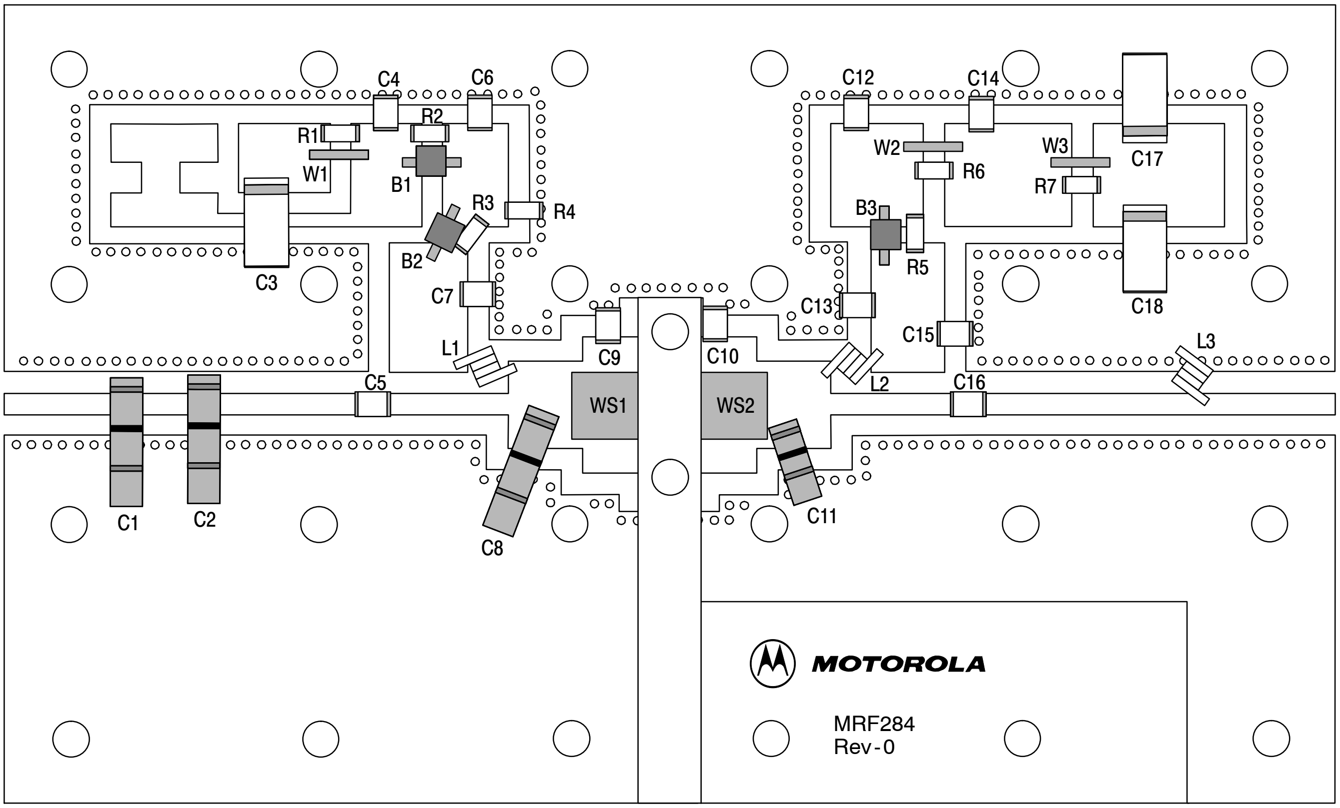
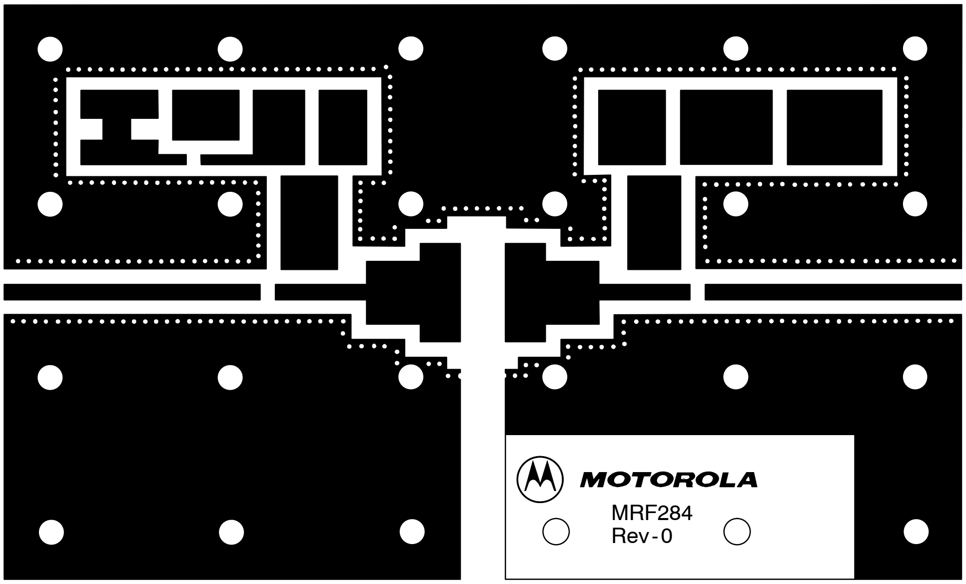
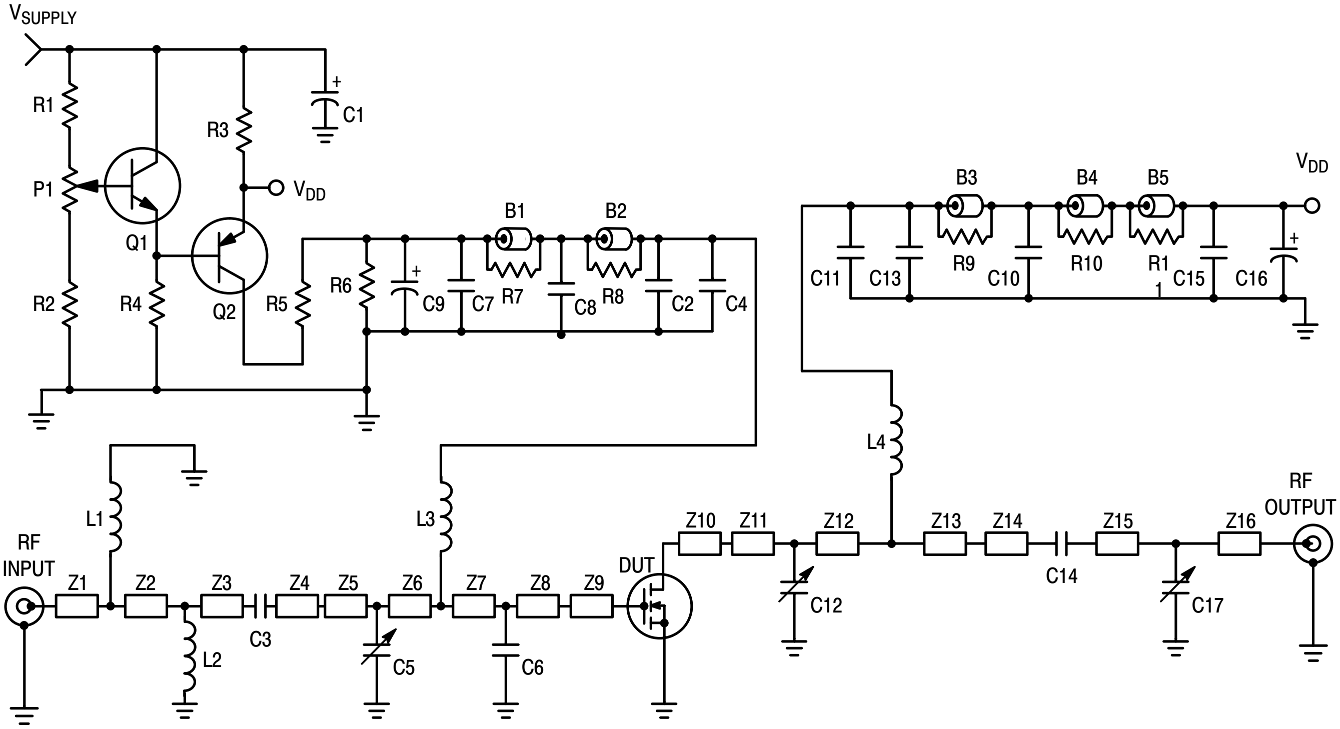


Figure 2. 1.93-2.0 GHz Broadband Test Circuit Component Layout



(Scale 1:1)

Figure 3. MRF284 Test Circuit Photomaster
(Reduced 18% in printed data book, DL110/D)



Z1	0.363″ x 0.080″ Microstrip
Z2	0.080″ x 0.080″ Microstrip
Z3	0.916″ x 0.080″ Microstrip
Z4	0.517″ x 0.080″ Microstrip
Z5	0.050″ x 0.325″ Microstrip
Z6	0.050″ x 0.325″ Microstrip
Z7	0.071″ x 0.325″ Microstrip
Z8	0.125″ x 0.325″ Microstrip
Z9	0.210″ x 0.515″ Microstrip
Z10	0.210″ x 0.515″ Microstrip
Z11	0.235″ x 0.325″ Microstrip
Z12	0.02″ x 0.325″ Microstrip
Z13	0.02″ x 0.325″ Microstrip
Z14	0.510″ x 0.080″ Microstrip
Z15	0.990″ x 0.080″ Microstrip
Z16	0.390″ x 0.080″ Microstrip
PCB	Arlon GX0300-55-22, 0.030″, ε_r = 2.55

Figure 4. 2.0 GHz Class A Test Circuit Schematic

Table 2. 2.0 GHz Class A Test Circuit Component Designations and Values

Designators	Description
B1 - B5	Ferrite Beads, Round, Ferroxcube # 56-590-65-3B
C1, C9, C16	100 μF, 50 V Electrolytic Capacitors, Mallory #SME50VB101M12X25L
C2, C13	51 pF Chip Capacitors, B Case, ATC #100B510JCA500x
C3, C14	10 pF Chip Capacitors, B Case, ATC #100B100JCA500X
C4, C11	12 pF Chip Capacitors, B Case, ATC #100B120JCA500X
C5	0.8 - 8.0 pF Variable Capacitor, Johansen Gigatrim #27291SL
C6	4.7 pF Chip Capacitor, B Case, ATC #100B4R7CCA500X
C7, C15	91 pF Chip Capacitors, B Case, ATC #100B910KP500X
C8	1000 pF Chip Capacitor, B Case, ATC #100B102JCA50X
C10	0.1 μF Chip Capacitor, Kemet #CDR33BX104AKWS
C12, C17	0.6 - 4.5 pF Variable Capacitors, Johansen Gigatrim #27271SL
L1	4 Turns, #27 AWG, 0.087″ OD, 0.050″ ID, 0.069″ Long, 10 nH
L2	5 Turns, #24 AWG, 0.083″ OD, 0.040″ ID, 0.128″ Long, 12.5 nH
L3, L4	9 Turns, #26 AWG, 0.080″ OD, 0.046″ ID, 0.170″ Long, 30.8 nH
P1	1000 Ω Potentiometer, 1/2 W, 10 Turns, Bourns
Q1	Transistor, NPN, Motorola P/N: MJD31, Case 369A-10
Q2	Transistor, PNP, Motorola P/N: MJD32, Case 369A-10
R1	360 Ω, Fixed Film Chip Resistor, 0.08″ x 0.13″, Garrett Instruments #RM73B2B361JT
R2	2 x 12 kΩ, Fixed Film Chip Resistor, 0.08″ x 0.13″, Garrett Instruments #RM73B2B122JT
R3	1 Ω, Wirewound, 5 W, 3% Resistor, Dale # RE60G1R00
R4	4 x 6.8 kΩ, Fixed Film Chip Resistor, 0.08″ x 0.13″, Garrett Instruments #RM73B2B682JT
R5	2 x 1500 Ω, Fixed Film Chip Resistor, 0.08″ x 0.13″, Garrett Instruments #RM73B2B152JT
R6	270 Ω, Fixed Film Chip Resistor, 0.08″ x 0.13″, Garrett Instruments #RM73B2B271JT
R7 - R11	12 Ω, Fixed Film Chip Resistors, 0.08″ x 0.13″, Garrett Instruments #RM73B2B120JT

TYPICAL CHARACTERISTICS

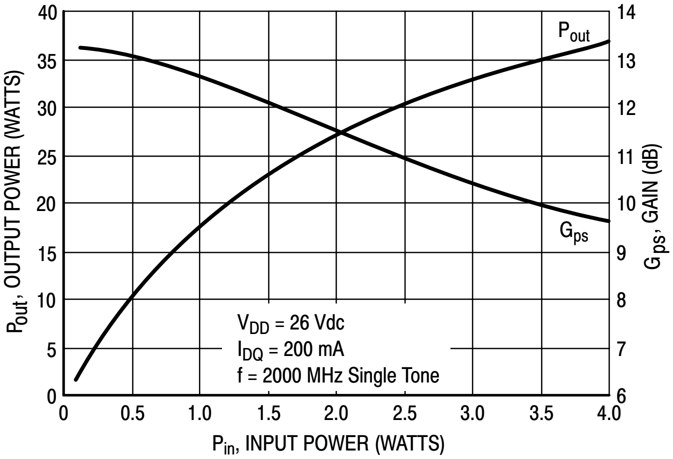


Figure 5. Output Power & Power Gain versus Input Power

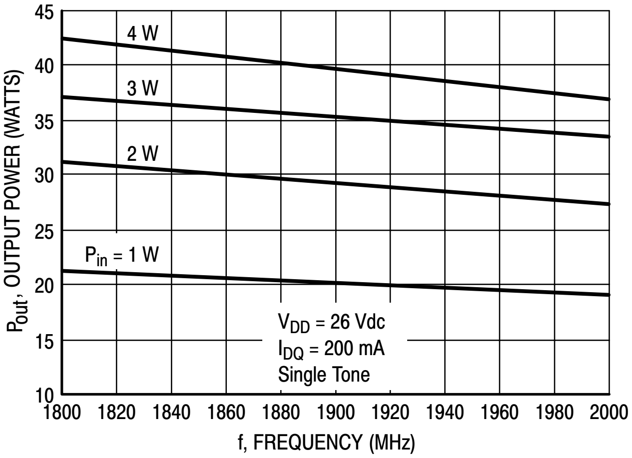


Figure 6. Output Power versus Frequency

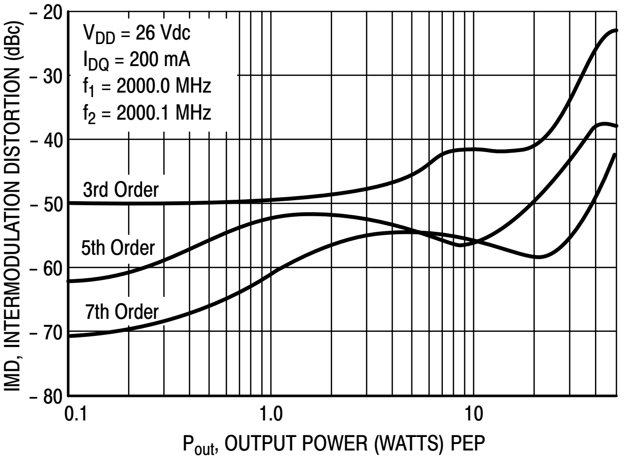


Figure 7. Intermodulation Distortion Products versus Output Power

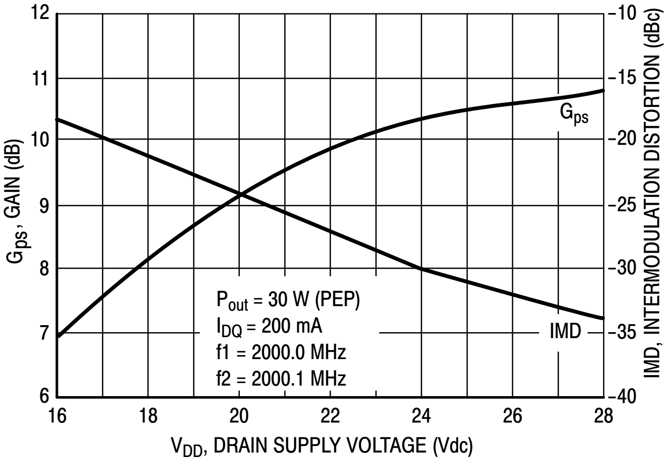


Figure 8. Power Gain and Intermodulation Distortion versus Supply Voltage

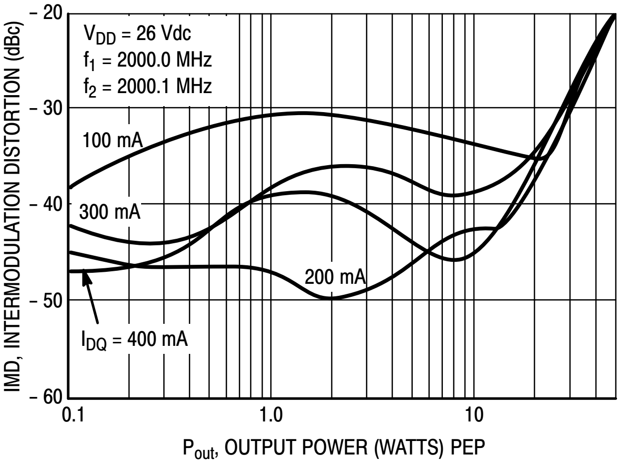


Figure 9. Intermodulation Distortion versus Output Power

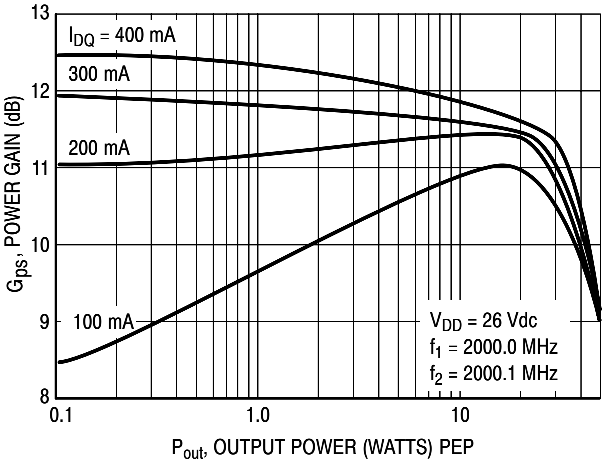


Figure 10. Power Gain versus Output Power

TYPICAL CHARACTERISTICS

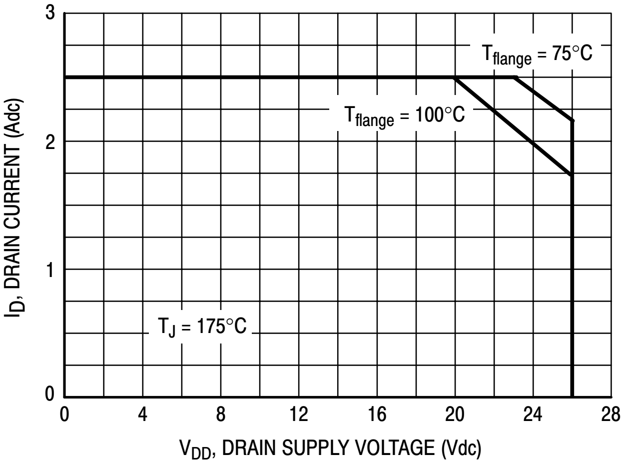


Figure 11. DC Safe Operating Area

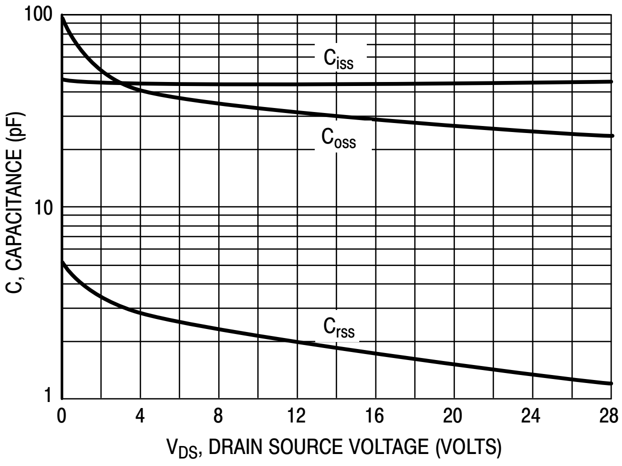


Figure 12. Capacitance versus Drain Source Voltage

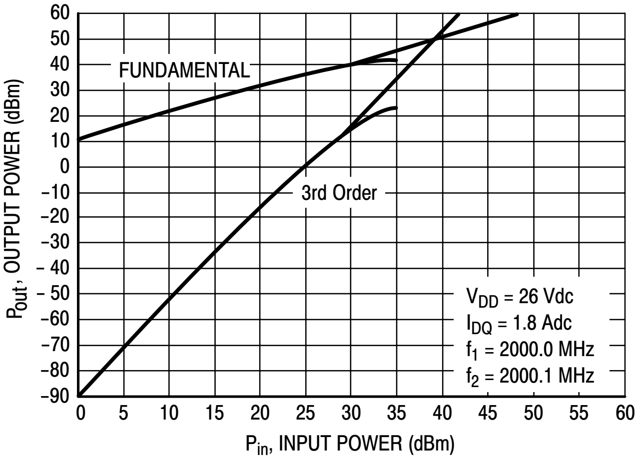


Figure 13. Class A Third Order Intercept Point

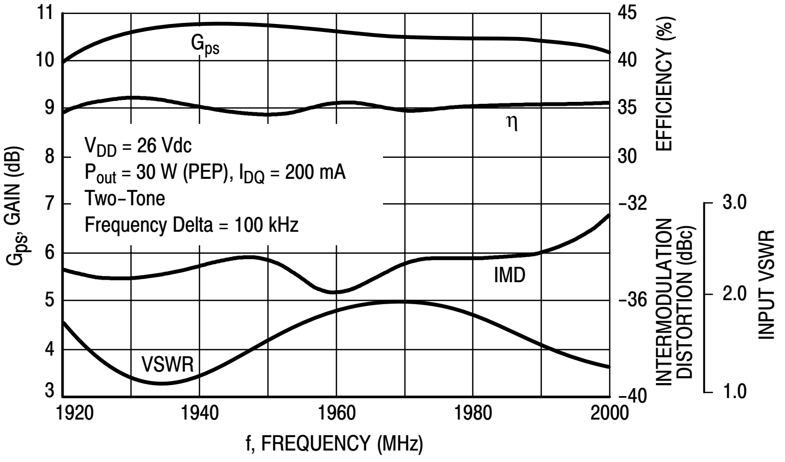
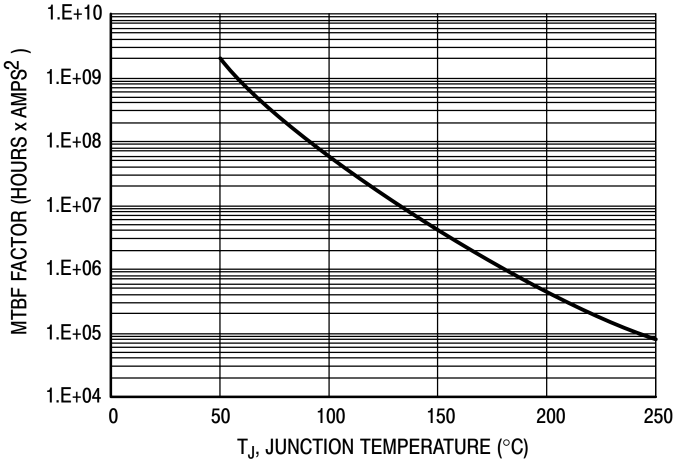
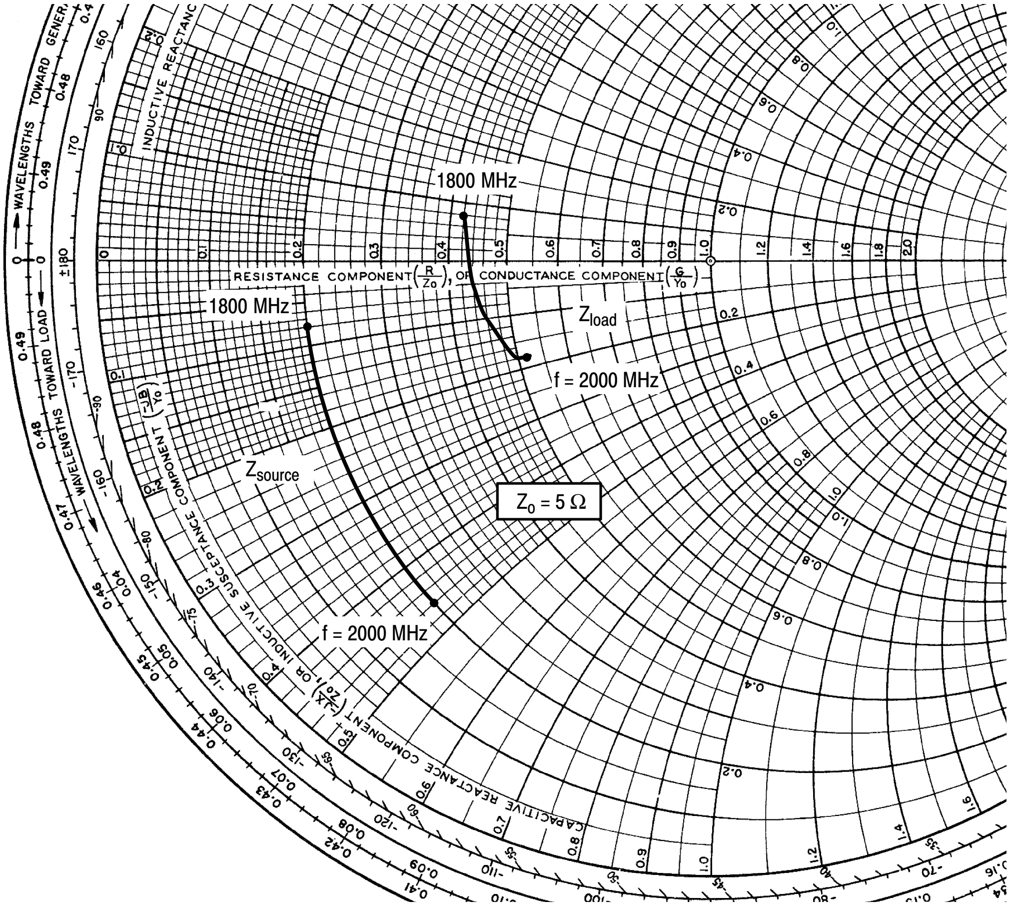


Figure 14. 1.92-2.0 GHz Broadband Circuit Performance



This graph displays calculated MTBF in hours x ampere^2 drain current. Life tests at elevated temperature have correlated to better than ±10% of the theoretical prediction for metal failure. Divide MTBF factor by I_D^2 for MTBF in a particular application.

Figure 15. MTBF Factor versus Junction Temperature



V_{CC} = 26 V, I_{DQ} = 200 mA, P_{out} = 15 W Avg.

f MHz	Z_{source} Ω	Z_{load} Ω
1800	1.0 - j0.4	2.1 + j0.4
1860	1.0 - j0.8	2.2 - j0.2
1900	1.0 - j1.1	2.3 - j0.5
1960	1.0 - j1.4	2.5 - j0.9
2000	1.0 - j2.3	2.6 - j0.92

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

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

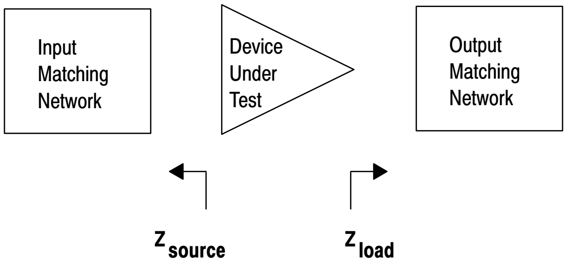
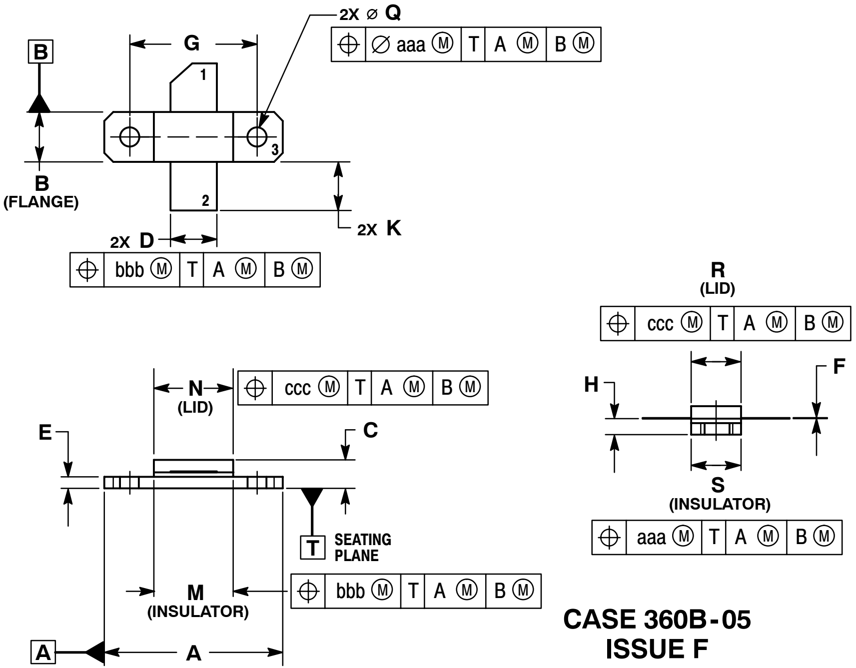


Figure 16. Series Equivalent Input and Output Impedence

NOTES

PACKAGE DIMENSIONS

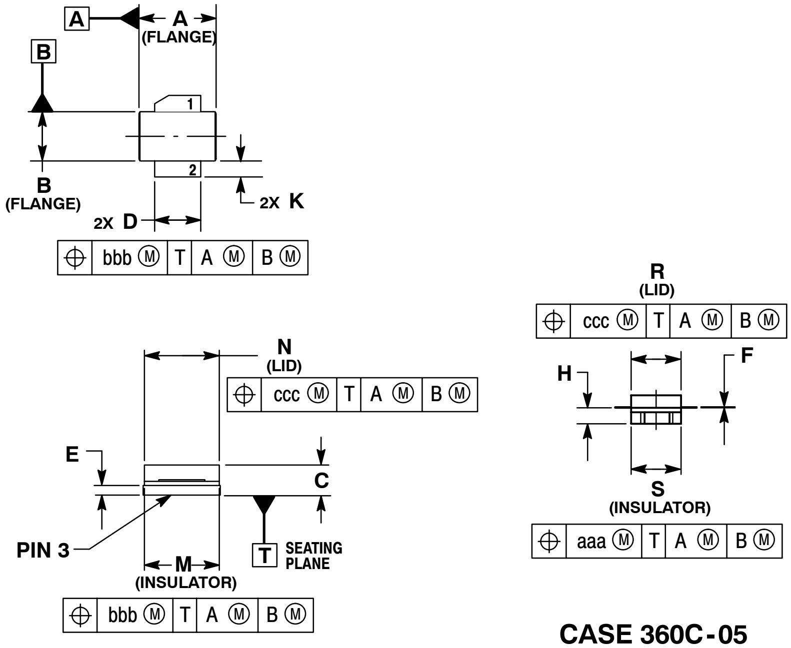


NOTES:
1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.

	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 F
NI-360
MRF284LR1



NOTES:
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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	0.375	0.385	9.53	9.78
B	0.225	0.235	5.72	5.97
C	0.105	0.155	2.67	3.94
D	0.210	0.220	5.33	5.59
E	0.035	0.045	0.89	1.14
F	0.004	0.006	0.10	0.15
H	0.057	0.067	1.45	1.70
K	0.085	0.115	2.16	2.92
M	0.355	0.365	9.02	9.27
N	0.357	0.363	9.07	9.22
R	0.227	0.23	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 360C-05
ISSUE D
NI-360S
MRF284LSR1

Freescale Semiconductor, Inc.

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2 Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong
852-26668334

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