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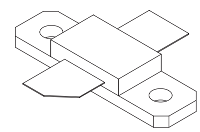
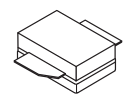
The RF Sub–Micron MOSFET Line
RF Power Field Effect Transistors
N–Channel Enhancement–Mode Lateral MOSFETs

MRF284
MRF284SR1

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



CASE 360B–03, STYLE 1
(MRF284)



CASE 360C–03, STYLE 1
(MRF284SR1)

Designed for PCN and PCS base station applications at 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%
- Characterized with Series Equivalent Large–Signal Impedance Parameters
- S–Parameter Characterization at High Bias Levels
- Excellent Thermal Stability
- Capable of Handling 10:1 VSWR, @ 26 Vdc, 2000 MHz, 30 Watts (CW) Output Power
- MRF284SR1 Is Available in Tape and Reel. R1 Suffix = 500 Units per 12 mm, 7 inch Reel.
- LDMOS Models, Test Fixture, Reference Design and Circuit Board Artwork Available at: http://motorola.com/sps/rf/designtds/

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

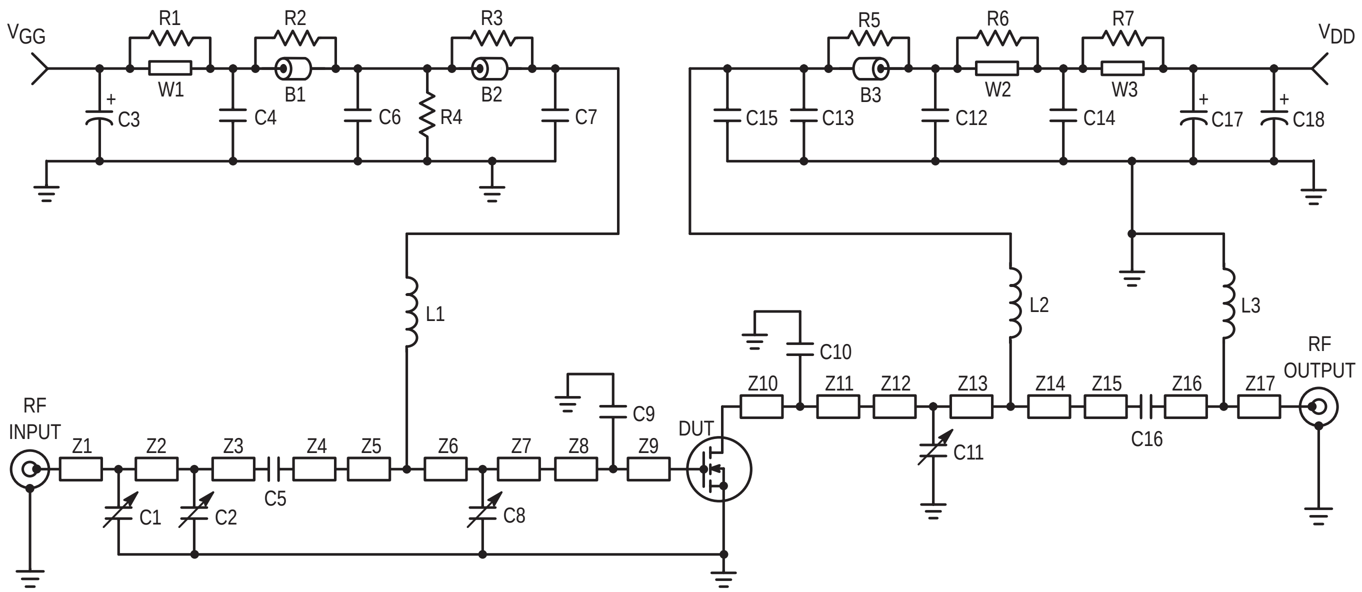
ELECTRICAL CHARACTERISTICS (TC = 25°C unless otherwise noted)

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.

ELECTRICAL CHARACTERISTICS (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)					
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	9	15	—	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	9	15	—	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	Z11	0.155″ x 0.515″ Microstrip
Z2	0.255″ x 0.080″ Microstrip	Z12	0.120″ x 0.325″ Microstrip
Z3	0.600″ x 0.080″ Microstrip	Z13	0.150″ x 0.325″ Microstrip
Z4	0.525″ x 0.080″ Microstrip	Z14	0.010″ x 0.325″ Microstrip
Z5	0.015″ x 0.325″ Microstrip	Z15	0.505″ x 0.080″ Microstrip
Z6	0.085″ x 0.325″ Microstrip	Z16	0.865″ x 0.080″ Microstrip
Z7	0.165″ x 0.325″ Microstrip	Z17	0.525″ x 0.080″ Microstrip
Z8	0.110″ x 0.515″ Microstrip	Raw Board Material	0.030″ Glass Teflon®, 2 oz Copper, 3″ x 5″ Dimensions, Arlon GX0300–55–22, ε_r = 2.55
Z9	0.095″ x 0.515″ Microstrip		
Z10	0.050″ x 0.515″ Microstrip		

Figure 1. 1.93–2.0 GHz Broadband Test Circuit Schematic

Table 1. 1.93 – 2.0 GHz Broadband Component Designations and Values

Designators	Description
B1 – B3	Ferrite Bead, 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 Capacitor, Kemet # T491X226K035AS4394
C4, C14	0.1 μF Chip Capacitor, Kemet # CDR33BX104AKWS
C5	220 pF B Case RF Chip Capacitor, ATC # 100B221KP500X
C6, C12	1000 pF B Case RF Chip Capacitor, ATC # 100B102JCA50X
C7, C13	5.1 pF B Case RF Chip Capacitor, ATC # 100B5R1CCA500X
C9	1.2 pF B Case RF Chip Capacitor, ATC # 100B1R2CCA500X
C10	2.7 pF B Case RF Chip Capacitor, ATC # 100B2R7CCA500X
C11	0.6–4.5 pF Gigatrim Variable Capacitors, Johanson # 27271SL
C15, C16	200 pF B Case RF Chip Capacitor, 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 Resistor 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	Berrylium Copper Wear Blocks 0.005″ x 0.250″ x 0.250″
	Brass Banana Jack and Nut
	Red Banana Jack and Nut
	Green Banana Jack and Nut
	Type “N” Jack Connectors, Omni–Spectra # 3052–1648–10
	4–40 Ph Head Screws, 0.125″ Long
	4–40 Ph Head Screws, 0.188″ Long
	4–40 Ph Head Screws, 0.312″ Long
	4–40 Ph Rec. Hd. Screws, 0.438″ Long
RF Circuit Board	3″ x 5″ Copper Clad PCB, Glass Teflon®

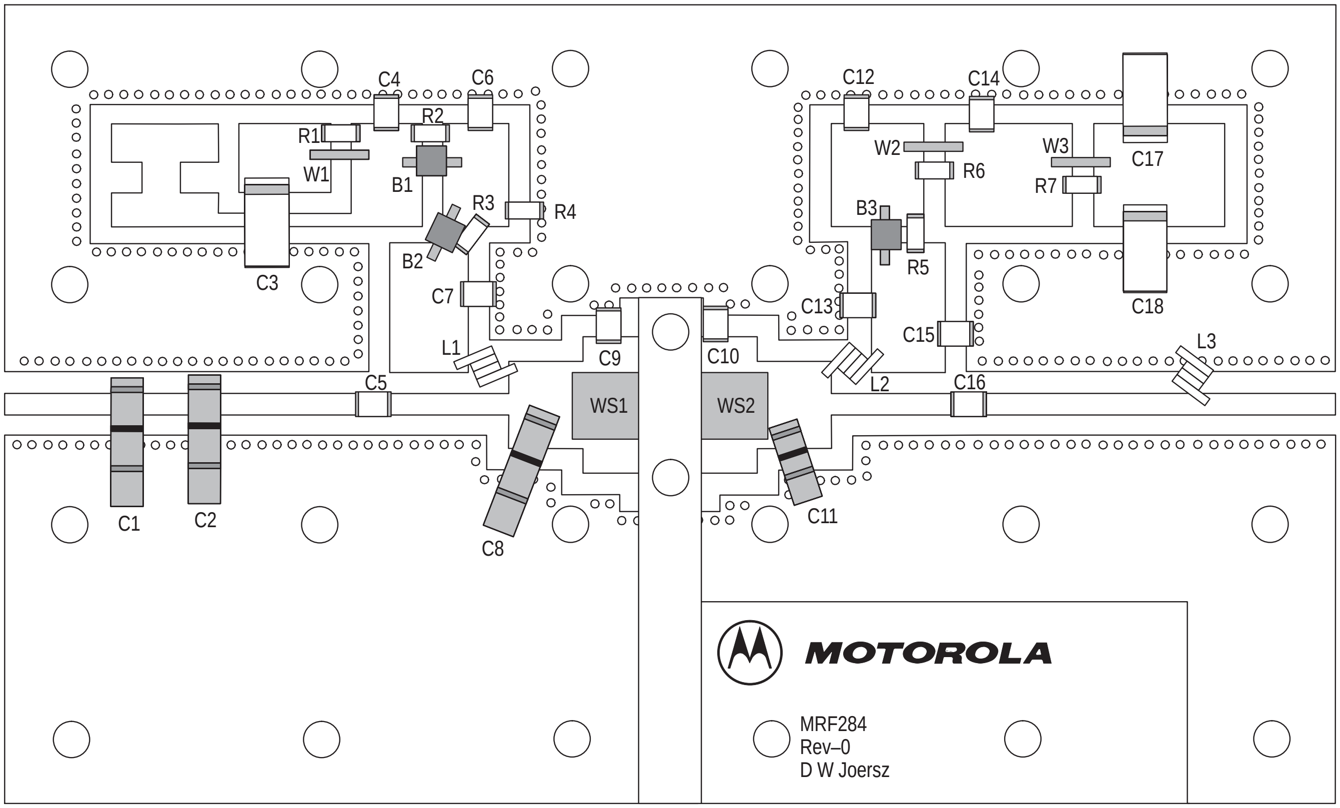


Figure 2. 1.93–2.0 GHz Broadband Test Circuit Component Layout

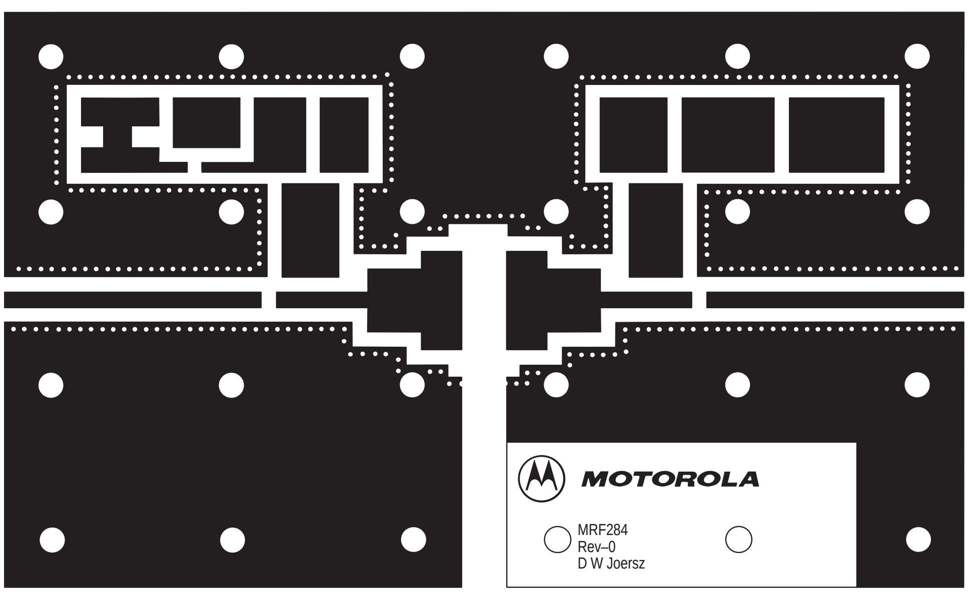
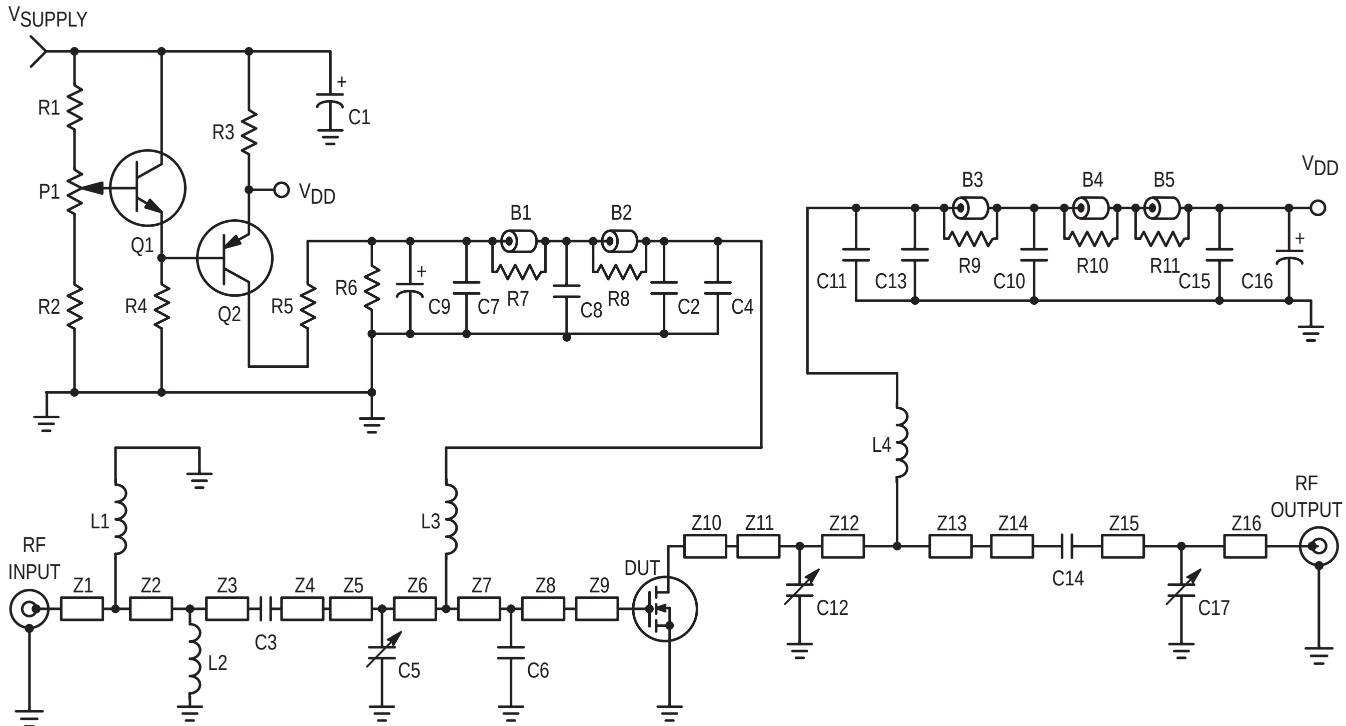


Figure 3. MRF284 Test Circuit Photomaster
(Reduced 18% in printed data book, DL110/D)



Z1	0.363″ x 0.080″ Microstrip	Z11	0.235″ x 0.325″ Microstrip
Z2	0.080″ x 0.080″ Microstrip	Z12	0.02″ x 0.325″ Microstrip
Z3	0.916″ x 0.080″ Microstrip	Z13	0.02″ x 0.325″ Microstrip
Z4	0.517″ x 0.080″ Microstrip	Z14	0.510″ x 0.080″ Microstrip
Z5	0.050″ x 0.325″ Microstrip	Z15	0.990″ x 0.080″ Microstrip
Z6	0.050″ x 0.325″ Microstrip	Z16	0.390″ x 0.080″ Microstrip
Z7	0.071″ x 0.325″ Microstrip	Raw Board Material	0.030″ Glass Teflon®, 2 oz Copper, 3″ x 5″ Dimensions, Arlon GX0300–55–22, ε_r = 2.55
Z8	0.125″ x 0.325″ Microstrip		
Z9	0.210″ x 0.515″ Microstrip		
Z10	0.210″ x 0.515″ Microstrip		

Figure 4. 2.0 GHz Class A Test Circuit Schematic

Table 2. 2.0 GHz Class A Component Designations and Values

Designators	Description
B1 – B5	Ferrite Bead, Round, Ferroxcube # 56–590–65–3B
C1, C9, C16	100 μF, 50 V, Electrolytic Capacitor, Mallory # SME50VB101M12X25L
C2, C13	51 pF, ATC RF Chip Capacitors, Case “B” # 100B510JCA500x
C3, C14	10 pF, ATC RF Chip Capacitors, Case “B” # 100B100JCA500X
C4, C11	12 pF, ATC RF Chip Capacitors, Case “B” # 100B120JCA500X
C5	0.8 – 8.0 pF Variable Capacitor, Johansen Gigatrim # 27291SL
C6	4.7 pF, ATC RF Chip Capacitor, Case “B” # 100B4R7CCA500X
C7, C15	91 pF, ATC RF Chip Capacitors, Case “B” # 100B910KP500X
C8	1000 pF, ATC RF Chip Capacitor, Case “B” # 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 Resistor 0.08″ x 0.13″, Garrett Instruments # RM73B2B120JT

TYPICAL CHARACTERISTICS

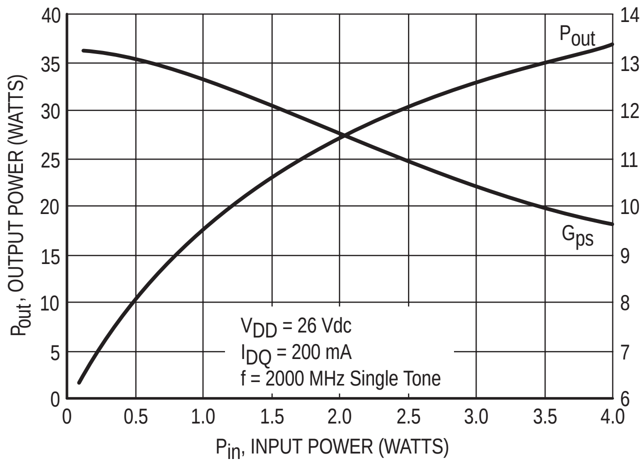


Figure 5. Output Power & Power Gain versus Input Power

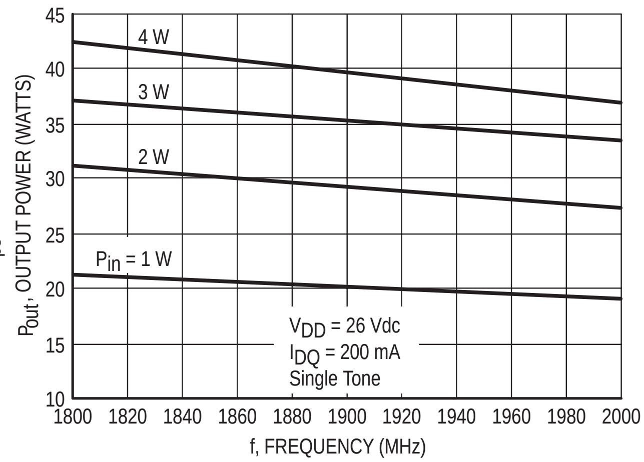


Figure 6. Output Power versus Frequency

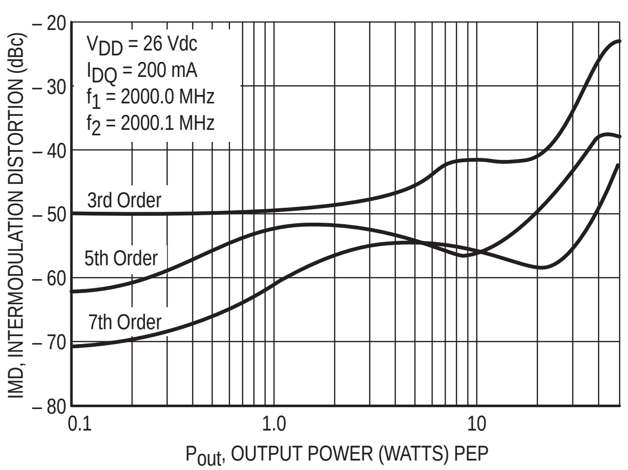


Figure 7. Intermodulation Distortion Products versus Output Power

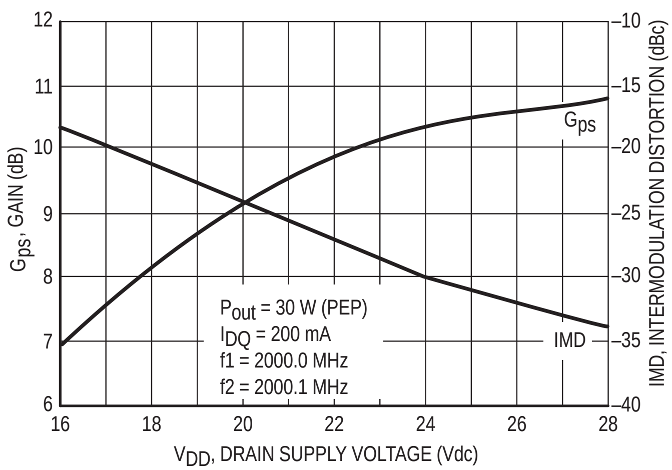


Figure 8. Power Gain and Intermodulation Distortion versus Supply Voltage

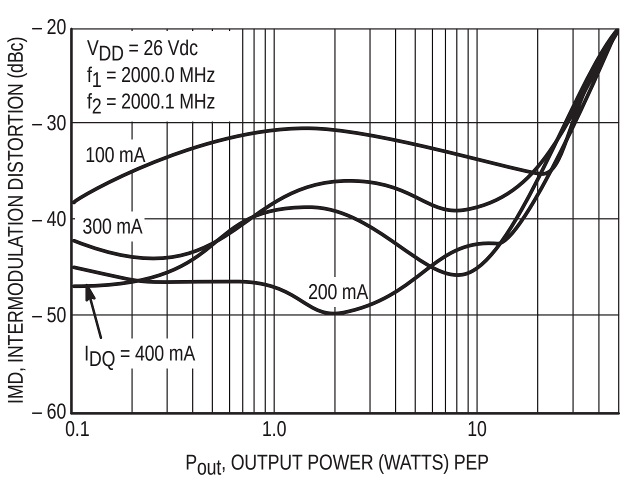


Figure 9. Intermodulation Distortion versus Output Power

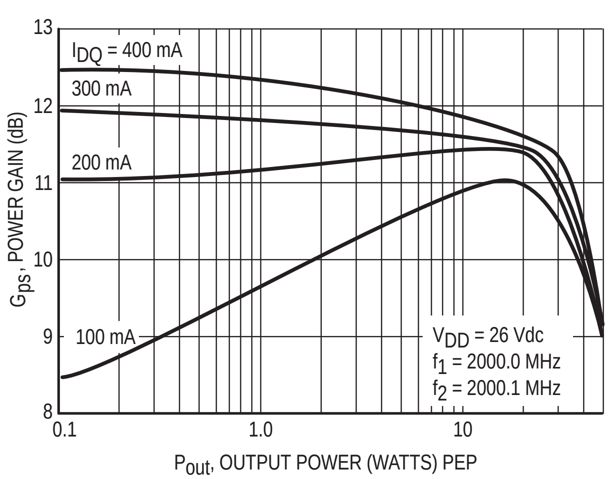


Figure 10. Power Gain versus Output Power

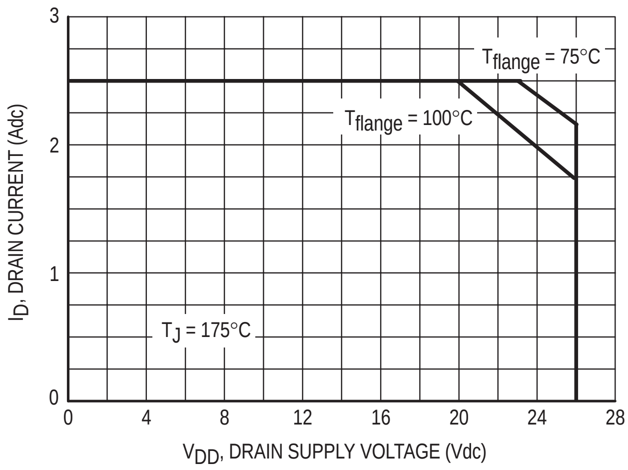


Figure 11. DC Safe Operating Area

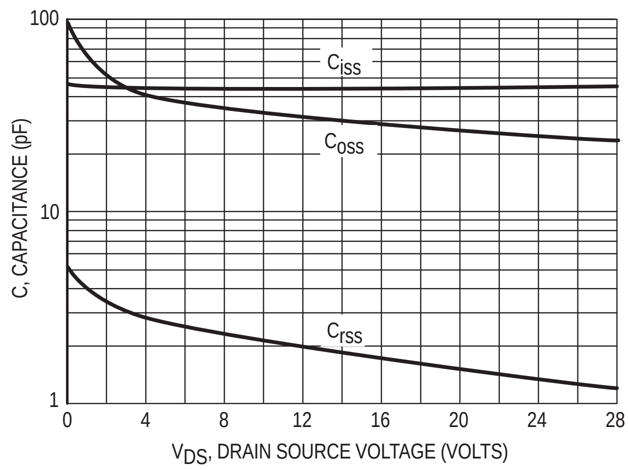


Figure 12. Capacitance versus Drain Source Voltage

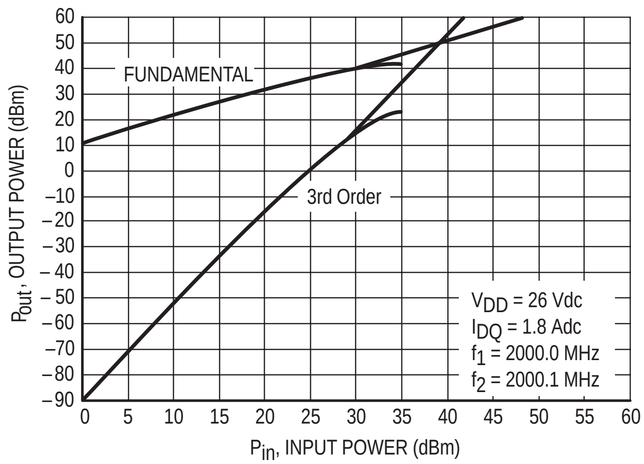


Figure 13. Class A Third Order Intercept Point

TYPICAL CHARACTERISTICS

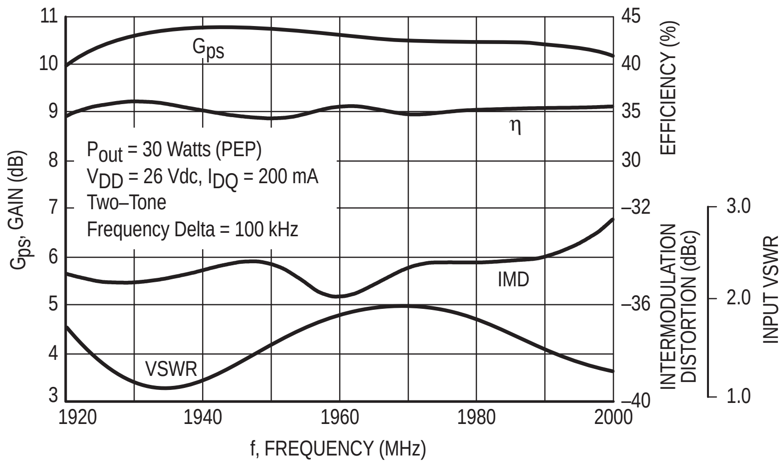
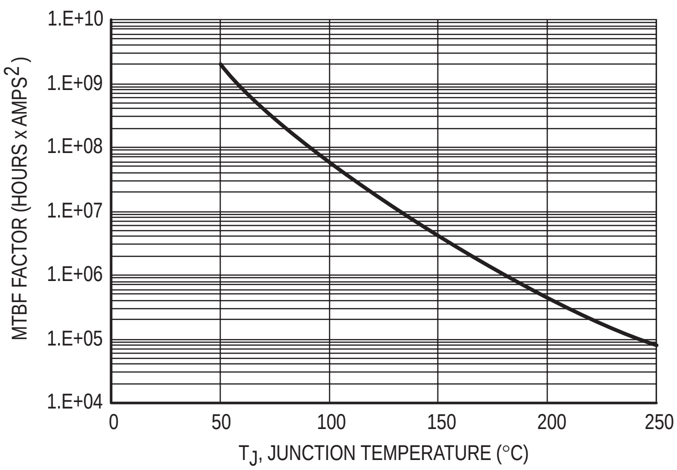
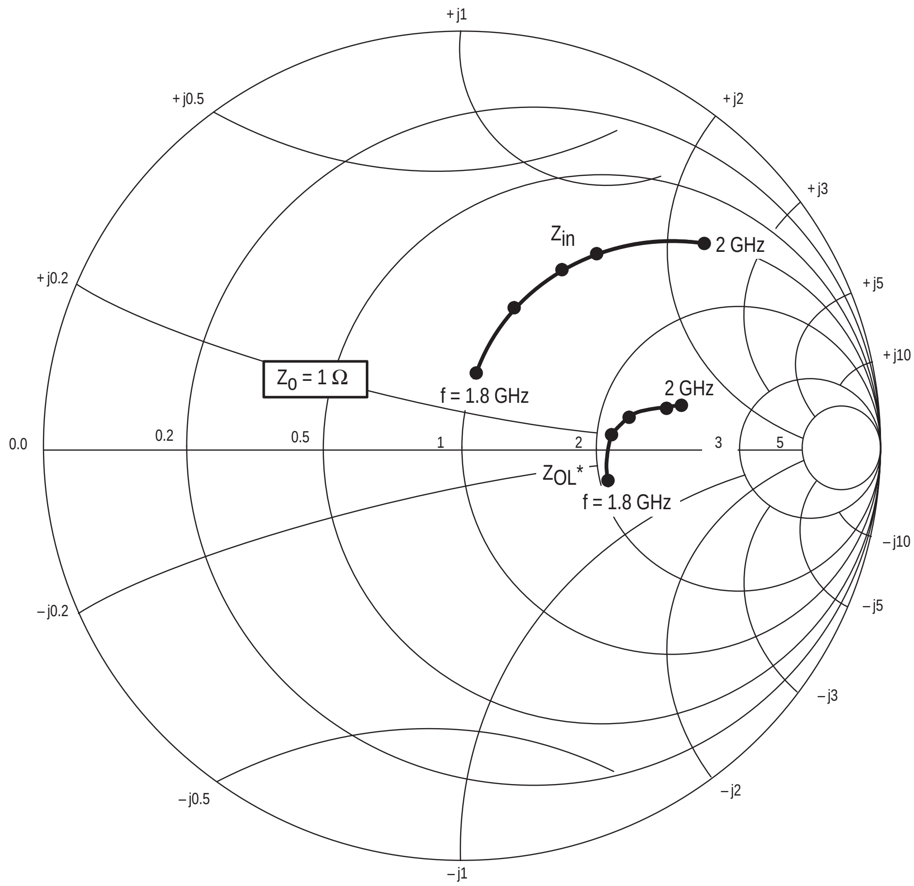


Figure 14. 1.92–2.0 GHz Broadband Circuit Performance



This graph displays calculated MTBF in hours x ampere² 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_{CQ} = 200 mA, P_{out} = 15 W_{avg}

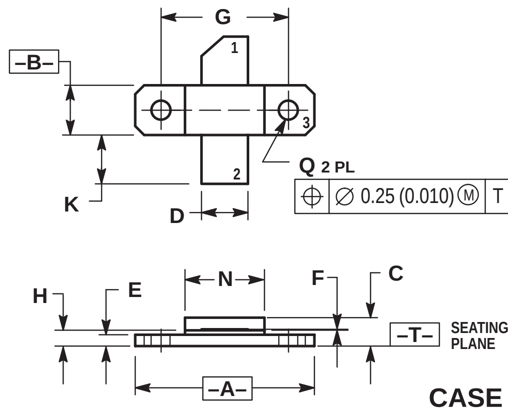
f MHz	Z_{in}(1) Ohms	Z_{OL}* Ohms
1800	1.0 + j0.4	2.1 – j0.4
1860	1.0 + j0.8	2.2 + j0.2
1900	1.0 + j1.1	2.3 + j0.5
1960	1.0 + j1.4	2.5 + j0.9
2000	1.0 + j2.3	2.6 + j0.92

Z_{in}(1) = Complex conjugate of source impedance.

Z_{OL}* = Conjugate of the optimum load impedance at given output power, voltage, bias current and frequency.

Figure 16. Series Equivalent Input and Output Impedence

PACKAGE DIMENSIONS

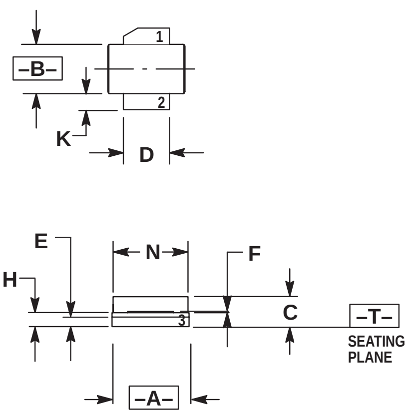


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION H IS MEASURED 0.030" AWAY FROM EDGE OF FLANGE.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.790	0.810	20.07	20.57
B	0.220	0.240	5.59	6.09
C	0.125	0.175	3.18	4.45
D	0.205	0.225	5.21	5.71
E	0.050	0.070	1.27	1.77
F	0.004	0.006	0.11	0.15
G	0.562 BSC		14.27 BSC	
H	0.077	0.087	1.96	2.21
K	0.215	0.255	5.47	6.47
N	0.350	0.370	8.89	9.39
Q	0.120	0.140	3.05	3.55

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

CASE 360B–03
ISSUE D
(MRF284)



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.370	0.390	9.40	9.91
B	0.220	0.240	5.59	6.09
C	0.105	0.155	2.67	3.94
D	0.205	0.225	5.21	5.71
E	0.035	0.045	0.89	1.14
F	0.004	0.006	0.11	0.15
H	0.057	0.067	1.45	1.70
K	0.085	0.115	2.16	2.92
N	0.350	0.370	8.89	9.39

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

CASE 360C–03
ISSUE B
(MRF284SR1)

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