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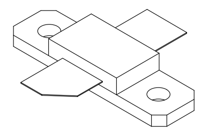
The RF Sub–Micron MOSFET Line
RF Power Field Effect Transistors
N–Channel Enhancement–Mode Lateral MOSFETs

MRF284
MRF284S

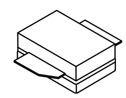
30 W, 2000 MHz, 26 V
LATERAL N–CHANNEL
BROADBAND
RF POWER MOSFETs

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



CASE 360B–01, STYLE 1
(MRF284)



CASE 360C–03, STYLE 1
(MRF284S)

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

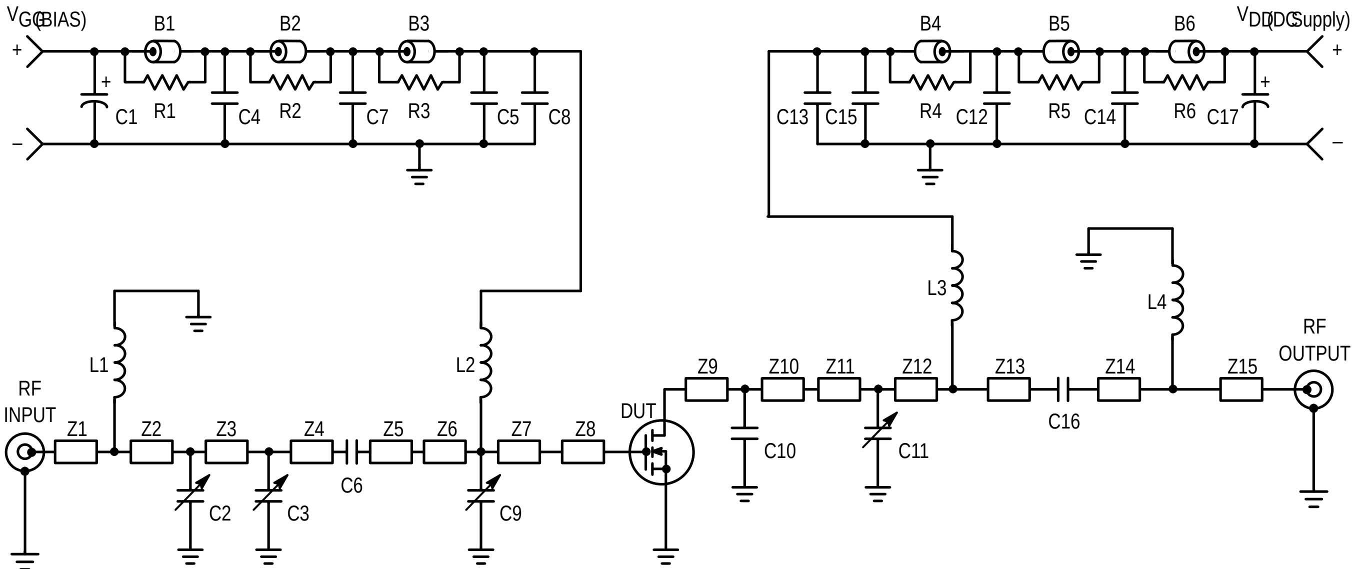
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

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.

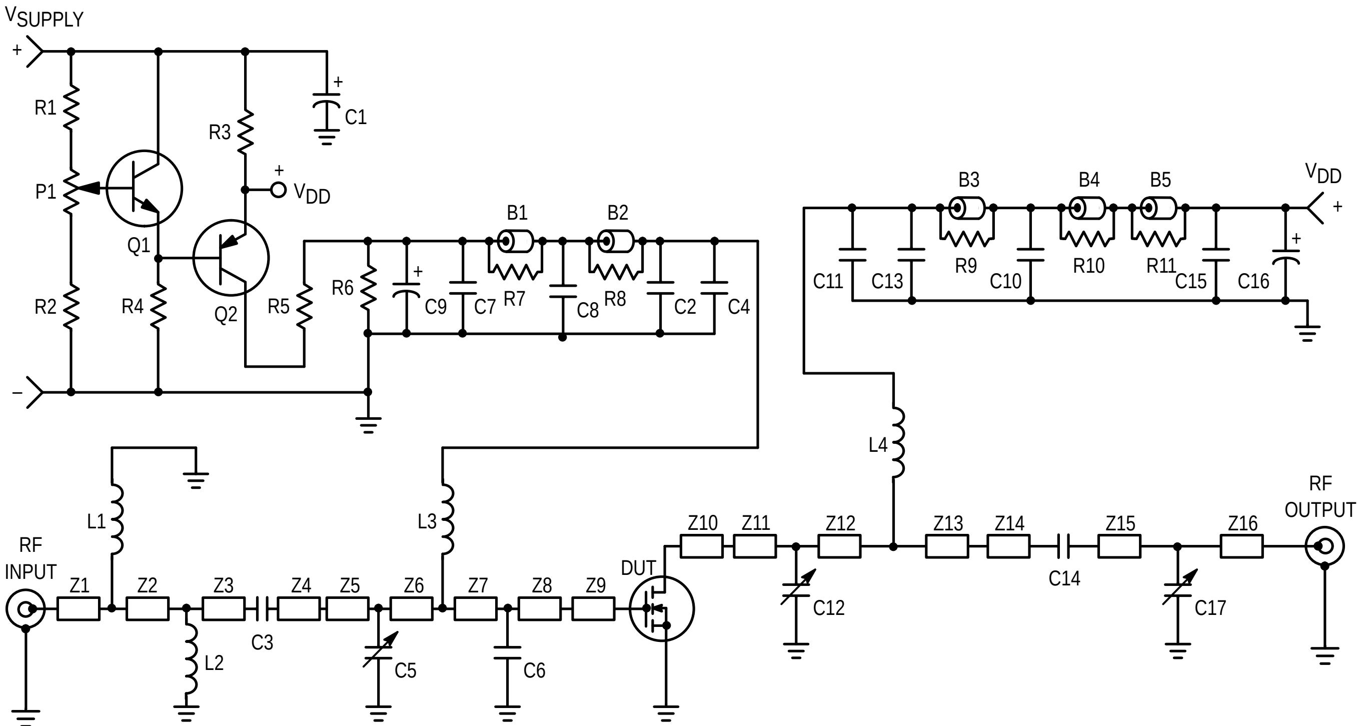
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

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}	1.0	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			



B1 – B6	Ferrite Bead, Round	Z3	0.185″ x 0.080″ Microstrip
C1, C17	470 µF, 63 V, Mallory Electrolytic Capacitor	Z4	0.395″ x 0.080″ Microstrip
C2	0.6 – 4.5 pF Johansen Gigatrim Variable Capacitors	Z5	0.490″ x 0.080″ Microstrip
C3, C9	0.8 – 8.0 pF Johansen Gigatrim Variable Capacitors	Z6	0.035″ x 0.325″ Microstrip
C4, C14	0.1 µF Chip Capacitor, KEMET	Z7	0.240″ x 0.325″ Microstrip
C5, C15	91 pF ATC RF Chip Capacitors, Case “B”	Z8	0.210″ x 0.515″ Microstrip
C6, C16	10 pF ATC RF Chip Capacitors, Case “B”	Z9	0.130″ x 0.515″ Microstrip
C7, C12	1000 pF ATC RF Chip Capacitors, Case “B”	Z10	0.080″ x 0.515″ Microstrip
C8, C13	5.1 pF ATC RF Chip Capacitors, Case “B”	Z11	0.190″ x 0.325″ Microstrip
C10	2.7 pF ATC RF Chip Capacitors, Case “B”	Z12	0.090″ x 0.325″ Microstrip
C11	0.4 – 2.5 pF Johansen Gigatrim Variable Capacitors	Z13	0.515″ x 0.080″ Microstrip
L1	4 Turns, #27 AWG, 0.087″ OD, 0.050″ ID, 0.069″ Long, 10 nH	Z14	0.860″ x 0.080″ Microstrip
L2, L3	9 Turns, #26 AWG, 0.080″ OD, 0.046″ ID, 0.170″ Long, 30.8 nH	Z15	0.510″ x 0.080″ Microstrip
L4	2 Turns, #24 AWG, 0.85″ OD, 0.042″ ID, 0.064″ Long, 5.2 nH	Board	0.030″ Glass Teflon, 2 oz Copper, 3 x 5″ Dimensions, Manufacturer; Arlon, P/N: GX0300–55–22, ε_r = 2.55
R1 – R6	12 Ω Fixed Film Chip Resistor 0.08″ x 0.13″		
Z1	0.145″ x 0.080″ Microstrip		
Z2	0.680″ x 0.080″ Microstrip		

Figure 1. Schematic of 1.93–2.0 GHz Broadband Test Circuit



B1 – B5	Ferrite Bead, Round
C1, C9, C16	100 µF, 50 V, Electrolytic Capacitor, Sprague
C2, C13	51 pF, ATC RF Chip Capacitors, Case “B”
C3, C14	10 pF, ATC RF Chip Capacitors, Case “B”
C4, C11	12 pF, ATC RF Chip Capacitors, Case “B”
C5	0.8 – 8.0 pF Variable Capacitor, Johansen Gigatrim
C6	4.7 pF, ATC RF Chip Capacitor, Case “B”
C7, C15	91 pF, ATC RF Chip Capacitors, Case “B”
C8	1000 pF, ATC RF Chip Capacitor, Case “B”
C10	0.1 µF, Chip Capacitor, KEMET
C12, C17	0.6 – 4.5 pF, Variable Capacitors, Johansen Gigatrim
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 Ohm Potentiometer, 1/2 W, 10 Turns
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″
R2	2 x 12 kΩ, Fixed Film Chip Resistor 0.08″ x 0.13″
R3	1 Ω, Wirewound, 5 W, 3% Resistor
R4	4 x 6.8 kΩ, Fixed Film Chip Resistor 0.08″ x 0.13″

R5	2 x 1500 Ω, Fixed Film Chip Resistor 0.08″ x 0.13″
R6	270 Ω, Fixed Film Chip Resistor, 0.08″ x 0.13″
R7 – R11	12 Ω, Fixed Film Chip Resistor, 0.08″ x 0.13″
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
Raw PCB Material	0.030″ Glass Teflon, 2 oz Copper, 3 x 5″ Dimensions, Manufacturer; Arlon, P/N: GX–0300–55–22, ε_r = 2.55

Figure 2. Schematic of 2.0 GHz Class A Test Circuit

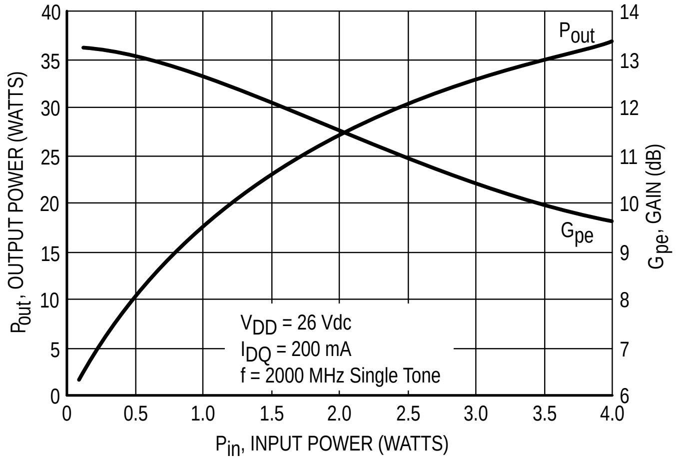


Figure 3. Output Power & Power Gain versus Input Power

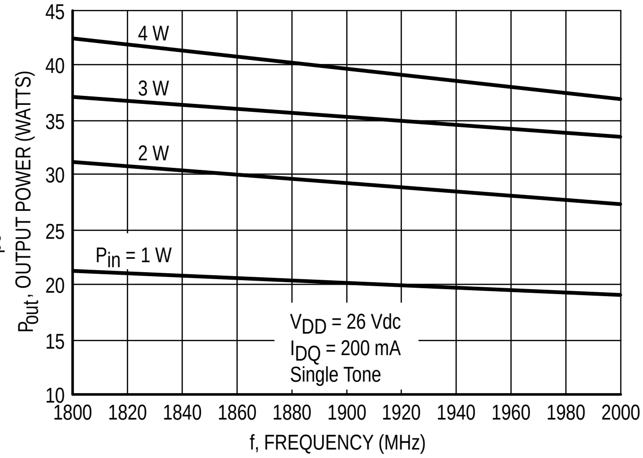


Figure 4. Output Power versus Frequency

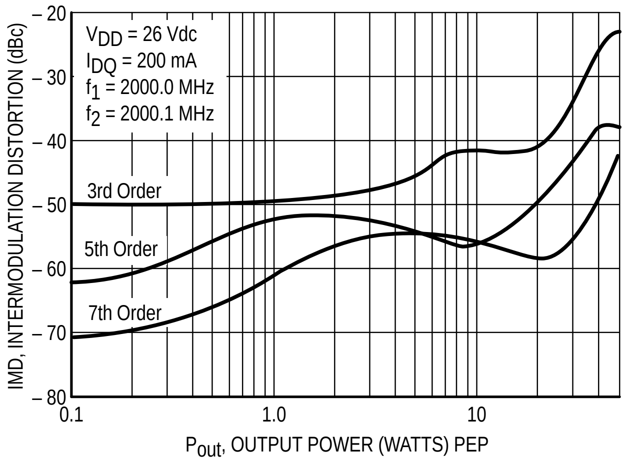


Figure 5. Intermodulation Distortion versus Output Power

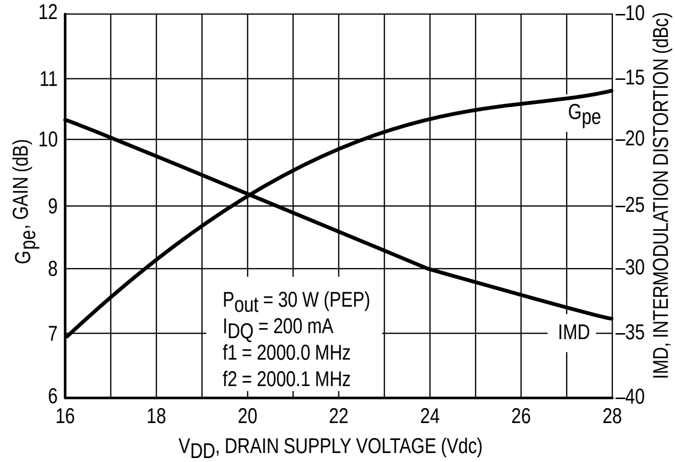


Figure 6. Power Gain and Intermodulation Distortion versus Supply Voltage

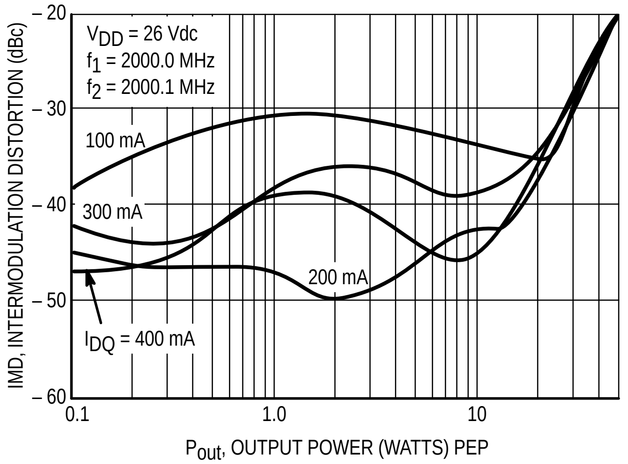


Figure 7. Intermodulation Distortion versus Output Power

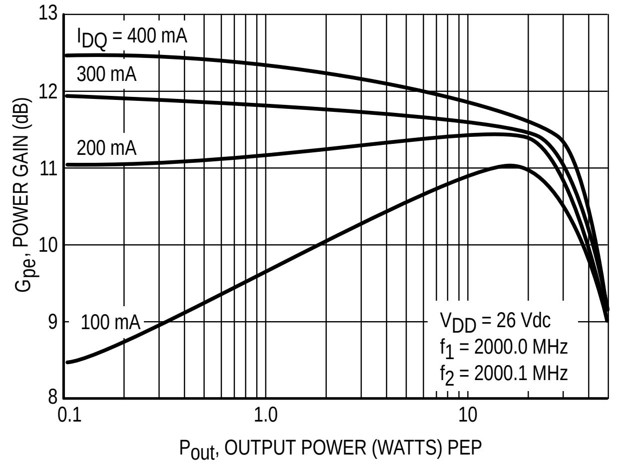


Figure 8. Power Gain versus Output Power

TYPICAL CHARACTERISTICS

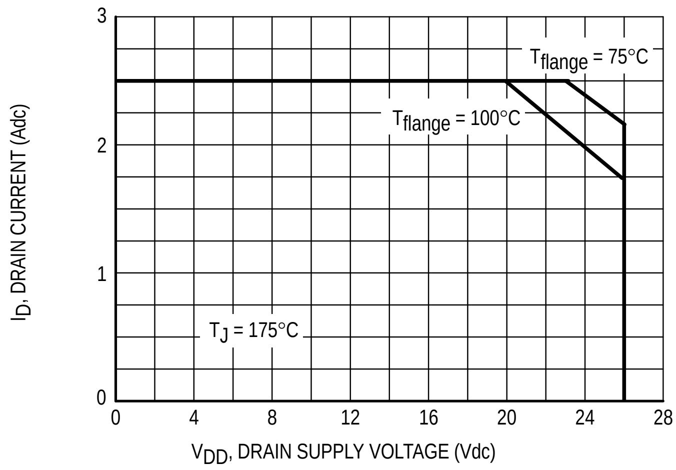


Figure 9. DC Safe Operating Area

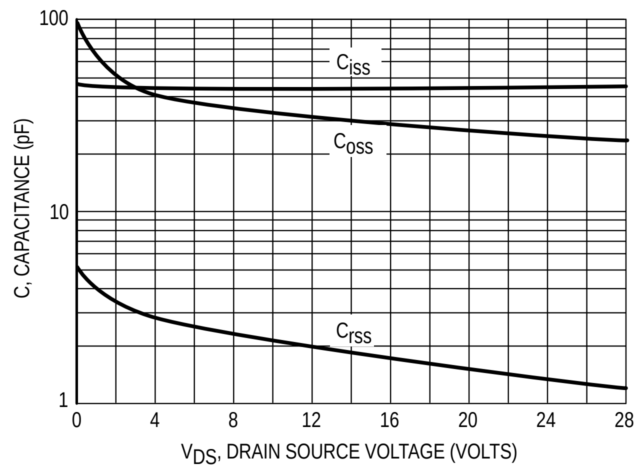


Figure 10. Capacitance versus Drain Source Voltage

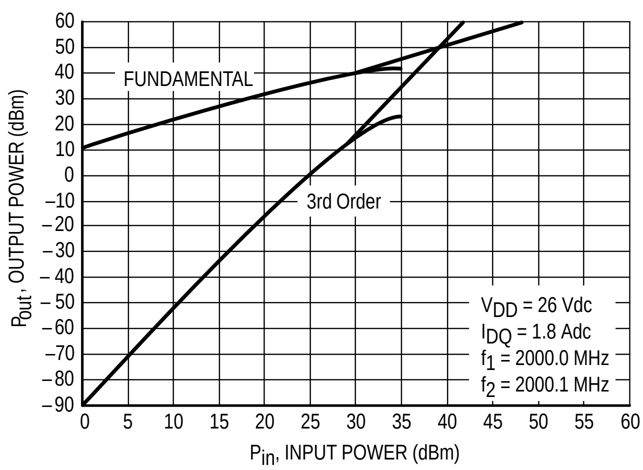


Figure 11. Class A Third Order Intercept Point

TYPICAL CHARACTERISTICS

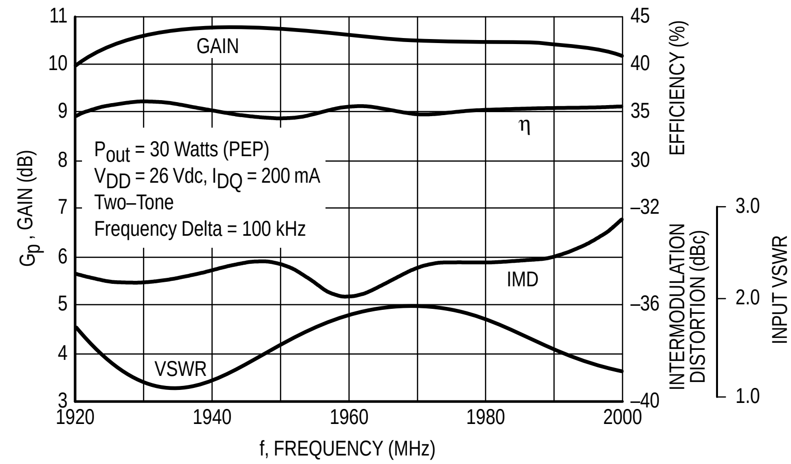
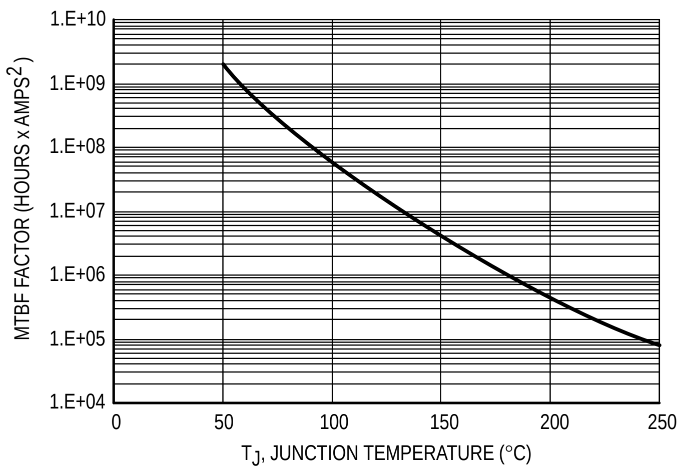
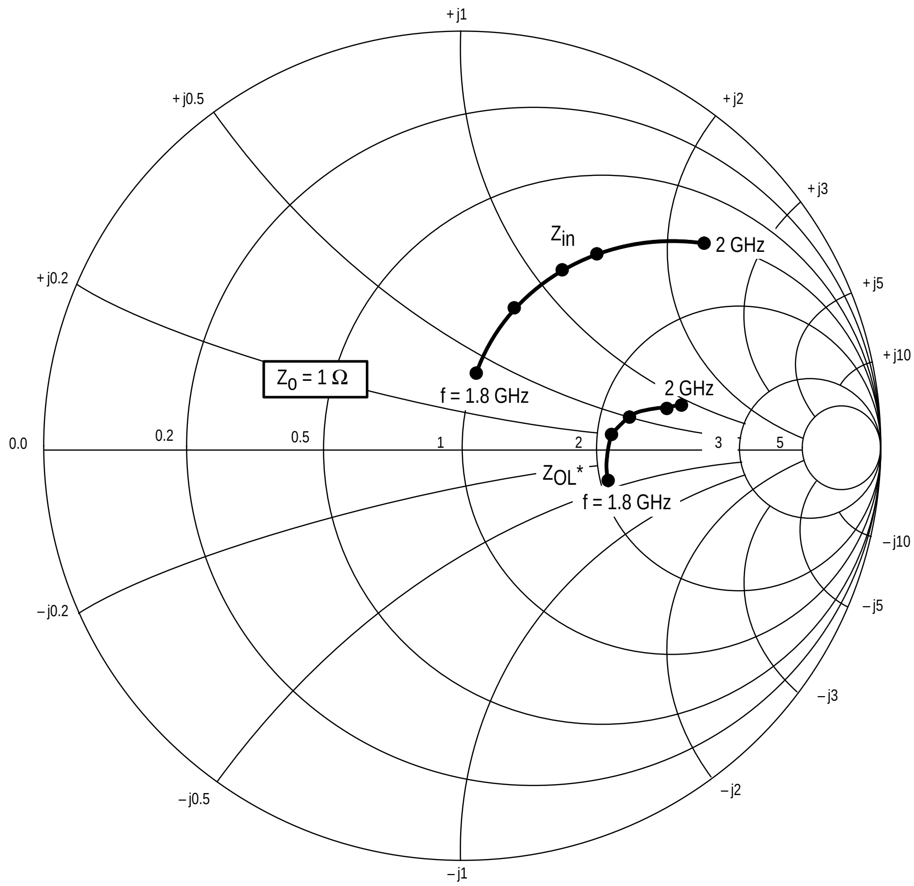


Figure 12. 1.92–2.0 GHz Broadband Circuit Performance



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 13. MTBF Factor versus Junction Temperature



V_{CC} = 26 V, I_{CQ} = 200 mA, P_{out} = 15 W_{avg}

f MHz	Z_{in}(1) Ω	Z_{OL}* 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_{in}(1) = Conjugate of fixture base terminal impedance.

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

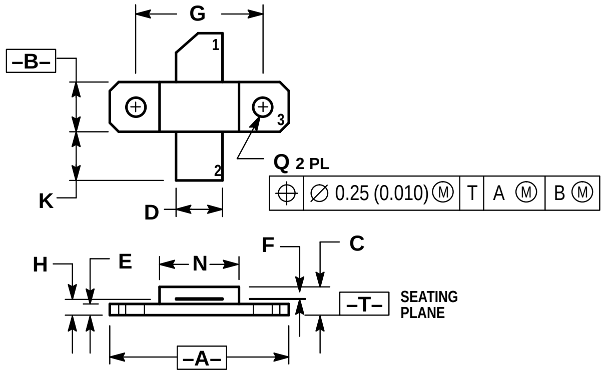
Figure 14. Series Equivalent Input and Output Impedence

Table 1. Common Source S–Parameters at V_{DS} = 26 Vdc, I_D = 1.8 Adc

f GHz	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
1.0	0.902	–170	1.10	28	0.005	60	0.913	–162
1.1	0.934	–167	0.92	26	0.006	82	0.921	–163
1.2	0.948	–167	0.85	24	0.007	89	0.924	–164
1.3	0.957	–169	0.73	21	0.009	94	0.929	–165
1.4	0.959	–169	0.68	19	0.011	94	0.931	–165
1.5	0.960	–170	0.59	17	0.014	94	0.933	–167
1.6	0.958	–172	0.53	14	0.015	92	0.936	–168
1.7	0.958	–172	0.50	13	0.016	93	0.936	–169
1.8	0.956	–174	0.45	10	0.019	92	0.937	–170
1.9	0.954	–175	0.43	8	0.020	90	0.937	–171
2	0.944	–177	0.39	6	0.023	82	0.937	–173
2.1	0.934	–177	0.38	4	0.023	72	0.935	–174
2.2	0.935	–178	0.35	–1	0.013	72	0.932	–176
2.3	0.945	180	0.31	–4	0.016	116	0.925	–179
2.4	0.944	178	0.30	–5	0.023	112	0.930	–179
2.5	0.946	177	0.29	–7	0.024	105	0.935	179
2.6	0.941	174	0.25	–11	0.025	112	0.930	176

NOTES

PACKAGE DIMENSIONS

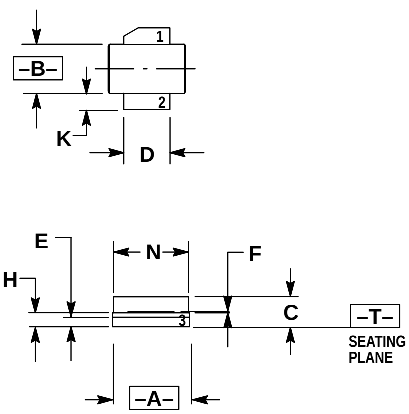


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS 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	0.070	0.090	1.78	2.29
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–01
ISSUE O
(MRF284)



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

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS 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
(MRF284S)

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