

The RF Sub-Micron MOSFET Line

RF Power Field Effect Transistors

N-Channel Enhancement-Mode Lateral MOSFETs

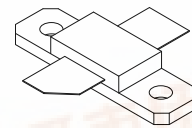
Designed for PCN and PCS base station applications at frequencies from 1000 to 2600 MHz. Suitable for FM, TDMA, CDMA, and multicarrier amplifier applications. To be used in class A and class AB for PCN-PCS/cellular radio and wireless local loop.

- 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

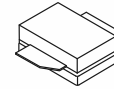
MRF284

MRF284S

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



CASE 360B-01, STYLE 1
(MRF284)



CASE 360C-03, STYLE 1
(MRF284S)

MAXIMUM RATINGS

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

THERMAL CHARACTERISTICS

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

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 10 \mu\text{Adc}$)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 20 \text{ Vdc}$, $V_{GS} = 0$)	I_{DSS}	—	—	1.0	μAdc
Gate-Source Leakage Current ($V_{GS} = 20 \text{ Vdc}$, $V_{DS} = 0$)	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 ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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ON CHARACTERISTICS

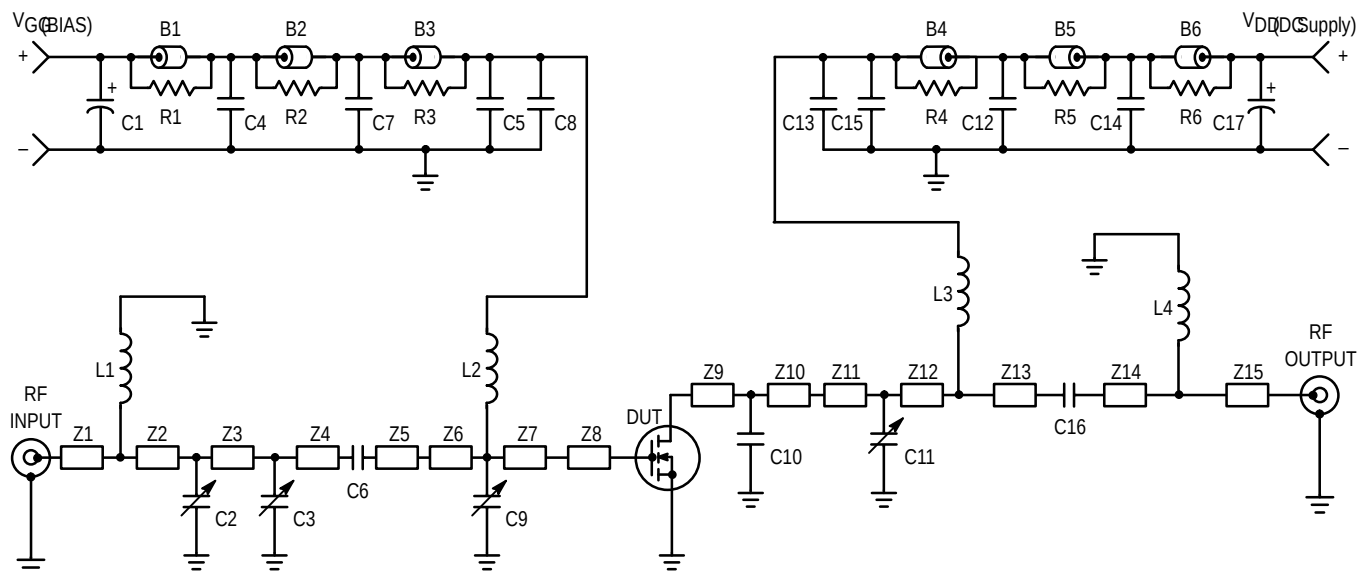
Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 150\text{ }\mu\text{Adc}$)	$V_{GS(th)}$	2.0	3.0	4.0	Vdc
Gate Quiescent Voltage ($V_{DS} = 26\text{ Vdc}$, $I_D = 200\text{ mAdc}$)	$V_{GS(q)}$	3.0	4.0	5.0	Vdc
Drain–Source On–Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 1.0\text{ Adc}$)	$V_{DS(on)}$	—	0.3	0.6	Vdc
Forward Transconductance ($V_{DS} = 10\text{ Vdc}$, $I_D = 1.0\text{ Adc}$)	g_{fs}	1.0	1.5	—	S

DYNAMIC CHARACTERISTICS

Input Capacitance ($V_{DS} = 26\text{ Vdc}$, $V_{GS} = 0$, $f = 1.0\text{ MHz}$)	C_{iss}	—	43	—	pF
Output Capacitance ($V_{DS} = 26\text{ Vdc}$, $V_{GS} = 0$, $f = 1.0\text{ MHz}$)	C_{oss}	—	23	—	pF
Reverse Transfer Capacitance ($V_{DS} = 26\text{ Vdc}$, $V_{GS} = 0$, $f = 1.0\text{ MHz}$)	C_{rss}	—	1.4	—	pF

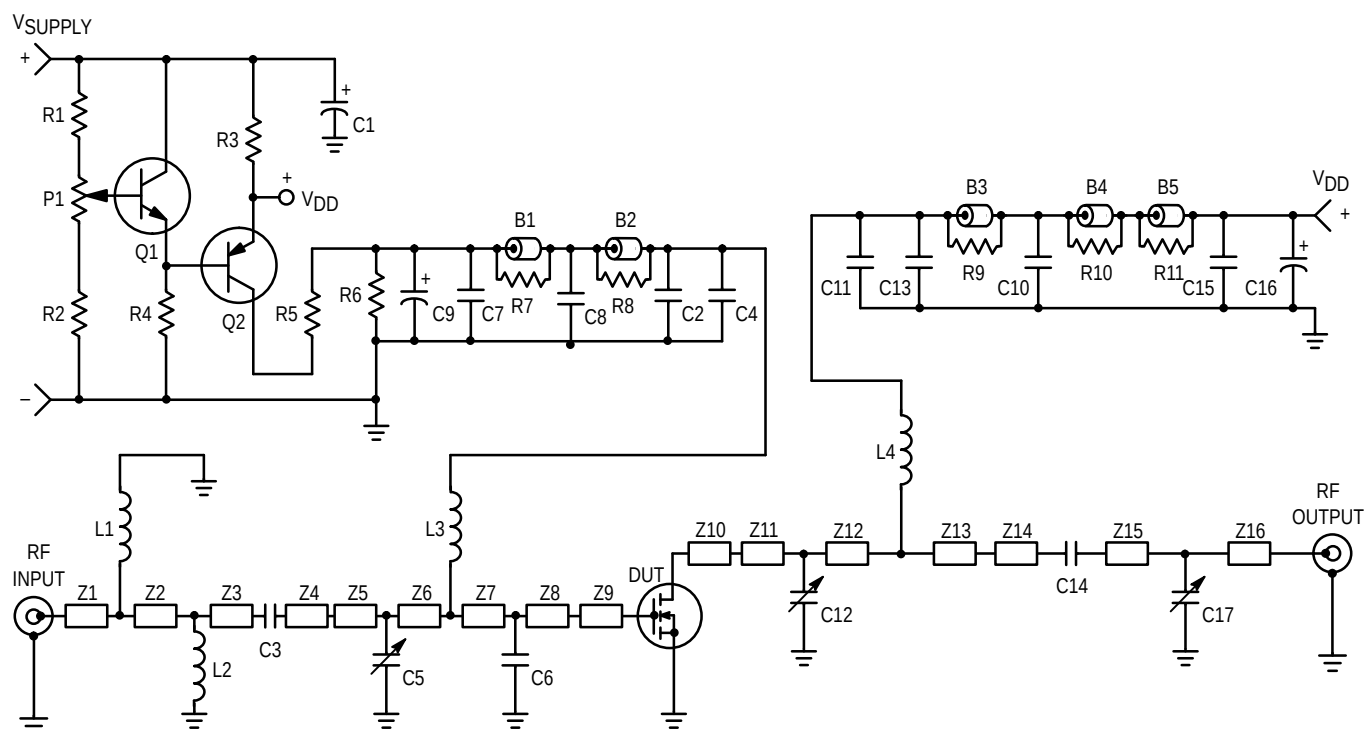
FUNCTIONAL TESTS (in Motorola Test Fixture)

Common–Source Power Gain ($V_{DD} = 26\text{ Vdc}$, $P_{out} = 30\text{ W}$, $I_{DQ} = 200\text{ mA}$, $f_1 = 2000.0\text{ MHz}$, $f_2 = 2000.1\text{ MHz}$)	G_{ps}	9	10.5	—	dB
Drain Efficiency ($V_{DD} = 26\text{ Vdc}$, $P_{out} = 30\text{ W}$, $I_{DQ} = 200\text{ mA}$, $f_1 = 2000.0\text{ MHz}$, $f_2 = 2000.1\text{ MHz}$)	η	30	35	—	%
Intermodulation Distortion ($V_{DD} = 26\text{ Vdc}$, $P_{out} = 30\text{ W}$, $I_{DQ} = 200\text{ mA}$, $f_1 = 2000.0\text{ MHz}$, $f_2 = 2000.1\text{ MHz}$)	IMD	—	–32	–29	dBc
Input Return Loss ($V_{DD} = 26\text{ Vdc}$, $P_{out} = 30\text{ W}$, $I_{DQ} = 200\text{ mA}$, $f_1 = 2000.0\text{ MHz}$, $f_2 = 2000.1\text{ MHz}$)	IRL	9	15	—	dB
Common–Source Amplifier Power Gain ($V_{DD} = 26\text{ Vdc}$, $P_{out} = 30\text{ W PEP}$, $I_{DQ} = 200\text{ mA}$, $f_1 = 1930.0\text{ MHz}$, $f_2 = 1930.1\text{ MHz}$)	G_{ps}	9	10.4	—	dB
Drain Efficiency ($V_{DD} = 26\text{ Vdc}$, $P_{out} = 30\text{ W PEP}$, $I_{DQ} = 200\text{ mA}$, $f_1 = 1930.0\text{ MHz}$, $f_2 = 1930.1\text{ MHz}$)	η	—	35	—	%
Intermodulation Distortion ($V_{DD} = 26\text{ Vdc}$, $P_{out} = 30\text{ W PEP}$, $I_{DQ} = 200\text{ mA}$, $f_1 = 1930.0\text{ MHz}$, $f_2 = 1930.1\text{ MHz}$)	IMD	—	–34	—	dBc
Input Return Loss ($V_{DD} = 26\text{ Vdc}$, $P_{out} = 30\text{ W PEP}$, $I_{DQ} = 200\text{ mA}$, $f_1 = 1930.0\text{ MHz}$, $f_2 = 1930.1\text{ MHz}$)	IRL	9	15	—	dB
Common–Source Amplifier Power Gain ($V_{DD} = 26\text{ Vdc}$, $P_{out} = 30\text{ W CW}$, $I_{DQ} = 200\text{ mA}$, $f_1 = 2000.0\text{ MHz}$)	G_{ps}	8.5	9.5	—	dB
Drain Efficiency ($V_{DD} = 26\text{ Vdc}$, $P_{out} = 30\text{ W CW}$, $I_{DQ} = 200\text{ mA}$, $f_1 = 2000.0\text{ MHz}$)	η	35	45	—	%
Output Mismatch Stress ($V_{DD} = 26\text{ Vdc}$, $P_{out} = 30\text{ W CW}$, $I_{DQ} = 200\text{ mA}$, $f_1 = 2000.0\text{ MHz}$, $V_{SWR} = 10:1$, 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 μ F, 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 μ F 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, $\epsilon_r = 2.55$
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	R5	2 x 1500 Ω , Fixed Film Chip Resistor 0.08" x 0.13"
C1, C9, C16	100 μ F, 50 V, Electrolytic Capacitor, Sprague	R6	270 Ω , Fixed Film Chip Resistor, 0.08" x 0.13"
C2, C13	51 pF, ATC RF Chip Capacitors, Case "B"	R7 – R11	12 Ω , Fixed Film Chip Resistor, 0.08" x 0.13"
C3, C14	10 pF, ATC RF Chip Capacitors, Case "B"	Z1	0.363" x 0.080" Microstrip
C4, C11	12 pF, ATC RF Chip Capacitors, Case "B"	Z2	0.080" x 0.080" Microstrip
C5	0.8 – 8.0 pF Variable Capacitor, Johansen Gigatrim	Z3	0.916" x 0.080" Microstrip
C6	4.7 pF, ATC RF Chip Capacitor, Case "B"	Z4	0.517" x 0.080" Microstrip
C7, C15	91 pF, ATC RF Chip Capacitors, Case "B"	Z5	0.050" x 0.325" Microstrip
C8	1000 pF, ATC RF Chip Capacitor, Case "B"	Z6	0.050" x 0.325" Microstrip
C10	0.1 μ F, Chip Capacitor, KEMET	Z7	0.071" x 0.325" Microstrip
C12, C17	0.6 – 4.5 pF, Variable Capacitors, Johansen Gigatrim	Z8	0.125" x 0.325" Microstrip
L1	4 Turns, #27 AWG, 0.087" OD, 0.050" ID, 0.069" Long, 10 nH	Z9	0.210" x 0.515" Microstrip
L2	5 Turns, #24 AWG, 0.083" OD, 0.040" ID, 0.128" Long, 12.5 nH	Z10	0.210" x 0.515" Microstrip
L3, L4	9 Turns, #26 AWG, 0.080" OD, 0.046" ID, 0.170" Long, 30.8 nH	Z11	0.235" x 0.325" Microstrip
P1	1000 Ohm Potentiometer, 1/2 W, 10 Turns	Z12	0.02" x 0.325" Microstrip
Q1	Transistor, NPN, Motorola P/N: MJD31, Case 369A–10	Z13	0.02" x 0.325" Microstrip
Q2	Transistor, PNP, Motorola P/N: MJD32, Case 369A–10	Z14	0.510" x 0.080" Microstrip
R1	360 Ω , Fixed Film Chip Resistor 0.08" x 0.13"	Z15	0.990" x 0.080" Microstrip
R2	2 x 12 k Ω , Fixed Film Chip Resistor 0.08" x 0.13"	Z16	0.390" x 0.080" Microstrip
R3	1 Ω , Wirewound, 5 W, 3% Resistor	Raw PCB	0.030" Glass Teflon, 2 oz Copper, 3 x 5" Dimensions, Manufacturer;
R4	4 x 6.8 k Ω , Fixed Film Chip Resistor 0.08" x 0.13"	Material	Arlon, P/N: GX–0300–55–22, $\epsilon_r = 2.55$

Figure 2. Schematic of 2.0 GHz Class A Test Circuit

TYPICAL CHARACTERISTICS

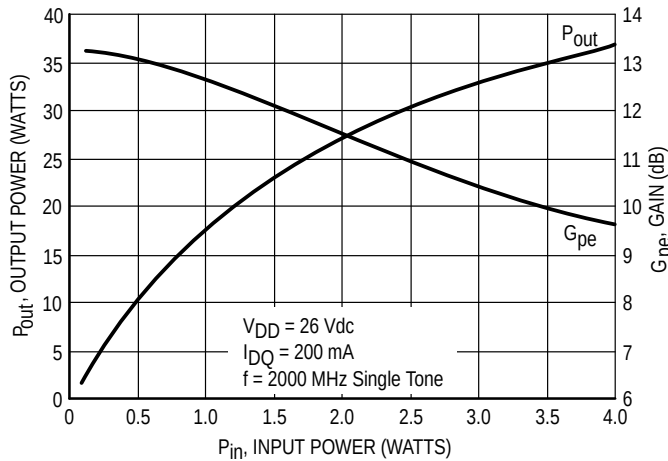


Figure 3. Output Power & Power Gain versus Input Power

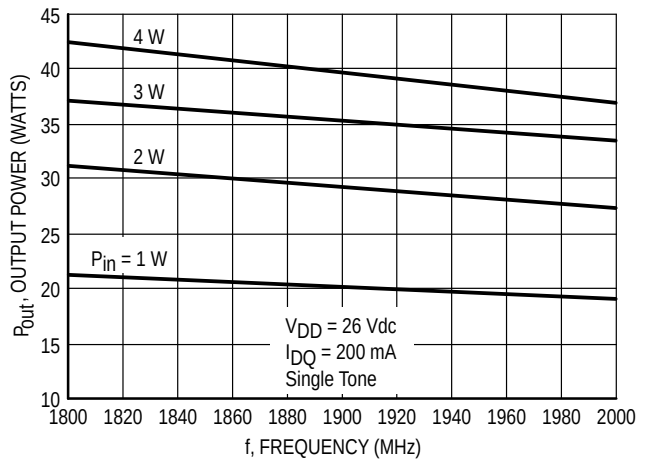


Figure 4. Output Power versus Frequency

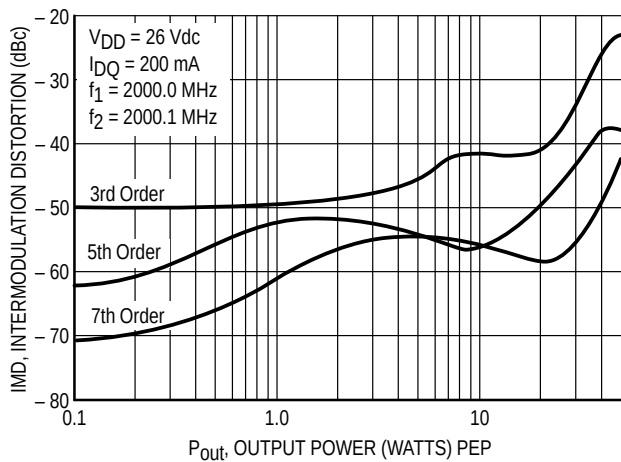


Figure 5. Intermodulation Distortion versus Output Power

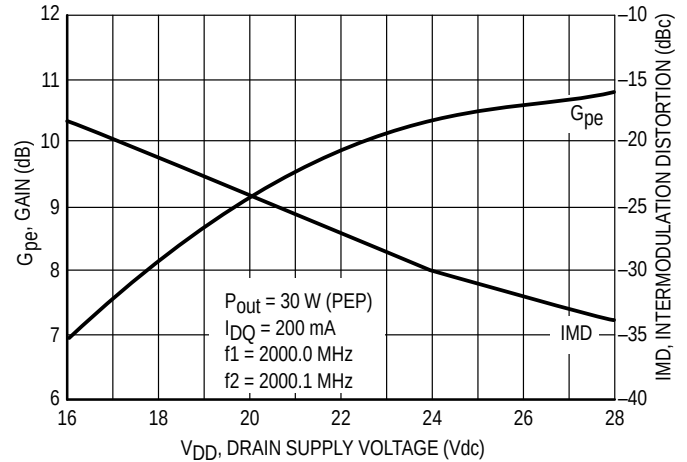


Figure 6. Power Gain and Intermodulation Distortion versus Supply Voltage

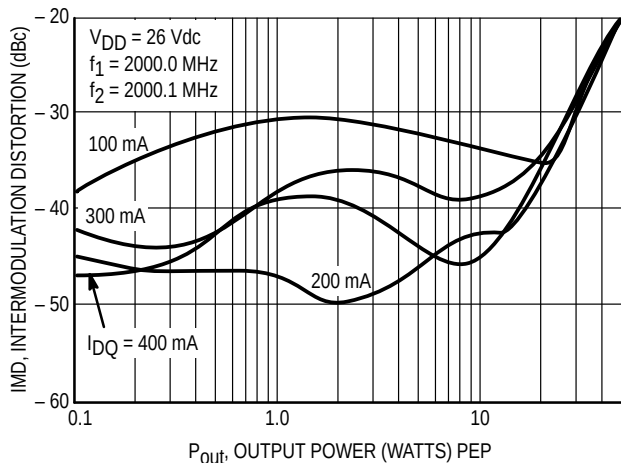


Figure 7. Intermodulation Distortion versus Output Power

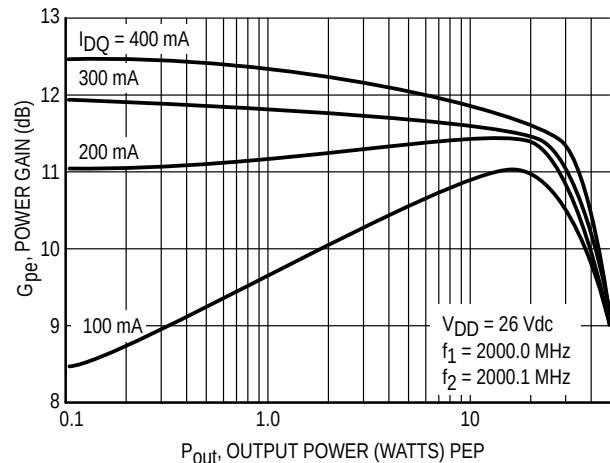


Figure 8. Power Gain versus Output Power

TYPICAL CHARACTERISTICS

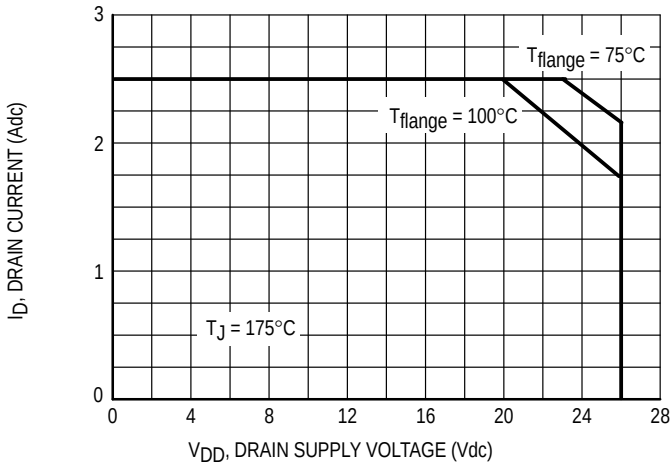


Figure 9. DC Safe Operating Area

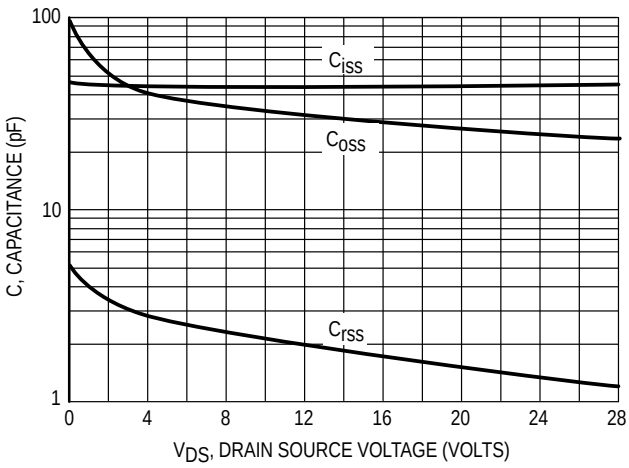


Figure 10. Capacitance versus Drain Source Voltage

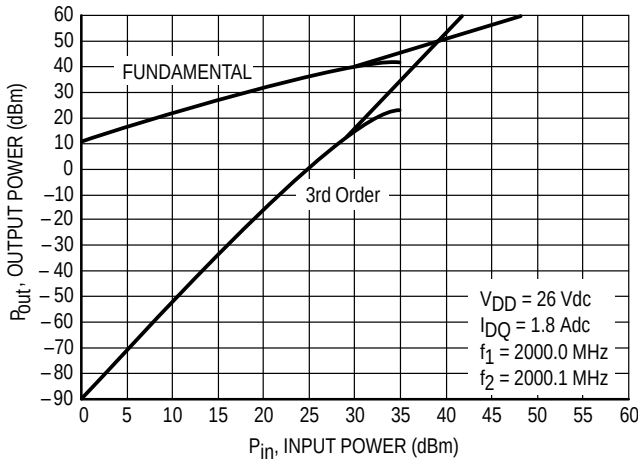


Figure 11. Class A Third Order Intercept Point

TYPICAL CHARACTERISTICS

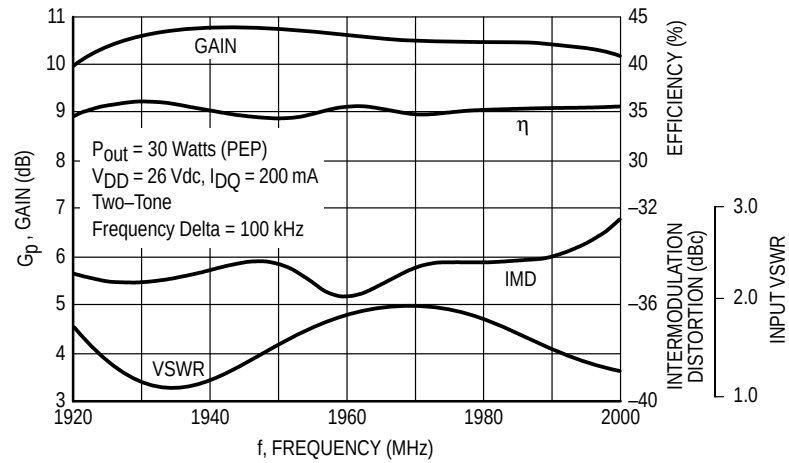
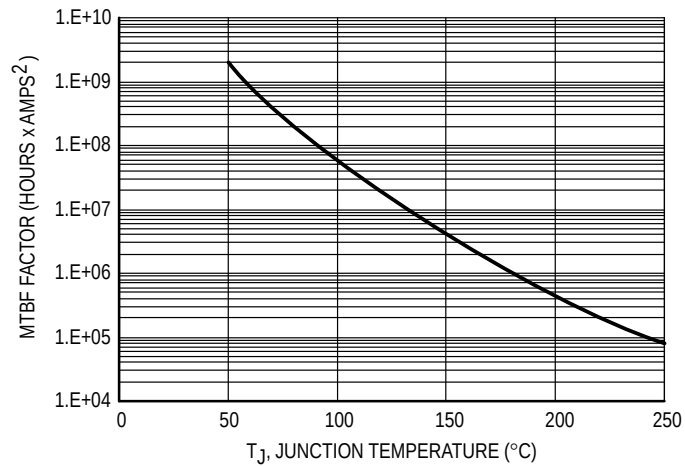
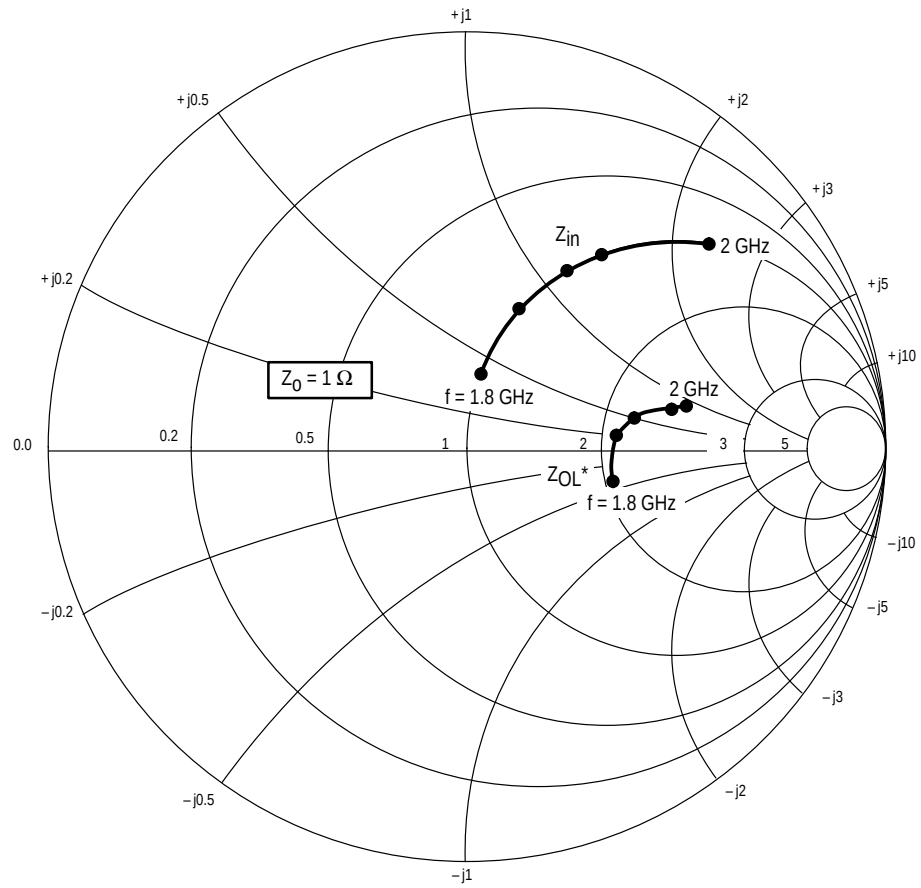


Figure 12. 1.92–2.0 GHz Broadband Circuit Performance



This graph displays calculated MTBF in hours x ampere² drain current. Life tests at elevated temperature have correlated to better than $\pm 10\%$ 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



$V_{CC} = 26 \text{ V}$, $I_{CQ} = 200 \text{ mA}$, $P_{out} = 15 \text{ W}_{avg}$

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.

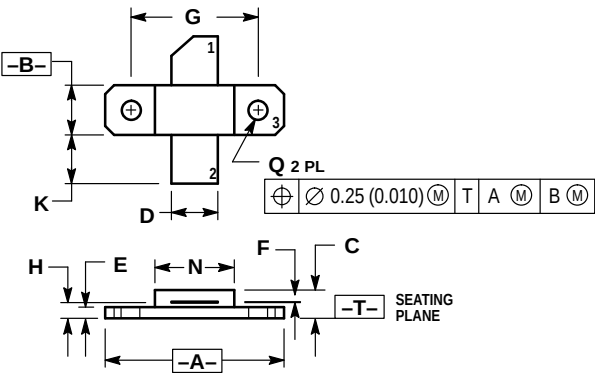
Figure 14. Series Equivalent Input and Output Impedance

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

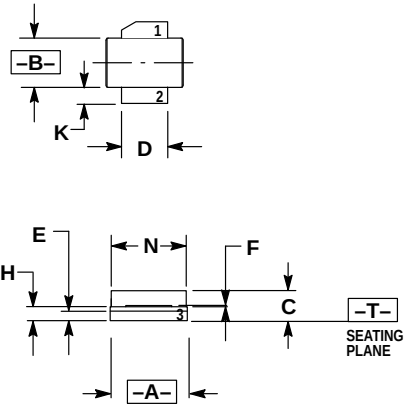


CASE 360B-01
ISSUE O
(MRF284)

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

DIM	INCHES		MILLIMETERS	
	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	0.070	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
 - GATE
 - SOURCE



CASE 360C-03
ISSUE B
(MRF284S)

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

DIM	INCHES		MILLIMETERS	
	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
 - GATE
 - SOURCE

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