

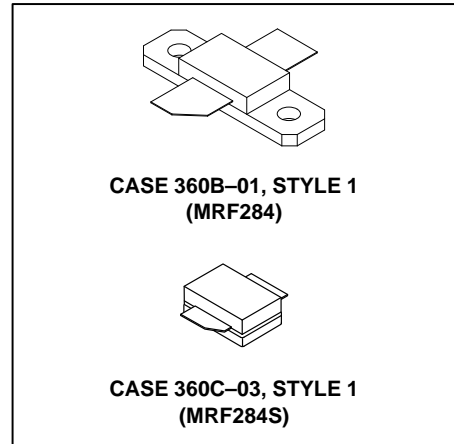
# The RF Sub-Micron MOSFET Line

## 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

#### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	$V_{DSS}$	65	Vdc
Gate-Source Voltage	$V_{GS}$	$\pm 20$	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	87.5 0.5	Watts $\text{W}/^\circ\text{C}$
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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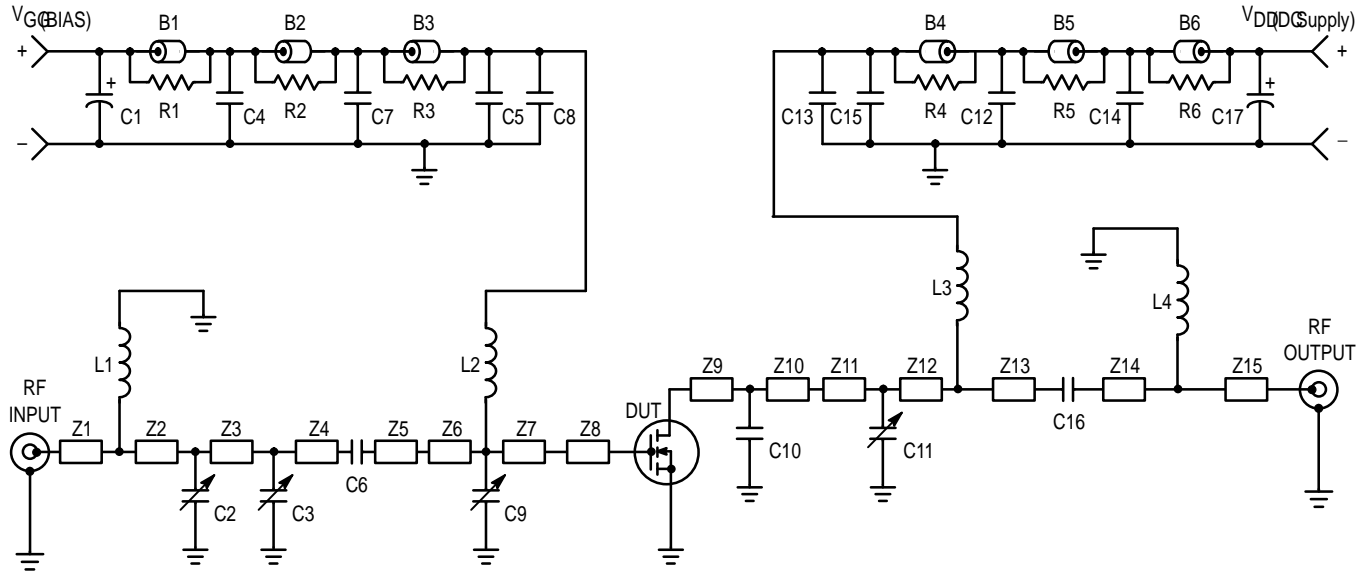
#### OFF CHARACTERISTICS

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	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 20 \text{ Vdc}, V_{DS} = 0$ )	$I_{GSS}$	—	—	10	$\mu\text{Adc}$

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

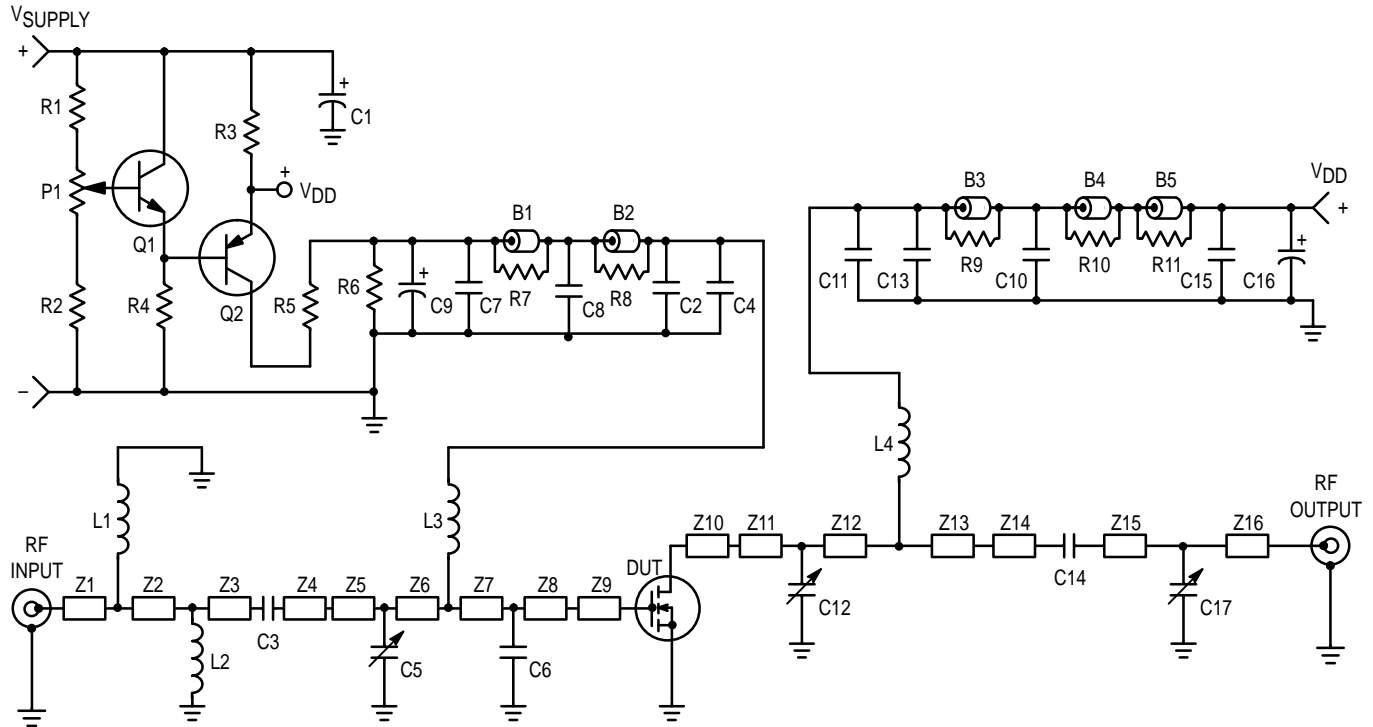
**ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>ON CHARACTERISTICS</b>					
Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 150\ \mu\text{Adc}$ )	$V_{GS(th)}$	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
<b>DYNAMIC CHARACTERISTICS</b>					
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
<b>FUNCTIONAL TESTS</b> (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 ( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\ \text{W}$ , $I_{DQ} = 200\ \text{mA}$ , $f_1 = 2000.0\ \text{MHz}$ , $f_2 = 2000.1\ \text{MHz}$ )	$\eta$	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 ( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\ \text{W PEP}$ , $I_{DQ} = 200\ \text{mA}$ , $f_1 = 1930.0\ \text{MHz}$ , $f_2 = 1930.1\ \text{MHz}$ )	$\eta$	—	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 ( $V_{DD} = 26\text{ Vdc}$ , $P_{out} = 30\ \text{W CW}$ , $I_{DQ} = 200\ \text{mA}$ , $f_1 = 2000.0\ \text{MHz}$ )	$\eta$	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)	$\Psi$	No Degradation In Output Power			



B1 – B6	Ferrite Bead, Round	Z3	0.185" x 0.080" Microstrip
C1, C17	470 $\mu$ 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 $\mu$ 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 $\Omega$ Fixed Film Chip Resistor 0.08" x 0.13"		
Z1	0.145" x 0.080" Microstrip		
Z2	0.680" x 0.080" Microstrip		

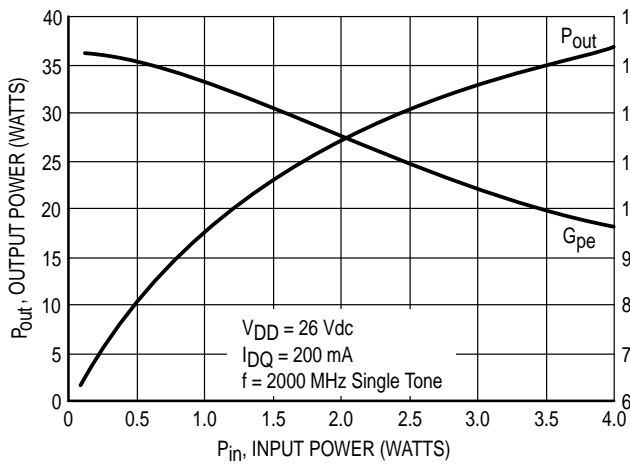
Figure 1. Schematic of 1.93–2.0 GHz Broadband Test Circuit



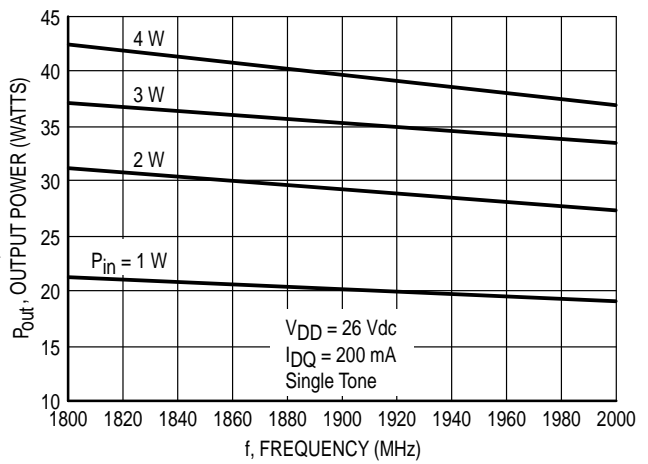
B1 – B5	Ferrite Bead, Round	R5	2 x 1500 $\Omega$ , Fixed Film Chip Resistor 0.08" x 0.13"
C1, C9, C16	100 $\mu$ F, 50 V, Electrolytic Capacitor, Sprague	R6	270 $\Omega$ , Fixed Film Chip Resistor, 0.08" x 0.13"
C2, C13	51 pF, ATC RF Chip Capacitors, Case "B"	R7 – R11	12 $\Omega$ , Fixed Film Chip Resistor, 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 $\mu$ 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 $\Omega$ , Fixed Film Chip Resistor 0.08" x 0.13"	Z15	0.990" x 0.080" Microstrip
R2	2 x 12 k $\Omega$ , Fixed Film Chip Resistor 0.08" x 0.13"	Z16	0.390" x 0.080" Microstrip
R3	1 $\Omega$ , Wirewound, 5 W, 3% Resistor	Raw PCB	
R4	4 x 6.8 k $\Omega$ , Fixed Film Chip Resistor 0.08" x 0.13"	Material	0.030" Glass Teflon, 2 oz Copper, 3 x 5" Dimensions, Manufacturer; Arlon, P/N: GX–0300–55–22, $\epsilon_r = 2.55$

Figure 2. Schematic of 2.0 GHz Class A Test Circuit

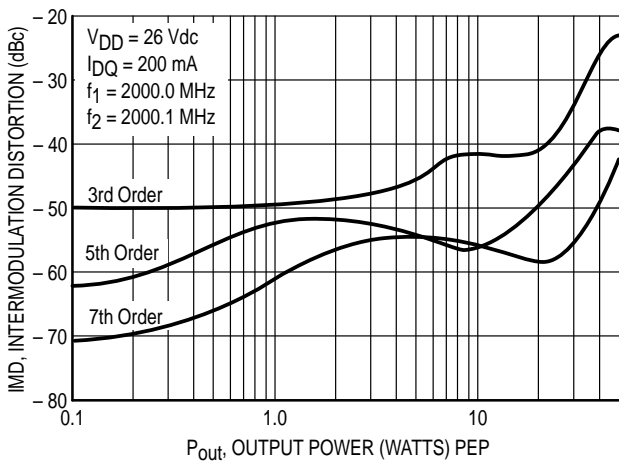
### TYPICAL CHARACTERISTICS



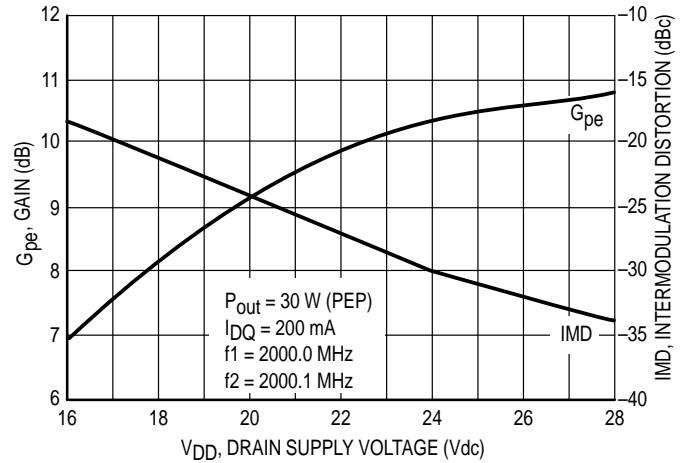
**Figure 3. Output Power & Power Gain versus Input Power**



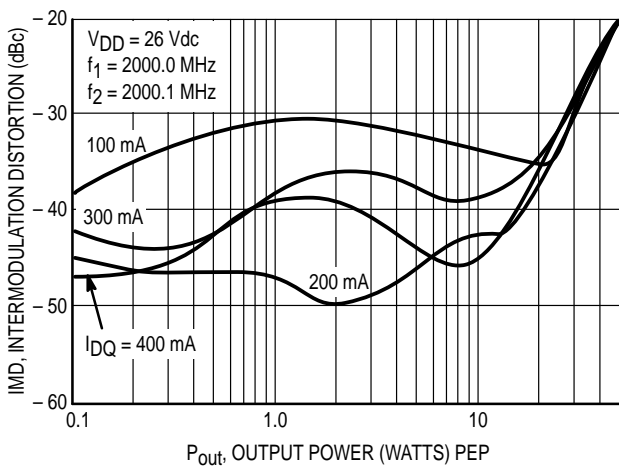
**Figure 4. Output Power versus Frequency**



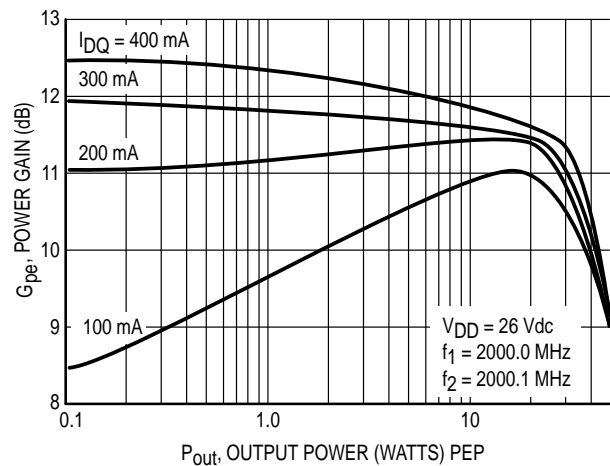
**Figure 5. Intermodulation Distortion versus Output Power**



**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

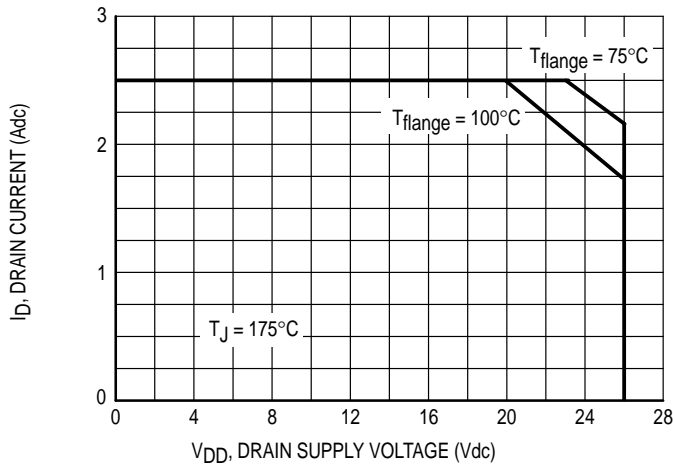


Figure 9. DC Safe Operating Area

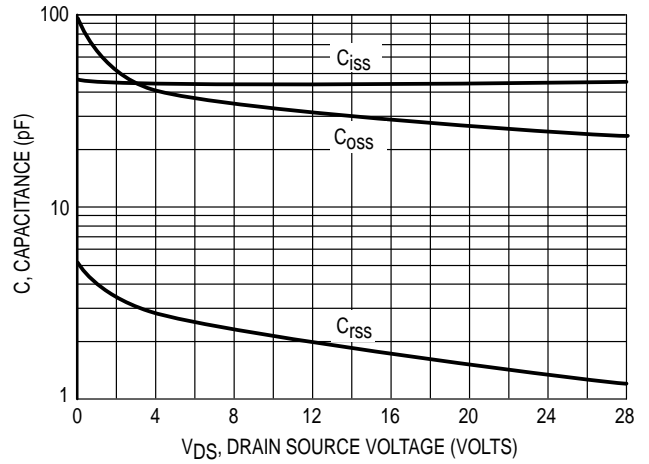


Figure 10. Capacitance versus Drain Source Voltage

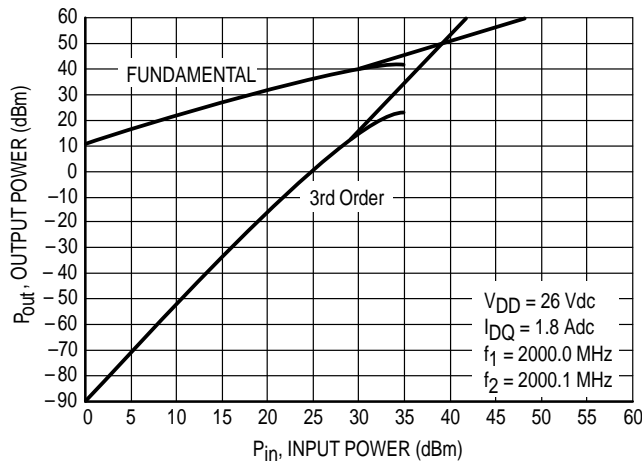


Figure 11. Class A Third Order Intercept Point

### TYPICAL CHARACTERISTICS

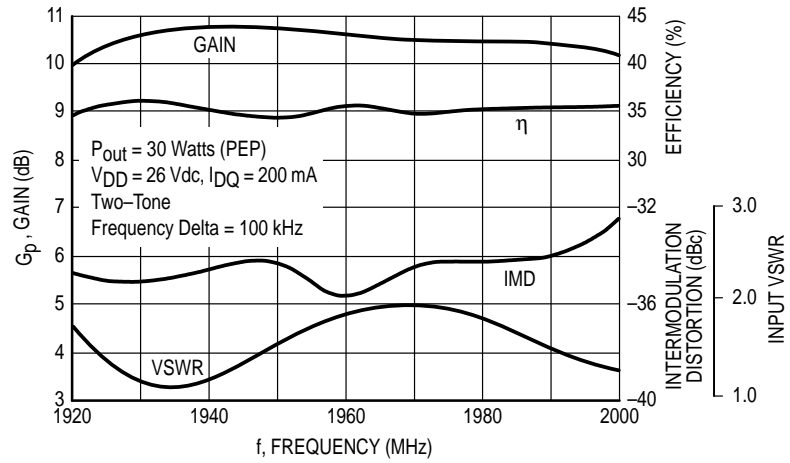
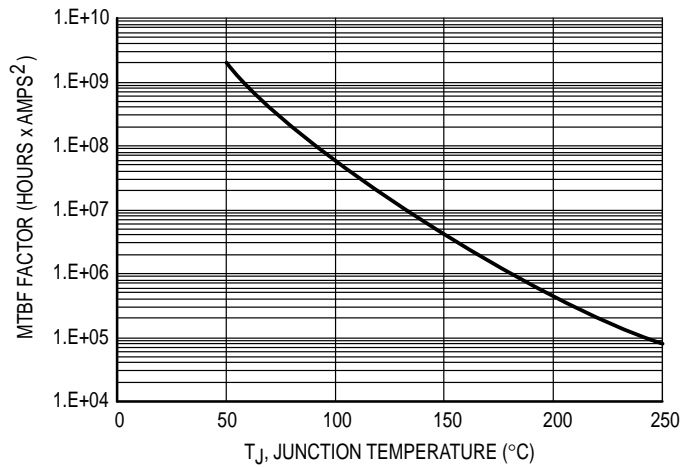
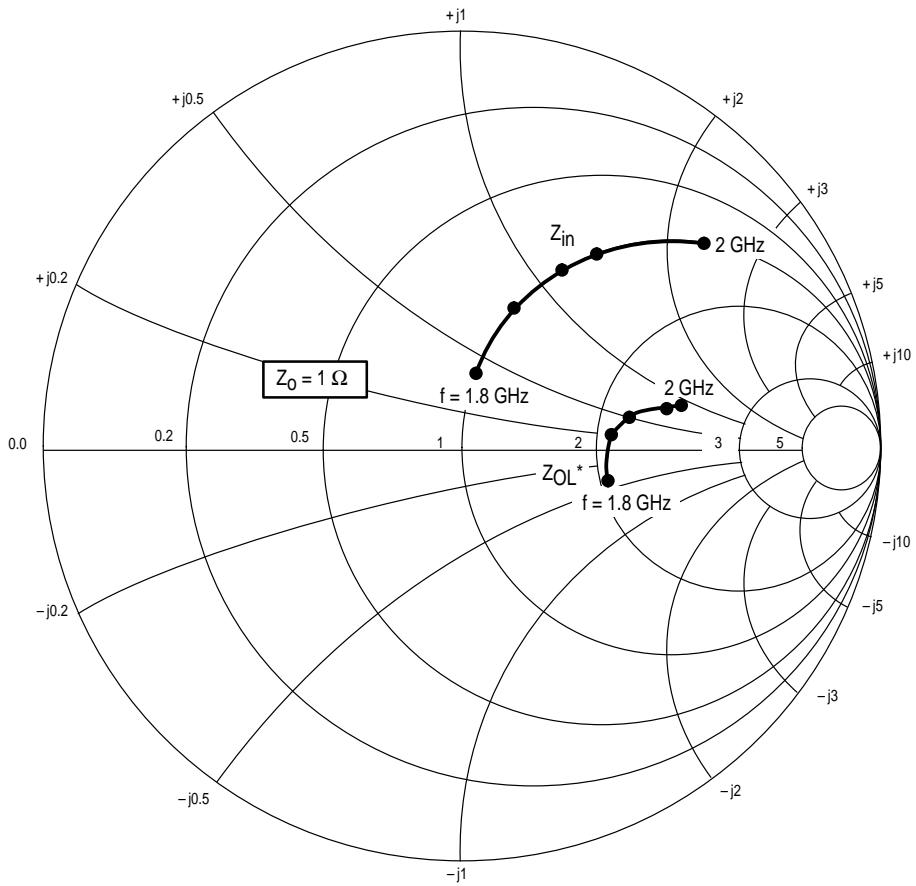


Figure 12. 1.92–2.0 GHz Broadband Circuit Performance



This graph displays calculated MTBF in hours x ampere<sup>2</sup> 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



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

f MHz	$Z_{in}(1)$ $\Omega$	$Z_{OL}^*$ $\Omega$
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**

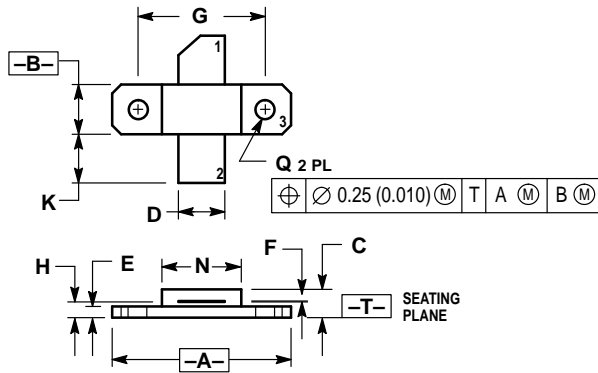


Table 1. Common Source S-Parameters at  $V_{DS} = 26$  Vdc,  $I_D = 1.8$  Adc

f GHz	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
	S <sub>11</sub>	∠ φ	S <sub>21</sub>	∠ φ	S <sub>12</sub>	∠ φ	S <sub>22</sub>	∠ 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

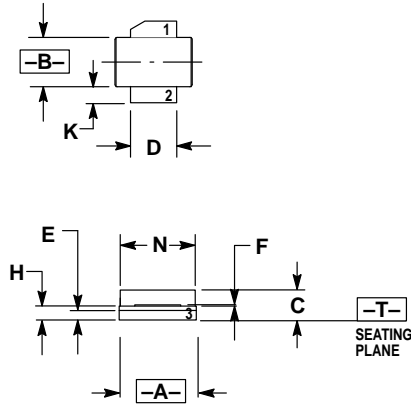


NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 2. CONTROLLING DIMENSION: INCH.

DIM	INCHES		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  
 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		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  
 2. GATE  
 3. SOURCE

CASE 360C-03  
 ISSUE B  
 (MRF284S)

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