MOTOROLA
SEMICONDUCTOR TECHNICAL DATA

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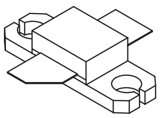
The RF Sub–Micron Bipolar Line
RF Power Bipolar Transistor

MRF20030

30 W, 2.0 GHz
NPN SILICON
BROADBAND
RF POWER TRANSISTOR



CASE 395D–03, STYLE 1

Designed for broadband commercial and industrial applications at frequencies from 1800 to 2000 MHz. The high gain and broadband performance of this device makes it ideal for large–signal, common–emitter class A and class AB amplifier applications. Suitable for frequency modulated, amplitude modulated and multi–carrier base station RF power amplifiers.

- Specified 26 Volts, 2.0 GHz, Class AB, Two–Tones Characteristics
  Output Power — 30 Watts (PEP)
  Power Gain — 9.8 dB
  Efficiency — 34%
  Intermodulation Distortion — –28 dBc
- Typical 26 Volts, 1.88 GHz, Class AB, CW Characteristics
  Output Power — 30 Watts
  Power Gain — 10.5 dB
  Efficiency — 40%
- Excellent Thermal Stability
- Capable of Handling 3:1 VSWR @ 26 Vdc, 2000 MHz, 30 Watts (PEP) Output Power
- Characterized with Series Equivalent Large–Signal Impedance Parameters
- S–Parameter Characterization at High Bias Levels
- Designed for FM, TDMA, CDMA, and Multi–Carrier Applications

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	25	Vdc
Collector–Emitter Voltage	V_{CES}	60	Vdc
Collector–Base Voltage	V_{CBO}	60	Vdc
Collector–Emitter Voltage (R_{BE} = 100 Ω)	V_{CER}	30	Vdc
Emitter–Base Voltage	V_{EB}	–3	Vdc
Collector Current – Continuous	I_C	4	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	125 0.71	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Rating	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1)	$R_{\theta JC}$	1.4	°C/W

(1) Thermal resistance is determined under specified RF operating condition.

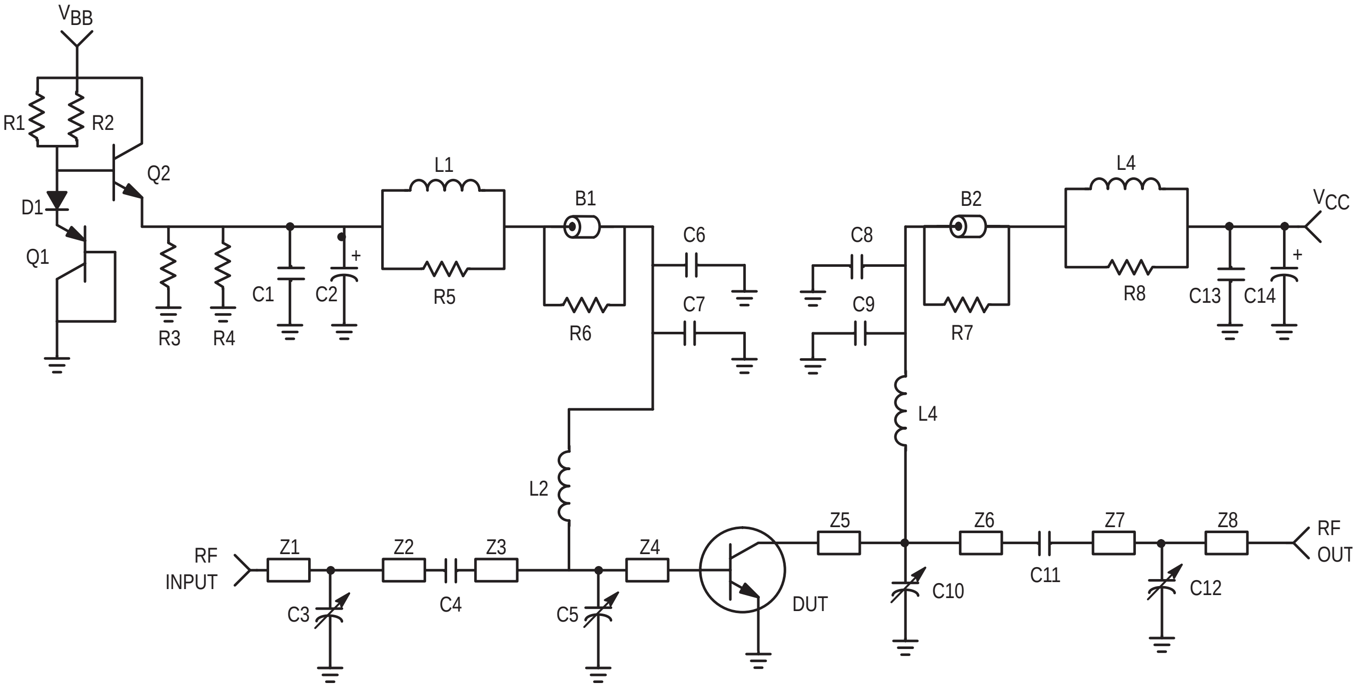
ELECTRICAL CHARACTERISTICS (T$_C$ = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	25	26	—	Vdc
Collector–Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	70	—	Vdc
Collector–Base Breakdown Voltage (I_C = 25 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	70	—	Vdc

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

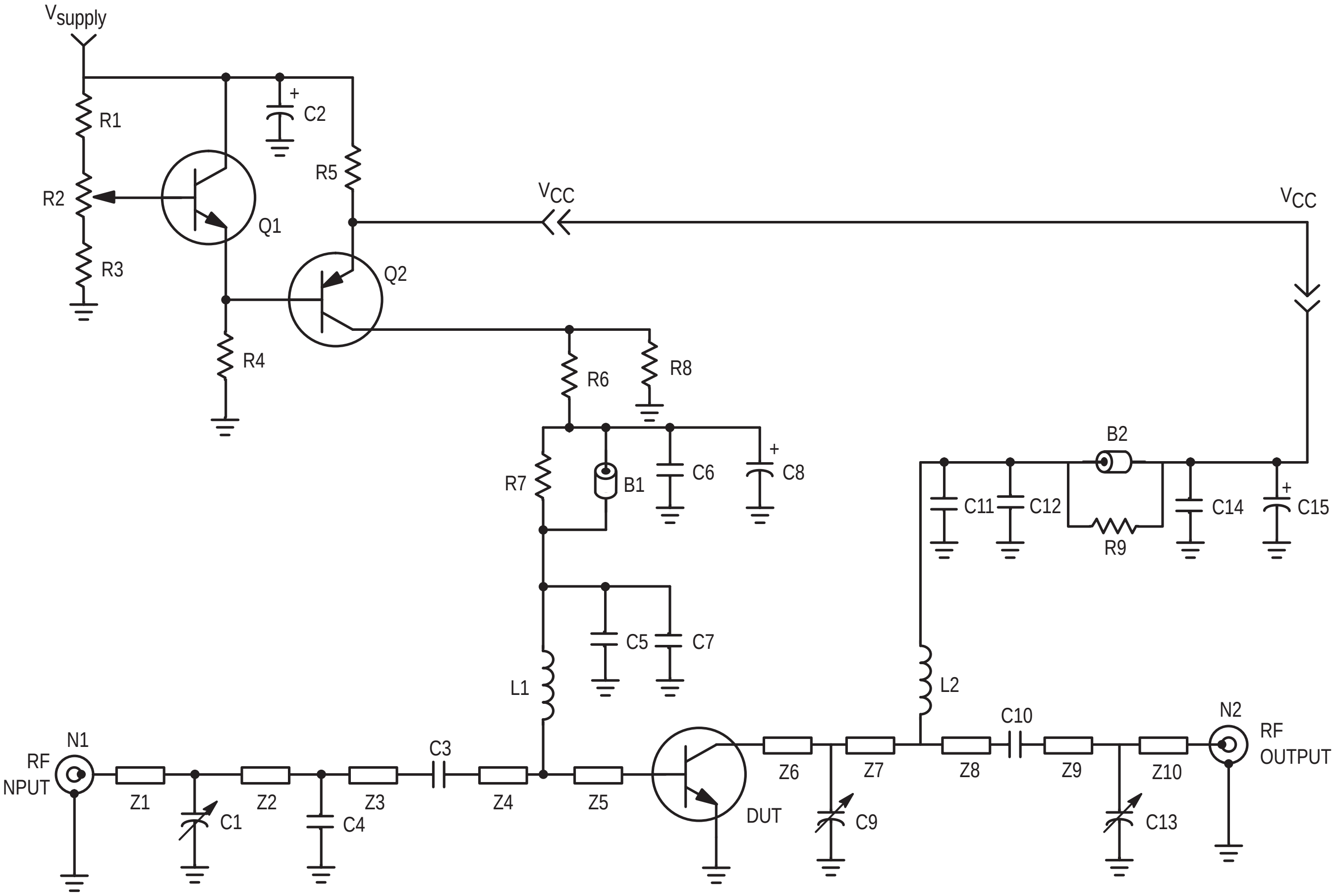
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Emitter–Base Breakdown Voltage (I_B = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	3	3.8	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (V_{CE} = 5 Vdc, I_{CE} = 1 Adc)	h_{FE}	20	40	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 Vdc, I_E = 0, f = 1.0 MHz) (1)	C_{ob}	—	28	—	pF
FUNCTIONAL TESTS (In Motorola Test Fixture)					
Common–Emitter Amplifier Power Gain (V_{CC} = 26 Vdc, P_{out} = 30 Watts, I_{CQ} = 120 mA, f_1 = 2000.0 MHz, f_2 = 2000.1 MHz)	G_{pe}	9.8	10.5	—	dB
Collector Efficiency (V_{CC} = 26 Vdc, P_{out} = 30 Watts (PEP), I_{CQ} = 120 mA, f_1 = 2000.0 MHz, f_2 = 2000.1 MHz)	η	34	38	—	%
Intermodulation Distortion (V_{CC} = 26 Vdc, P_{out} = 30 Watts (PEP), I_{CQ} = 120 mA, f_1 = 2000.0 MHz, f_2 = 2000.1 MHz)	IMD	—	– 33	– 28	dBc
Input Return Loss (V_{CC} = 26 Vdc, P_{out} = 30 Watts (PEP), I_{CQ} = 125 mA, f_1 = 2000.0 MHz, f_2 = 2000.1 MHz)	IRL	10	17	—	dB
Load Mismatch (V_{CC} = 26 Vdc, P_{out} = 30 Watts (PEP), I_{CQ} = 120 mA, f_1 = 2000.0 MHz, f_2 = 2000.1 MHz, Load VSWR = 3:1, All Phase Angles at Frequency of Test)	ψ	No Degradation in Output Power			
Common–Emitter Amplifier Power Gain (V_{CC} = 26 Vdc, P_{out} = 30 Watts (PEP), I_{CQ} = 125 mA, f_1 = 1930.0 MHz, f_2 = 1930.1 MHz)	G_{pe}	—	10.5	—	dB
Collector Efficiency (V_{CC} = 26 Vdc, P_{out} = 30 Watts (PEP), I_{CQ} = 125 mA, f_1 = 1930.0 MHz, f_2 = 1930.1 MHz)	η	—	34	—	%
Intermodulation Distortion (V_{CC} = 26 Vdc, P_{out} = 30 Watts (PEP), I_{CQ} = 125 mA, f_1 = 1930.0 MHz, f_2 = 1930.1 MHz)	IMD	—	– 35	—	dBc
Input Return Loss (V_{CC} = 26 Vdc, P_{out} = 30 Watts (PEP), I_{CQ} = 125 mA, f_1 = 1930.0 MHz, f_2 = 1930.1 MHz)	IRL	—	14	—	dB
GUARANTEED BUT NOT TESTED (In Motorola Test Fixture)					
Common–Emitter Amplifier Power Gain (V_{CC} = 26 Vdc, P_{out} = 30 Watts, I_{CQ} = 125 mA, f = 1880 MHz)	G_{pe}	—	10.5	—	dB
Collector Efficiency (V_{CC} = 26 Vdc, P_{out} = 30 Watts , I_{CQ} = 125 mA, f = 1880 MHz)	η	—	40	—	%
Input Return Loss (V_{CC} = 26 Vdc, P_{out} = 30 Watts , I_{CQ} = 125 mA, f = 1880 MHz)	IRL	—	14	—	dB
Output Mismatch Stress (V_{CC} = 25 Vdc, P_{out} = 30 Watts, I_{CQ} = 125 mA, f = 1880 MHz, VSWR = 3:1, All Phase Angles at Frequency of Test)	ψ	Typically No Degradation in Output Power			

(1) For Information Only. This Part Is Collector Matched.



B1, B2	Ferrite Bead, P/N 5659065/3B, Ferroxcube
C1, C13	0.1 μF, Chip Capacitor, Kermet
C2	100 μF, 50 V, Electrolytic Capacitor, Mallory
C3, C5, C12	0.6–4 pF, Variable Capacitor, Johanson, Gigatrim
C4, C11	10 pF, B Case Chip Capacitor, ATC
C6, C8	24 pF, B Case Chip Capacitor, ATC
C7, C9	75 pF, B Case Chip Capacitor, ATC
C10	0.4–2.5 pF, Variable Capacitor, Johanson, Gigatrim
C14	470 μF, 63 V, Electrolytic Capacitor, Mallory
D1	Diode, Motorola (MUR3160T3)
L1, L4	12 Turns, 22 AWG, IDIA. 0.195″
L2, L3	0.750″ 20 AWG
N1, N2	Type N Flange Mount RF Connector MA/COM 3052–1648–10
R1, R2	130 Ω, 1/8 W Chip Resistor, Rohm
R3, R4	100 Ω, 1/8 W Chip Resistor, Rohm
R5, R8	10 Ω, 1/2 W Resistor
R6, R7	10 Ω, 1/8 W Chip Resistor, Rohm (10J)
Q1	Transistor, PNP Motorola (BD136)
Q2	Transistor, NPN Motorola (MJD47)
Board	30 Mil Glass Teflon®, Arlon GX–0300–55–22, $\varepsilon_r = 2.55$

Figure 1. Class AB Test Fixture Electrical Schematic



B1, B2	Long Bead, Fair Rite	Q1	Transistor, NPN, Motorola (BD135)
C1, C9, C13	0.6–4 pF, Variable Capacitor, Johanson, Gigatrim	Q2	Transistor, PNP, Motorola (BD136)
C2, C8	100 μF, 50 V, Electrolytic Capacitor, Mallory	R1	250 Ω, Chip Resistor, 1/8 Watt, Rohm
C3, C10	18 pF B Case Chip Capacitor, ATC	R2	500 Ω, 1/4 Watt, Potentiometer
C4	1.3 pF, B Case Chip Capacitor, ATC	R3	4.7 kΩ, Chip Resistor, 1/8 Watt, Rohm
C5, C11	24 pF, B Case Chip Capacitor, ATC	R4	2 x 4.7 kΩ, Chip Resistor, 1/8 Watt, Rohm
C6, C14	0.1 μF, Chip Capacitor, Kermet	R5	1.0 Ω, 10 Watt, Resistor, DALE
C7, C12	75 pF, B Case Chip Capacitor, ATC	R6	39 Ω, 1 Watt, Resistor
C15	470 μF, 63 V, Electrolytic Capacitor, Mallory	R7, R9	4 x 39 Ω, Chip Resistors, 1/8 Watt, Rohm
L1, L2	0.75 in., 20 AWG	R8	75 Ω, Chip Resistor, 1/8 Watt, Rohm
N1, N2	Type N Flange Mount RF Connector, MA/COM	Board	30 Mil Glass Teflon®, Arlon GX–0300–55–22, $\varepsilon_r = 2.55$

Figure 2. Class A Test Fixture Electrical Schematic

TYPICAL CHARACTERISTICS

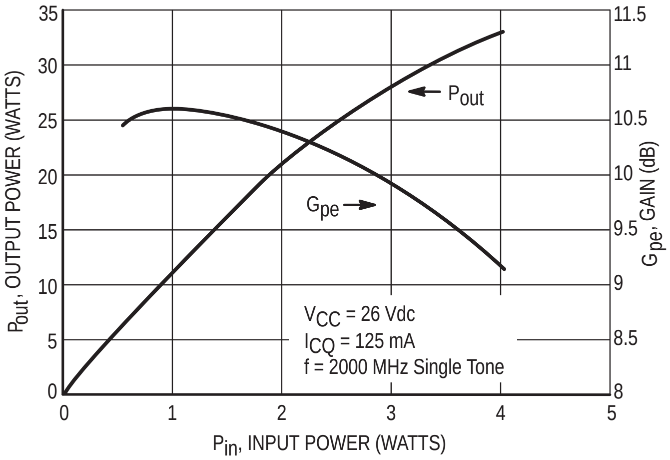


Figure 3. Output Power & Power Gain versus Input Power

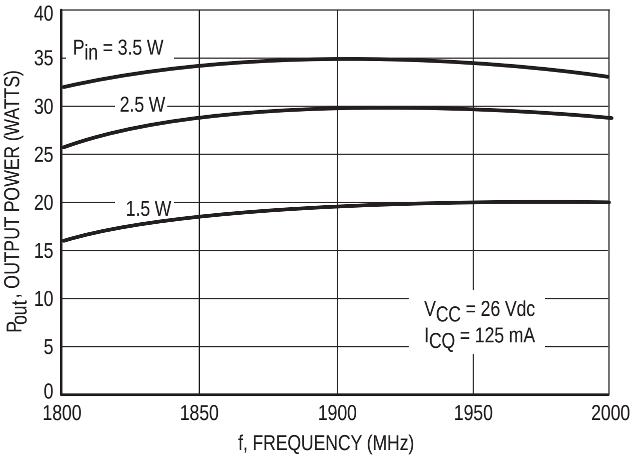


Figure 4. Output Power versus Frequency

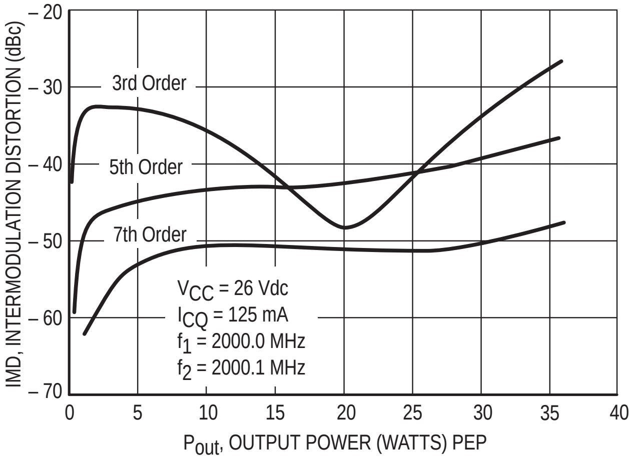


Figure 5. Intermodulation Distortion versus Output Power

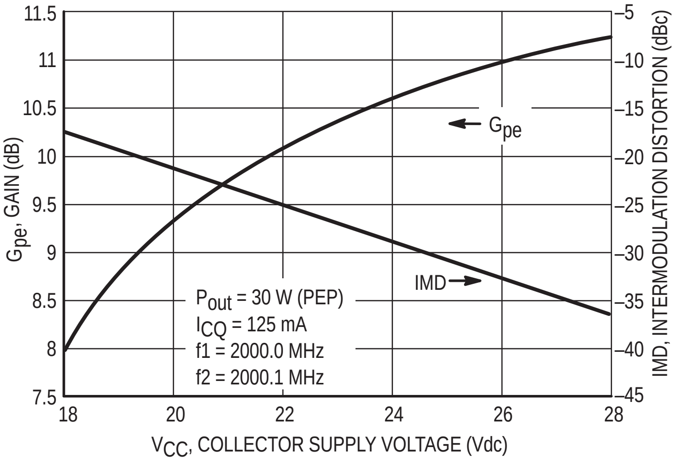


Figure 6. Power Gain and Intermodulation Distortion versus Supply Voltage

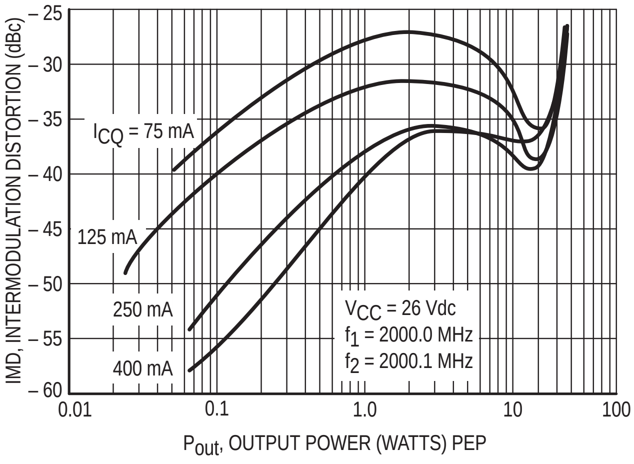


Figure 7. Intermodulation Distortion versus Output Power

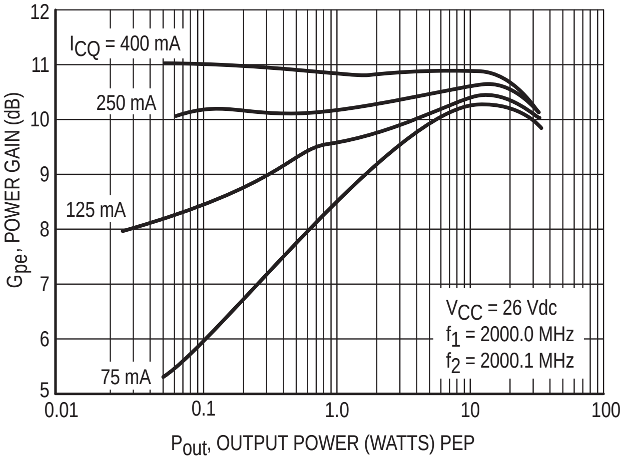


Figure 8. Power Gain versus Output Power

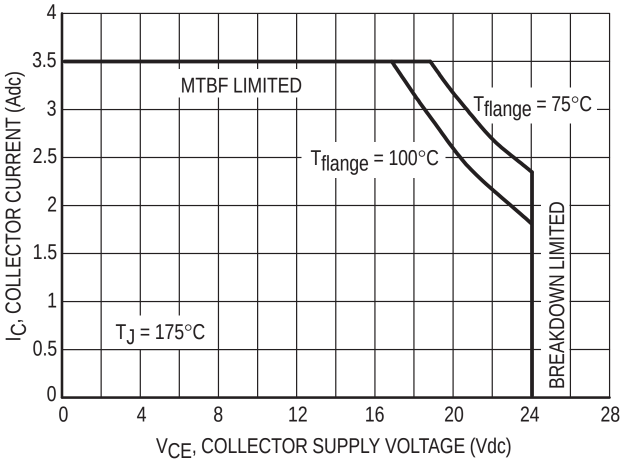


Figure 9. DC Class A Safe Operating Area

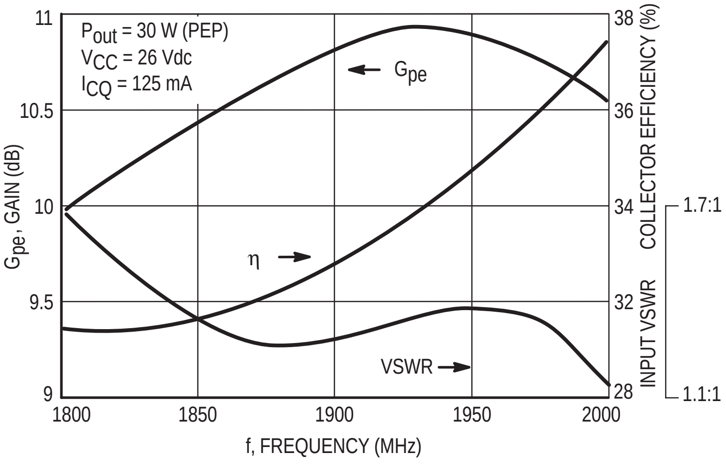


Figure 10. Performance in Broadband Circuit

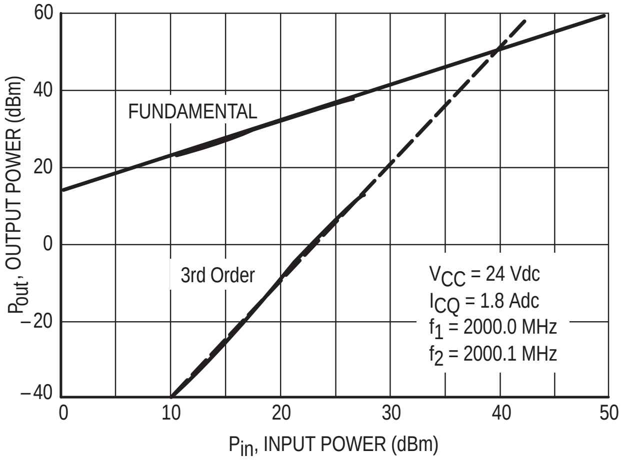
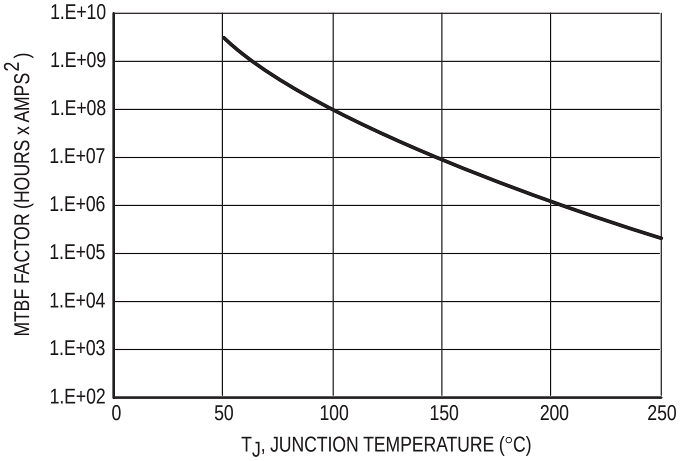
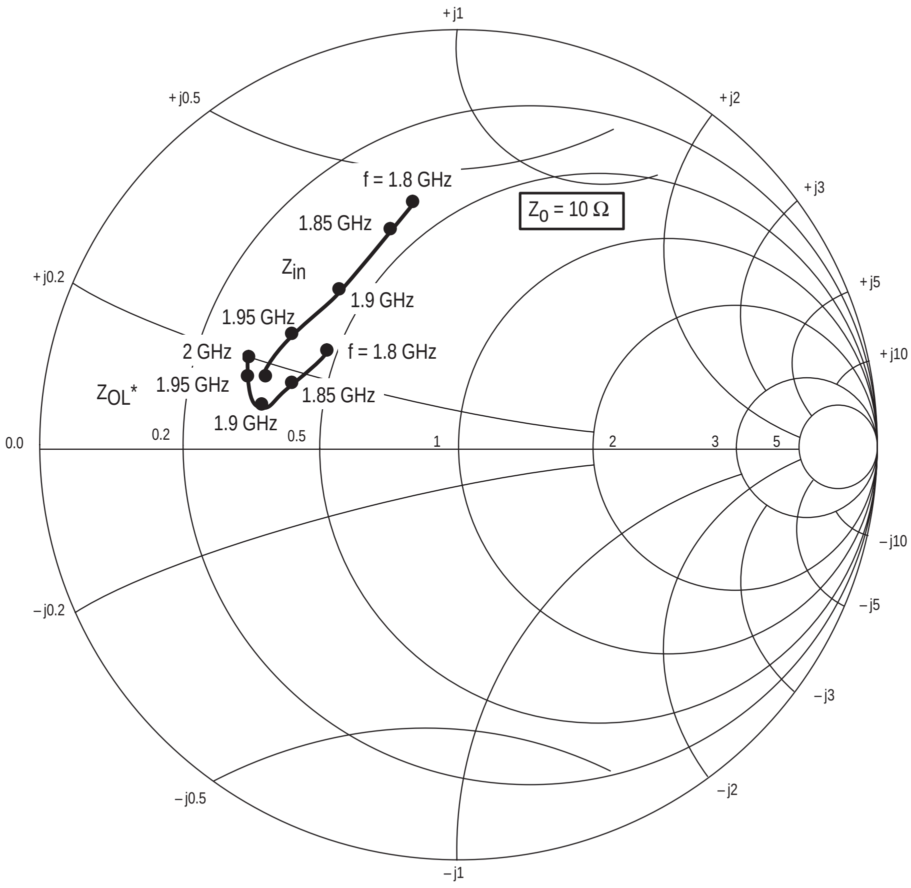


Figure 11. Class A Third Order Intercept Point



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

Figure 12. MTBF Factor versus Junction Temperature



V_{CC} = 26 V, I_{CQ} = 125 mA, P_{out} = 30 W (PEP)

f **MHz**	**Z_{in}(1)** Ω	**Z_{OL}*** Ω
1800	4.5 + j7.0	4.7 + j2.4
1850	4.5 + j6.0	4.4 + j1.6
1900	4.5 + j4.6	3.4 + j1.2
1950	3.7 + j2.4	3.3 + j1.6
2000	3.5 + j1.5	3.5 + j2.0

Z_{in}(1) = Conjugate of fixture base impedance.

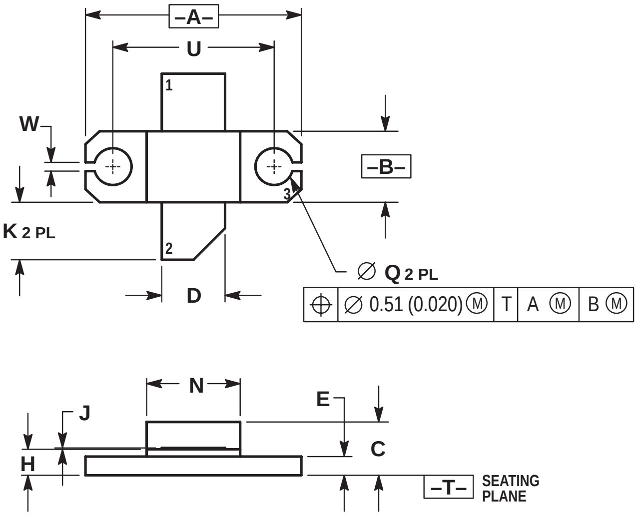
Z_{OL}* = Conjugate of the optimum load impedance at given output power, voltage, bias current and frequency.

Figure 13. Series Equivalent Input and Output Impedence

Table 1. Common Emitter S–Parameters at V_{CE} = 24 Vdc, I_C = 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
1.5	.964	158	.65	74	.046	60	.859	161
1.55	.960	156	.74	68	.047	56	.841	161
1.6	.952	155	.87	60	.049	53	.815	160
1.65	.933	153	1.05	50	.048	46	.787	161
1.7	.892	149	1.32	35	.047	40	.744	163
1.75	.804	149	1.64	13	.040	29	.719	168
1.8	.727	157	1.78	–18	.026	21	.778	175
1.85	.787	163	1.50	–50	.015	54	.883	174
1.9	.873	163	1.14	–73	.020	81	.937	171
1.95	.921	160	.84	–89	.026	88	.949	168
2	.941	157	.62	–102	.031	93	.950	165
2.05	.943	155	.48	–109	.036	93	.946	164
2.1	.940	153	.38	–118	.040	92	.942	163
2.15	.928	151	.30	–127	.042	97	.939	162
2.2	.917	150	.24	–133	.049	99	.935	161
2.25	.907	150	.20	–140	.056	101	.933	160
2.3	.888	148	.17	–150	.066	100	.926	159
2.35	.861	148	.14	–159	.077	98	.916	157
2.4	.853	149	.11	–167	.087	92	.909	157
2.45	.860	146	.10	–176	.095	89	.900	155
2.5	.880	146	.10	156	.119	84	.880	155

PACKAGE DIMENSIONS



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

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.739	0.750	18.77	19.05
B	0.240	0.260	6.10	6.60
C	0.165	0.198	4.19	5.03
D	0.215	0.225	5.46	5.72
E	0.060	0.070	1.52	1.78
H	0.084	0.096	2.13	2.44
J	0.004	0.006	0.10	0.15
K	0.178	0.208	4.52	5.28
N	0.315	0.330	8.00	8.38
Q	0.125	0.135	3.18	3.42
U	0.560 BSC		14.23 BSC	
W	0.035	0.045	0.89	1.14

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER

CASE 395D–03
ISSUE B

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ARCHIVE INFORMATION

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