MOTOROLA
SEMICONDUCTOR TECHNICAL DATA

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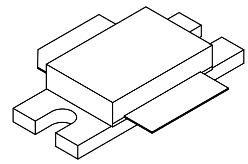
The RF Sub–Micron Bipolar Line
RF Power Bipolar Transistors

Designed for broadband commercial and industrial applications at frequencies from 1400 to 1600 MHz. The high gain and broadband performance of these devices makes them ideal for large–signal, common–emitter class A and class AB amplifier applications in 26 volt amplitude modulated and multi–carrier base station equipment.

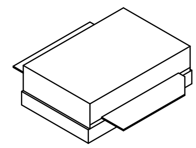
- Guaranteed Two–Tone Performance at 1490 MHz, 26 Volts
  Output Power — 60 Watts (PEP)
  Power Gain — 10 dB
  Efficiency — 33%
- Characterized with Series Equivalent Large–Signal Impedance Parameters
- S–Parameter Characterization at High Bias Levels
- Excellent Thermal Stability
- All Gold Metal for Ultra Reliability
- Capable of Handling 3:1 VSWR @ 26 Vdc, 1490 MHz, 60 Watts (PEP) Output Power

MRF15060
MRF15060S

60 W, 1.49 GHz
RF POWER
BIPOLAR
TRANSISTORS



CASE 451–04, STYLE 1
(MRF15060)



CASE 451A–01, STYLE 1
(MF15060S)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector–Emitter Voltage	V_{CEO}	25	Vdc
Collector–Emitter Voltage	V_{CES}	60	Vdc
Emitter–Base Voltage	V_{EBO}	60	Adc
Collector Current – Continuous	I_C	8	Adc
Total Device Dissipation @ T_C = 70°C Derate above 70°C	P_D	185 1.43	Watts W/°C
Storage Temperature Range	T_{stg}	– 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

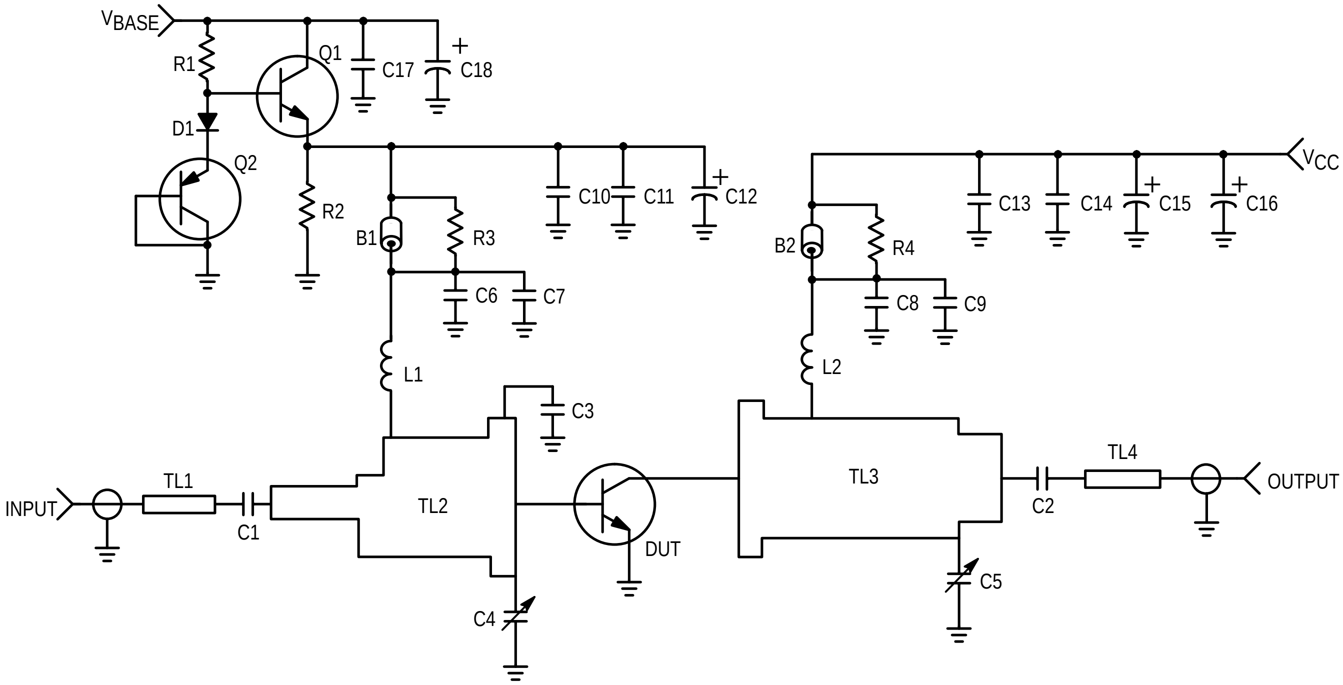
Rating	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	°C/W

MOTOROLA

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector–Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0 mAdc)	$V_{(BR)EBO}$	3	3.5	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	20	40	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 Vdc, I_E = 0, f = 1.0 MHz) (1)	C_{ob}	—	55	—	pF
FUNCTIONAL TESTS (In Motorola Test Circuit. See Figure 1)					
Common–Emitter Amplifier Power Gain (V_{CC} = 26 Vdc, P_{out} = 60 Watts (PEP), I_{CQ} = 200 mA, f_1 = 1490.0 MHz, f_2 = 1490.1 MHz)	G_{pe}	10	11.7	—	dB
Collector Efficiency (V_{CC} = 26 Vdc, P_{out} = 60 Watts (PEP), I_{CQ} = 200 mA, f_1 = 1490.0 MHz, f_2 = 1490.1 MHz)	η	33	38	—	dB
3rd Order Intermodulation Distortion (V_{CC} = 26 Vdc, P_{out} = 60 Watts (PEP), I_{CQ} = 200 mA, f_1 = 1490.0 MHz, f_2 = 1490.1 MHz)	IMD	—	– 32	– 28	dB
Input Return Loss (V_{CC} = 26 Vdc, P_{out} = 60 Watts (PEP), I_{CQ} = 200 mA, f_1 = 1490.0 MHz, f_2 = 1490.1 MHz)	IRL	12	20	—	dB
Output Mismatch Stress (V_{CC} = 26 Vdc, P_{out} = 60 Watts (PEP), I_{CQ} = 200 mA, f_1 = 1490.0 MHz, f_2 = 1490.1 MHz, VSWR = 3:1, at All Phase Angles)	ψ	No Degradation in Output Power			

(1) For information only. This part is collector matched.



B1, B2	Short RF Bead Fair Rite–2743019447	D1	Diode, 1N4003
C1, C2, C6, C8	18 pF, Chip Capacitor	L1, L2	3 Turns, 20 AWG, IDIA 0.102″ (17.7 nH)
C3	3.9 pF, Chip Capacitor	Q1	Transistor, NPN BD135
C4, C5	0.6–4.5 pF, Variable Capacitor	Q2	Transistor, PNP BD136
C7, C9	100 pF, Chip Capacitor	R1	120 Ω, 1/4 W Resistor
C10, C13	1000 pF, Chip Capacitor	R2	51 Ω, 1/4 W, Chip Resistor
C11, C14, C17	0.1 µF, 50 Vdc Ceramic Capacitor	R3, R4	4 x 39 Ω, 1/8 W Chip Resistors
C12, C15, C18	10 µF, 50 Vdc Electrolytic Capacitor	TL1–TL4	Microstrip Line See Photomaster
C16	250 µF, 50 Vdc Electrolytic Capacitor	Board	1/32″ Glass Teflon®, Arlon GX–0300–55–22, ε_r = 2.55

Figure 1. MRF15060 RF Test Fixture Schematic

TYPICAL CHARACTERISTICS

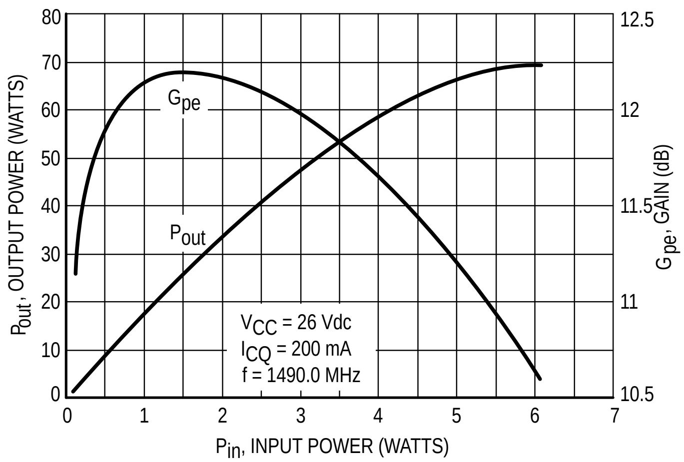


Figure 2. Output Power & Power Gain versus Input Power

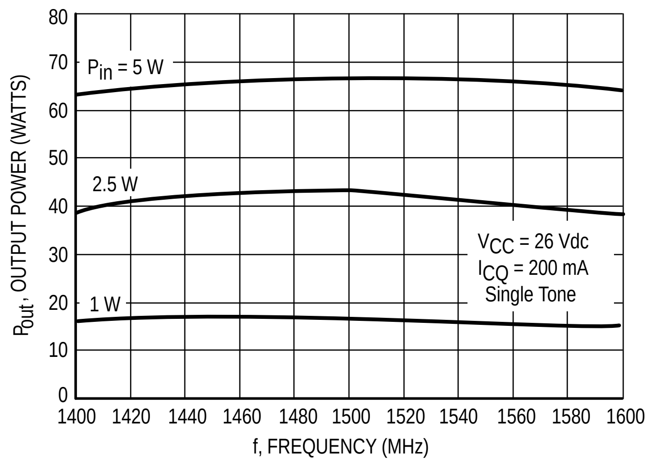


Figure 3. Output Power versus Frequency

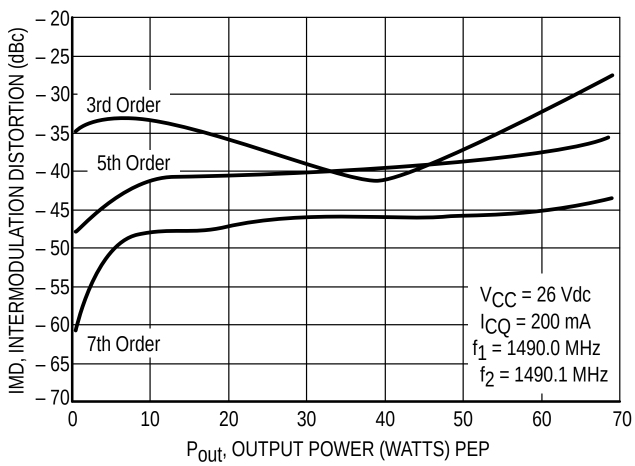


Figure 4. Intermodulation Distortion versus Output Power

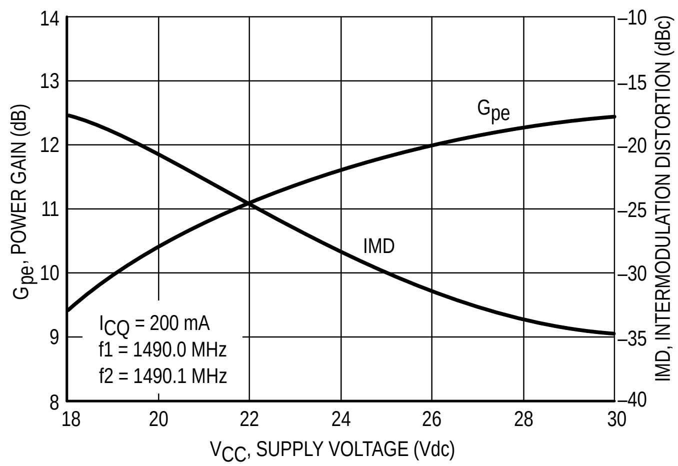


Figure 5. Power Gain and Intermodulation Distortion versus Supply Voltage

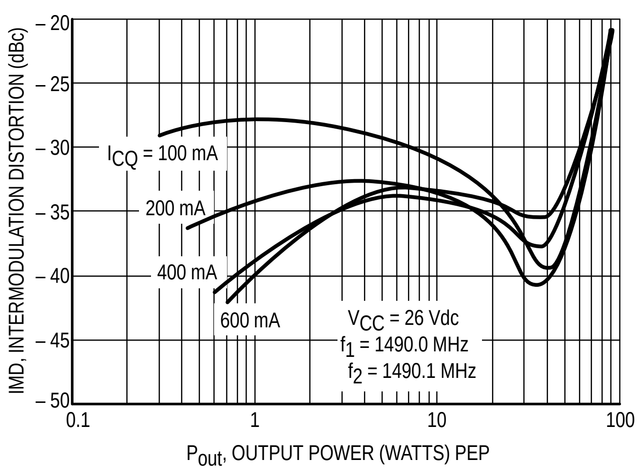


Figure 6. Intermodulation Distortion versus Output Power

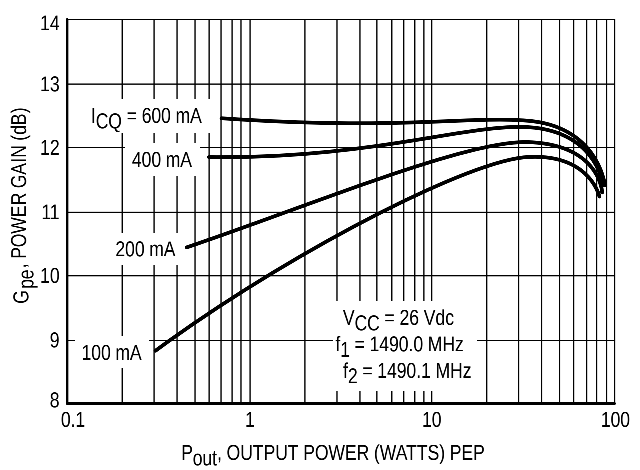


Figure 7. Power Gain versus Output Power

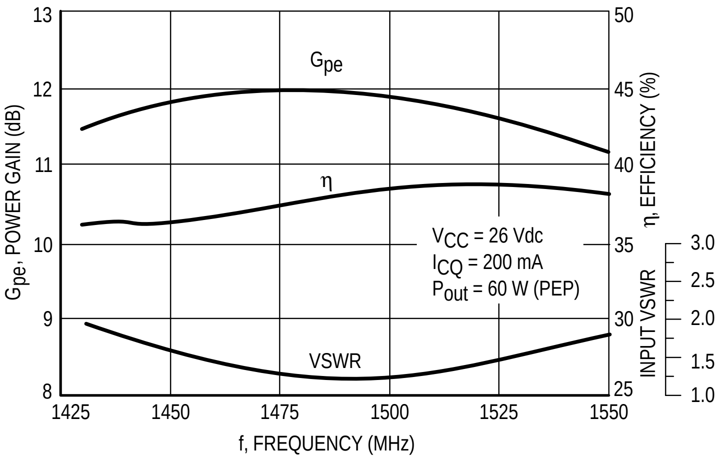


Figure 8. Performance in Broadband Circuit

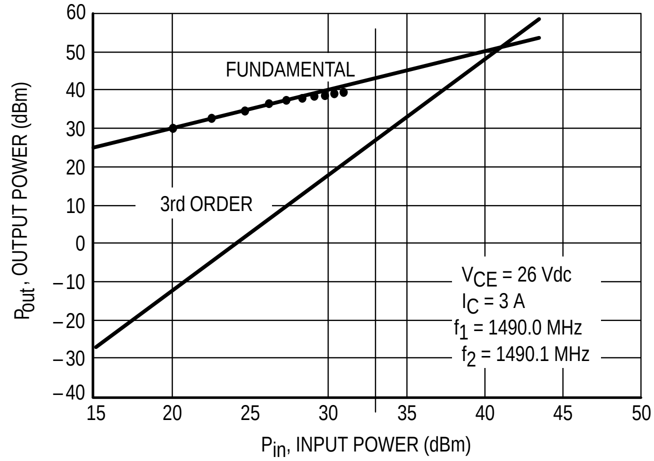


Figure 9. Class A Third Order Intercept Point

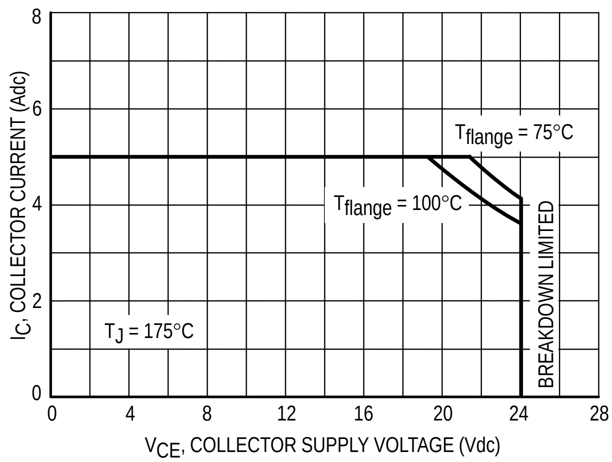
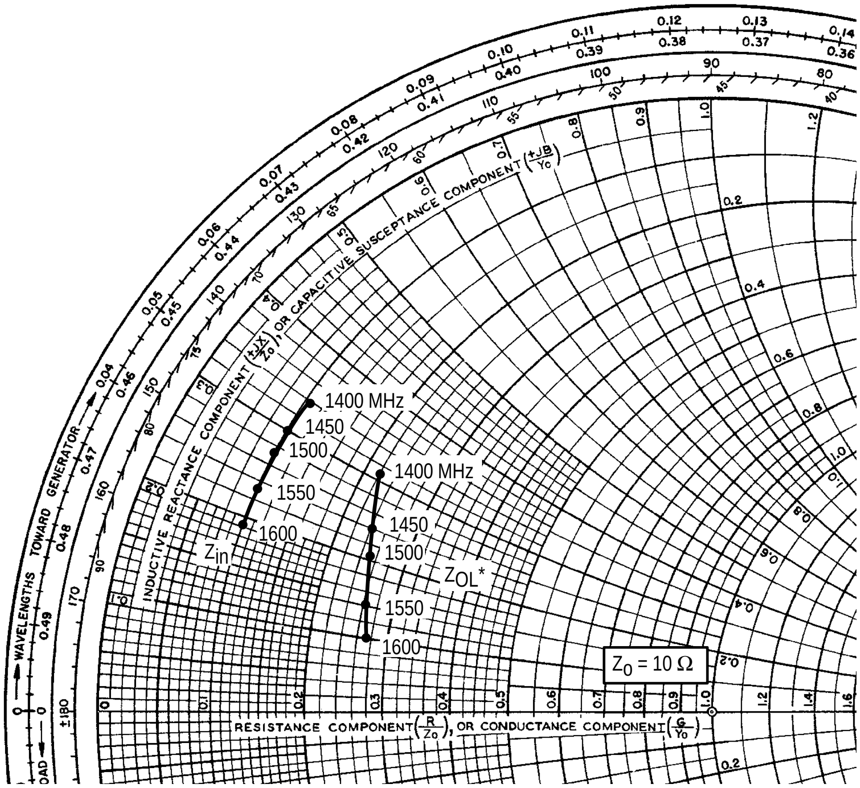


Figure 10. DC Safe Operating Area



V_{CC} = 26 Vdc, I_{CQ} = 200 mA, P_{out} = 60 Watts PEP

f MHz	Z_{in}(1) Ohms	Z_{OL}* Ohms
1400	1.07 + j3.4	2.25 + j3.1
1450	1.04 + j3.0	2.37 + j2.4
1500	1.01 + j2.7	2.46 + j2.1
1550	0.99 + j2.3	2.54 + j1.4
1600	0.97 + j1.9	2.66 + j1.0

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 11. Series Equivalent Input and Output Impedence

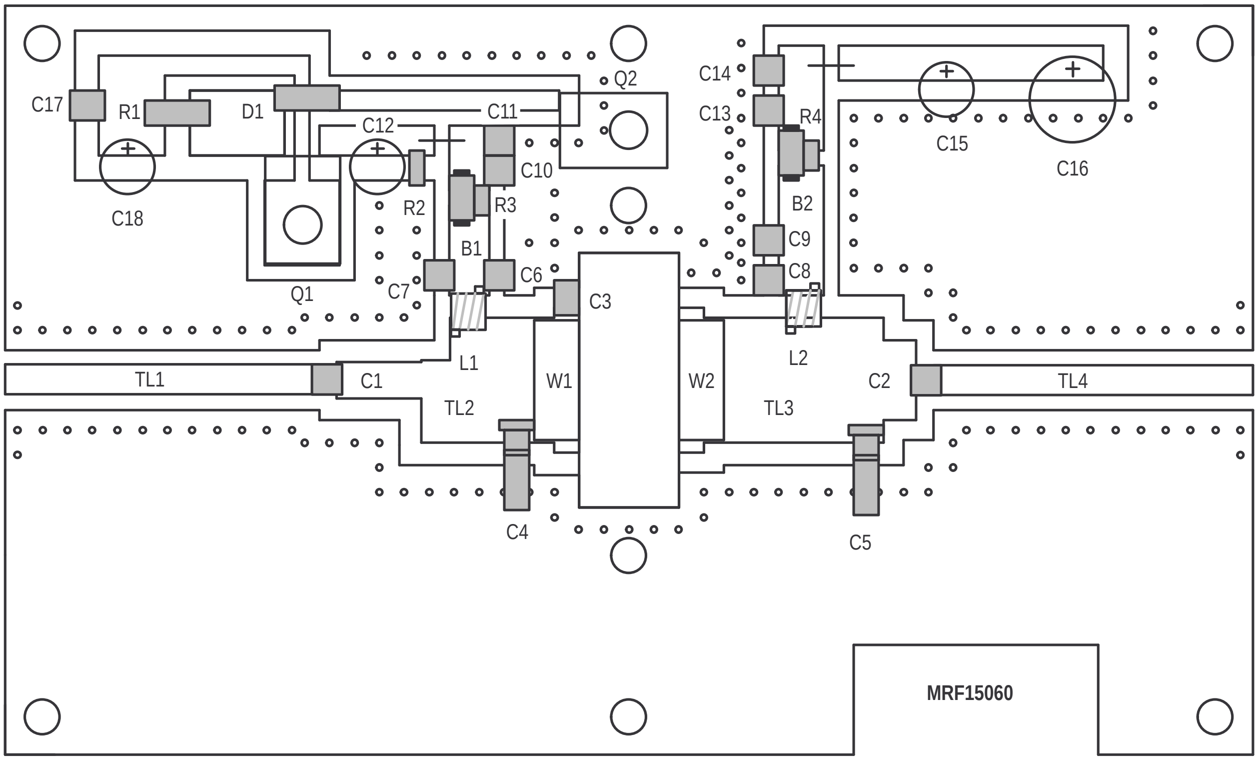


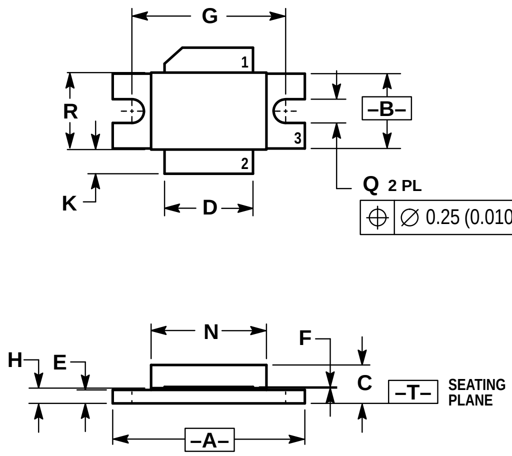
Figure 12. MRF15060 Component Parts Layout

Table 1. Typical Common Emitter S–Parameters (V_{CC} = 26 V)

I_D = 3.0 A

f MHz	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
1000	0.964	163	0.28	93	0.018	73	0.991	178
1050	0.958	162	0.30	87	0.018	76	0.989	178
1100	0.957	161	0.31	82	0.017	81	0.987	179
1150	0.956	160	0.34	76	0.022	73	0.982	179
1200	0.955	158	0.38	70	0.023	67	0.969	179
1250	0.953	157	0.42	62	0.022	57	0.956	180
1300	0.941	155	0.47	53	0.019	60	0.937	180
1350	0.922	154	0.55	43	0.015	64	0.915	-180
1400	0.920	153	0.67	28	0.013	66	0.891	-180
1450	0.901	152	0.80	6	0.012	71	0.880	-180
1500	0.903	151	0.83	-24	0.007	76	0.911	-179
1550	0.906	152	0.70	-54	0.008	89	0.954	-180
1600	0.913	153	0.51	-75	0.009	92	0.971	-180
1650	0.921	154	0.38	-89	0.010	95	0.973	-179
1700	0.946	154	0.29	-98	0.012	97	0.974	-179
1750	0.974	155	0.34	-107	0.014	105	0.976	-178
1800	0.968	154	0.19	-115	0.016	116	0.977	-178
1850	0.966	153	0.16	-121	0.018	138	0.978	-177
1900	0.947	152	0.14	-128	0.021	143	0.980	-177
1950	0.918	151	0.12	-138	0.027	151	0.982	-177
2000	0.912	150	0.09	-146	0.031	159	0.985	-176

PACKAGE DIMENSIONS

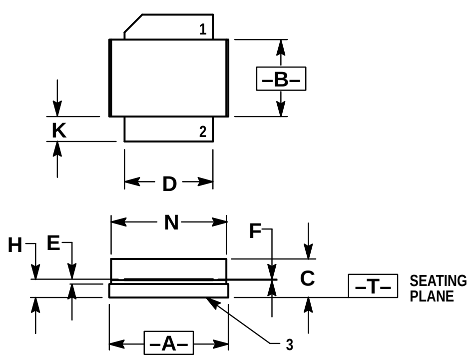


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.995	1.005	25.27	25.53
B	0.380	0.390	9.65	9.91
C	0.170	0.205	4.32	5.21
D	0.455	0.465	11.56	11.81
E	0.060	0.075	1.52	1.91
F	0.004	0.006	0.10	0.15
G	0.800 BSC		20.32 BSC	
H	0.078	0.090	1.98	2.29
K	0.117	0.137	2.97	3.48
N	0.595	0.605	15.11	15.37
Q	0.120	0.130	3.05	3.30
R	0.395	0.410	10.03	10.41

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

CASE 451–04
ISSUE D



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

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.615	0.625	15.62	15.88
B	0.395	0.410	10.03	10.41
C	0.170	0.205	4.32	5.21
D	0.455	0.465	11.56	11.81
E	0.060	0.075	1.52	1.91
F	0.004	0.006	0.10	0.15
H	0.078	0.090	1.98	2.29
K	0.117	0.137	2.97	3.48
N	0.595	0.605	15.11	15.37

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

CASE 451A–01
ISSUE O

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