

The RF Line

NPN Silicon

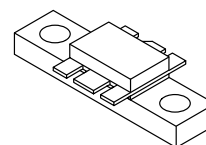
RF Power Transistor

Designed for 24 Volt UHF large-signal, common emitter, class A linear amplifier applications in industrial and commercial equipment operating in the range of 800 to 960 MHz.

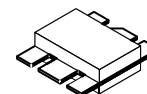
- Specified for $V_{CE} = 24$ Vdc, $I_C = 0.9$ Adc Characteristics
 - Output Power = 6.5 Watts CW
 - Minimum Power Gain = 11.5 dB
 - Minimum ITO = +47 dBm
 - Typical Noise Figure = 6 dB
- Characterized with Small-Signal S-Parameters and Series Equivalent Large-Signal Parameters from 800 to 960 MHz
- Silicon Nitride Passivated
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ 24 Vdc, $I_C = 0.9$ Adc and Rated Output Power
- Will Withstand RF Input Overdrive of 2 W CW
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Circuit Board Photomaster Available by Ordering Document MRF859PHT/D from Motorola Literature Distribution.

MRF859
MRF859S

CLASS A
800–960 MHz
6.5 W (CW), 24 V
NPN SILICON
RF POWER TRANSISTOR



CASE 319-07, STYLE 2
MRF859



CASE 319A-02, STYLE 2
MRF859S

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------|-------------|------------------------------|
| Collector-Emitter Voltage | V_{CEO} | 30 | Vdc |
| Collector-Base Voltage | V_{CBO} | 55 | Vdc |
| Emitter-Base Voltage | V_{EBO} | 4 | Vdc |
| Total Device Dissipation @ $T_C = 60^\circ\text{C}$ Derate above 60°C | P_D | 34 0.24 | Watts W/ $^\circ\text{C}$ |
| Operating Junction Temperature | T_J | 200 | $^\circ\text{C}$ |
| Storage Temperature Range | T_{stg} | -65 to +150 | $^\circ\text{C}$ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-----------------|-----|---------------------------|
| Thermal Resistance ($T_J = 150^\circ\text{C}$, $T_C = 60^\circ\text{C}$) | $R_{\theta JC}$ | 3.9 | $^\circ\text{C}/\text{W}$ |

ELECTRICAL CHARACTERISTICS

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

OFF CHARACTERISTICS

| | | | | | |
|---|---------------|----|----|---|-----|
| Collector-Emitter Breakdown Voltage ($I_C = 25$ mA, $I_B = 0$) | $V_{(BR)CEO}$ | 28 | 32 | — | Vdc |
| Collector-Emitter Breakdown Voltage ($I_C = 25$ mA, $V_{BE} = 0$) | $V_{(BR)CES}$ | 55 | 75 | — | Vdc |
| Collector-Base Breakdown Voltage ($I_C = 25$ mA, $I_E = 0$) | $V_{(BR)CBO}$ | 55 | 75 | — | Vdc |
| Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$) | $V_{(BR)EBO}$ | 4 | 5 | — | Vdc |
| Collector Cutoff Current ($V_{CB} = 15$ V, $I_E = 0$) | I_{CES} | — | — | 2 | mA |

(continued)

Teflon is a registered trademark of du Pont de Nemours & Co., Inc.

ELECTRICAL CHARACTERISTICS — continued

| Characteristic | Symbol | Min | Typ | Max | Unit |
|--|----------------|--------------------------------|-----|-----|------|
| ON CHARACTERISTICS | | | | | |
| DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$) | h_{FE} | 20 | 60 | 120 | — |
| DYNAMIC CHARACTERISTICS | | | | | |
| Output Capacitance ($V_{CB} = 24\text{ V}$, $f = 1\text{ MHz}$) | C_{ob} | 13 | — | 26 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Common-Emitter Power Gain ($V_{CE} = 24\text{ V}$, $I_C = 0.9\text{ A}$, $f = 840\text{--}900\text{ MHz}$, $P_{out} = 6.5\text{ W}$) | P_g | 11.5 | 13 | — | dB |
| Load Mismatch ($V_{CE} = 24\text{ V}$, $I_C = 0.9\text{ A}$, $f = 840\text{ MHz}$, $P_{out} = 6.5\text{ W}$, Load VSWR = 30:1, All Phase Angles) | ψ | No Degradation in Output Power | | | |
| RF Input Overdrive ($V_{CE} = 24\text{ V}$, $I_C = 0.9\text{ A}$, $f = 840\text{ MHz}$) No degradation | $P_{in(over)}$ | — | — | 2 | W |
| Third Order Intercept Point ($V_{CE} = 24\text{ V}$, $I_C = 0.9\text{ A}$, $f_1 = 900\text{ MHz}$, $f_2 = 900.1\text{ MHz}$, Meas. @ IMD 3rd Order = -40 dBc) | ITO | +47 | +48 | — | dBm |
| Noise Figure ($V_{CE} = 24\text{ V}$, $I_C = 0.9\text{ A}$, $f = 900\text{ MHz}$) | NF | — | 6 | — | dB |
| Input Return Loss ($V_{CE} = 24\text{ V}$, $I_C = 0.9\text{ A}$, $f = 840\text{--}900\text{ MHz}$, $P_{out} = 6.5\text{ W}$) | IRL | — | — | -9 | dB |

Table 1. Common Emitter S-Parameters

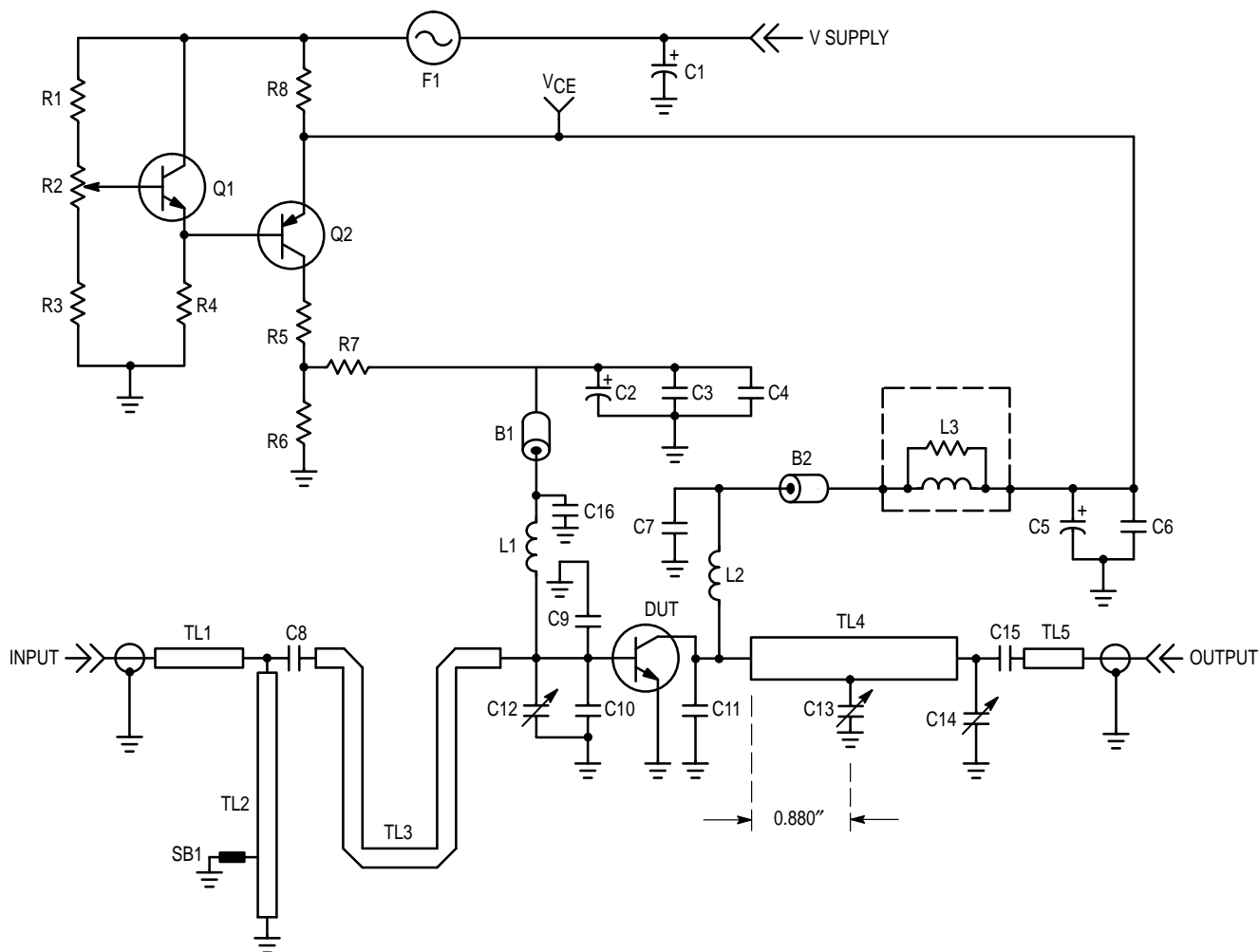
| V_{CE} (V) | I_C (A) | f (MHz) | S_{11} | | S_{21} | | S_{12} | | S_{22} | |
|-----------------|--------------|------------|------------|---------------|------------|---------------|------------|---------------|------------|---------------|
| | | | $ S_{11} $ | $\angle \phi$ | $ S_{21} $ | $\angle \phi$ | $ S_{12} $ | $\angle \phi$ | $ S_{22} $ | $\angle \phi$ |
| 24 | 0.9 | 800 | 0.906 | 170 | 1.022 | 12 | 0.016 | 11 | 0.804 | -168 |
| | | 820 | 0.902 | 170 | 1.022 | 7 | 0.015 | 8 | 0.823 | -167 |
| | | 840 | 0.897 | 171 | 1.018 | 3 | 0.013 | 6 | 0.845 | -167 |
| | | 860 | 0.894 | 171 | 1.012 | -3 | 0.011 | 4 | 0.870 | -167 |
| | | 880 | 0.893 | 171 | 1.005 | -8 | 0.009 | 3 | 0.895 | -168 |
| | | 900 | 0.893 | 171 | 0.988 | -14 | 0.007 | 5 | 0.920 | -168 |
| | | 920 | 0.894 | 172 | 0.962 | -20 | 0.005 | 14 | 0.946 | -169 |
| | | 940 | 0.897 | 172 | 0.924 | -26 | 0.008 | 47 | 0.969 | -170 |
| | | 960 | 0.903 | 172 | 0.884 | -32 | 0.004 | 102 | 0.987 | -172 |

Table 2. Z_{in} and Z_{OL}^* versus Frequency

| f (MHz) | Z_{in} (Ohms) | | Z_{OL}^* (Ohms) | |
|------------|--------------------|-----|----------------------|------|
| 840 | 1.6 | 3.3 | 2 | -4.1 |
| 870 | 1.5 | 3.6 | 1.6 | -3.3 |
| 900 | 2.2 | 3.5 | 1.7 | -2.7 |

$$V_{CE} = 24\text{ V}, I_C = 0.9\text{ A}, P_o = 6.5\text{ W}$$

Z_{OL}^* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.



| | | | |
|---------------|--|----------|--|
| B1, B2 | Ferrite Bead, Ferroxcube (56-390-65/3B) | R1 | 470 Ω , 1/4 W |
| C1 | 250 μ F, 50 Vdc, Electrolytic Capacitor | R2 | 500 Ω Potentiometer, 1/4 W |
| C2, C5 | 10 μ F, 50 Vdc, Electrolytic Capacitor | R3 | 4.7K Ω , 1/4 W |
| C3, C6 | 0.1 μ F, Chip Capacitor | R4 | 2 x 4.7K Ω , 1/4 W |
| C4 | 1000 pF, Chip Capacitor | R5 | 50 Ω , 2 W |
| C7, C16 | 100 pF, Chip Capacitor | R6 | 75 Ω , 1/4 W |
| C8, C15 | 43 pF, 100 Mil Chip Capacitor | R7 | 4.7 Ω , 1/4 W |
| C9, C10 | 6.8 pF, Mini-Unelco | R8 | 4 Ω , 10 W |
| C11 | 18 pF, Mini-Unelco | SB1 | Copper Block 0.550" x 0.180" x 0.050" |
| C12, C13, C14 | 0.8-8.0 pF, Johanson Gigatrim | TL1, TL5 | 50 Ω , Microstrip Transmission Line |
| F1 | 3 Amp Micro-Fuse | TL2 | Microstrip Transmission Line |
| L1, L2 | 3 Turns, 18 AWG, 0.170" ID | TL3 | Microstrip Transmission Line |
| L3 | 12 Turns, 22 AWG, 0.150" ID (10 Ω 1/2 W Resistor) | TL4 | Microstrip Transmission Line |
| Q1 | MMBT2222ALT1, NPN Transistor | Board | 0.030" Glass-Teflon [®] 2 oz. Cu, $\epsilon_r = 2.55$ |
| Q2 | BD136, PNP Transistor | V Supply | +27.6 Vdc \pm 0.5 Vdc Due to Resistor Tolerance |
| | | VCE | +24 Vdc @ 0.9 A |

Figure 1. MRF859 Class A RF Test Fixture Schematic

TYPICAL CHARACTERISTICS

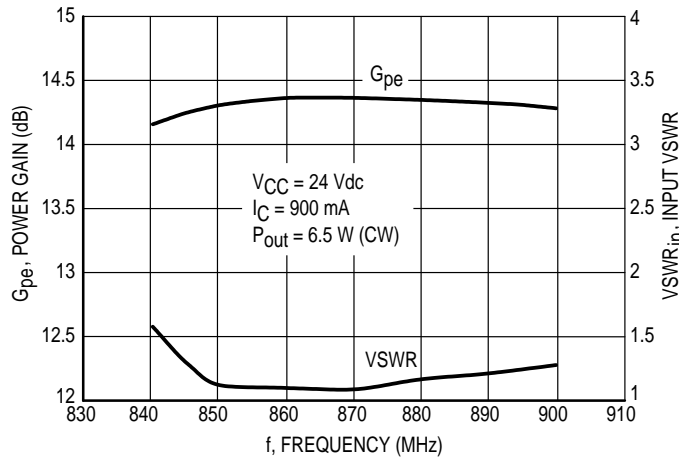


Figure 2. Performance in Broadband Circuit

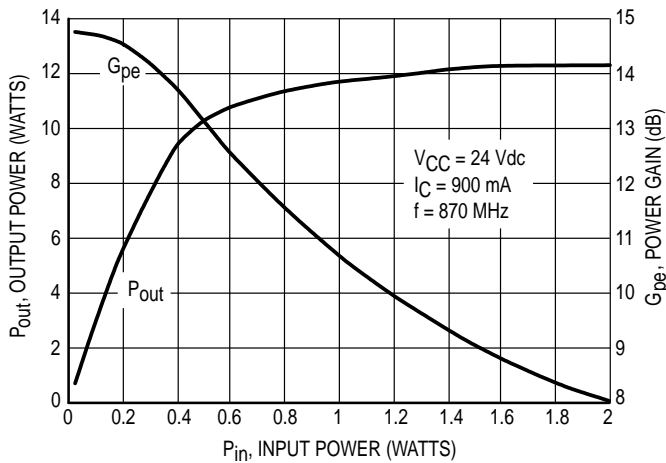


Figure 3. Output Power & Power Gain versus Input Power

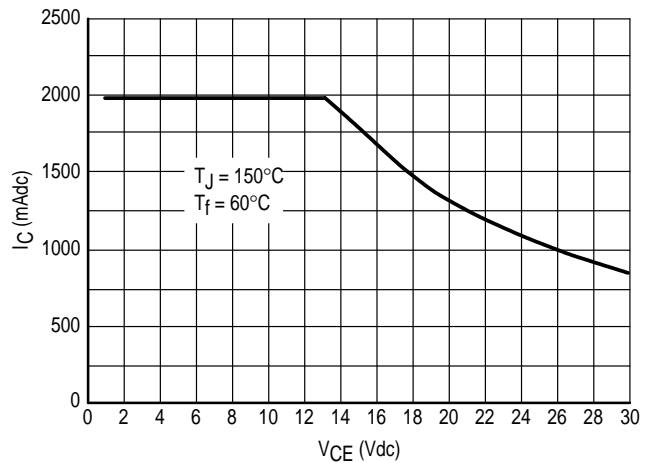


Figure 4. DC SOA

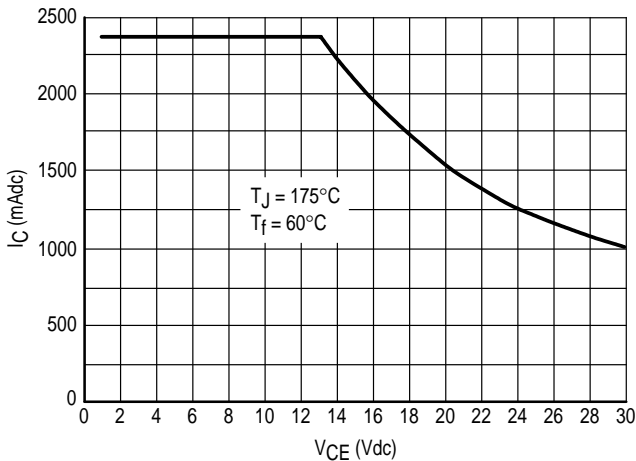


Figure 5. DC SOA

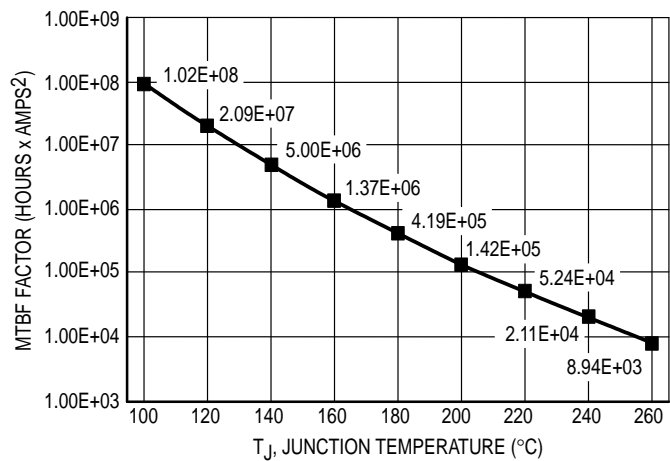


Figure 6. MTBF Factor versus Junction Temperature

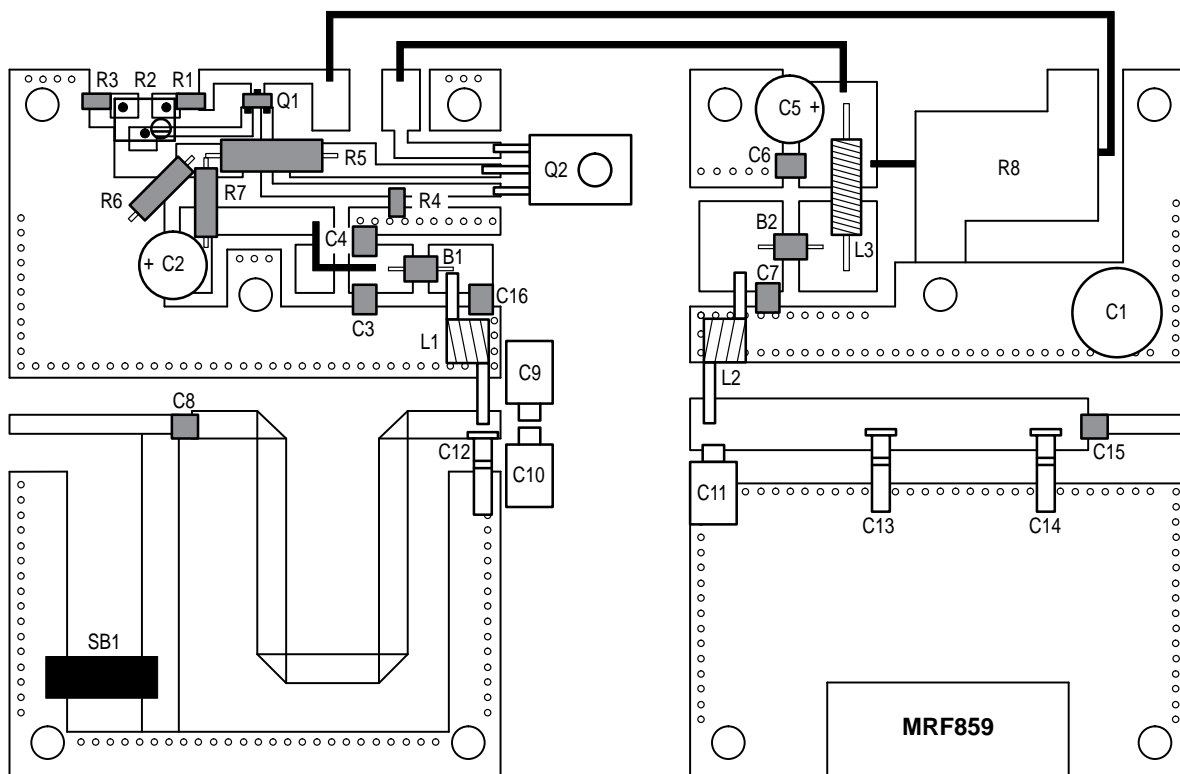



Figure 7. MRF859 Test Fixture Component Layout

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters can and do vary in different applications. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

PACKAGE DIMENSIONS

Q 2 PL
 $\oplus \text{ } \ominus 0.15 (0.006) \text{ (M) T A (M) N (M)}$

-A-
 $\oplus 0.38 (0.015) \text{ (M) T A (M) N (M)}$

D 2 PL
 $\oplus 0.38 (0.015) \text{ (M) T A (M) N (M)}$

B
 $\oplus 0.38 (0.015) \text{ (M) T A (M) N (M)}$

-N-

-T- SEATING PLANE

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

| DIM | INCHES | | MILLIMETER | |
|-----|-----------|-------|------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.965 | 0.985 | 24.52 | 25.01 |
| B | 0.355 | 0.375 | 9.02 | 9.52 |
| C | 0.230 | 0.260 | 5.85 | 6.60 |
| D | 0.115 | 0.125 | 2.93 | 3.17 |
| E | 0.102 | 0.114 | 2.59 | 2.90 |
| F | 0.075 | 0.085 | 1.91 | 2.15 |
| H | 0.160 | 0.170 | 4.07 | 4.31 |
| J | 0.004 | 0.006 | 0.11 | 0.15 |
| K | 0.090 | 0.110 | 2.29 | 2.79 |
| L | 0.725 BSC | | 18.42 BSC | |
| N | 0.225 | 0.241 | 5.72 | 6.12 |
| Q | 0.125 | 0.135 | 3.18 | 3.42 |

STYLE 2:
 PIN 1. EMITTER (COMMON)
 2. BASE (INPUT)
 3. EMITTER (COMMON)
 4. EMITTER (COMMON)
 5. COLLECTOR (OUTPUT)
 6. EMITTER (COMMON)

**CASE 319-07
 ISSUE M
 MRF859**

IDENTIFICATION NOTCH

A

K

B

1 **2** **3**

F

D

J

H

C SEATING PLANE

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

| DIM | INCHES | | MILLIMETERS | |
|-----|--------|-------|-------------|------|
| | MIN | MAX | MIN | MAX |
| A | 0.355 | 0.365 | 9.02 | 9.27 |
| B | 0.225 | 0.235 | 5.72 | 5.96 |
| C | 0.110 | 0.125 | 2.80 | 3.17 |
| D | 0.115 | 0.125 | 2.93 | 3.17 |
| F | 0.075 | 0.085 | 1.91 | 2.15 |
| H | 0.035 | 0.045 | 0.89 | 1.14 |
| J | 0.004 | 0.006 | 0.11 | 0.15 |
| K | 0.090 | 0.110 | 2.29 | 2.79 |

STYLE 2:
 PIN 1. EMITTER
 2. BASE
 3. EMITTER
 4. EMITTER
 5. COLLECTOR
 6. EMITTER

**CASE 319A-02
 ISSUE B
 MRF859S**

How to reach us:

USA / EUROPE: Motorola Literature Distribution;
 P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447

MFAX: RMFAX0@email.sps.mot.com - TOUCHTONE (602) 244-6609
INTERNET: http://Design-NET.com

JAPAN: Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, Toshikatsu Otsuki,
 6F Seibu-Butsuryu-Center, 3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-3521-8315

HONG KONG: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,
 51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

