**MOTOROLA**
**SEMICONDUCTOR TECHNICAL DATA**

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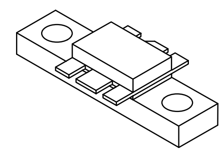
# The RF Line
# NPN Silicon RF Power Transistor

**MRF858**
**MRF858S**

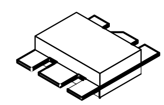
Designed for 24 Volt UHF large–signal, common emitter, class A linear amplifier applications in industrial and commercial equipment operating in the range of 800–960 MHz.

- Specified for $V_{CE}$ = 24 Vdc, $I_C$ = 0.5 Adc Characteristics
  - Output Power = 3.6 Watts CW
  - Minimum Power Gain = 11 dB
  - Minimum ITO = +44.5 dBm
  - Typical Noise Figure = 6 dB
- Characterized with Small–Signal S–Parameters and Series Equivalent Large–Signal Parameters from 800–960 MHz
- Silicon Nitride Passivated
- 100% Tested for Load Mismatch Stress at All Phase Angles with 30:1 VSWR @ 24 Vdc, $I_C$ = 0.5 Adc and Rated Output Power
- Will Withstand RF Input Overdrive of 0.85 W CW
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Circuit board photomaster available upon request by contacting RF Tactical Marketing in Phoenix, AZ.

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



**CASE 319–07, STYLE 2**
**MRF858**



**CASE 319A–02, STYLE 2**
**MRF858S**

### 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 @ $T_C$ = 50°C<br>Derate above 50°C | $P_D$ | 20<br>0.138 | Watts<br>W/°C |
| Operating Junction Temperature | $T_J$ | 200 | °C |
| Storage Temperature Range | $T_{stg}$ | –65 to +150 | °C |

### THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Thermal Resistance ($T_J$ = 150°C, $T_C$ = 50°C) | $R_{\theta JC}$ | 6.9 | °C/W |

### ELECTRICAL CHARACTERISTICS

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector–Emitter Breakdown Voltage ($I_C$ = 20 mA, $I_B$ = 0) | $V_{(BR)CEO}$ | 28 | 35 | — | Vdc |
| Collector–Emitter Breakdown Voltage ($I_C$ = 20 mA, $V_{BE}$ = 0) | $V_{(BR)CES}$ | 55 | 85 | — | Vdc |
| Collector–Base Breakdown Voltage ($I_C$ = 20 mA, $I_E$ = 0) | $V_{(BR)CBO}$ | 55 | 85 | — | Vdc |
| Emitter–Base Breakdown Voltage ($I_E$ = 1 mA, $I_C$ = 0) | $V_{(BR)EBO}$ | 4 | 5 | — | Vdc |
| Collector Cutoff Current ($V_{CB}$ = 24 V, $I_E$ = 0) | $I_{CES}$ | — | — | 1 | mA |

(continued)

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REV 2



MOTOROLA

## ELECTRICAL CHARACTERISTICS — continued

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **ON CHARACTERISTICS** | | | | | |
| DC Current Gain ($I_C$ = 0.1 A, $V_{CE}$ = 5 V) | $h_{FE}$ | 30 | 60 | 120 | — |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Output Capacitance ($V_{CB}$ = 24 V, f = 1 MHz) | $C_{ob}$ | — | 6.5 | 8 | pF |
| **FUNCTIONAL CHARACTERISTICS** | | | | | |
| Common–Emitter Power Gain ($V_{CE}$ = 24 V, $I_C$ = 0.5 A, f = 840–900 MHz, Power Output = 3.6 W) | $P_g$ | 11 | 12 | — | dB |
| Load Mismatch ($P_o$ = 3.6 W) ($V_{CE}$ = 24 V, $I_C$ = 0.5 A, f = 840 MHz, Load VSWR = 30:1, All Phase Angles) | ψ | No Degradation in Output Power | | | |
| RF Input Overdrive ($V_{CE}$ = 24 V, $I_C$ = 0.5 A, f = 840 MHz) No degradation | $P_{in(over)}$ | — | — | 0.85 | W |
| Third Order Intercept Point ($V_{CE}$ = 24 V, $I_C$ = 0.5 A) (f1 = 900 MHz, f2 = 900.1 MHz, Meas. @ IMD 3rd Order = –40 dBc) | ITO | +44.5 | +45.5 | — | dBm |
| Noise Figure ($V_{CE}$ = 24 V, $I_C$ = 0.5 A, f = 900 MHz) | NF | — | 6 | — | dB |
| Input Return Loss ($V_{CE}$ = 24 V, $I_C$ = 0.5 A, f = 840–900 MHz, Power Output = 3.6 W) | IRL | — | –12 | –9 | dB |

### Table 1. MRF858 Common Emitter S–Parameters

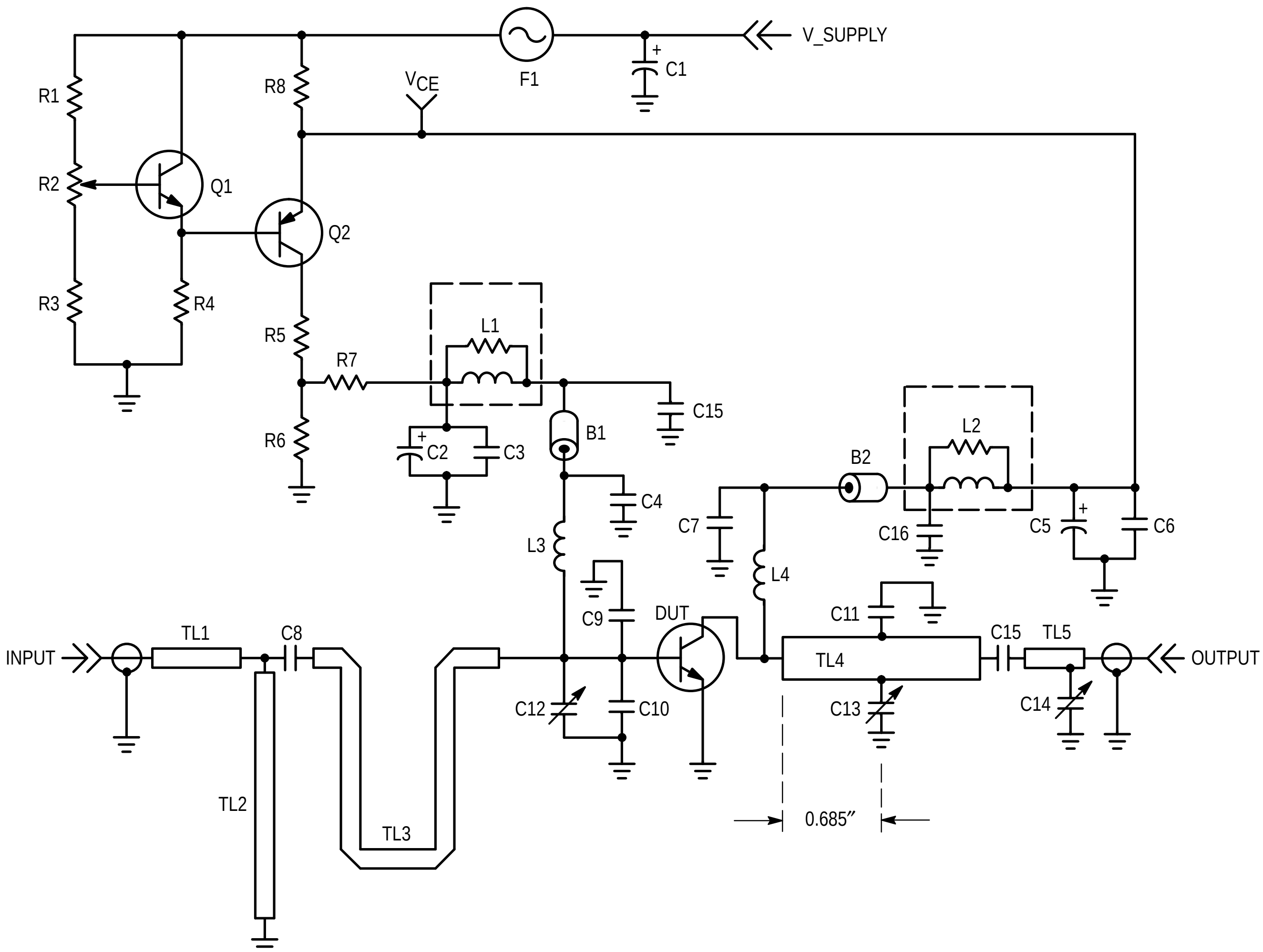
| $V_{CE}$ (V) | $I_C$ (A) | f (MHz) | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\|S_{11}\|$ | ∠ φ | $\|S_{21}\|$ | ∠ φ | $\|S_{12}\|$ | ∠ φ | $\|S_{22}\|$ | ∠ φ |
| 24 | 0.5 | 800 | 0.942 | 167 | 1.493 | 50 | 0.027 | 58 | 0.538 | –165 |
| | | 820 | 0.942 | 166 | 1.453 | 50 | 0.027 | 58 | 0.541 | –164 |
| | | 840 | 0.941 | 166 | 1.415 | 49 | 0.028 | 59 | 0.545 | –165 |
| | | 860 | 0.940 | 166 | 1.379 | 48 | 0.028 | 59 | 0.550 | –165 |
| | | 880 | 0.941 | 165 | 1.351 | 47 | 0.029 | 59 | 0.553 | –165 |
| | | 900 | 0.940 | 165 | 1.320 | 46 | 0.030 | 59 | 0.557 | –165 |
| | | 920 | 0.940 | 165 | 1.289 | 45 | 0.030 | 59 | 0.562 | –165 |
| | | 940 | 0.940 | 164 | 1.252 | 44 | 0.031 | 59 | 0.566 | –165 |
| | | 960 | 0.940 | 164 | 1.222 | 43 | 0.031 | 59 | 0.570 | –165 |

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

| f (MHz) | $Z_{in}$ (Ohms) | | $Z_{OL}$* (Ohms) | |
|---|---|---|---|---|
| 840 | 1.1 | 2.9 | 9.9 | –14.4 |
| 870 | 1.1 | 3.5 | 9.5 | –14.6 |
| 900 | 1.2 | 3.5 | 9 | –14.5 |

$V_{CE}$ = 24 V, $I_C$ = 0.5 A, $P_o$ = 3.6 W

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




| | | | |
|---|---|---|---|
| B1, B2 | Short Ferrite Bead, Fair Rite (2743021447) | R1 | 390 Ω, 1/4 W |
| C1 | 250 µF, 50 Vdc Electrolytic Capacitor | R2 | 500 Ω Potentiometer, 1/4 W |
| C2, C5 | 10 µF, 50 Vdc Electrolytic Capacitor | R3 | 7.5K Ω, 1/4 W |
| C3, C6 | 0.1 µF, Chip Capacitor | R4 | 2 x 4.7K Ω, 1/4 W |
| C4, C7 | 100 pF, Chip Capacitor | R5 | 56 Ω, 2 W |
| C8, C15 | 43 pF, 100 Mil Chip Capacitor | R6 | 75 Ω, 1/4 W |
| C9, C10 | 10 pF, Mini–Unelco | R7 | 4.7 Ω, 1/4 W |
| C11 | 5 pF, Mini–Unelco | R8 | 4 Ω, 10 W |
| C12, C13, C14 | 0.8 – 8.0 pF, Johanson Gigatrim | TL1, TL5 | 50 Ω, Microstrip Transmission Line |
| C15, C16 | 1000 pF, Chip Capacitor | TL2 | Microstrip Transmission Line |
| F1 | 1 A Micro–Fuse | TL3 | Microstrip Transmission Line |
| L1, L2 | 10 Turns, 20 AWG, 0.150″ ID (10 Ω 1/2 W Resistor) | TL4 | Microstrip Transmission Line |
| L3 | 4 Turns, 16 AWG, 0.101″ ID | V_Supply | + 26 Vdc ± 0.5 Vdc Due to Resistor Tolerance |
| L4 | 0.5″ 18 AWG Wire | $V_{CE}$ | + 24 Vdc @ 0.5 A |
| Q1 | MMBT2222ALT1, NPN Transistor | Board | 0.030″ Glass–Teflon® 2 oz. Cu, $\varepsilon_r$ = 2.55 |
| Q2 | BD136, PNP Transistor | | |

**Figure 1. MRF858 Class A RF Test Fixture Schematic**

# TYPICAL CHARACTERISTICS

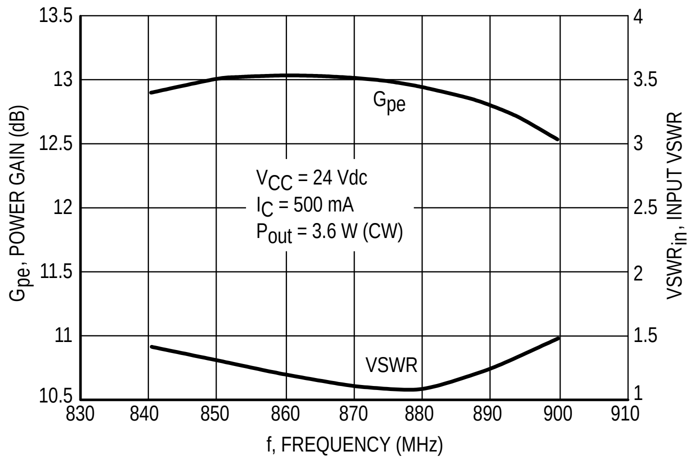



**Figure 2. Performance in Broadband Circuit**

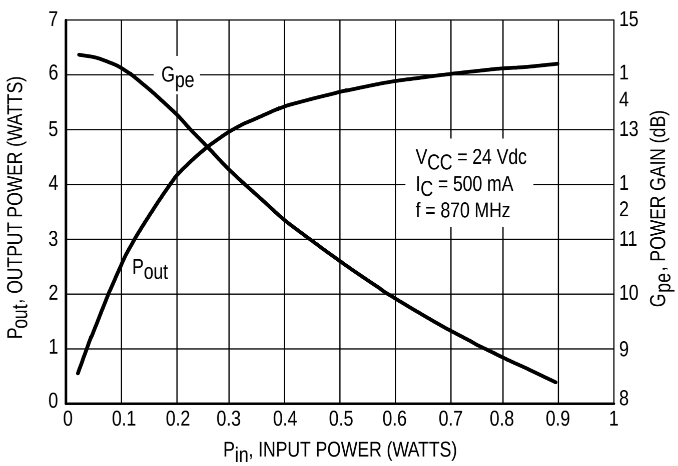



**Figure 3. Output Power & Power Gain versus Input Power**

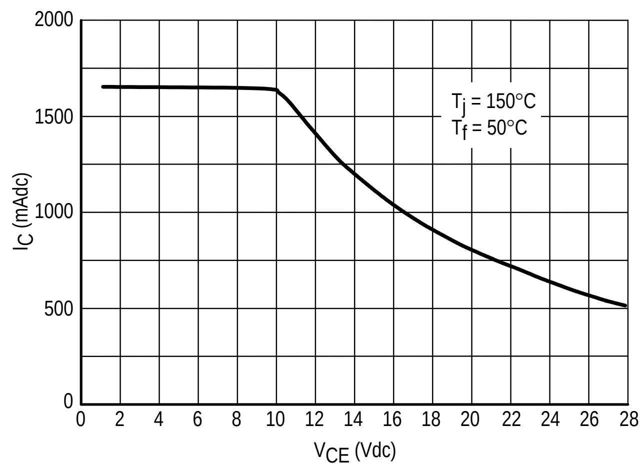



**Figure 4. DC SOA**

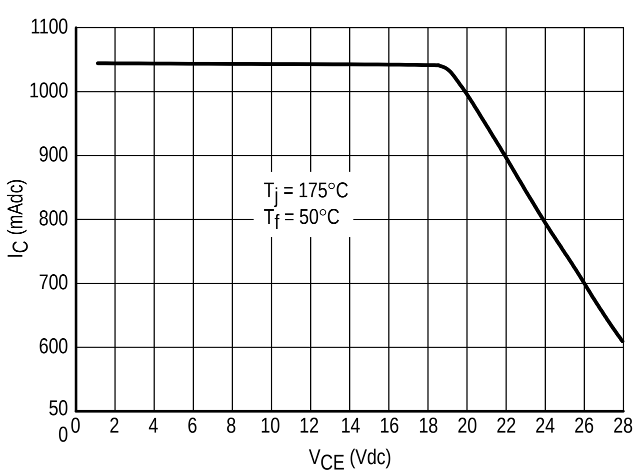



**Figure 5. DC SOA**
**(This device is MTBF limited for $V_{CE} < 20$ Vdc.)**

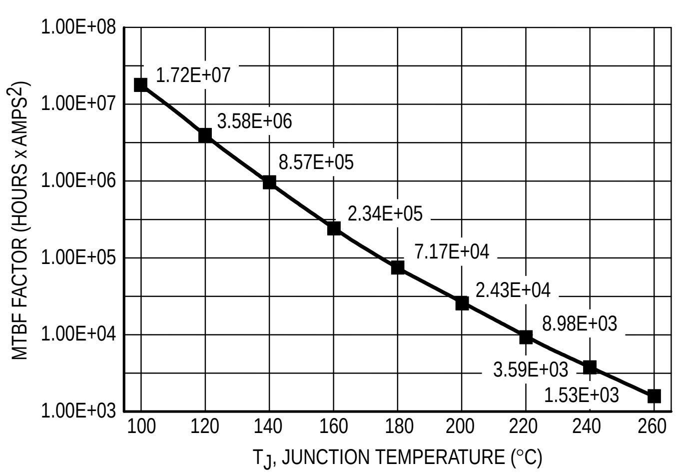



**Figure 6. MTBF Factor versus Junction Temperature**

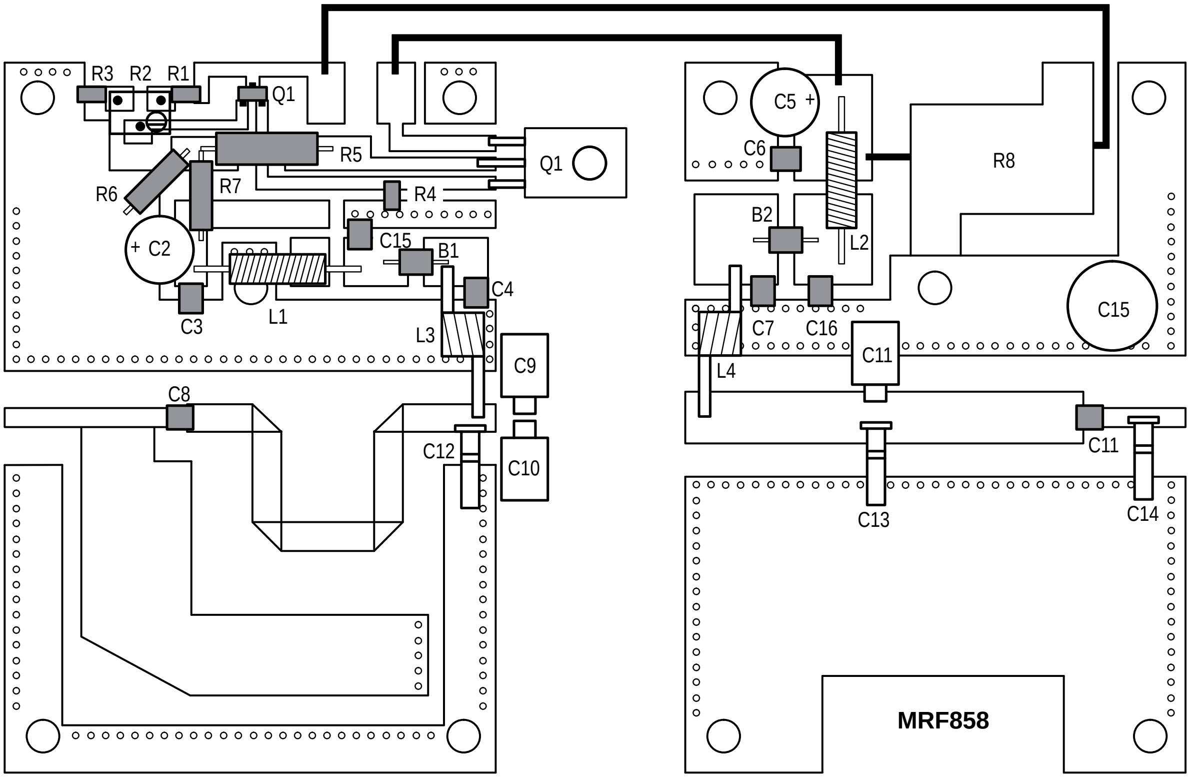
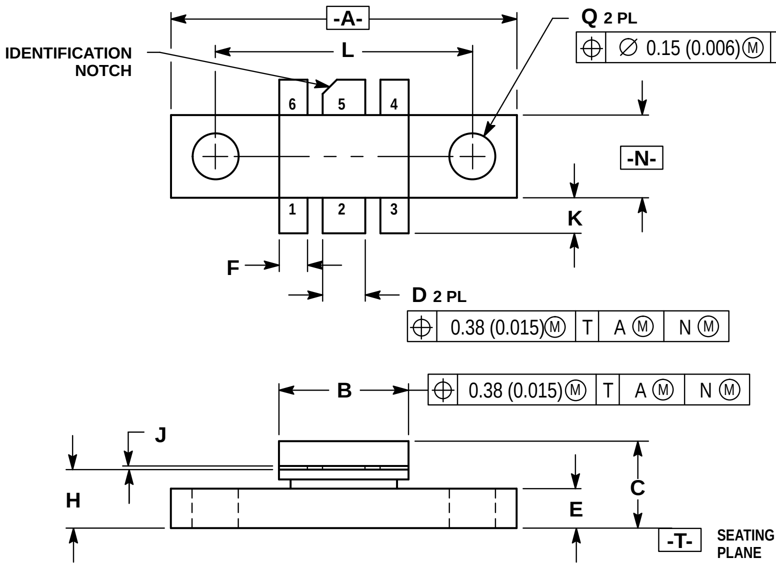



**Figure 7. MRF858 Test Fixture Component Layout**

# PACKAGE DIMENSIONS

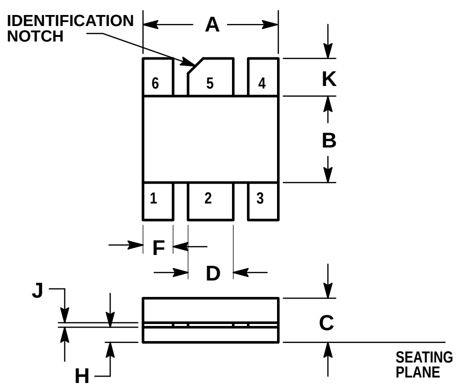



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

| 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**
**MRF858**




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

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

| 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 |

**CASE 319A–02**
**ISSUE B**
**MRF858S**



**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
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**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