*Advance Information*

## The RF Line

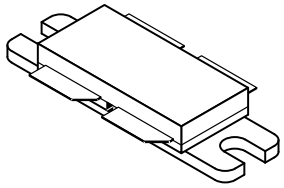
# NPN Silicon RF Power Transistor

Designed for 26 volts microwave large–signal, common emitter, class A and class AB linear amplifier applications in industrial and commercial FM/AM equipment operating in the range 1400–1600 MHz.

- Specified 26 Volts, 1490 MHz, Class AB Characteristics
  - Output Power — 90 Watts (PEP)
  - Gain — 7.5 dB Min @ 90 Watts (PEP)
  - Collector Efficiency — 30% Min @ 90 Watts (PEP)
  - Intermodulation Distortion — –28 dBc Max @ 90 Watts (PEP)
- Third Order Intercept Point — 56.5 dBm Typ @ 1490 MHz, $V_{CE}$ = 24 Vdc, $I_C$ = 5 Adc
- Characterized with Series Equivalent Large–Signal Parameters from 1400–1600 MHz
- Characterized with Small–Signal S–Parameters from 1000–2000 MHz
- Silicon Nitride Passivated
- 100% Tested for Load Mismatch Stress at All Phase Angles with 3:1 Load VSWR @ 28 Vdc, and Rated Output Power
- 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.

**MRF15090**

**90 W, 1.5 GHz**
**RF POWER TRANSISTOR**
**NPN SILICON**



**CASE 375A–01, STYLE 1**

**MAXIMUM RATINGS**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector–Emitter Voltage | $V_{CEO}$ | 25 | Vdc |
| Collector–Emitter Voltage | $V_{CES}$ | 60 | Vdc |
| Emitter–Base Voltage | $V_{EBO}$ | 4 | Vdc |
| Collector–Current — Continuous @ $T_{J(max)}$ = 150°C | $I_C$ | 15 | Adc |
| Total Device Dissipation @ $T_C$ = 25°C<br>Derate above 25°C | $P_D$ | 250<br>1.43 | Watts<br>W/°C |
| Storage Temperature Range | $T_{stg}$ | – 65 to +150 | °C |

**THERMAL CHARACTERISTICS**

| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 0.70 | °C/W |

**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 | 28 | — | Vdc |
| Collector–Emitter Breakdown Voltage ($I_C$ = 50 mAdc, $V_{BE}$ = 0) | $V_{(BR)CES}$ | 60 | 65 | — | Vdc |
| Collector–Emitter Breakdown Voltage ($I_C$ = 50 mAdc, $R_{BE}$ = 100 Ω) | $V_{(BR)CER}$ | 30 | — | — | Vdc |

(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS — continued** | | | | | |
| Emitter–Base Breakdown Voltage ($I_E$ = 5 mAdc, $I_C$ = 0) | $V_{(BR)EBO}$ | 4 | 4.8 | — | Vdc |
| Collector Cutoff Current ($V_{CE}$ = 30 Vdc, $V_{BE}$ = 0) | $I_{CES}$ | — | — | 10 | mAdc |
| **ON CHARACTERISTICS** | | | | | |
| DC Current Gain ($I_{CE}$ = 1 Adc, $V_{CE}$ = 5 Vdc) | $h_{FE}$ | 20 | 40 | 80 | — |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Output Capacitance ($V_{CB}$ = 26 Vdc, $I_E$ = 0, f = 1 MHz) – For Information Only. This Part Is Collector Matched. | $C_{ob}$ | — | 52 | — | pF |
| **FUNCTIONAL TESTS** (Figure 12) | | | | | |
| Common–Emitter Amplifier Power Gain ($V_{CC}$ = 26 Vdc, $P_{out}$ = 90 W (PEP), $I_{CQ}$ = 250 mA, $f_1$ = 1490 MHz, $f_2$ = 1490.1 MHz) | $G_{pe}$ | 7.5 | 8.3 | — | dB |
| Collector Efficiency ($V_{CC}$ = 26 Vdc, $P_{out}$ = 90 W (PEP), $I_{CQ}$ = 250 mA, $f_1$ = 1490 MHz, $f_2$ = 1490.1 MHz) | $\eta$ | 30 | 36 | — | % |
| Intermodulation Distortion ($V_{CC}$ = 26 Vdc, $P_{out}$ = 90 W (PEP), $I_{CQ}$ = 250 mA, $f_1$ = 1490 MHz, $f_2$ = 1490.1 MHz) | IMD | — | – 32 | – 28 | dBc |
| Input Return Loss ($V_{CC}$ = 26 Vdc, $P_{out}$ = 90 W (PEP), $I_{CQ}$ = 250 mA, $f_1$ = 1490 MHz, $f_2$ = 1490.1 MHz) | IRL | 12 | 15 | — | dB |
| Load Mismatch ($V_{CC}$ = 28 Vdc, $P_{out}$ = 90 W (PEP), $I_{CQ}$ = 250 mA, $f_1$ = 1490 MHz, $f_2$ = 1490.1 MHz, Load VSWR = 3:1, All Phase Angles at Frequency of Test) | $\psi$ | No Degradation in Output Power | | | |

## TYPICAL CHARACTERISTICS

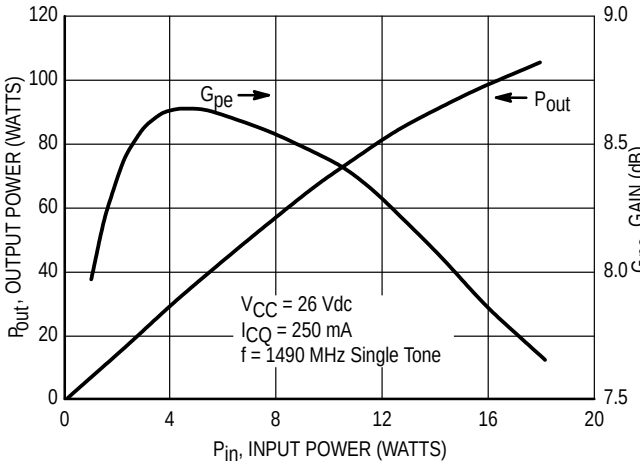



**Figure 1. Output Power & Power Gain versus Input Power**

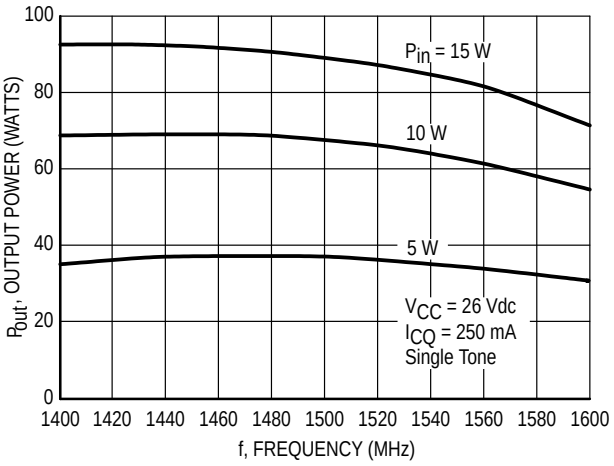



**Figure 2. Output Power versus Frequency**

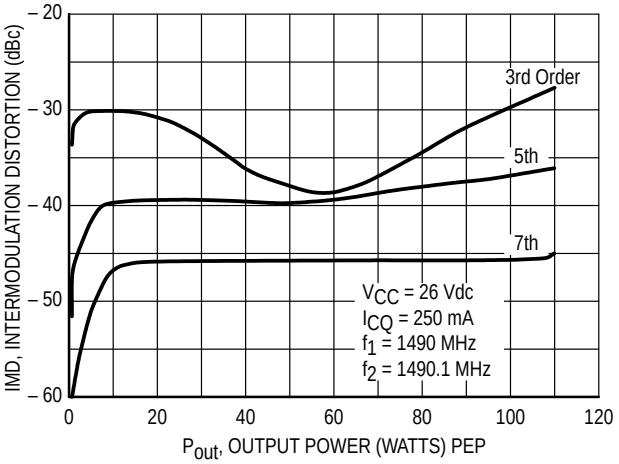



**Figure 3. Intermodulation Distortion versus Output Power**

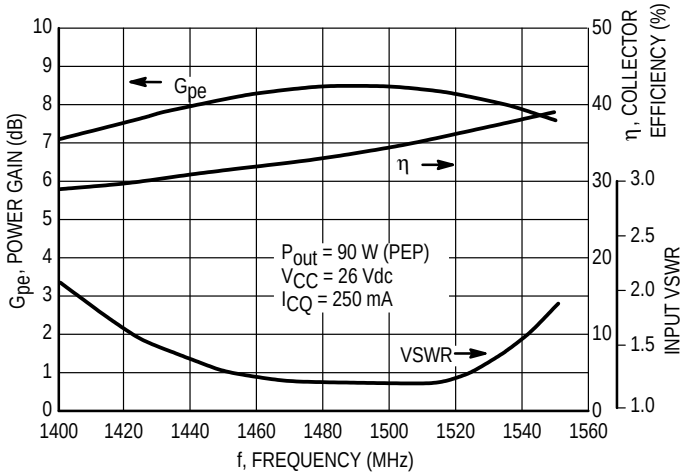



**Figure 4. Performance in Broadband Circuit**

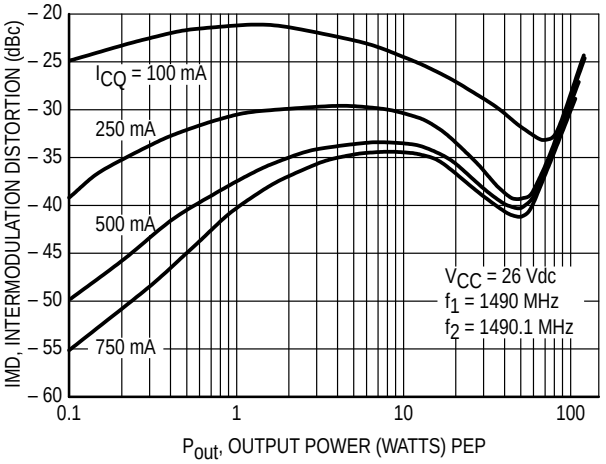



**Figure 5. Intermodulation Distortion versus Output Power**

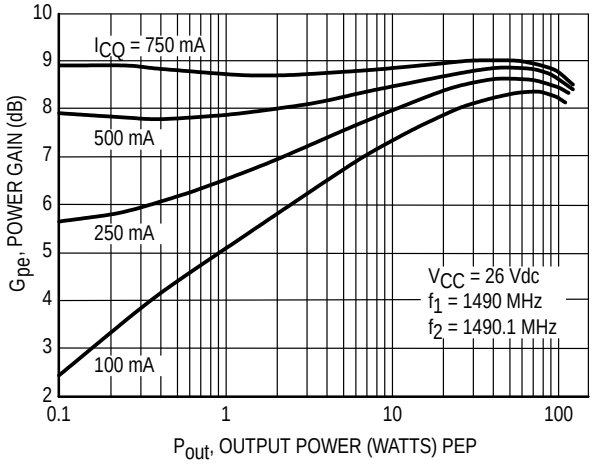



**Figure 6. Power Gain versus Output Power**

## TYPICAL CHARACTERISTICS

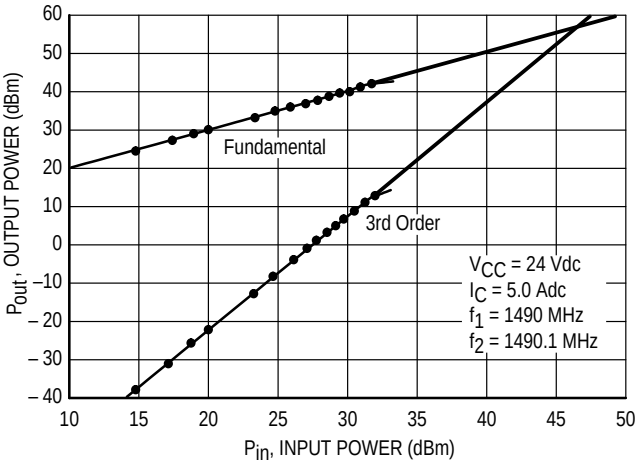



**Figure 7. Class A Third Order Intercept Point**

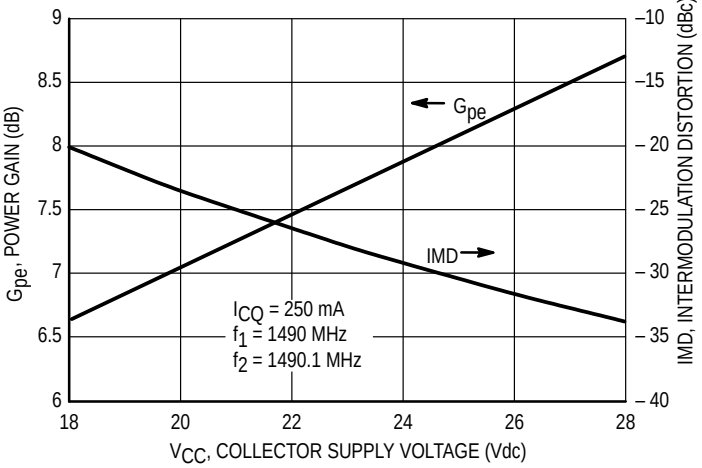



**Figure 8. Power Gain and Intermodulation Distortion versus Supply Voltage**

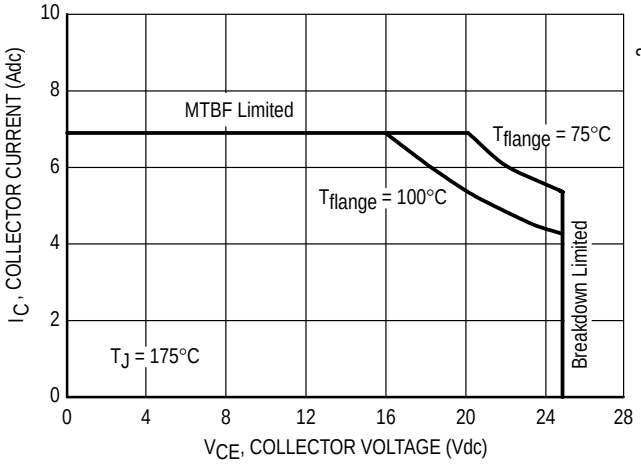



**Figure 9. DC Safe Operating Area**

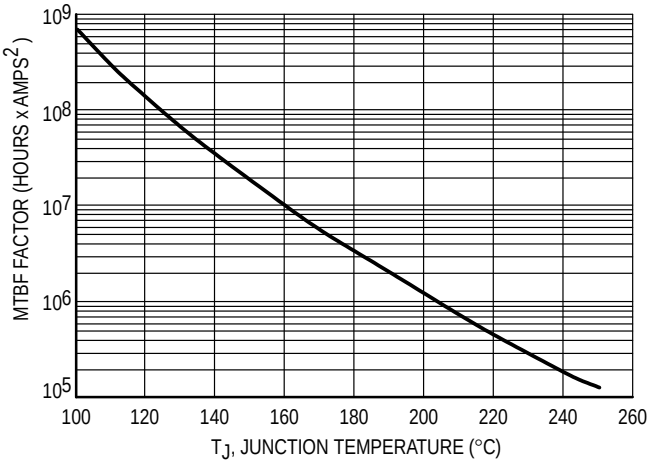
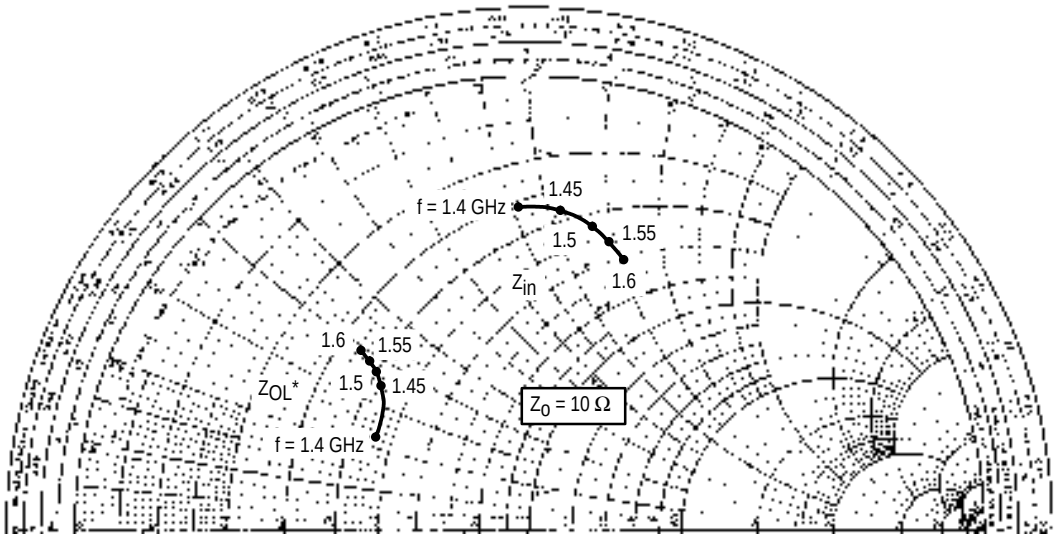



**Figure 10. MTBF Factor versus Junction Temperature**

The graph above 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.




| f (MHz) | $Z_{in}$ (Ω) | $Z_{OL}$* (Ω) |
|---|---|---|
| 1400 | 3.28 + j9.07 | 4.62 + j2.23 |
| 1450 | 3.85 + j10.4 | 4.35 + j3.41 |
| 1500 | 4.55 + j11.4 | 4.08 + j3.60 |
| 1550 | 5.45 + j11.9 | 3.80 + j3.78 |
| 1600 | 6.20 + j12.2 | 3.55 + j3.84 |

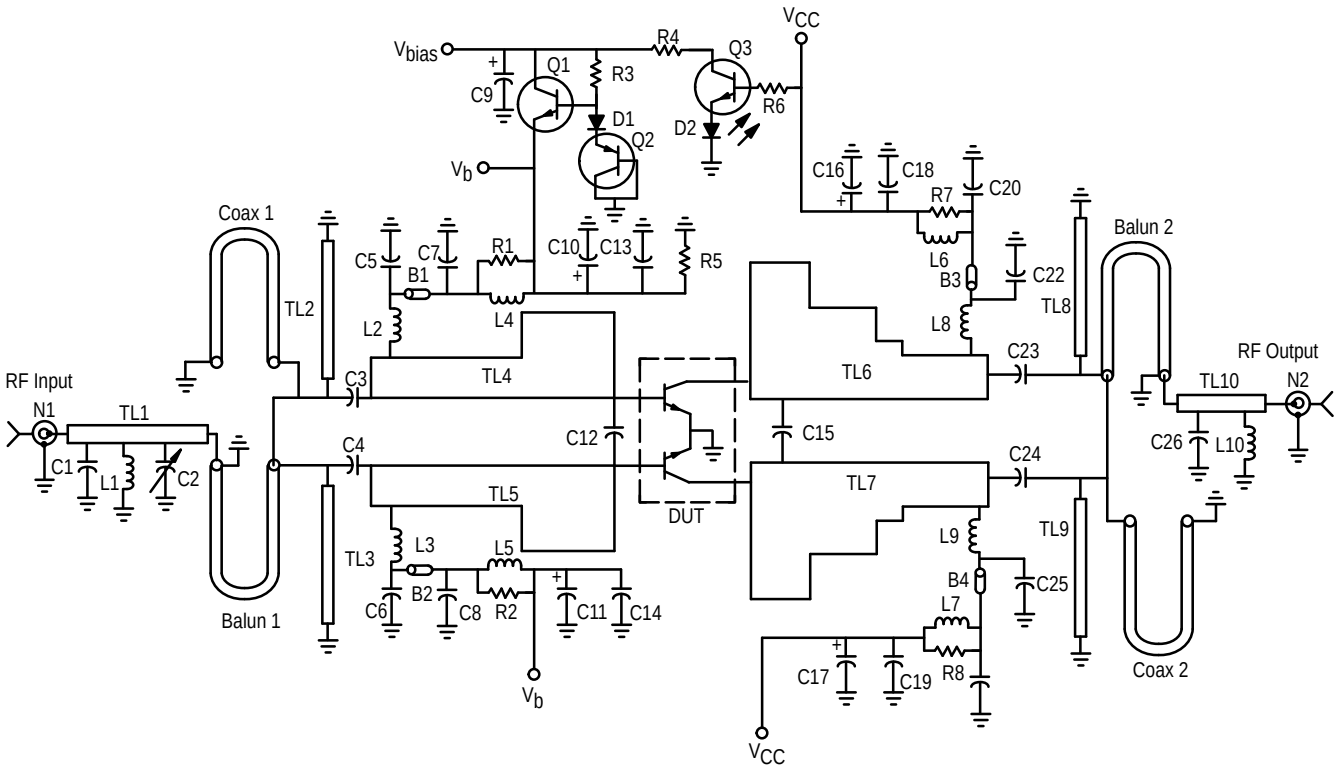
$Z_{in}$ = Input impedance is a balanced base to base measurement.

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

**Figure 11. Input and Output Impedances with Circuit Tuned for Maximum Gain @ $P_{out}$ = 90 Watts (PEP), $V_{CC}$ = 26 Volts, $I_{CQ}$ = 250 mA, and Driven by Two Equal Amplitude Tones with Separation of 100 KHz**

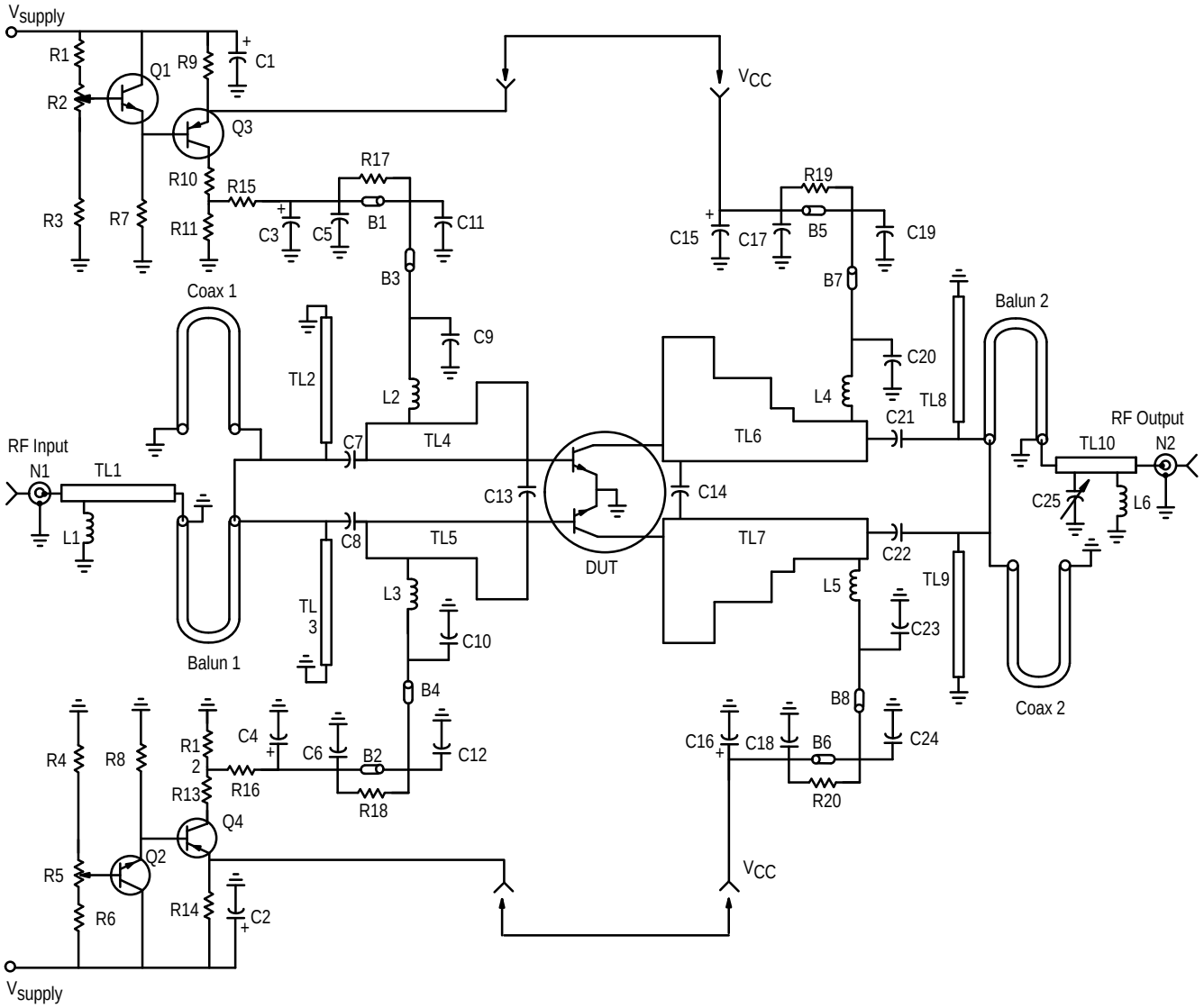
**Table 1. Common Emitter S–Parameters (for One Side of Push–Pull MRF15090) at $V_{CE}$ = 24 Vdc, $I_C$ = 2.5 Adc**

| f | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| MHz | $\|S_{11}\|$ | ∠ϕ | $\|S_{21}\|$ | ∠ϕ | $\|S_{12}\|$ | ∠ϕ | $\|S_{22}\|$ | ∠ϕ |
| 1000 | 0.999 | 172 | 0.164 | 108 | 0.006 | 72 | 0.957 | 173 |
| 1050 | 0.999 | 171 | 0.179 | 103 | 0.007 | 69 | 0.956 | 172 |
| 1100 | 0.994 | 170 | 0.196 | 97 | 0.007 | 66 | 0.948 | 172 |
| 1150 | 0.992 | 170 | 0.216 | 92 | 0.008 | 63 | 0.940 | 171 |
| 1200 | 0.994 | 169 | 0.241 | 86 | 0.008 | 62 | 0.935 | 171 |
| 1250 | 0.986 | 168 | 0.269 | 80 | 0.009 | 57 | 0.924 | 170 |
| 1300 | 0.982 | 167 | 0.306 | 73 | 0.010 | 51 | 0.915 | 170 |
| 1350 | 0.973 | 166 | 0.351 | 66 | 0.011 | 45 | 0.905 | 170 |
| 1400 | 0.957 | 164 | 0.408 | 56 | 0.012 | 33 | 0.888 | 170 |
| 1450 | 0.938 | 163 | 0.483 | 44 | 0.013 | 22 | 0.876 | 170 |
| 1500 | 0.903 | 162 | 0.571 | 29 | 0.014 | 7 | 0.859 | 171 |
| 1550 | 0.857 | 163 | 0.651 | 10 | 0.014 | –13 | 0.855 | 173 |
| 1600 | 0.821 | 165 | 0.673 | –14 | 0.013 | – 40 | 0.877 | 174 |
| 1650 | 0.837 | 169 | 0.623 | – 37 | 0.011 | – 67 | 0.902 | 174 |
| 1700 | 0.872 | 170 | 0.529 | – 56 | 0.009 | –104 | 0.922 | 173 |
| 1750 | 0.901 | 170 | 0.437 | –70 | 0.008 | –138 | 0.931 | 172 |
| 1800 | 0.920 | 170 | 0.363 | – 81 | 0.007 | –165 | 0.932 | 171 |
| 1850 | 0.940 | 169 | 0.309 | – 90 | 0.008 | 173 | 0.930 | 170 |
| 1900 | 0.954 | 169 | 0.265 | – 98 | 0.008 | 150 | 0.932 | 169 |
| 1950 | 0.965 | 168 | 0.232 | –104 | 0.009 | 139 | 0.930 | 169 |
| 2000 | 0.971 | 167 | 0.205 | –110 | 0.010 | 132 | 0.929 | 168 |




| | | | |
|---|---|---|---|
| B1, B2, B3, B4 | Ferrite Bead, Ferroxcube | L1 | 1 Turn, 24 AWG, 0.042″ ID Choke |
| C1 | 2.7 pF, B Case Chip Capacitor, ATC | L2, L3, L8, L9 | 3 Turn, 20 AWG, 0.126″ ID Choke |
| C2 | 0.6–4.0 pF, Variable Capacitor, Johanson | L4, L5, L6, L7 | 12 Turns, 22 AWG, 0.140″ ID Choke |
| C3, C4, C23, C24 | 18 pF, B Case Chip Capacitor, ATC | L10 | 3 Turns, 24 AWG, 0.046″ ID Choke |
| C5, C6, C22, C25 | 51 pF, Chip Capacitor, Murata Erie | N1, N2 | Type N Flange Mount RF Connector, Omni Spectra |
| C7, C8, C20, C21 | 1800 pF, Chip Capacitor, Kemit | Q1, Q3 | Transistor, NPN, Motorola (MJD47) |
| C9, C10, C11 | 100 μF, Electrolytic Capacitor, Mallory | Q2 | Transistor PNP Motorola (BD136) |
| C12 | 5.1 pF, A Case Chip Capacitor, ATC | R1, R2, R7, R8 | 10 Ω, 1/2 W, Resistor |
| C13, C14, C18, C19 | 0.1 μF, Chip Capacitor, Kemit | R3 | 150 Ω, 1/2 W, Resistor |
| C15 | 1.1 pF, B Case Chip Capacitor, ATC | R4 | 2 x 66 Ω, 1/8 W, Chip Resistors in Parallel, Rohm |
| C16, C17 | 470 μF, Electrolytic Capacitor, Mallory | R5 | 93 Ω, 1/8 W, Chip Resistor, Rohm |
| C26 | 0.3 pF, B Case Chip Capacitor, ATC | R6 | 22 KΩ, 1/8 W, Chip Resistor, Rohm |
| D1 | Diode, Motorola (MUR5120T3) | TL1 to TL10 | See Photomaster |
| D2 | Light Emitting Diode, Industrial Devices | Board | Glass Teflon®, Arlon GX–0300–55–22, $\varepsilon_r$ = 2.55 |

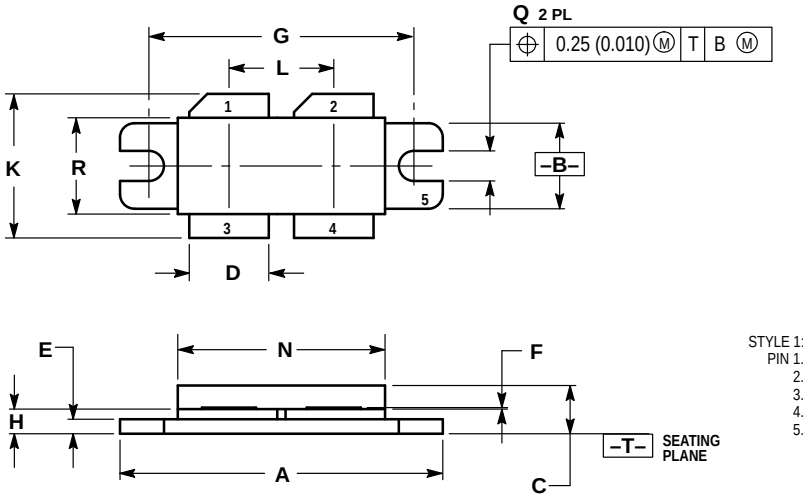
**Figure 12. Class AB Test Fixture Electrical Schematic**




| | | | |
|---|---|---|---|
| B1, B2, B5, B6 | Long Bead, Fair Rite | N1, N2 | Type N Flange Mount RF Connector, Omni Spectra |
| B3, B4, B7, B8 | Short Bead, Fair Rite | Q1, Q2 | Transistor NPN Motorola (BD135) |
| C1, C2, C3, C4 | 100 μF, Electrolytic Capacitor, Mallory | Q3, Q4 | Transistor PNP Motorola (BD136) |
| C5, C6, C17, C18 | 0.1 μF, Chip Capacitor, Kemit | R1, R6 | 250 Ω, 1/8 W, Chip Resistor, Rohm |
| C7, C8, C21, C22 | 18 pF, B Case Chip Capacitor, ATC | R2, R5 | 500 Ω, 1/4 W, Potentiometer, State of the Art |
| C9, C10, C20, C23 | 51 pF, Chip Capacitor, Murata Erie | R3, R4 | 4.7 Ω, 1/8 W, Chip Resistor, Rohm |
| C11, C12, C19, C24 | 1800 pF, Chip Capacitor, Kemit | R7, R8 | 2 x 4.7 KΩ, 1/8 W, Chip Resistors |
| C13 | 4.3 pF, B Case Chip Capacitor, ATC | | in Parallel, Rohm |
| C14 | 2.0 pF, B Case Chip Capacitor, ATC | R9, R14 | 1.0 Ω, 10 W, Resistor, Dale |
| C15, C16 | 470 μF, Electrolytic Capacitor, Mallory | R10, R13 | 38 Ω, 1 W, Resistor |
| C25 | 0.6–4 pF Variable Capacitor, Johanson | R11, R12 | 75 Ω, 1/8 W, Chip Resistor, Rohm |
| L1 | 3 Turns, 24 AWG, 0.046″ ID Choke | R15, R16 | 2 x 10 Ω, 1/8 W, Chip Resistors in Parallel, Rohm |
| L2, L3, L4, L5 | 3 Turns, 20 AWG, 0.126″ ID Choke | R17, R18, R19, R20 | 4 x 38 Ω, 1/8 W, Chip Resistors in Parallel, Rohm |
| L6 | 2 Turns, 24 AWG, 0.042″ ID Choke | Board | Glass Teflon®, Arlon GX–0300–55–22, $\varepsilon_r$ = 2.55 |

**Figure 13. Class A Test Fixture Electrical Schematic**

## PACKAGE DIMENSIONS




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

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 1.330 | 1.350 | 33.79 | 34.29 |
| B | 0.375 | 0.395 | 9.52 | 10.03 |
| C | 0.180 | 0.205 | 4.57 | 5.21 |
| D | 0.320 | 0.340 | 8.13 | 8.64 |
| E | 0.060 | 0.070 | 1.52 | 1.77 |
| F | 0.004 | 0.006 | 0.11 | 0.15 |
| G | 1.100 BSC | | 27.94 BSC | |
| H | 0.082 | 0.097 | 2.08 | 2.46 |
| K | 0.580 | 0.620 | 14.73 | 15.75 |
| L | 0.435 BSC | | 11.05 BSC | |
| N | 0.845 | 0.875 | 21.46 | 22.23 |
| Q | 0.118 | 0.130 | 3.00 | 3.30 |
| R | 0.390 | 0.410 | 9.91 | 10.41 |

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

**CASE 375A–01**
**ISSUE O**

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