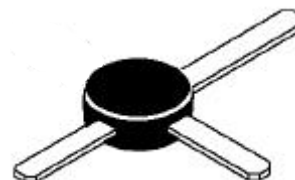


## BFR90

### RF & MICROWAVE DISCRETE LOW POWER TRANSISTORS

#### Features

- High Current-Gain – Bandwidth Product,  $f_T = 5.0 \text{ GHz}$  (typ) @  $I_C = 14 \text{ mA}$
- Low Noise Figure –  $NF = 2.4 \text{ dB}$  (typ) @  $f = 0.5 \text{ GHz}$
- High Power Gain –  $G_{\text{max}} = 18\text{dB}$  (typ) @  $f = 0.5 \text{ GHz}$



**Macro T**  
 (STYLE #2)

**DESCRIPTION:** Designed primarily for use in high-gain, low noise, small-signal amplifiers. Also used in applications requiring fast switching times.

#### ABSOLUTE MAXIMUM RATINGS ( $T_{\text{case}} = 25^\circ\text{C}$ )

| Symbol           | Parameter                 | Value | Unit |
|------------------|---------------------------|-------|------|
| $V_{\text{CEO}}$ | Collector-Emitter Voltage | 15    | Vdc  |
| $V_{\text{CBO}}$ | Collector-Base Voltage    | 20    | Vdc  |
| $V_{\text{EBO}}$ | Emitter-Base Voltage      | 3.0   | Vdc  |
| $I_C$            | Collector Current         | 30    | mA   |

#### Thermal Data

|       |                                                                                        |            |                                |
|-------|----------------------------------------------------------------------------------------|------------|--------------------------------|
| $P_D$ | Total Device Dissipation @ $T_A = 60^\circ\text{C}$<br>Derate above $60^\circ\text{C}$ | 180<br>2.0 | mWatts<br>mW/ $^\circ\text{C}$ |
|-------|----------------------------------------------------------------------------------------|------------|--------------------------------|

ELECTRICAL SPECIFICATIONS (Tcase = 25°C)

STATIC  
(off)

| Symbol | Test Conditions                                                                   | Value |      |      | Unit            |
|--------|-----------------------------------------------------------------------------------|-------|------|------|-----------------|
|        |                                                                                   | Min.  | Typ. | Max. |                 |
| BVCEO  | Collector-Emitter Breakdown Voltage<br>(IC = 1.0 mA <sub>dc</sub> , IB = 0)       | 15    | -    | -    | V <sub>dc</sub> |
| BVCB0  | Collector-Base Breakdown Voltage<br>(IC = 0.1 mA <sub>dc</sub> , IE = 0)          | 20    | -    | -    | V <sub>dc</sub> |
| BVEBO  | Emitter-Base Breakdown Voltage<br>(IE = 0.1 mA <sub>dc</sub> , IC = 0)            | 3.0   | -    | -    | V <sub>dc</sub> |
| ICBO   | Collector Cutoff Current<br>(VCB = 10 V <sub>dc</sub> , VBE = 0 V <sub>dc</sub> ) | -     | -    | 50   | nA              |

(on)

|     |                                                                           |    |   |     |   |
|-----|---------------------------------------------------------------------------|----|---|-----|---|
| HFE | DC Current Gain<br>(IC = 14 mA <sub>dc</sub> , VCE = 10 V <sub>dc</sub> ) | 25 | - | 250 | - |
|-----|---------------------------------------------------------------------------|----|---|-----|---|

DYNAMIC

| Symbol           | Test Conditions                                                                          | Value |      |      | Unit |
|------------------|------------------------------------------------------------------------------------------|-------|------|------|------|
|                  |                                                                                          | Min.  | Typ. | Max. |      |
| F <sub>tau</sub> | Current-Gain – Bandwidth Product<br>(IC = 14 mA, VCE = 10 V <sub>dc</sub> , f = 0.5 GHz) | -     | 5.0  | -    | GHz  |
| CCB              | Output Capacitance<br>(VCB = 10 V <sub>dc</sub> , IE = 0, f = 1.0 MHz)                   | -     | 0.5  | 1.0  | pF   |

FUNCTIONAL

| Symbol       | Test Conditions                                                                  | Value |      |      | Unit |
|--------------|----------------------------------------------------------------------------------|-------|------|------|------|
|              |                                                                                  | Min.  | Typ. | Max. |      |
| NF           | Noise Figure<br>(IC = 2.0 mAdc, VCE = 10 Vdc, f = 0.5 GHz)                       | -     | 2.4  | -    | dB   |
|              | (IC = 2.0 mAdc, VCE = 10 Vdc, f = 1.0 GHz)                                       | -     | 3.0  | -    |      |
| GNF          | Power Gain at Optimum Noise Figure<br>(IC = 2.0 mAdc, VCE = 10 Vdc, f = 0.5 GHz) | -     | 15   | -    | dB   |
|              | (IC = 2.0 mAdc, VCE = 10 Vdc, f = 1.0 GHz)                                       | -     | 10   | -    |      |
| $ S_{21} ^2$ | Insertion Gain<br>(IC = 14 mAdc, VCE = 10 Vdc, f = 0.5 GHz)                      | 15    | 16   | -    | dB   |
|              | (IC = 14 mAdc, VCE = 10 Vdc, f = 1.0 GHz)                                        |       | 11   |      |      |
| MSG          | Maximum Stable Gain<br>(IC = 14 mAdc, VCE = 10 Vdc, f = 0.5 GHz)                 | -     | 20   | -    | dB   |
|              | (IC = 14 mAdc, VCE = 10 Vdc, f = 1.0 GHz)                                        |       | 15   |      |      |
| $G_{U \max}$ | Maximum Unilateral Gain (1)<br>(IC = 14 mAdc, VCE = 10 Vdc, f = 0.5 GHz)         | -     | 18   | -    | dB   |
|              | (IC = 14 mAdc, VCE = 10 Vdc, f = 1.0 GHz)                                        |       | 12.5 |      |      |

**Table 1. Common Emitter S-Parameters, @ VCE = 10 V, IC = 14 mA**

| f<br>(MHz) | S11   |               | S21   |               | S12   |               | S22   |               |
|------------|-------|---------------|-------|---------------|-------|---------------|-------|---------------|
|            | S11   | $\angle \phi$ | S21   | $\angle \phi$ | S12   | $\angle \phi$ | S22   | $\angle \phi$ |
| 100        | 0.382 | -41           | 21.21 | 141           | 0.016 | 79            | 0.718 | -9            |
| 200        | 0.282 | -77           | 14.85 | 116           | 0.028 | 74            | 0.662 | -18           |
| 300        | 0.217 | -101          | 10.71 | 104           | 0.039 | 74            | 0.599 | -20           |
| 500        | 0.162 | -131          | 6.78  | 91            | 0.061 | 76            | 0.558 | -24           |
| 700        | 0.140 | -151          | 4.98  | 83            | 0.082 | 76            | 0.55  | -28           |
| 800        | 0.135 | -159          | 4.42  | 80            | 0.093 | 76            | 0.552 | -29           |
| 1000       | 0.124 | -176          | 3.59  | 74            | 0.117 | 75            | 0.553 | -33           |

## RF Low Power PA, LNA, and General Purpose Discrete Selector Guide

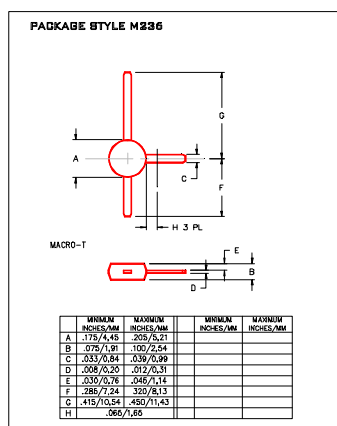
| Package     | Device          | Type | GPE Freq (MHz) | Pout (watts) | GPE (dB) | Efficiency (%) | GPE VCC | BVCEO | IC max (mA) |
|-------------|-----------------|------|----------------|--------------|----------|----------------|---------|-------|-------------|
| SO-8        | MRF4427, R2     | NPN  | 175            | 0.15         | 18       | 60             | 12      | 20    | 400         |
| TO-39       | 2N4427          | NPN  | 175            | 1            | 10       | 50             | 12      | 20    | 400         |
| POWER MACRO | MRF553          | NPN  | 175            | 1.5          | 11.5     | 60             | 12.5    | 16    | 500         |
| POWER MACRO | MRF553T         | NPN  | 175            | 1.5          | 11.5     | 50             | 12.5    | 16    | 500         |
| TO-39       | MRF607          | NPN  | 175            | 1.75         | 11.5     | 50             | 12.5    | 16    | 330         |
| TO-39       | 2N6255          | NPN  | 175            | 3            | 7.8      | 50             | 12.5    | 18    | 1000        |
| TO-72       | 2N5179          | NPN  | 200            |              | 20       |                | 6       | 12    | 50          |
| MACRO X     | MRF559          | NPN  | 512            | 0.5          | 10       | 65             | 7.5     | 16    | 150         |
| MACRO X     | MRF559          | NPN  | 512            | 0.5          | 13       | 60             | 12.5    | 16    | 150         |
| TO-39       | 2N3866A         | NPN  | 400            | 1            | 10       | 45             | 28      | 30    | 400         |
| SO-8        | MRF3866, R1, R2 | NPN  | 400            | 1            | 10       | 45             | 28      | 30    | 400         |
| POWER MACRO | MRF555          | NPN  | 470            | 1.5          | 11       | 50             | 12.5    | 16    | 400         |
| POWER MACRO | MRF555T         | NPN  | 470            | 1.5          | 11       | 50             | 12.5    | 16    | 400         |
| MACRO X     | MRF559          | NPN  | 870            | 0.5          | 6.5      | 70             | 7.5     | 16    | 150         |
| MACRO X     | MRF559          | NPN  | 870            | 0.5          | 9.5      | 65             | 12.5    | 16    | 150         |
| SO-8        | MRF8372, R1, R2 | NPN  | 870            | 0.75         | 8        | 55             | 12.5    | 16    | 200         |
| POWER MACRO | MRF557          | NPN  | 870            | 1.5          | 8        | 55             | 12.5    | 16    | 400         |
| POWER MACRO | MRF557T         | NPN  | 870            | 1.5          | 8        | 55             | 12.5    | 16    | 400         |

| Package | Device          | Type | Freq (MHz) | NF (dB) | NF IC (mA) | NF VCE | GN (dB) | Gu Max (dB) | Ftau (MHz) | Ccb(pF) | BVCEO | IC max (mA) |
|---------|-----------------|------|------------|---------|------------|--------|---------|-------------|------------|---------|-------|-------------|
| TO-39   | 2N5109          | NPN  | 200        | 3       | 10         | 15     |         | 12          | 1200       | 3.5     | 20    | 400         |
| TO-39   | MRF5943C        | NPN  | 200        | 3.4     | 30         | 15     |         | 11.4        | 1000       |         | 30    | 400         |
| SO-8    | MRF5943, R1, R2 | NPN  | 200        | 3.4     | 30         | 15     |         | 15          | 1300       |         | 30    | 400         |
| TO-72   | 2N5179          | NPN  | 200        | 4.5     | 1.5        | 6      |         | 17          | 900        | 1       | 12    | 50          |
| TO-72   | 2N2857          | NPN  | 300        | 5.5     | 50         | 6      |         | 13          | 1600       | 1       | 15    | 40          |
| TO-39   | MRF517          | NPN  | 300        | 7.5     | 50         | 15     |         | 5.5         | 4600       | 3       | 25    | 150         |
| TO-72   | MRF904          | NPN  | 450        | 1.5     | 5          | 6      |         | 11          | 4000       | 1       | 15    | 30          |
| TO-72   | 2N6304          | NPN  | 450        | 5       | 2          | 5      |         | 14          | 1400       | 1       | 15    | 50          |
| MACRO T | BFR91           | NPN  | 500        | 1.9     | 2          | 5      | 11      | 16.5        | 5000       | 1       | 12    | 35          |
| MACRO T | BFR96           | NPN  | 500        | 2       | 10         | 10     |         | 14.5        | 500        | 2.6     | 15    | 100         |
| SO-8    | MRF5812, R1, R2 | NPN  | 500        | 2       | 50         | 10     | 15.5    | 17.8        | 5000       |         | 15    | 200         |
| MACRO X | MRF581A         | NPN  | 500        | 2       | 50         | 10     | 14      | 15          | 5000       |         | 15    | 200         |
| Macro   | BFR90           | NPN  | 500        | 2.4     | 2          | 10     | 15      | 18          | 5000       | 1       | 15    | 30          |
| TO-72   | BFY90           | NPN  | 500        | 2.5     | 2          | 5      |         | 20          | 1300       |         | 15    | 50          |
| TO-72   | MRF914          | NPN  | 500        | 2.5     | 5          | 10     | 15      | 15          | 4500       |         | 12    | 40          |
| MACRO X | MRF581          | NPN  | 500        | 2.5     | 50         | 10     | 15      | 17.8        | 5000       |         | 16    | 200         |
| TO-39   | MRF586          | NPN  | 500        | 3       | 90         | 15     | 11      | 14.5        | 4500       | 2.2     | 17    | 200         |
| MACRO X | MRF951          | NPN  | 1000       | 1.3     | 5          | 6      | 14      | 17          | 8000       | 0.45    | 10    | 100         |
| MACRO X | MRF571          | NPN  | 1000       | 1.5     | 10         | 6      | 10      |             | 8000       | 1       | 10    | 70          |
| MACRO T | BFR91           | NPN  | 1000       | 2.5     | 2          | 5      | 8       | 11          | 5000       | 1       | 12    | 35          |
| MACRO T | BFR90           | NPN  | 1000       | 3       | 2          | 10     | 10      | 12.5        | 5000       | 1       | 15    | 30          |
| TO-39   | MRF545          | PNP  |            |         |            |        |         | 14          | 1400       | 2       | 70    | 400         |
| TO-39   | MRF544          | NPN  |            |         |            |        |         | 13.5        | 1500       |         | 70    | 400         |

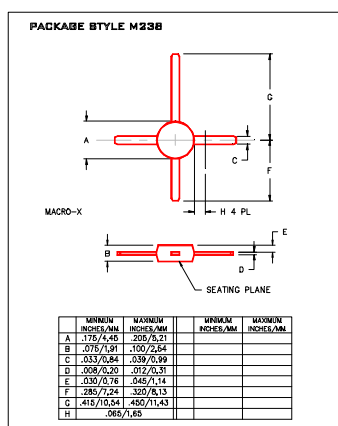
RF (Low Power PA / General Purpose) Selection Guide

RF (LNA / General Purpose) Selection Guide

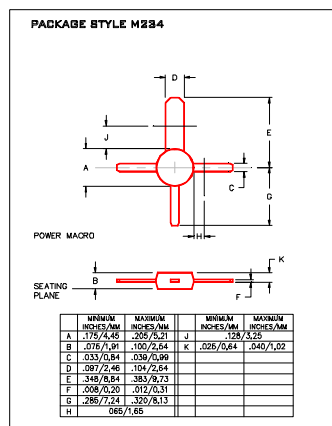
## Low Cost RF Plastic Package Options



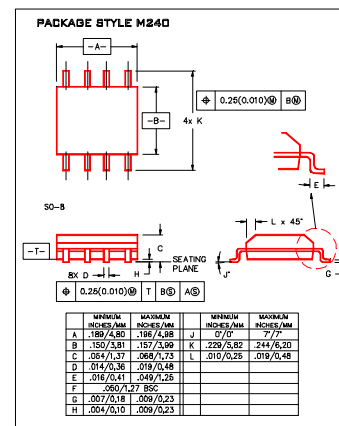
Macro T



Macro X



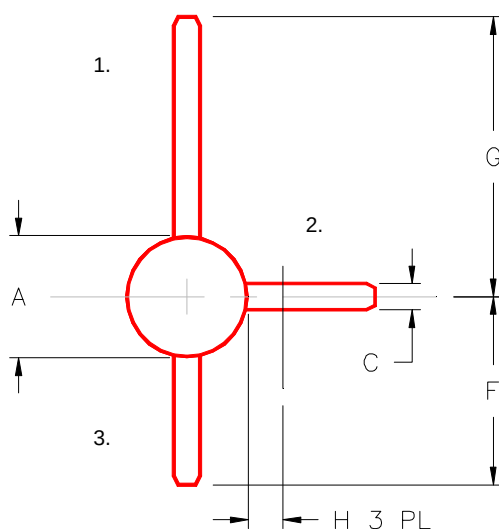
Power Macro



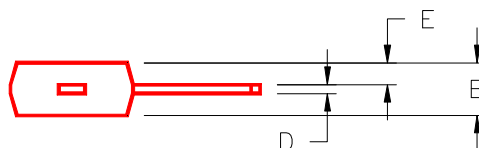
SO-8

PACKAGE STYLE M236

PIN 1. COLLECTOR  
 2. EMITTER  
 3. BASE



MACRO-T



|   | MINIMUM<br>INCHES/MM | MAXIMUM<br>INCHES/MM |  | MINIMUM<br>INCHES/MM | MAXIMUM<br>INCHES/MM |
|---|----------------------|----------------------|--|----------------------|----------------------|
| A | .175/4,45            | .205/5,21            |  |                      |                      |
| B | .075/1,91            | .100/2,54            |  |                      |                      |
| C | .033/0,84            | .039/0,99            |  |                      |                      |
| D | .008/0,20            | .012/0,31            |  |                      |                      |
| E | .030/0,76            | .045/1,14            |  |                      |                      |
| F | .285/7,24            | .320/8,13            |  |                      |                      |
| G | .415/10,54           | .450/11,43           |  |                      |                      |
| H | .065/1,65            |                      |  |                      |                      |