

**MOTOROLA**

Order this document by MRF1047T1/D

# NPN Silicon Low Noise Transistor

The MRF1047T1 is fabricated utilizing Motorola's latest 12 GHz  $f_t$  discrete bipolar silicon process. The minimum noise figure is 1.0 dB at  $V_{CE} = 3.0$  V and  $I_C = 3.0$  mA. The noise performance of the MRF1047T1 at low bias makes this device the ideal choice in high gain, low noise applications. This device is well suited for low-voltage, low-current, front-end applications, for use in pagers, cellular and cordless phones, and other portable wireless systems.

The MRF1047T1 has 16 emitter fingers, with self-aligned and enhanced processing, resulting in a high  $f_t$ , low operating current transistor with reduced parasitics. The MRF1047T1 is fully-ion implanted with gold metallization and nitride passivation for maximum device reliability, performance and uniformity.

- Low Noise Figure,  $NF_{min} = 1.0$  dB (Typ) @ 1.0 GHz, 3.0 V and 3.0 mA
- High Current Gain-Bandwidth Product,  $f_t = 12$  GHz, 3.0 V @ 15 mA
- Maximum Stable Gain, 17 dB @ 1.0 GHz, 3.0 V and 10 mA
- Output Third Order Intercept,  $OIP_3 = 26$  dBm @ 1.0 GHz 3.0 V and 15 mA
- Fully Ion-Implanted with Gold Metallization and Nitride Passivation

## MAXIMUM RATINGS

| Rating                                                                                            | Symbol       | Value        | Unit       |
|---------------------------------------------------------------------------------------------------|--------------|--------------|------------|
| Collector-Emitter Voltage                                                                         | $V_{CEO}$    | 5.0          | Vdc        |
| Collector-Base Voltage                                                                            | $V_{CBO}$    | 12           | Vdc        |
| Emitter-Base Voltage                                                                              | $V_{EBO}$    | 2.5          | Vdc        |
| Collector Current – Continuous [Note 3]                                                           | $I_C$        | 45           | mA dc      |
| Power Dissipation @ $T_C = 75^\circ\text{C}$<br>Derate Linearly above $T_C = 75^\circ\text{C}$ at | $P_{D(max)}$ | 0.172<br>2.3 | W<br>mW/°C |
| Storage Temperature Range                                                                         | $T_{stg}$    | -55 to 150   | °C         |
| Maximum Junction Temperature                                                                      | $T_{J(max)}$ | 150          | °C         |

**NOTES:** 1. Meets Human Body Model (HBM)  $\leq 300$  V and Machine Model (MM)  $\leq 75$  V.  
2. ESD data available upon request.  
3. For MTBF >10 years.

## THERMAL CHARACTERISTIC

| Characteristics                      | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction-to-Case | $R_{\theta JC}$ | 435 | °C/W |

**NOTE:** To calculate the junction temperature use  $T_J = (P_D \times R_{\theta JC}) + T_C$ . The case temperature measured on collector lead adjacent to the package body.

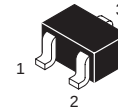
## MRF1047T1

### RF NPN SILICON TRANSISTOR

$f_t = 12$  GHz  
 $NF_{min} = 1.0$  dB  
 $I_{CMAX} = 45$  mA  
 $V_{CEO} = 5.0$  V

### SEMICONDUCTOR TECHNICAL DATA

Pin 1. Base  
2. Emitter  
3. Collector



PLASTIC PACKAGE  
CASE 419  
(SC-70, Tape & Reel Only)

## ORDERING INFORMATION

| Device    | Marking | Package               |
|-----------|---------|-----------------------|
| MRF1047T1 | WB      | SC-70<br>Tape & Reel* |

\*3,000 Units per 8 mm, 7 inch reel.

LIFETIME BUY

LAST ORDER: 03AUG01 LAST SHIP: 26MAR02

# MRF1047T1

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C, unless otherwise noted)

| Characteristic                                                                                                                                                                               | Symbol                         | Min    | Typ        | Max    | Unit |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|--------|------------|--------|------|
| <b>OFF CHARACTERISTICS</b> [Note 1]                                                                                                                                                          |                                |        |            |        |      |
| Collector–Emitter Breakdown Voltage (I <sub>C</sub> = 0.1 mA, I <sub>B</sub> = 0)                                                                                                            | V <sub>(BR)CEO</sub>           | 5.0    | –          | –      | Vdc  |
| Collector–Base Breakdown Voltage (I <sub>C</sub> = 0.1 mA, I <sub>E</sub> = 0)                                                                                                               | V <sub>(BR)CBO</sub>           | 12     | –          | –      | Vdc  |
| Emitter–Base Breakdown Voltage (I <sub>E</sub> = 0.1 mA, I <sub>C</sub> = 0)                                                                                                                 | V <sub>(BR)CBO</sub>           | 2.5    | –          | –      | Vdc  |
| Collector Cutoff Current (V <sub>CB</sub> = 1.0 V, I <sub>E</sub> = 0)                                                                                                                       | I <sub>CBO</sub>               | –      | –          | 0.2    | μA   |
| Emitter Cutoff Current (V <sub>EB</sub> = 1.0 V, I <sub>C</sub> = 0)                                                                                                                         | I <sub>EBO</sub>               | –      | –          | 0.1    | μA   |
| <b>ON CHARACTERISTICS</b> [Note 1]                                                                                                                                                           |                                |        |            |        |      |
| DC Current Gain (V <sub>CE</sub> = 3.0 V, I <sub>C</sub> = 3.0 mA)                                                                                                                           | h <sub>FE</sub>                | 100    | –          | 300    | –    |
| <b>DYNAMIC CHARACTERISTICS</b>                                                                                                                                                               |                                |        |            |        |      |
| Collector–Base Capacitance (V <sub>CB</sub> = 1.0 Vdc, I <sub>E</sub> = 0, f = 1.0 MHz)                                                                                                      | C <sub>cb</sub>                | –      | 0.4        | –      | pF   |
| Current–Gain Bandwidth Product (V <sub>CE</sub> = 3.0 Vdc, I <sub>C</sub> = 15 mA, f = 1.0 GHz)                                                                                              | f <sub>t</sub>                 | –      | 12         | –      | GHz  |
| <b>PERFORMANCE CHARACTERISTICS</b>                                                                                                                                                           |                                |        |            |        |      |
| Insertion Gain<br>V <sub>CE</sub> = 1.0 V, I <sub>C</sub> = 1.0 mA, f = 1.0 GHz<br>V <sub>CE</sub> = 3.0 V, I <sub>C</sub> = 3.0 mA, f = 1.0 GHz                                             | S <sub>21</sub>   <sup>2</sup> | –<br>– | 8.0<br>13  | –<br>– | dB   |
| Maximum Stable Gain and/or Maximum Available Gain [Note 2]<br>V <sub>CE</sub> = 1.0 V, I <sub>C</sub> = 1.0 mA, f = 1.0 GHz<br>V <sub>CE</sub> = 3.0 V, I <sub>C</sub> = 3.0 mA, f = 1.0 GHz | MSG, MAG                       | –<br>– | 11<br>16   | –<br>– | dB   |
| Minimum Noise Figure<br>V <sub>CE</sub> = 1.0 V, I <sub>C</sub> = 1.0 mA, f = 1.0 GHz<br>V <sub>CE</sub> = 3.0 V, I <sub>C</sub> = 3.0 mA, f = 1.0 GHz                                       | NF <sub>min</sub>              | –<br>– | 1.2<br>1.0 | –<br>– | dB   |
| Associated Gain at Minimum NF<br>V <sub>CE</sub> = 1.0 V, I <sub>C</sub> = 1.0 mA, f = 1.0 GHz<br>V <sub>CE</sub> = 3.0 V, I <sub>C</sub> = 3.0 mA, f = 1.0 GHz                              | G <sub>NF</sub>                | –<br>– | 10<br>13   | –<br>– | dB   |
| Output Power at 1.0 dB Gain Compression [Note 3] (V <sub>CE</sub> = 3.0 V, I <sub>C</sub> = 3.0 mA, f = 1.0 GHz)                                                                             | P <sub>1dB</sub>               | –      | 0.5        | –      | dBm  |
| Output Third Order Intercept [Note 3] (V <sub>CE</sub> = 3.0 V, I <sub>C</sub> = 3.0 mA, f = 1.0 GHz)                                                                                        | OIP <sub>3</sub>               | –      | 22         | –      | dBm  |

**NOTES:** 1. Pulse width ≤300 μs, duty cycle ≤2% pulsed.

2. Maximum Available Gain and Maximum Stable Gain are defined by the K factor as follows:

$$\text{MAG} = \left| \frac{S_{21}}{S_{12}} \left( K \pm \sqrt{K^2 - 1} \right) \right|, \text{ if } K > 1, \text{ MSG} = \left| \frac{S_{21}}{S_{12}} \right|, \text{ if } K < 1$$

3. Z<sub>in</sub> = 50 Ω and Z<sub>out</sub> matched for optimum IP3.

Figure 1. Capacitance  
versus Voltage

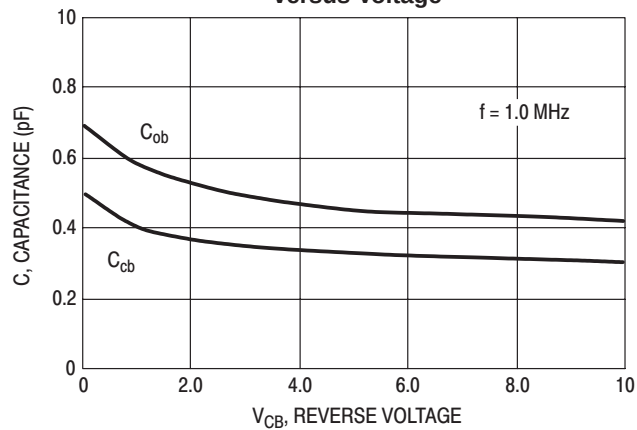


Figure 2. Input Capacitance  
versus Voltage

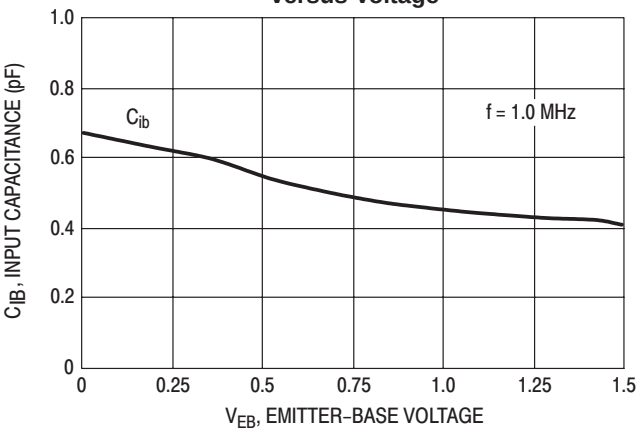


Figure 3. DC Current Gain  
versus Collector Current

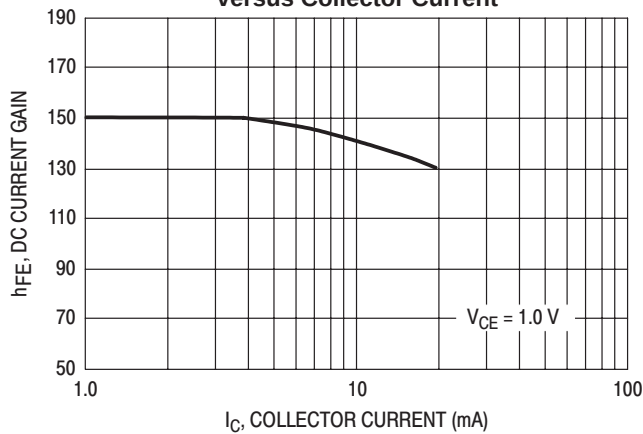


Figure 4. Gain-Bandwidth Product  
versus Collector Current

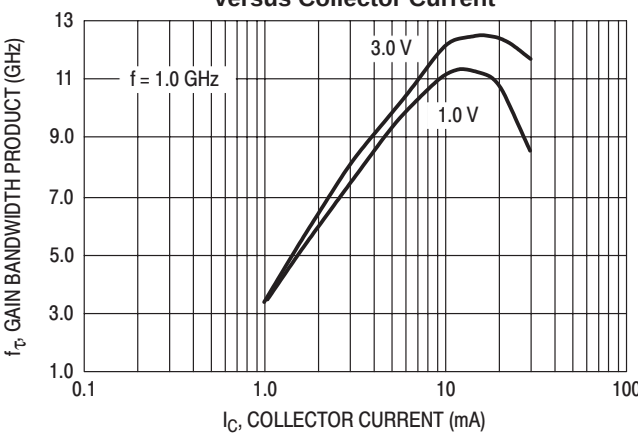
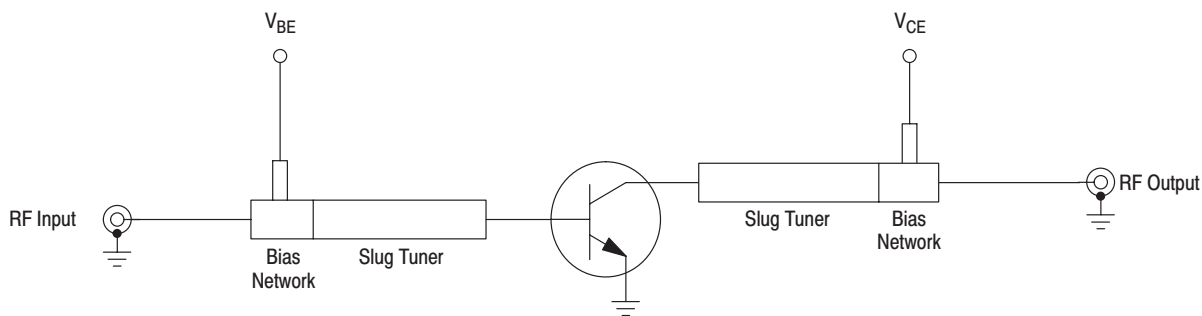


Figure 5. Functional Circuit Schematic



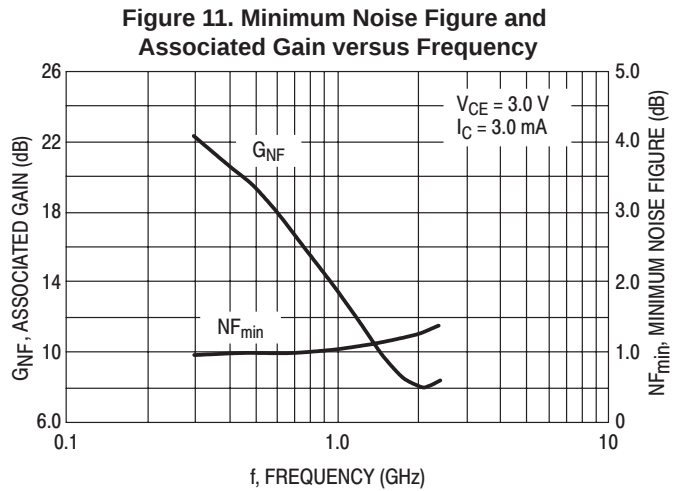
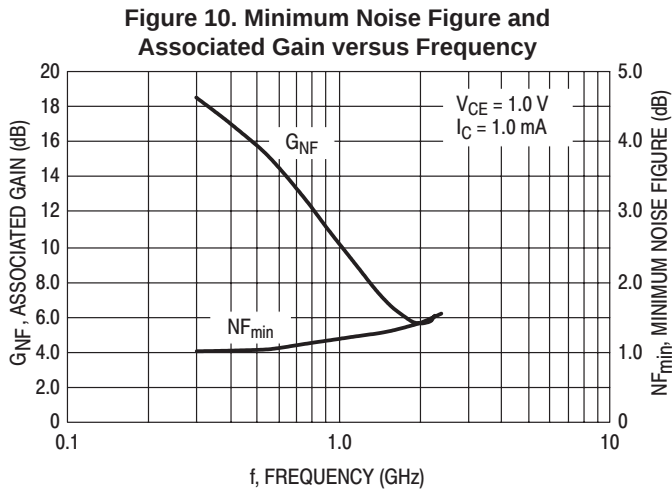
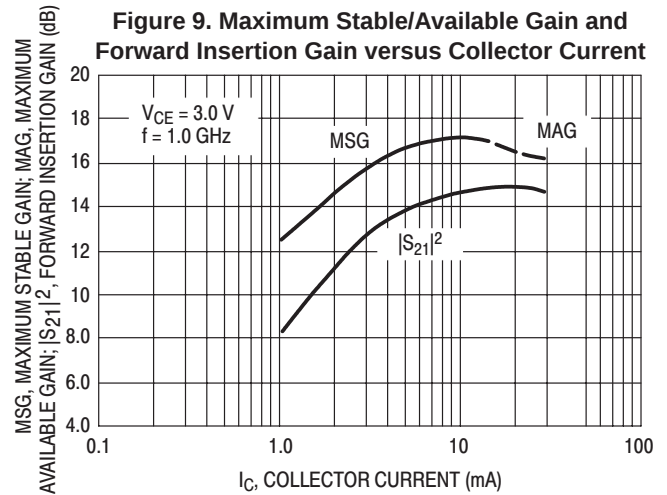
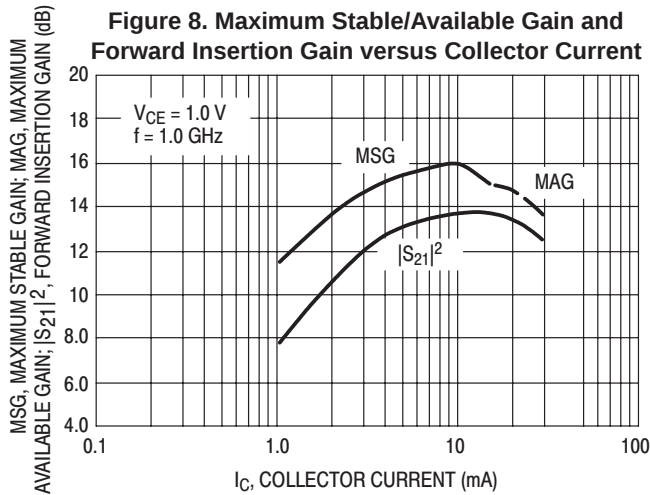
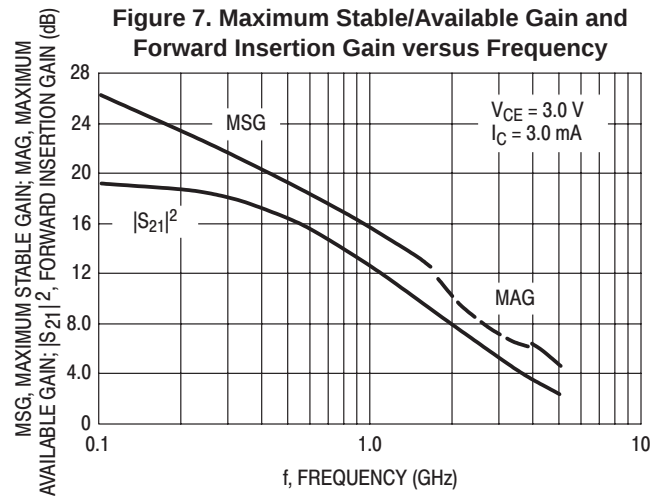
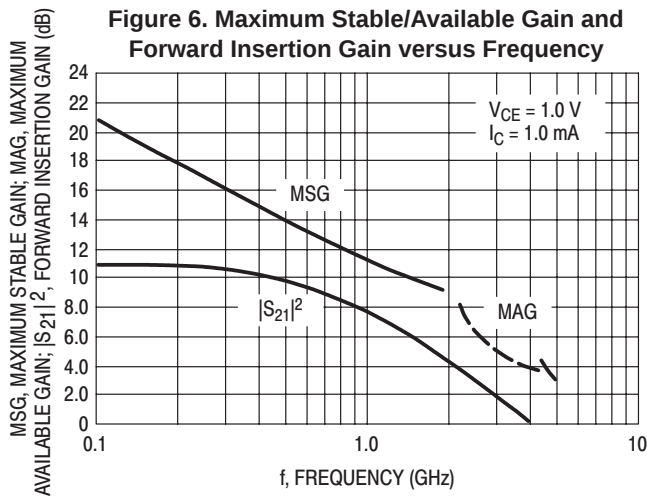


Figure 12. Minimum Noise Figure and Associated Gain versus Collector Current

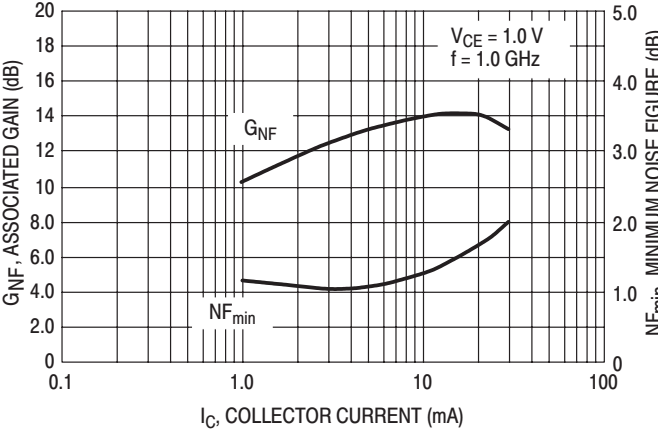


Figure 13. Minimum Noise Figure and Associated Gain versus Collector Current

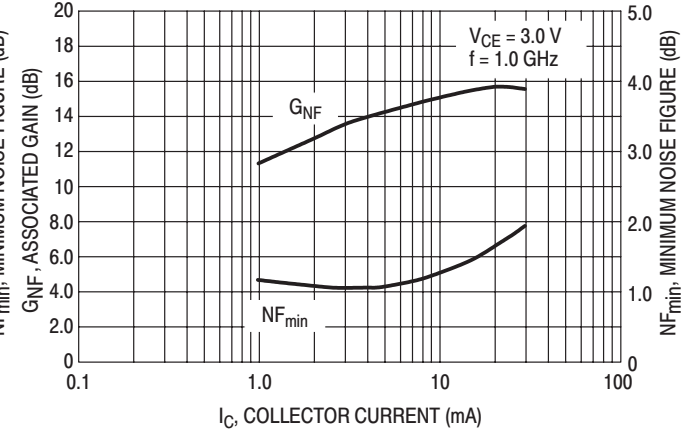
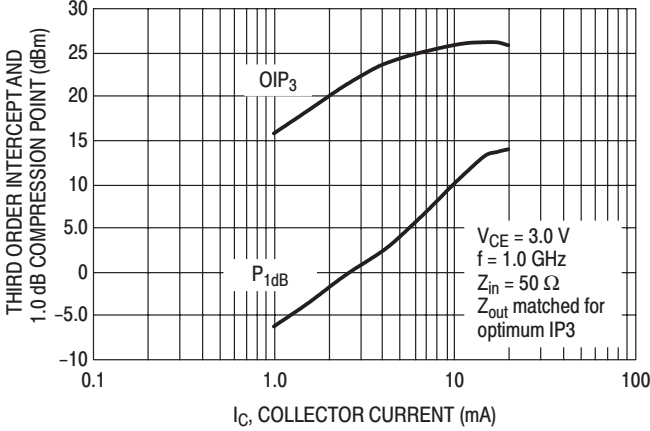


Figure 14. Output Third Order Intercept and Output Power at 1.0 dB Gain Compression versus Collector Current



LIFETIME BUY

LAST ORDER: 03AUG01 LAST SHIP: 26MAR02

# MRF1047T1

Table 1. Common Emitter S-Parameters

| V <sub>CE</sub><br>(Vdc) | I <sub>C</sub><br>(mA) | f<br>(GHz) | S <sub>11</sub> |      | S <sub>21</sub> |     | S <sub>12</sub> |     | S <sub>22</sub> |      | K    |
|--------------------------|------------------------|------------|-----------------|------|-----------------|-----|-----------------|-----|-----------------|------|------|
|                          |                        |            | S <sub>11</sub> | ∠ φ  | S <sub>21</sub> | ∠ φ | S <sub>12</sub> | ∠ φ | S <sub>22</sub> | ∠ φ  |      |
| 1.0                      | 1.0                    | 0.1        | 0.973           | -10  | 3.49            | 171 | 0.029           | 84  | 0.987           | -6   | 0.04 |
|                          |                        | 0.3        | 0.938           | -30  | 3.35            | 154 | 0.082           | 72  | 0.952           | -17  | 0.12 |
|                          |                        | 0.5        | 0.875           | -48  | 3.03            | 137 | 0.124           | 60  | 0.877           | -25  | 0.27 |
|                          |                        | 0.7        | 0.770           | -64  | 2.75            | 124 | 0.153           | 51  | 0.812           | -33  | 0.36 |
|                          |                        | 0.9        | 0.685           | -79  | 2.51            | 112 | 0.174           | 45  | 0.745           | -39  | 0.45 |
|                          |                        | 1.0        | 0.649           | -85  | 2.40            | 107 | 0.181           | 42  | 0.717           | -42  | 0.49 |
|                          |                        | 1.3        | 0.555           | -105 | 2.09            | 92  | 0.195           | 36  | 0.639           | -48  | 0.64 |
|                          |                        | 1.5        | 0.509           | -117 | 1.92            | 84  | 0.202           | 33  | 0.601           | -53  | 0.72 |
|                          |                        | 1.8        | 0.454           | -136 | 1.72            | 72  | 0.204           | 30  | 0.553           | -58  | 0.85 |
|                          |                        | 2.0        | 0.434           | -148 | 1.59            | 66  | 0.205           | 30  | 0.531           | -62  | 0.92 |
|                          |                        | 2.5        | 0.417           | -175 | 1.38            | 50  | 0.208           | 32  | 0.477           | -73  | 1.09 |
|                          |                        | 3.0        | 0.403           | 164  | 1.23            | 39  | 0.227           | 37  | 0.457           | -83  | 1.14 |
|                          |                        | 3.5        | 0.416           | 142  | 1.10            | 28  | 0.259           | 41  | 0.454           | -93  | 1.12 |
|                          |                        | 4.0        | 0.442           | 125  | 1.00            | 20  | 0.310           | 43  | 0.448           | -105 | 1.05 |
|                          |                        | 4.5        | 0.454           | 109  | 0.95            | 12  | 0.378           | 41  | 0.433           | -118 | 0.99 |
|                          |                        | 5.0        | 0.478           | 96   | 0.89            | 6   | 0.445           | 37  | 0.437           | -133 | 0.95 |
|                          | 3.0                    | 0.1        | 0.917           | -17  | 9.30            | 165 | 0.028           | 80  | 0.955           | -11  | 0.10 |
|                          |                        | 0.3        | 0.792           | -48  | 7.94            | 140 | 0.072           | 65  | 0.831           | -29  | 0.26 |
|                          |                        | 0.5        | 0.630           | -69  | 6.31            | 121 | 0.098           | 56  | 0.674           | -39  | 0.47 |
|                          |                        | 0.7        | 0.505           | -87  | 5.11            | 107 | 0.116           | 51  | 0.571           | -45  | 0.62 |
|                          |                        | 0.9        | 0.418           | -103 | 4.26            | 97  | 0.131           | 50  | 0.498           | -49  | 0.74 |
|                          |                        | 1.0        | 0.388           | -110 | 3.93            | 93  | 0.138           | 49  | 0.471           | -50  | 0.78 |
|                          |                        | 1.3        | 0.317           | -129 | 3.20            | 82  | 0.158           | 49  | 0.406           | -54  | 0.91 |
|                          |                        | 1.5        | 0.289           | -142 | 2.84            | 76  | 0.172           | 48  | 0.380           | -58  | 0.96 |
|                          |                        | 1.8        | 0.265           | -161 | 2.45            | 67  | 0.192           | 48  | 0.346           | -62  | 1.02 |
|                          |                        | 2.0        | 0.260           | -173 | 2.24            | 61  | 0.206           | 48  | 0.329           | -65  | 1.05 |
|                          |                        | 2.5        | 0.282           | 164  | 1.88            | 49  | 0.244           | 47  | 0.284           | -76  | 1.07 |
|                          |                        | 3.0        | 0.283           | 147  | 1.65            | 39  | 0.287           | 45  | 0.271           | -85  | 1.07 |
|                          |                        | 3.5        | 0.306           | 128  | 1.47            | 30  | 0.330           | 42  | 0.269           | -95  | 1.04 |
|                          |                        | 4.0        | 0.334           | 115  | 1.34            | 21  | 0.374           | 38  | 0.262           | -107 | 1.02 |
|                          |                        | 4.5        | 0.354           | 103  | 1.25            | 13  | 0.423           | 34  | 0.256           | -119 | 0.99 |
|                          |                        | 5.0        | 0.382           | 93   | 1.176           | 6   | 0.470           | 29  | 0.260           | -133 | 0.97 |
|                          | 5.0                    | 0.1        | 0.861           | -23  | 13.74           | 160 | 0.027           | 78  | 0.923           | -15  | 0.15 |
|                          |                        | 0.3        | 0.671           | -59  | 10.50           | 130 | 0.064           | 63  | 0.727           | -36  | 0.38 |
|                          |                        | 0.5        | 0.489           | -81  | 7.68            | 112 | 0.085           | 57  | 0.552           | -44  | 0.62 |
|                          |                        | 0.7        | 0.379           | -100 | 5.95            | 100 | 0.103           | 56  | 0.455           | -48  | 0.77 |
|                          |                        | 0.9        | 0.311           | -115 | 4.82            | 92  | 0.119           | 55  | 0.393           | -50  | 0.87 |
|                          |                        | 1.0        | 0.289           | -122 | 4.41            | 88  | 0.128           | 55  | 0.372           | -51  | 0.90 |
|                          |                        | 1.3        | 0.241           | -143 | 3.53            | 78  | 0.153           | 55  | 0.323           | -54  | 0.98 |
|                          |                        | 1.5        | 0.223           | -155 | 3.11            | 72  | 0.171           | 55  | 0.303           | -57  | 1.01 |
|                          |                        | 1.8        | 0.214           | -175 | 2.66            | 65  | 0.197           | 54  | 0.277           | -62  | 1.04 |
|                          |                        | 2.0        | 0.217           | 174  | 2.43            | 60  | 0.215           | 53  | 0.263           | -65  | 1.05 |
|                          |                        | 2.5        | 0.251           | 154  | 2.03            | 49  | 0.260           | 50  | 0.222           | -77  | 1.06 |
|                          |                        | 3.0        | 0.256           | 138  | 1.77            | 39  | 0.306           | 46  | 0.213           | -86  | 1.05 |
|                          |                        | 3.5        | 0.282           | 122  | 1.58            | 30  | 0.351           | 42  | 0.212           | -97  | 1.03 |
|                          |                        | 4.0        | 0.310           | 110  | 1.44            | 22  | 0.395           | 37  | 0.205           | -111 | 1.01 |
|                          |                        | 4.5        | 0.330           | 100  | 1.34            | 14  | 0.440           | 32  | 0.202           | -123 | 1.00 |
|                          |                        | 5.0        | 0.360           | 91   | 1.26            | 7   | 0.483           | 27  | 0.206           | -138 | 0.98 |
| 3.0                      | 3.0                    | 0.1        | 0.926           | -13  | 9.03            | 167 | 0.021           | 82  | 0.967           | -8   | 0.10 |
|                          |                        | 0.3        | 0.820           | -37  | 7.99            | 145 | 0.056           | 70  | 0.877           | -22  | 0.26 |
|                          |                        | 0.5        | 0.673           | -55  | 6.60            | 126 | 0.079           | 61  | 0.750           | -30  | 0.48 |
|                          |                        | 0.7        | 0.541           | -69  | 5.47            | 113 | 0.096           | 57  | 0.663           | -34  | 0.62 |
|                          |                        | 0.9        | 0.441           | -80  | 4.63            | 103 | 0.110           | 56  | 0.595           | -38  | 0.73 |
|                          |                        | 1.0        | 0.402           | -85  | 4.30            | 99  | 0.117           | 55  | 0.571           | -39  | 0.78 |
|                          |                        | 1.3        | 0.308           | -100 | 3.53            | 87  | 0.136           | 55  | 0.512           | -42  | 0.90 |
|                          |                        | 1.5        | 0.262           | -109 | 3.16            | 81  | 0.149           | 54  | 0.485           | -45  | 0.95 |
|                          |                        | 1.8        | 0.208           | -126 | 2.73            | 72  | 0.169           | 54  | 0.453           | -48  | 1.01 |
|                          |                        | 2.0        | 0.185           | -139 | 2.50            | 67  | 0.183           | 54  | 0.436           | -51  | 1.03 |
|                          |                        | 2.5        | 0.176           | -172 | 2.11            | 55  | 0.219           | 52  | 0.389           | -59  | 1.06 |
|                          |                        | 3.0        | 0.160           | 165  | 1.85            | 45  | 0.259           | 51  | 0.379           | -66  | 1.05 |

# MRF1047T1

Table 1. Common Emitter S-Parameters (continued)

| $V_{CE}$<br>(Vdc) | $I_C$<br>(mA) | f<br>(GHz) | $S_{11}$   |               | $S_{21}$   |               | $S_{12}$   |               | $S_{22}$   |               | K    |
|-------------------|---------------|------------|------------|---------------|------------|---------------|------------|---------------|------------|---------------|------|
|                   |               |            | $ S_{11} $ | $\angle \phi$ | $ S_{21} $ | $\angle \phi$ | $ S_{12} $ | $\angle \phi$ | $ S_{22} $ | $\angle \phi$ |      |
|                   |               | 3.5        | 0.177      | 137           | 1.65       | 35            | 0.301      | 48            | 0.374      | -74           | 1.03 |
|                   |               | 4.0        | 0.208      | 120           | 1.50       | 27            | 0.346      | 45            | 0.363      | -84           | 1.00 |
|                   |               | 4.5        | 0.228      | 106           | 1.40       | 19            | 0.395      | 41            | 0.354      | -93           | 0.97 |
|                   |               | 5.0        | 0.261      | 96            | 1.32       | 11            | 0.444      | 37            | 0.353      | -105          | 0.94 |
|                   | 5.0           | 0.1        | 0.884      | -19           | 13.66      | 162           | 0.020      | 80            | 0.941      | -12           | 0.14 |
|                   |               | 0.3        | 0.713      | -49           | 10.92      | 135           | 0.052      | 67            | 0.786      | -28           | 0.37 |
|                   |               | 0.5        | 0.529      | -68           | 8.25       | 116           | 0.071      | 61            | 0.632      | -34           | 0.61 |
|                   |               | 0.7        | 0.406      | -83           | 6.48       | 104           | 0.086      | 59            | 0.546      | -37           | 0.75 |
|                   |               | 0.9        | 0.324      | -95           | 5.31       | 95            | 0.101      | 59            | 0.489      | -38           | 0.85 |
|                   |               | 1.0        | 0.293      | -101          | 4.87       | 92            | 0.108      | 59            | 0.470      | -39           | 0.89 |
|                   |               | 1.3        | 0.223      | -118          | 3.90       | 82            | 0.131      | 59            | 0.426      | -41           | 0.97 |
|                   |               | 1.5        | 0.192      | -129          | 3.45       | 76            | 0.146      | 59            | 0.406      | -44           | 1.00 |
|                   |               | 1.8        | 0.163      | -149          | 2.96       | 68            | 0.169      | 58            | 0.383      | -47           | 1.03 |
|                   |               | 2.0        | 0.155      | -163          | 2.70       | 64            | 0.185      | 57            | 0.369      | -49           | 1.04 |
|                   |               | 2.5        | 0.176      | 168           | 2.25       | 53            | 0.226      | 55            | 0.327      | -58           | 1.05 |
|                   |               | 3.0        | 0.174      | 149           | 1.96       | 43            | 0.269      | 52            | 0.321      | -65           | 1.03 |
|                   |               | 3.5        | 0.198      | 128           | 1.74       | 34            | 0.311      | 48            | 0.317      | -74           | 1.01 |
|                   |               | 4.0        | 0.229      | 115           | 1.59       | 26            | 0.355      | 44            | 0.306      | -84           | 0.99 |
|                   |               | 4.5        | 0.249      | 104           | 1.47       | 18            | 0.400      | 40            | 0.299      | -93           | 0.97 |
|                   |               | 5.0        | 0.279      | 95            | 1.38       | 11            | 0.446      | 35            | 0.297      | -105          | 0.94 |
|                   | 10.0          | 0.1        | 0.781      | -27           | 21.48      | 155           | 0.019      | 77            | 0.886      | -17           | 0.25 |
|                   |               | 0.3        | 0.530      | -62           | 14.32      | 123           | 0.045      | 66            | 0.648      | -33           | 0.56 |
|                   |               | 0.5        | 0.350      | -79           | 9.81       | 106           | 0.062      | 65            | 0.504      | -35           | 0.80 |
|                   |               | 0.7        | 0.257      | -92           | 7.38       | 96            | 0.078      | 66            | 0.439      | -35           | 0.91 |
|                   |               | 0.9        | 0.198      | -105          | 5.90       | 89            | 0.096      | 66            | 0.401      | -35           | 0.96 |
|                   |               | 1.0        | 0.179      | -110          | 5.37       | 86            | 0.105      | 66            | 0.389      | -36           | 0.98 |
|                   |               | 1.3        | 0.133      | -128          | 4.24       | 78            | 0.131      | 65            | 0.362      | -37           | 1.02 |
|                   |               | 1.5        | 0.114      | -142          | 3.73       | 73            | 0.149      | 64            | 0.348      | -40           | 1.03 |
|                   |               | 1.8        | 0.104      | -166          | 3.18       | 66            | 0.176      | 62            | 0.331      | -43           | 1.03 |
|                   |               | 2.0        | 0.106      | 178           | 2.90       | 62            | 0.194      | 61            | 0.320      | -46           | 1.04 |
|                   |               | 2.5        | 0.144      | 154           | 2.41       | 52            | 0.239      | 57            | 0.280      | -55           | 1.03 |
|                   |               | 3.0        | 0.149      | 137           | 2.09       | 43            | 0.284      | 53            | 0.276      | -62           | 1.02 |
|                   |               | 3.5        | 0.176      | 118           | 1.85       | 35            | 0.327      | 48            | 0.273      | -72           | 1.00 |
|                   |               | 4.0        | 0.208      | 108           | 1.69       | 27            | 0.370      | 43            | 0.260      | -82           | 0.99 |
|                   |               | 4.5        | 0.228      | 99            | 1.56       | 19            | 0.414      | 39            | 0.253      | -92           | 0.97 |
|                   |               | 5.0        | 0.257      | 91            | 1.47       | 12            | 0.457      | 34            | 0.250      | -104          | 0.95 |

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Table 2. Common-Emitter Noise Parameters

| V <sub>CE</sub><br>(Vdc) | I <sub>C</sub><br>(mA) | f<br>(GHz) | NF <sub>min</sub><br>(dB) | Γ <sub>O</sub> |       | R <sub>N</sub><br>Ω | r <sub>n</sub> | G <sub>NF</sub><br>(dB) | K    |
|--------------------------|------------------------|------------|---------------------------|----------------|-------|---------------------|----------------|-------------------------|------|
|                          |                        |            |                           | Magnitude      | Angle |                     |                |                         |      |
| 1.0                      | 1.0                    | 0.3        | 1.00                      | 0.67           | 15    | 28                  | 0.55           | 18.6                    | 0.12 |
|                          |                        | 0.5        | 1.04                      | 0.64           | 25    | 26                  | 0.52           | 15.8                    | 0.27 |
|                          |                        | 0.7        | 1.08                      | 0.61           | 35    | 25                  | 0.49           | 13.3                    | 0.36 |
|                          |                        | 0.9        | 1.13                      | 0.59           | 46    | 23                  | 0.46           | 11.2                    | 0.45 |
|                          |                        | 1.0        | 1.16                      | 0.57           | 51    | 22                  | 0.44           | 10.2                    | 0.49 |
|                          |                        | 1.5        | 1.28                      | 0.52           | 81    | 16                  | 0.33           | 6.8                     | 0.72 |
|                          |                        | 2.0        | 1.41                      | 0.48           | 116   | 10                  | 0.20           | 5.5                     | 0.92 |
|                          |                        | 2.4        | 1.52                      | 0.47           | 146   | 6.0                 | 0.12           | 6.0                     | 1.07 |
|                          | 3.0                    | 0.3        | 0.83                      | 0.56           | 14    | 17                  | 0.34           | 20.9                    | 0.26 |
|                          |                        | 0.5        | 0.88                      | 0.52           | 23    | 16                  | 0.32           | 18.0                    | 0.47 |
|                          |                        | 0.7        | 0.94                      | 0.48           | 32    | 15                  | 0.30           | 15.5                    | 0.62 |
|                          |                        | 0.9        | 0.99                      | 0.45           | 42    | 14                  | 0.29           | 13.3                    | 0.74 |
|                          |                        | 1.0        | 1.02                      | 0.43           | 47    | 14                  | 0.28           | 12.4                    | 0.78 |
|                          |                        | 1.5        | 1.16                      | 0.38           | 79    | 11                  | 0.22           | 8.7                     | 0.96 |
|                          |                        | 2.0        | 1.31                      | 0.35           | 117   | 8.0                 | 0.15           | 7.1                     | 1.05 |
|                          |                        | 2.4        | 1.44                      | 0.35           | 152   | 5.0                 | 0.10           | 7.3                     | 1.07 |
|                          | 5.0                    | 0.3        | 0.90                      | 0.48           | 13    | 15                  | 0.29           | 21.6                    | 0.38 |
|                          |                        | 0.5        | 0.94                      | 0.44           | 21    | 14                  | 0.28           | 18.8                    | 0.62 |
|                          |                        | 0.7        | 0.98                      | 0.40           | 31    | 13                  | 0.26           | 16.3                    | 0.77 |
|                          |                        | 0.9        | 1.03                      | 0.36           | 42    | 12                  | 0.25           | 14.1                    | 0.87 |
|                          |                        | 1.0        | 1.06                      | 0.35           | 48    | 12                  | 0.24           | 13.1                    | 0.90 |
|                          |                        | 1.5        | 1.20                      | 0.30           | 82    | 10                  | 0.19           | 9.4                     | 1.01 |
|                          |                        | 2.0        | 1.37                      | 0.28           | 123   | 7.0                 | 0.14           | 7.7                     | 1.05 |
|                          |                        | 2.4        | 1.53                      | 0.30           | 161   | 5.0                 | 0.11           | 7.7                     | 1.06 |
| 3.0                      | 1.0                    | 0.3        | 1.11                      | 0.67           | 14    | 31                  | 0.62           | 19.7                    | 0.11 |
|                          |                        | 0.5        | 1.12                      | 0.65           | 22    | 30                  | 0.59           | 16.8                    | 0.26 |
|                          |                        | 0.7        | 1.13                      | 0.64           | 31    | 28                  | 0.56           | 14.3                    | 0.35 |
|                          |                        | 0.9        | 1.16                      | 0.62           | 41    | 26                  | 0.52           | 12.2                    | 0.44 |
|                          |                        | 1.0        | 1.17                      | 0.60           | 46    | 25                  | 0.50           | 11.2                    | 0.48 |
|                          |                        | 1.5        | 1.26                      | 0.56           | 74    | 19                  | 0.38           | 7.7                     | 0.70 |
|                          |                        | 2.0        | 1.39                      | 0.51           | 106   | 12                  | 0.24           | 6.5                     | 0.91 |
|                          |                        | 2.4        | 1.51                      | 0.47           | 135   | 7.0                 | 0.15           | 7.0                     | 1.05 |
|                          | 3.0                    | 0.3        | 0.94                      | 0.60           | 13    | 21                  | 0.41           | 22.3                    | 0.26 |
|                          |                        | 0.5        | 0.96                      | 0.57           | 19    | 20                  | 0.40           | 19.3                    | 0.48 |
|                          |                        | 0.7        | 0.98                      | 0.54           | 25    | 19                  | 0.39           | 16.7                    | 0.62 |
|                          |                        | 0.9        | 1.01                      | 0.51           | 33    | 18                  | 0.36           | 14.5                    | 0.73 |
|                          |                        | 1.0        | 1.03                      | 0.50           | 37    | 18                  | 0.35           | 13.5                    | 0.78 |
|                          |                        | 1.5        | 1.13                      | 0.44           | 61    | 15                  | 0.29           | 9.7                     | 0.95 |
|                          |                        | 2.0        | 1.26                      | 0.37           | 92    | 11                  | 0.21           | 8.1                     | 1.03 |
|                          |                        | 2.4        | 1.39                      | 0.32           | 121   | 8.0                 | 0.15           | 8.3                     | 1.06 |
|                          | 5.0                    | 0.3        | 0.92                      | 0.53           | 13    | 17                  | 0.34           | 22.8                    | 0.37 |
|                          |                        | 0.5        | 0.95                      | 0.49           | 20    | 16                  | 0.32           | 19.9                    | 0.61 |
|                          |                        | 0.7        | 0.99                      | 0.46           | 28    | 16                  | 0.31           | 17.4                    | 0.75 |
|                          |                        | 0.9        | 1.03                      | 0.43           | 37    | 15                  | 0.29           | 15.2                    | 0.85 |
|                          |                        | 1.0        | 1.06                      | 0.42           | 42    | 14                  | 0.28           | 14.2                    | 0.89 |
|                          |                        | 1.5        | 1.20                      | 0.36           | 72    | 12                  | 0.23           | 10.4                    | 1.00 |
|                          |                        | 2.0        | 1.36                      | 0.32           | 109   | 8.0                 | 0.17           | 8.7                     | 1.04 |
|                          |                        | 2.4        | 1.53                      | 0.30           | 144   | 6.0                 | 0.12           | 8.8                     | 1.05 |
|                          | 10.0                   | 0.3        | 1.17                      | 0.39           | 13    | 15                  | 0.29           | 23.8                    | 0.56 |
|                          |                        | 0.5        | 1.18                      | 0.35           | 21    | 14                  | 0.28           | 20.9                    | 0.80 |
|                          |                        | 0.7        | 1.21                      | 0.32           | 31    | 13                  | 0.26           | 18.3                    | 0.91 |
|                          |                        | 0.9        | 1.24                      | 0.29           | 42    | 13                  | 0.25           | 16.1                    | 0.96 |
|                          |                        | 1.0        | 1.26                      | 0.28           | 48    | 12                  | 0.25           | 15.1                    | 0.98 |
|                          |                        | 1.5        | 1.40                      | 0.24           | 83    | 10                  | 0.21           | 11.2                    | 1.03 |
|                          |                        | 2.0        | 1.59                      | 0.23           | 128   | 8.0                 | 0.16           | 9.3                     | 1.04 |
|                          |                        | 2.4        | 1.79                      | 0.24           | 170   | 7.0                 | 0.13           | 9.3                     | 1.03 |

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Table 3. Spice Parameters (MRF1047 Die Gummel–Poon Parameters)

| Name | Value     | Name | Value    | Name | Value    |
|------|-----------|------|----------|------|----------|
| IS   | 5.8 E–16  | IRB  | 7.50E–03 | TF   | 1.50E–11 |
| BF   | 180       | RBM  | 4.0      | XTF  | 8.0      |
| NF   | 0.99      | RE   | 1.0      | VTF  | 4.2355   |
| VAF  | 40        | RC   | 7.0      | ITF  | 0.2      |
| IKF  | 0.18      | XTB  | 0        | PTF  | 60       |
| ISE  | 3.140E–14 | EG   | 1.11     | TR   | 1.00E–09 |
| NE   | 1.78      | XTI  | 3.0      | FC   | 0.95     |
| BR   | 26.8      | CJE  | 5.70E–13 |      |          |
| NR   | 0.9974    | VJE  | 0.98     |      |          |
| VAR  | 2.0       | MJE  | 0.5      |      |          |
| IKR  | 7.50E–03  | CJC  | 4.00E–13 |      |          |
| ISC  | 2.200E–14 | VJC  | 0.59     |      |          |
| NC   | 1.48      | MJC  | 0.314    |      |          |
| RB   | 6.924     | XCJC | 0.6      |      |          |

Figure 15. MRF1047 SC–70 Package Equivalent Circuit

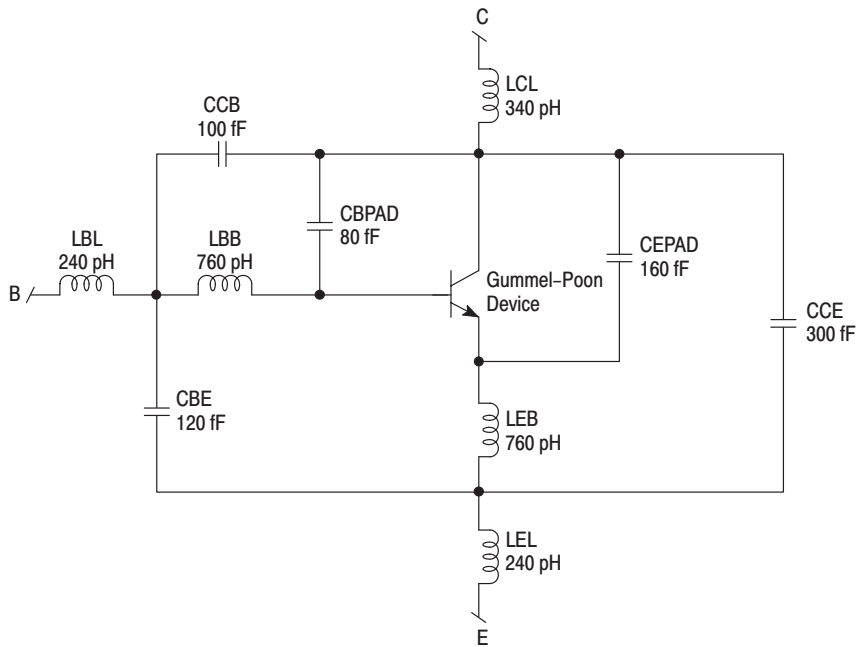
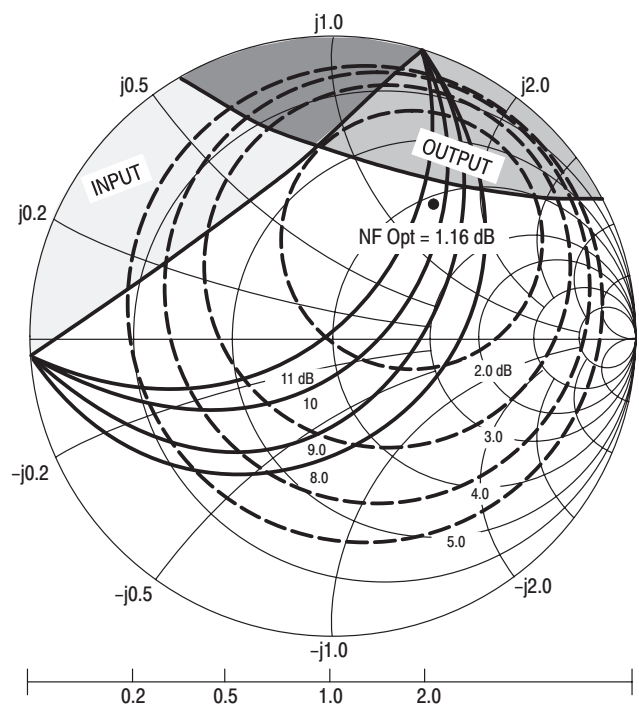


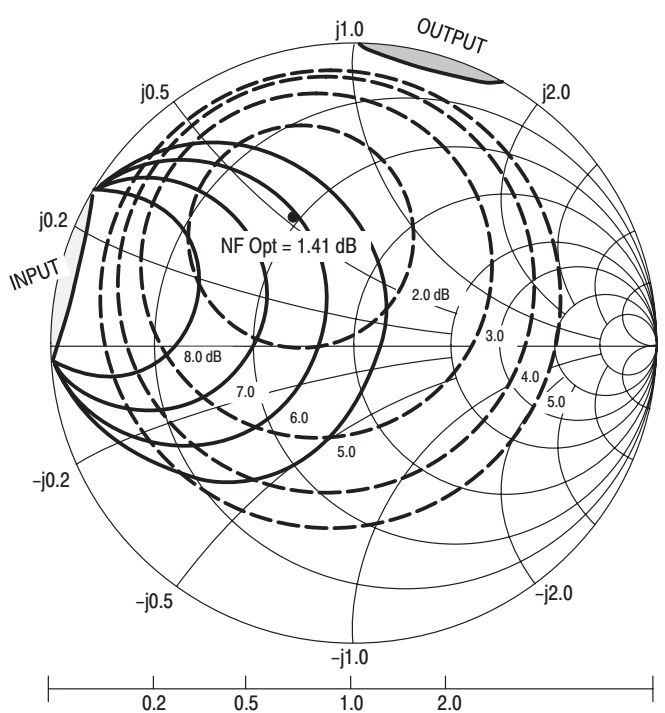
Figure 16. Constant Gain and Noise Figure Contours  
(f = 1.0 GHz)



$V_{CE} = 1.0 \text{ V}$   
 $I_C = 1.0 \text{ mA}$   
— Potentially Unstable

| f (GHz) | NF Opt (dB) | $\Gamma_o$               | Rn   | K    |
|---------|-------------|--------------------------|------|------|
| 1.0     | 1.16        | $0.57 \angle 51.3^\circ$ | 21.8 | 0.49 |

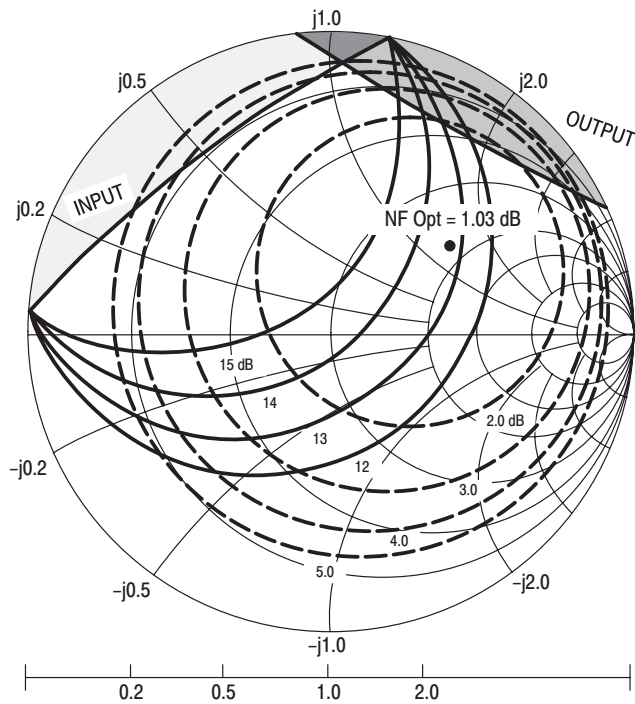
Figure 17. Constant Gain and Noise Figure Contours  
(f = 2.0 GHz)



$V_{CE} = 1.0 \text{ V}$   
 $I_C = 1.0 \text{ mA}$   
— Potentially Unstable

| f (GHz) | NF Opt (dB) | $\Gamma_o$                | Rn  | K    |
|---------|-------------|---------------------------|-----|------|
| 2.0     | 1.41        | $0.48 \angle 115.6^\circ$ | 9.8 | 0.92 |

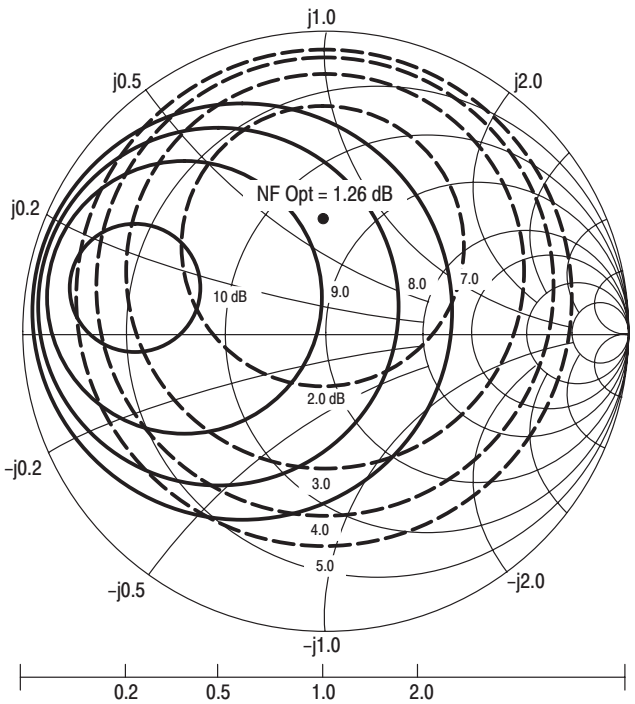
Figure 18. Constant Gain and Noise Figure Contours  
(f = 1.0 GHz)



$V_{CE} = 3.0 \text{ V}$   
 $I_C = 3.0 \text{ mA}$   
 — Potentially Unstable

| f (GHz) | NF Opt (dB) | $\Gamma_o$               | Rn   | K    |
|---------|-------------|--------------------------|------|------|
| 1.0     | 1.03        | $0.50 \angle 37.1^\circ$ | 17.6 | 0.78 |

Figure 19. Constant Gain and Noise Figure Contours  
(f = 2.0 GHz)



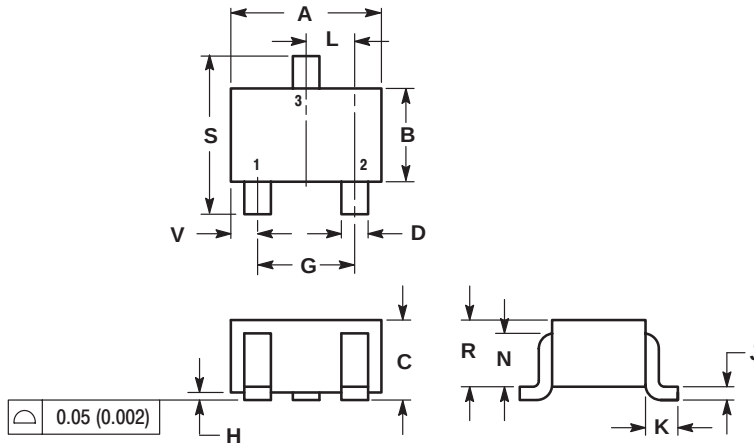
$V_{CE} = 3.0 \text{ V}$   
 $I_C = 3.0 \text{ mA}$   
 — Potentially Unstable

| f (GHz) | NF Opt (dB) | $\Gamma_o$               | Rn   | K    |
|---------|-------------|--------------------------|------|------|
| 2.0     | 1.26        | $0.37 \angle 91.7^\circ$ | 10.7 | 1.03 |

# MRF1047T1

## OUTLINE DIMENSIONS

PLASTIC PACKAGE  
CASE 419-02  
(SC-70)  
ISSUE J



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

| DIM | INCHES    |           | MILLIMETERS |      |
|-----|-----------|-----------|-------------|------|
|     | MIN       | MAX       | MIN         | MAX  |
| A   | 0.071     | 0.087     | 1.80        | 2.20 |
| B   | 0.045     | 0.053     | 1.15        | 1.35 |
| C   | 0.035     | 0.049     | 0.90        | 1.25 |
| D   | 0.012     | 0.016     | 0.30        | 0.40 |
| E   | 0.047     | 0.055     | 1.20        | 1.40 |
| F   | 0.000     | 0.004     | 0.00        | 0.10 |
| G   | 0.004     | 0.010     | 0.10        | 0.25 |
| H   | 0.017 REF | 0.425 REF |             |      |
| I   | 0.026 BSC | 0.650 BSC |             |      |
| J   | 0.028 REF | 0.700 REF |             |      |
| K   | 0.031     | 0.039     | 0.80        | 1.00 |
| L   | 0.079     | 0.087     | 2.00        | 2.20 |
| M   | 0.012     | 0.016     | 0.30        | 0.40 |

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MRF1047T1/D