



# Surface Mount Low Noise Silicon Bipolar Transistor Chip

## Technical Data

### Features

- **Low Noise Figure:**  
1.4 dB Typical at 1.0 GHz  
1.8 dB Typical at 2.0 GHz
- **High Associated Gain:**  
18.0 dB Typical at 1.0 GHz  
13.0 dB Typical at 2.0 GHz
- **High Gain-Bandwidth Product:** 7.0 GHz Typical  $f_T$
- **Low Cost Surface Mount Plastic Package**
- **Tape-and-Reel Packaging Option Available<sup>(1)</sup>**

### Description

Agilent's AT-41411 is a general purpose NPN bipolar transistor that offers excellent high frequency performance. The AT-41411 is housed in a low cost low parasitic 4 lead SOT-143 surface mount package. The SOT-143 is an industry standard and is compatible with high volume surface mount assembly techniques. The 4 micron emitter-to-emitter pitch

enables this transistor to be used in many different functions. The 14 emitter finger interdigitated geometry yields an intermediate sized transistor with impedances that are easy to match for low noise and moderate power applications. This device is designed for use in low noise, wideband amplifier, mixer and oscillator applications in the VHF, UHF, and microwave frequencies. An optimum noise match near  $50 \Omega$  in the 1 to 2 GHz frequency range, makes this device easy to use as a low noise amplifier.

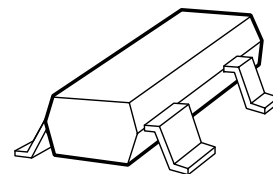
The AT-41411 bipolar transistor is fabricated using Agilent's 10 GHz  $f_T$  Self-Aligned-Transistor (SAT) process. The die is nitride passivated for surface protection. Excellent device uniformity, performance and reliability are produced by the use of ion-implantation, self-alignment techniques, and gold metalization in the fabrication of this device.

#### Note:

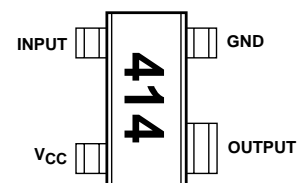
1. Refer to "Tape-and-Reel Packaging for Semiconductor Devices".

## AT-41411

### SOT-143 Plastic



### Pin Connections



## AT-41411 Absolute Maximum Ratings

| Symbol           | Parameter                          | Units | Absolute Maximum <sup>[1]</sup> |
|------------------|------------------------------------|-------|---------------------------------|
| V <sub>EBO</sub> | Emitter-Base Voltage               | V     | 1.5                             |
| V <sub>CBO</sub> | Collector-Base Voltage             | V     | 20                              |
| V <sub>CEO</sub> | Collector-Emitter Voltage          | V     | 12                              |
| I <sub>C</sub>   | Collector Current                  | mA    | 50                              |
| P <sub>T</sub>   | Power Dissipation <sup>[2,3]</sup> | mW    | 225                             |
| T <sub>j</sub>   | Junction Temperature               | °C    | 150                             |
| T <sub>STG</sub> | Storage Temperature                | °C    | -65 to 150                      |

### Thermal Resistance<sup>[2,4]</sup>:

$$\theta_{jc} = 550^{\circ}\text{C/W}$$

#### Notes:

1. Permanent damage may occur if any of these limits are exceeded.
2. T<sub>CASE</sub> = 25°C.
3. Derate at 1.8 mW/°C for T<sub>C</sub> > 26°C.
4. See MEASUREMENTS section "Thermal Resistance" for more information.

## Part Number Ordering Information

| Part Number  | Increment | Comments |
|--------------|-----------|----------|
| AT-41411-TR1 | 3000      | Reel     |
| AT-41411-BLK | 100       | Bulk     |

**Note:** For more information, see "Tape and Reel Packaging for Semiconductor Devices".

## Electrical Specifications, T<sub>A</sub> = 25°C

| Symbol                          | Parameters and Test Conditions <sup>[1]</sup>   | Units                                     | Min. | Typ. | Max.                |
|---------------------------------|---|---|------|------|---------------------|
| S <sub>21E</sub>   <sup>2</sup> | Insertion Power Gain; V <sub>CE</sub> = 8 V, I <sub>C</sub> = 20 mA                   | f = 1.0 GHz<br>f = 2.0 GHz                | dB   | 14.5 | 16.5<br>11.0        |
| P <sub>1 dB</sub>               | Power Output @ 1 dB Gain Compression<br>V <sub>CE</sub> = 8 V, I <sub>C</sub> = 20 mA | f = 2.0 GHz                               | dBm  |      | 17.0                |
| G <sub>1 dB</sub>               | 1 dB Compressed Gain; V <sub>CE</sub> = 8 V, I <sub>C</sub> = 20 mA                   | f = 2.0 GHz                               | dB   |      | 13.0                |
| NF <sub>O</sub>                 | Optimum Noise Figure; V <sub>CE</sub> = 8 V, I <sub>C</sub> = 10 mA                   | f = 1.0 GHz<br>f = 2.0 GHz<br>f = 4.0 GHz | dB   |      | 1.4<br>1.8<br>3.5   |
| G <sub>A</sub>                  | Gain @ NF <sub>O</sub> ; V <sub>CE</sub> = 8 V, I <sub>C</sub> = 10 mA                | f = 1.0 GHz<br>f = 2.0 GHz<br>f = 4.0 GHz | dB   |      | 18.0<br>13.0<br>9.0 |
| f <sub>T</sub>                  | Gain Bandwidth Product; V <sub>CE</sub> = 8 V, I <sub>C</sub> = 20 mA                 |   | GHz  |      | 7.0                 |
| h <sub>FE</sub>                 | Forward Current Transfer Ratio; V <sub>CE</sub> = 8 V, I <sub>C</sub> = 10 mA         |   | —    | 30   | 150                 |
| I <sub>CBO</sub>                | Collector Cutoff Current; V <sub>CB</sub> = 8 V                                       |   | μA   |      | 0.2                 |
| I <sub>EBO</sub>                | Emitter Cutoff Current; V <sub>EB</sub> = 1 V   |   | μA   |      | 1.0                 |

#### Notes:

1. Refer to PACKAGING Section, "Tape-and-Reel Packaging for Semiconductor Devices."

### AT-41411 Typical Performance, $T_A = 25^\circ\text{C}$

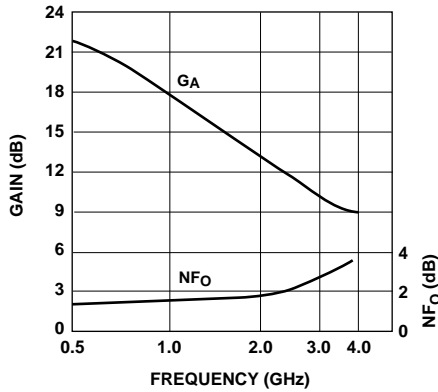


Figure 1. Noise Figure and Associated Gain vs. Frequency.  $V_{CE} = 8\text{ V}$ ,  $I_C = 10\text{ mA}$ .

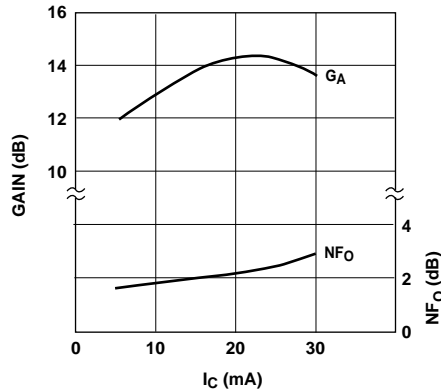


Figure 2. Optimum Noise Figure and Associated Gain vs. Collector Current and Frequency.  $V_{CE} = 8\text{ V}$ ,  $f = 2.0\text{ GHz}$ .

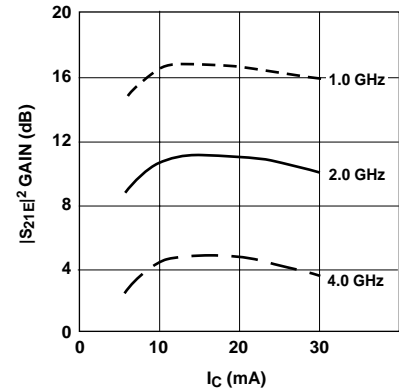


Figure 3. Insertion Power Gain vs. Collector Current and Frequency.  $V_{CE} = 8\text{ V}$ .

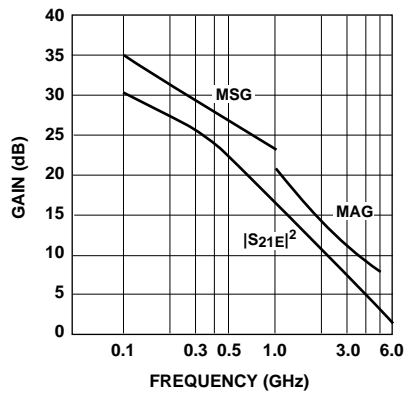


Figure 4. Insertion Power Gain, Maximum Available Gain and Maximum Stable Gain vs. Frequency.  $V_{CE} = 8\text{ V}$ ,  $I_C = 20\text{ mA}$ .

**AT-41411 Typical Scattering Parameters,**Common Emitter,  $Z_0 = 50 \Omega$ ,  $T_A = 25^\circ\text{C}$ ,  $V_{CE} = 8 \text{ V}$ ,  $I_C = 10 \text{ mA}$ 

| Freq.<br>GHz | $S_{11}$ |      | dB   | $S_{21}$ |      | dB    | $S_{12}$ |      | $S_{22}$ |      |
|--------------|----------|------|------|----------|------|-------|----------|------|----------|------|
|              | Mag.     | Ang. |      | Mag.     | Ang. |       | Mag.     | Ang. | Mag.     | Ang. |
| 0.1          | .85      | -30  | 27.3 | 23.20    | 158  | -37.7 | .013     | 64   | .93      | -11  |
| 0.5          | .58      | -112 | 21.7 | 12.18    | 109  | -29.1 | .035     | 44   | .62      | -30  |
| 1.0          | .49      | -156 | 16.5 | 6.70     | 85   | -27.2 | .044     | 43   | .50      | -33  |
| 1.5          | .49      | 178  | 13.2 | 4.58     | 71   | -25.0 | .056     | 47   | .46      | -36  |
| 2.0          | .50      | 160  | 10.8 | 3.45     | 59   | -23.4 | .068     | 47   | .45      | -41  |
| 2.5          | .53      | 153  | 9.0  | 2.82     | 53   | -22.5 | .075     | 56   | .43      | -43  |
| 3.0          | .55      | 142  | 7.5  | 2.37     | 43   | -21.0 | .089     | 54   | .43      | -53  |
| 3.5          | .56      | 133  | 6.1  | 2.02     | 33   | -19.8 | .102     | 52   | .44      | -63  |
| 4.0          | .56      | 121  | 4.9  | 1.76     | 23   | -18.8 | .115     | 49   | .46      | -73  |

**AT-41411 Typical Scattering Parameters,**Common Emitter,  $Z_0 = 50 \Omega$ ,  $T_A = 25^\circ\text{C}$ ,  $V_{CE} = 8 \text{ V}$ ,  $I_C = 20 \text{ mA}$ 

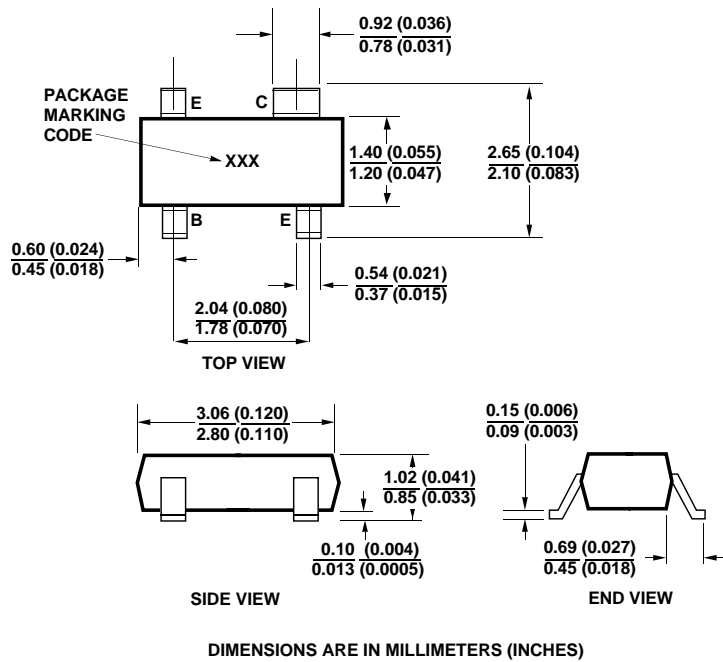
| Freq.<br>GHz | $S_{11}$ |      | dB   | $S_{21}$ |      | dB    | $S_{12}$ |      | $S_{22}$ |      |
|--------------|----------|------|------|----------|------|-------|----------|------|----------|------|
|              | Mag.     | Ang. |      | Mag.     | Ang. |       | Mag.     | Ang. | Mag.     | Ang. |
| 0.1          | .65      | -46  | 30.4 | 33.07    | 150  | -40.0 | .010     | 59   | .89      | -15  |
| 0.5          | .46      | -137 | 22.4 | 13.21    | 100  | -32.0 | .025     | 56   | .57      | -26  |
| 1.0          | .43      | -175 | 16.7 | 6.85     | 80   | -28.4 | .038     | 58   | .52      | -29  |
| 1.5          | .44      | 163  | 13.3 | 4.63     | 67   | -26.4 | .048     | 61   | .51      | -32  |
| 2.0          | .47      | 148  | 10.8 | 3.47     | 56   | -24.2 | .062     | 61   | .50      | -37  |
| 2.5          | .50      | 140  | 9.0  | 2.82     | 50   | -22.9 | .071     | 60   | .47      | -39  |
| 3.0          | .53      | 132  | 7.5  | 2.36     | 40   | -20.7 | .092     | 61   | .46      | -48  |
| 3.5          | .55      | 122  | 6.1  | 2.02     | 30   | -19.6 | .105     | 57   | .45      | -60  |
| 4.0          | .56      | 112  | 4.8  | 1.74     | 19   | -18.3 | .122     | 53   | .45      | -73  |

A model for this device is available in the DEVICE MODELS section.

**AT-41411 Noise Parameters:  $V_{CE} = 8 \text{ V}$ ,  $I_C = 10 \text{ mA}$** 

| Freq.<br>GHz | $N_{F0}$<br>dB | $\Gamma_{opt}$ |      | $R_N/50$ |
|--------------|----------------|----------------|------|----------|
|              |                | Mag            | Ang  |          |
| 0.1          | 1.3            | .12            | 4    | 0.17     |
| 0.5          | 1.3            | .10            | 23   | 0.17     |
| 1.0          | 1.4            | .07            | 57   | 0.16     |
| 2.0          | 1.8            | .09            | -158 | 0.16     |
| 4.0          | 3.5            | .31            | -87  | 0.38     |

## SOT-143 Plastic Dimensions





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5965-8924E (11/99)