HEWLETT® PACKARD

# Up to 6 GHz Medium Power Silicon Bipolar Transistor

## Technical Data

**AT-42035**

## Features

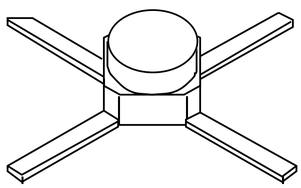
- **High Output Power:**
  21.0 dBm Typical $P_{1\,dB}$ at 2.0 GHz
  20.5 dBm Typical $P_{1\,dB}$ at 4.0 GHz
- **High Gain at 1 dB Compression:**
  14.0 dB Typical $G_{1\,dB}$ at 2.0 GHz
  9.5 dB Typical $G_{1\,dB}$ at 4.0 GHz
- **Low Noise Figure:**
  1.9 dB Typical $NF_O$ at 2.0 GHz
- **High Gain-Bandwidth Product:** 8.0 GHz Typical $f_T$
- **Cost Effective Ceramic Microstrip Package**

## Description

Hewlett-Packard's AT-42035 is a general purpose NPN bipolar transistor that offers excellent high frequency performance. The AT-42035 is housed in a cost effective surface mount 100 mil micro-X package. The 4 micron emitter-to-emitter pitch enables this transistor to be used in many different functions. The 20 emitter finger interdigitated geometry yields a medium sized transistor with impedances that are easy to match for low noise and medium 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 Ω up to 1 GHz, makes this device easy to use as a low noise amplifier.

The AT-42035 bipolar transistor is fabricated using Hewlett- Packard'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.

## 35 micro-X Package





5965-8911E

## AT-42035 Absolute Maximum Ratings [1]

| Symbol | Parameter | Units | Absolute Maximum |
|---|---|---|---|
| $V_{EBO}$ | Emitter-Base Voltage | V | 1.5 |
| $V_{CBO}$ | Collector-Base Voltage | V | 20 |
| $V_{CEO}$ | Collector-Emitter Voltage | V | 12 |
| $I_C$ | Collector Current | mA | 80 |
| $P_T$ | Power Dissipation [2,3] | mW | 600 |
| $T_j$ | Junction Temperature | °C | 200 |
| $T_{STG}$ | Storage Temperature[4] | °C | -65 to 200 |

**Thermal Resistance [2,5]:**
$\theta_{jc}$ = 175°C/W

**Notes:**
1. Permanent damage may occur if any of these limits are exceeded.
2. $T_{CASE}$ = 25°C.
3. Derate at 5.7 mW/°C for $T_C$ > 95°C.
4. Storage above +150°C may tarnish the leads of this package making it difficult to solder into a circuit. After a device has been soldered into a circuit, it may be safely stored up to 200°C.
5. The small spot size of this technique results in a higher, though more accurate determination of $\theta_{jc}$ than do alternate methods. See MEASUREMENTS section "Thermal Resistance" for more information.

## Electrical Specifications, $T_A$ = 25°C

| Symbol | Parameters and Test Conditions[1] | | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|---|
| $\|S_{21E}\|^2$ | Insertion Power Gain; $V_{CE}$ = 8 V, $I_C$ = 35 mA | f = 2.0 GHz<br>f = 4.0 GHz | dB | 10.0 | 11.0<br>5.0 | |
| $P_{1\ dB}$ | Power Output @ 1 dB Gain Compression<br>$V_{CE}$ = 8 V, $I_C$ = 35 mA | f = 2.0 GHz<br>f= 4.0 GHz | dBm | | 21.0<br>20.5 | |
| $G_{1\ dB}$ | 1 dB Compressed Gain; $V_{CE}$ = 8 V, $I_C$ = 35 mA | f = 2.0 GHz<br>f = 4.0 GHz | dB | | 14.0<br>9.5 | |
| $NF_O$ | Optimum Noise Figure: $V_{CE}$ = 8 V, $I_C$ = 10 mA | f = 2.0 GHz<br>f = 4.0 GHz | dB | | 2.0<br>3.0 | |
| $G_A$ | Gain @ $NF_O$; $V_{CE}$ = 8 V, $I_C$ = 10 mA | f = 2.0 GHz<br>f = 4.0 GHz | dB | | 13.5<br>10.0 | |
| $f_T$ | Gain Bandwidth Product: $V_{CE}$ = 8 V, $I_C$ = 35 mA | | GHz | | 8.0 | |
| $h_{FE}$ | Forward Current Transfer Ratio; $V_{CE}$ = 8 V, $I_C$ = 35 mA | | — | 30 | 150 | 270 |
| $I_{CBO}$ | Collector Cutoff Current; $V_{CB}$ = 8 V | | µA | | | 0.2 |
| $I_{EBO}$ | Emitter Cutoff Current; $V_{EB}$ = 1 V | | µA | | | 2.0 |
| $C_{CB}$ | Collector Base Capacitance[1]: $V_{CB}$ = 8 V, f = 1 MHz | | pF | | 0.28 | |

**Notes:**
1. For this test, the emitter is grounded.

# AT-42035 Typical Performance, $T_A = 25°C$

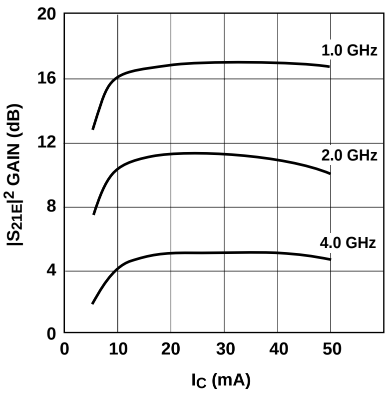



**Figure 1. Insertion Power Gain vs. Collector Current and Frequency. $V_{CE}$ = 8 V.**

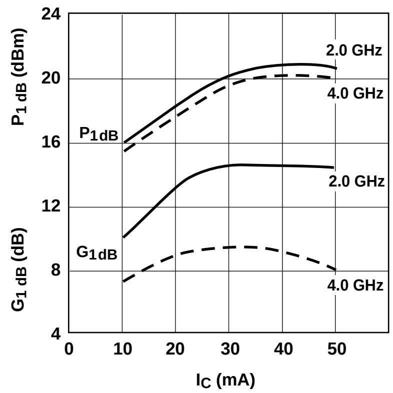



**Figure 2. Output Power and 1 dB Compressed Gain vs. Collector Current and Frequency. $V_{CE}$ = 8 V.**

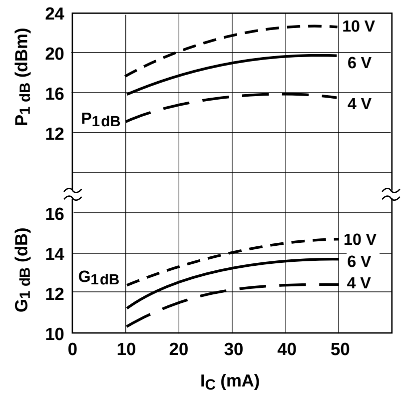



**Figure 3. Output Power and 1 dB Compressed Gain vs. Collector Current and Voltage. f = 2.0 GHz.**

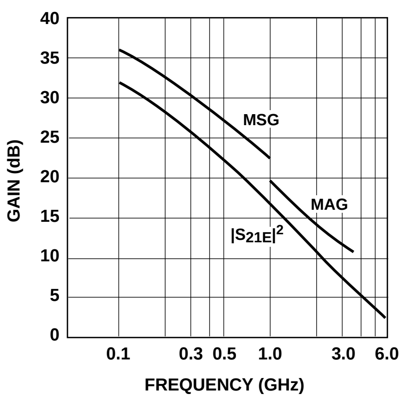



**Figure 4. Insertion Power Gain, Maximum Available Gain and Maximum Stable Gain vs. Frequency. $V_{CE}$ = 8 V, $I_C$ = 35 mA.**

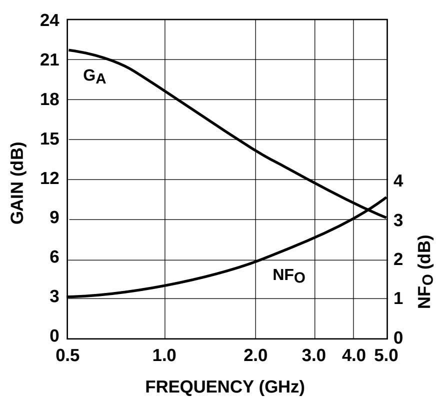



**Figure 5. Noise Figure and Associated Gain vs. Frequency. $V_{CE}$ = 8 V, $I_C$ = 10mA.**

## AT-42035 Typical Scattering Parameters,

Common Emitter, $Z_O = 50\ \Omega$, $T_A = 25°C$, $V_{CE} = 8\ V$, $I_C = 10\ mA$

| Freq. | $S_{11}$ | | $S_{21}$ | | | $S_{12}$ | | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| GHz | Mag. | Ang. | dB | Mag. | Ang. | dB | Mag. | Ang. | Mag. | Ang. |
| 0.1 | .72 | -46 | 28.3 | 26.09 | 152 | -37.0 | .014 | 73 | .92 | -14 |
| 0.5 | .59 | -137 | 20.9 | 11.13 | 102 | -31.0 | .028 | 44 | .58 | -27 |
| 1.0 | .56 | -171 | 15.4 | 5.91 | 80 | -28.2 | .039 | 47 | .51 | -29 |
| 1.5 | .56 | 169 | 12.1 | 4.03 | 67 | -26.6 | .047 | 52 | .50 | -33 |
| 2.0 | .58 | 155 | 9.7 | 3.06 | 55 | -24.2 | .062 | 55 | .48 | -38 |
| 2.5 | .59 | 147 | 8.0 | 2.50 | 48 | -22.6 | .074 | 61 | .47 | -42 |
| 3.0 | .61 | 137 | 6.5 | 2.10 | 38 | -20.8 | .092 | 65 | .46 | -51 |
| 3.5 | .63 | 128 | 5.2 | 1.82 | 27 | -19.6 | .105 | 62 | .47 | -63 |
| 4.0 | .63 | 117 | 4.0 | 1.60 | 17 | -18.0 | .126 | 57 | .49 | -72 |
| 4.5 | .63 | 106 | 3.1 | 1.43 | 7 | -16.5 | .149 | 53 | .51 | -80 |
| 5.0 | .64 | 93 | 2.3 | 1.30 | -3 | -15.4 | .169 | 48 | .52 | -87 |
| 5.5 | .67 | 79 | 1.5 | 1.19 | -13 | -14.3 | .193 | 41 | .51 | -94 |
| 6.0 | .72 | 70 | 0.6 | 1.07 | -23 | -13.4 | .215 | 35 | .46 | -105 |

## AT-42035 Typical Scattering Parameters,

Common Emitter, $Z_O = 50\ \Omega$, $T_A = 25°C$, $V_{CE} = 8\ V$, $I_C = 35\ mA$

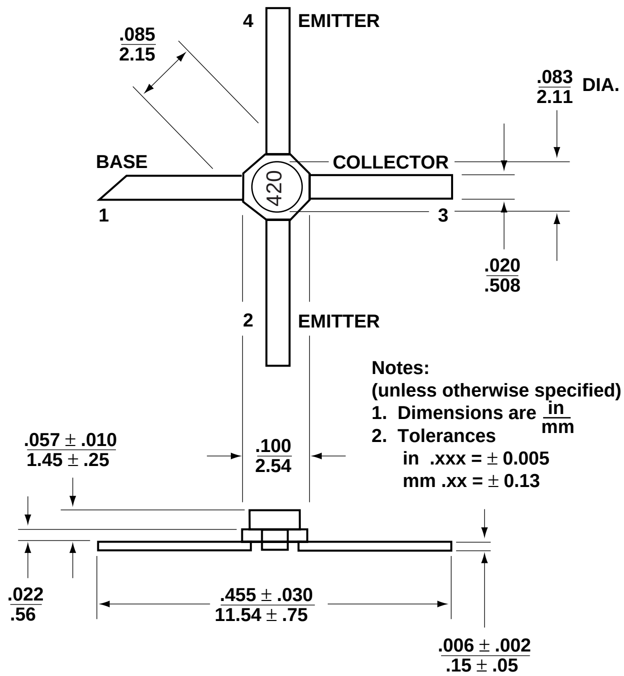
| Freq. | $S_{11}$ | | $S_{21}$ | | | $S_{12}$ | | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| GHz | Mag. | Ang. | dB | Mag. | Ang. | dB | Mag. | Ang. | Mag. | Ang. |
| 0.1 | .50 | -88 | 33.2 | 45.64 | 135 | -42.0 | .008 | 68 | .77 | -22 |
| 0.5 | .52 | -164 | 22.4 | 13.24 | 92 | -32.8 | .023 | 57 | .45 | -25 |
| 1.0 | .53 | 174 | 16.6 | 6.75 | 76 | -28.2 | .039 | 63 | .42 | -26 |
| 1.5 | .53 | 160 | 13.1 | 4.55 | 64 | -25.6 | .053 | 66 | .41 | -30 |
| 2.0 | .55 | 148 | 10.8 | 3.45 | 53 | -23.2 | .069 | 65 | .41 | -36 |
| 2.5 | .57 | 142 | 9.0 | 2.81 | 47 | -21.6 | .084 | 67 | .39 | -40 |
| 3.0 | .59 | 134 | 7.5 | 2.37 | 37 | -20.0 | .101 | 64 | .38 | -49 |
| 3.5 | .60 | 125 | 6.3 | 2.06 | 27 | -18.4 | .120 | 61 | .39 | -61 |
| 4.0 | .60 | 116 | 5.2 | 1.81 | 17 | -17.0 | .141 | 57 | .41 | -71 |
| 4.5 | .60 | 104 | 4.2 | 1.62 | 7 | -16.0 | .158 | 50 | .43 | -78 |
| 5.0 | .61 | 92 | 3.4 | 1.47 | -2 | -14.9 | .179 | 45 | .44 | -84 |
| 5.5 | .64 | 79 | 2.6 | 1.35 | -13 | -14.1 | .198 | 37 | .43 | -91 |
| 6.0 | .69 | 70 | 1.7 | 1.21 | -23 | -13.2 | .219 | 30 | .38 | -102 |

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

## AT-42035 Noise Parameters: $V_{CE} = 8\ V$, $I_C = 10\ mA$

| Freq. GHz | $NF_O$ dB | $\Gamma_{opt}$ | | $R_N/50$ |
|---|---|---|---|---|
| | | Mag | Ang | |
| 0.1 | 1.0 | .04 | 10 | 0.13 |
| 0.5 | 1.1 | .04 | 66 | 0.12 |
| 1.0 | 1.3 | .07 | 150 | 0.12 |
| 2.0 | 2.0 | .20 | -178 | 0.12 |
| 4.0 | 3.0 | .51 | -110 | 0.36 |

## 35 micro-X Package Dimensions




Notes:
(unless otherwise specified)
1. Dimensions are in/mm
2. Tolerances
in .xxx = ± 0.005
mm .xx = ± 0.13