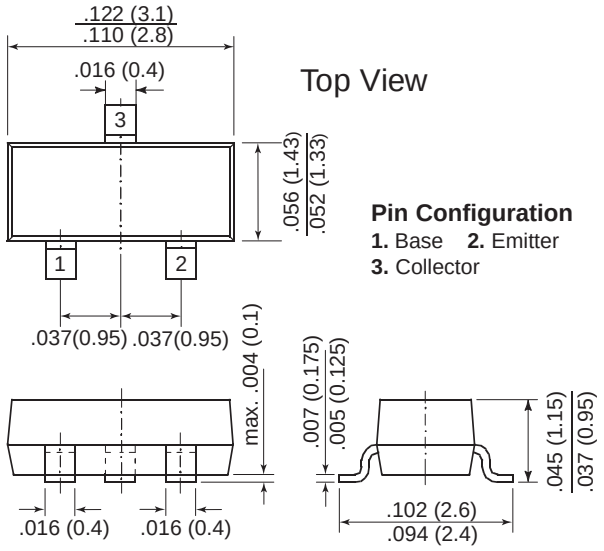
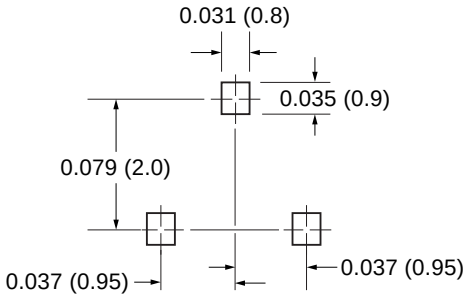
# Small Signal Transistors (NPN)

**TO-236AB (SOT-23)**




**Pin Configuration**
**1.** Base **2.** Emitter
**3.** Collector

**Mounting Pad Layout**




*Dimensions in inches and (millimeters)*

## Features

- NPN Silicon Epitaxial Planar Transistors
- Suited for low level, low noise, low frequency applications in hybrid cicuits.
- Low Current, Low Voltage.
- As complementary types, BCW61 Series PNP transistors are recommended.

## Mechanical Data

**Case:** SOT-23 Plastic Package

**Weight:** approx. 0.008g

**Marking Code:** BCW60A = AA
BCW60B = AB
BCW60C = AC
BCW60D = AD

**Packaging Codes/Options:**
E8/10K per 13” reel (8mm tape), 30K/box
E9/3K per 7” reel (8mm tape), 30K/box

## Maximum Ratings & Thermal Characteristics

Ratings at 25°C ambient temperature unless otherwise specified.

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Collector-Emitter Voltage ($V_{BE}$=0) | $V_{CES}$ | 32 | V |
| Collector-Emitter Voltage | $V_{CEO}$ | 32 | V |
| Emitter-Base Voltage | $V_{EBO}$ | 5.0 | V |
| Collector Current (DC) | $I_C$ | 100 | mA |
| Peak Collector Current | $I_{CM}$ | 200 | mA |
| Base Current (DC) | $I_B$ | 50 | mA |
| Power Dissipation | $P_{tot}$ | 250 | mW |
| Maximum Junction Temperature | $T_j$ | 150 | °C |
| Storage Temperature Range | $T_S$ | –65 to +150 | °C |
| Thermal Resistance Junction to Ambient Air | $R_{\Theta JA}$ | 500(1) | °C/W |

**Note:**
(1) Mounted on FR-4 printed-ciruit board.

## Electrical Characteristics

Ratings at 25°C ambient temperature unless otherwise specified.

| Parameter | | Symbol | Min. | TYP. | Max. | Unit |
|---|---|---|---|---|---|---|
| DC Current Gain | | | | | | |
| at $V_{CE}$ = 5V, $I_C$ = 10 µA | BCW60A | $h_{FE}$ | – | – | – | – |
| at $V_{CE}$ = 5V, $I_C$ = 10 µA | BCW60B | $h_{FE}$ | 20 | – | – | – |
| at $V_{CE}$ = 5V, $I_C$ = 10 µA | BCW60C | $h_{FE}$ | 40 | – | – | – |
| at $V_{CE}$ = 5V, $I_C$ = 10 µA | BCW60D | $h_{FE}$ | 100 | – | – | – |
| at $V_{CE}$ = 5V, $I_C$ = 2 mA | BCW60A | $h_{FE}$ | 120 | – | 220 | – |
| at $V_{CE}$ = 5V, $I_C$ = 2 mA | BCW60B | $h_{FE}$ | 180 | – | 310 | – |
| at $V_{CE}$ = 5V, $I_C$ = 2 mA | BCW60C | $h_{FE}$ | 250 | – | 460 | – |
| at $V_{CE}$ = 5V, $I_C$ = 2 mA | BCW60D | $h_{FE}$ | 380 | – | 630 | – |
| at $V_{CE}$ = 1V, $I_C$ = 50 mA | BCW60A | $h_{FE}$ | 50 | – | – | – |
| at $V_{CE}$ = 1V, $I_C$ = 50 mA | BCW60B | $h_{FE}$ | 70 | – | – | – |
| at $V_{CE}$ = 1V, $I_C$ = 50 mA | BCW60C | $h_{FE}$ | 90 | – | – | – |
| at $V_{CE}$ = 1V, $I_C$ = 50 mA | BCW60D | $h_{FE}$ | 100 | – | – | – |
| Collector-Emitter Saturation Voltage | | | | | | |
| at $I_C$ = 10 mA, $I_B$ = 0.25 mA | | $V_{CEsat}$ | 50 | – | 350 | mV |
| at $I_C$ = 50 mA, $I_B$ = 1.25 mA | | $V_{CEsat}$ | 100 | – | 550 | mV |
| Base-Emitter Saturation Voltage | | | | | | |
| at $I_C$ = 10 mA, $I_B$ = 0.25 mA | | $V_{BEsat}$ | 600 | – | 850 | mV |
| at $I_C$ = 50 mA, $I_B$ = 1.25 mA | | $V_{BEsat}$ | 700 | – | 1050 | mV |
| Base-Emitter Voltage | | | | | | |
| at $V_{CE}$ = 5V, $I_C$ = 2 mA | | $V_{BE}$ | 550 | 650 | 750 | mV |
| at $V_{CE}$ = 5V, $I_C$ = 10 µA | | $V_{BE}$ | – | 520 | – | mV |
| at $V_{CE}$ = 1V, $I_C$ = 50 mA | | $V_{BE}$ | – | 780 | – | mV |
| Collector-Emitter Cut-off Current | | | | | | |
| at $V_{CE}$ = 32V, $V_{BE}$ = 0V | | $I_{CES}$ | – | – | 20 | nA |
| at $V_{CE}$ = 32V, $V_{BE}$ = 0V, $T_A$ = 150°C | | | – | – | 20 | µA |
| Emitter-Base Cut-off Current | | | | | | |
| at $V_{EB}$ = 4V, $I_C$ = 0 | | $I_{EBO}$ | – | – | 20 | nA |
| Gain-Bandwidth Product | | | | | | |
| at $V_{CE}$ = 5V, $I_C$ = 10 mA, f = 100 MHz | | $f_T$ | 100 | 250 | – | MHz |
| Collector-Base Capacitance | | | | | | |
| at $V_{CB}$ = 10V, f = 1 MHz, $I_E$=0 | | $C_{CBO}$ | – | 2.5 | – | pF |
| Emitter-Base Capacitance | | | | | | |
| at $V_{EB}$ = 0.5V, f = 1 MHz, $I_C$=0 | | $C_{EBO}$ | – | 8 | – | pF |
| Noise Figure | | | | | | |
| at $V_{CE}$ = 5V, $I_C$ = 200 µA, $R_S$ = 2 kΩ, f = 1kHz, B = 200Hz | | F | – | 2 | 6 | dB |
| Small Signal Current Gain | BCW60A | $h_{fe}$ | – | 200 | | |
| at $V_{CE}$ = 5V, $I_C$ = 2 mA, f = 1.0 kHz | BCW60B | | – | 260 | | |
| | BCW60C | | – | 330 | | |
| | BCW60D | | – | 520 | | |
| Turn-on Time at $R_L$ = 990Ω (see fig. 1) | | | | | | |
| $V_{CC}$ = 10V, Ic = 10mA, $I_{B(on)}$ = $-I_{B(off)}$ = 1mA | | $t_{on}$ | – | 85 | 150 | ns |
| Turn-off Time at $R_L$ = 990Ω (see fig. 1) | | | | | | |
| $V_{CC}$ = 10V, Ic = 10mA, $I_{B(on)}$ = $-I_{B(off)}$ = 1mA | | $t_{off}$ | – | 480 | 800 | ns |

**Fig. 1 - Switching Waveforms**