DATA SHEET

BLW77
HF/VHF power transistor

Product specification
August 1986
**DESCRIPTION**

N-P-N silicon planar epitaxial transistor intended for use in class-AB or class-B operated high power transmitters in the h.f. and v.h.f. bands. The transistor presents excellent performance as a linear amplifier in the h.f. band. It is resistance stabilized and is guaranteed to withstand severe load mismatch conditions. Transistors are delivered in matched $h_{FE}$ groups.

The transistor has a $\frac{1}{2}$" flange envelope with a ceramic cap. All leads are isolated from the flange.

**QUICK REFERENCE DATA**

R.F. performance up to $T_h = 25 \, ^\circ C$

<table>
<thead>
<tr>
<th>MODE OF OPERATION</th>
<th>$V_{CE}$ (V)</th>
<th>$I_{C(ZS)}$ (A)</th>
<th>$f$ (MHz)</th>
<th>$P_L$ (W)</th>
<th>$G_p$ (dB)</th>
<th>$\eta$ (%)</th>
<th>$d_3$ (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>s.s.b. (class-AB)</td>
<td>28</td>
<td>0,1</td>
<td>1,6 – 28</td>
<td>15 – 130</td>
<td>&gt; 12</td>
<td>&gt; 37.5 &lt; 1</td>
<td></td>
</tr>
<tr>
<td>c.w. (class-B)</td>
<td>28</td>
<td>–</td>
<td>87,5</td>
<td>130</td>
<td>typ. 7,5</td>
<td>typ. 75</td>
<td>&lt; 30</td>
</tr>
</tbody>
</table>

**Note**

1. At 130 W P.E.P.

**PIN CONFIGURATION**

![Fig.1 Simplified outline. SOT121B.](image)

**PINNING - SOT121B.**

<table>
<thead>
<tr>
<th>PIN</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>collector</td>
</tr>
<tr>
<td>2</td>
<td>emitter</td>
</tr>
<tr>
<td>3</td>
<td>base</td>
</tr>
<tr>
<td>4</td>
<td>emitter</td>
</tr>
</tbody>
</table>

**PRODUCT SAFETY** This device incorporates beryllium oxide, the dust of which is toxic. The device is entirely safe provided that the BeO disc is not damaged.

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PHILIPS SEMICONDUCTORS

Product specification

HF/VHF power transistor

BLW77

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-emitter voltage (\(V_{BE} = 0\))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit (max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage</td>
<td>70 V</td>
</tr>
<tr>
<td>Collector-emitter voltage (open base)</td>
<td>35 V</td>
</tr>
<tr>
<td>Emitter-base voltage (open collector)</td>
<td>4 V</td>
</tr>
<tr>
<td>Collector current (average)</td>
<td>12 A</td>
</tr>
<tr>
<td>Collector current (peak value); (f &gt; 1) MHz</td>
<td>30 A</td>
</tr>
</tbody>
</table>

R.F. power dissipation (\(f > 1\) MHz); \(T_{mb} = 25\) °C

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit (max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.F. power dissipation</td>
<td>245 W</td>
</tr>
</tbody>
</table>

Storage temperature

-25 to +150 °C

Operating junction temperature

-200 °C

Thermal resistance

(dissipation = 100 W; \(T_{mb} = 90\) °C, i.e. \(T_h = 70\) °C)

From junction to mounting base (d.c. dissipation)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value (K/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(R_{th,j-mb} (dc))</td>
<td>1.03</td>
</tr>
</tbody>
</table>

From junction to mounting base (r.f. dissipation)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value (K/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(R_{th,j-mb} (rf))</td>
<td>0.71</td>
</tr>
</tbody>
</table>

From mounting base to heatsink

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value (K/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(R_{th,mb-h})</td>
<td>0.2</td>
</tr>
</tbody>
</table>
CHARACTERISTICS

$T_j = 25 \, ^\circ C$ unless otherwise specified

Collector-emitter breakdown voltage

$V_{BE} = 0; \, I_C = 50 \, mA \quad V_{(BR) \, CES} > 70 \, V$

Collector-emitter breakdown voltage

open base; $I_C = 100 \, mA \quad V_{(BR) \, CEO} > 35 \, V$

Emitter-base breakdown voltage

open collector; $I_E = 20 \, mA \quad V_{(BR) \, EBO} > 4 \, V$

Collector cut-off current

$V_{BE} = 0; \, V_{CE} = 35 \, V \quad I_{CES} < 20 \, mA$

D.C. current gain$^{(1)}$

$I_C = 7 \, A; \, V_{CE} = 5 \, V \quad h_{FE} \quad 15 \, to \, 80$

D.C. current gain ratio of matched devices$^{(1)}$

$I_C = 7 \, A; \, V_{CE} = 5 \, V \quad h_{FE1}/h_{FE2} < 1.2$

Collector-emitter saturation voltage$^{(1)}$

$I_C = 20 \, A; \, I_B = 4 \, A \quad V_{CEsat} \quad \text{typ.} \, 2 \, V$

Transition frequency at $f = 100 \, MHz^{(2)}$

$-I_E = 7 \, A; \, V_{CB} = 28 \, V \quad f_T \quad \text{typ.} \, 320 \, MHz$

$-I_E = 20 \, A; \, V_{CB} = 28 \, V \quad f_T \quad \text{typ.} \, 300 \, MHz$

Collector capacitance at $f = 1 \, MHz$

$I_E = I_B = 0; \, V_{CB} = 28 \, V \quad C_c \quad \text{typ.} \, 255 \, pF$

Feedback capacitance at $f = 1 \, MHz$

$I_C = 100 \, mA; \, V_{CE} = 28 \, V \quad C_{re} \quad \text{typ.} \, 175 \, pF$

Collector-flange capacitance

$C_{cf} \quad \text{typ.} \, 3 \, pF$

Notes

1. Measured under pulse conditions: $t_p \leq 300 \, \mu s; \, \delta \leq 0.02$.
2. Measured under pulse conditions: $t_p \leq 50 \, \mu s; \, \delta \leq 0.01$.

![Graph](image-url) Fig.4 Typical values; $V_{CE} = 20 \, V$.  

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Fig.5 Typical values; $T_j = 25 \, ^\circ C$.

Fig.6 $I_E = I_e = 0; f = 1 \, MHz; T_j = 25 \, ^\circ C$.

Fig.7 $V_{CB} = 28 \, V; f = 100 \, MHz; T_j = 25 \, ^\circ C$. 
# APPLICATION INFORMATION

R.F. performance in s.s.b. class-AB operation (linear power amplifier)

\[ V_{CE} = 28 \text{ V; } T_h = 25 \, ^\circ \text{C; } f_1 = 28,000 \text{ MHz; } f_2 = 28,001 \text{ MHz} \]

<table>
<thead>
<tr>
<th>OUTPUT POWER</th>
<th>( G_p ) (dB)</th>
<th>( \eta_{dd} ) (%) at 130 W P.E.P.</th>
<th>( I_C ) (A)</th>
<th>( d_3 ) dB</th>
<th>( d_5 ) dB</th>
<th>( I_C(ZS) ) (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 to 130 (P.E.P.)</td>
<td>&gt; 12</td>
<td>&gt; 37.5</td>
<td>&lt; 6.2</td>
<td>&lt; −30</td>
<td>&lt; −30</td>
<td>0.1</td>
</tr>
</tbody>
</table>

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**Fig.8** Test circuit; s.s.b. class-AB.
List of components:

- C1 = 27 pF ceramic capacitor (500 V)
- C2 = 100 pF air dielectric trimmer (single insulated rotor type)
- C3 = 180 pF polystyrene capacitor
- C4 = C6 = C9 = 100 nF polyester capacitor
- C5 = 100 pF air dielectric trimmer (single non-insulated rotor type)
- C7 = C8 = 3.9 nF ceramic capacitor
- C10 = 2.2 \mu F moulded metallized polyester capacitor
- C11 = 2 \times 180 pF polystyrene capacitors in parallel
- C12 = 3 \times 56 pF and 33 pF ceramic capacitors in parallel (500 V)
- C13 = 4 \times 56 pF and 68 pF ceramic capacitors in parallel (500 V)
- C14 = 360 pF air dielectric trimmer (single insulated rotor type)
- C15 = 360 pF air dielectric trimmer (single non-insulated rotor type)
- L1 = 88 nH; 3 turns Cu wire (1.0 mm); int. dia. 9.0 mm; length 6.1 mm; leads 2 \times 7 mm
- L2 = L4 = Ferroxcube wide-band h.f. choke, grade 3B (cat. no. 4312 020 36640)
- L3 = L5 = 80 nH; 2.5 turns closely wound enamelled Cu wire (1.6 mm); int. dia. 10.0 mm; leads 2 \times 7 mm
- R1 = 470 \Omega wirewound resistor (5.5 W)
- R2 = 4.7 \Omega wirewound potentiometer (3 W)
- R3 = 0.55 \Omega; parallel connection of 4 \times 2.2 \Omega carbon resistors (\pm 5\%; 0.5 W each)
- R4 = 45 \Omega; parallel connection of 4 \times 180 \Omega wirewound resistors (5.5 W each)
- R5 = 56 \Omega (\pm 5\%) carbon resistor (0.5 W)
- R6 = 27 \Omega (\pm 5\%) carbon resistor (0.5 W)
- R7 = 4.7 \Omega (\pm 5\%) carbon resistor (0.5 W)
1. Stated intermodulation distortion figures are referred to the according level of either of the equal amplified tones. Relative to the according peak envelope powers these figures should be increased by 6 dB.

\[ V_{CE} = 28 \, \text{V}; \, I_{CZS} = 100 \, \text{mA}; \, f_1 = 28,000 \, \text{MHz}; \, f_2 = 28,001 \, \text{MHz}; \, T_h = 25 ^\circ \text{C}; \, \text{typical values.} \]

Fig.9  Intermodulation distortion as a function of output power.\(^{(1)}\)

\[ V_{CE} = 28 \, \text{V}; \, I_{CZS} = 100 \, \text{mA}; \, f_1 = 28,000 \, \text{MHz}; \, f_2 = 28,001 \, \text{MHz}; \, T_h = 25 ^\circ \text{C}; \, \text{typical values.} \]

Fig.10  Double-tone efficiency and power gain as a function of output power.
HF/VHF power transistor    \hspace{1cm}  BLW77

Fig.11  Power gain as a function of frequency.

\begin{align*}
V_{CE} &= 28 \text{ V}; I_C(Z_S) = 100 \text{ mA}; P_L = 130 \text{ W}; \\
T_h &= 25 \text{ °C}; Z_L = 2.5 \Omega.
\end{align*}

Fig.12  Input impedance (series components) as a function of frequency.

\begin{align*}
V_{CE} &= 28 \text{ V}; I_C(Z_S) = 100 \text{ mA}; P_L = 130 \text{ W}; \\
T_h &= 25 \text{ °C}; Z_L = 2.5 \Omega.
\end{align*}

Figs 11 and 12 are typical curves and hold for an unneutralized amplifier in s.s.b. class-AB operation.
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Fig. 13  Power gain as a function of frequency.

$V_{CE} = 28 \text{ V}; I_{C(ZS)} = 100 \text{ mA}; P_L = 130 \text{ W}; T_h = 25 \degree \text{C};$
$Z_L = 2.5 \Omega; \text{ neutralizing capacitor: } 150 \text{ pF}.$

13 and 14 are typical curves and hold for a push-pull amplifier with cross-neutralization in s.s.b class-AB operation.

Fig. 14  Input impedance (series components) as a function of frequency.

$V_{CE} = 28 \text{ V}; I_{C(ZS)} = 100 \text{ mA}; P_L = 130 \text{ W}; T_h = 25 \degree \text{C};$
$Z_L = 2.5 \Omega; \text{ neutralizing capacitor: } 150 \text{ pF}.$
The graph shows the permissible output power under nominal conditions (VSWR = 1) as a function of the expected VSWR during short-time mismatch conditions with heatsink temperatures as parameter.

Fig.15 R.F. SOAR; s.s.b. class-AB operation;
\[ f_1 = 28,000 \text{ MHz}; f_2 = 28,001 \text{ MHz}; \]
\[ V_{CE} = 28 \text{ V}; R_{th mb-h} = 0.2 \text{ K/W}. \]
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R.F. performance in c.w. operation (unneutralized common-emitter class-B circuit); $T_h = 25 \, ^\circ\text{C}$

<table>
<thead>
<tr>
<th>$f$ (MHz)</th>
<th>$V_{CE}$ (V)</th>
<th>$P_L$ (W)</th>
<th>$P_S$ (W)</th>
<th>$G_p$ (dB)</th>
<th>$I_C$ (A)</th>
<th>$\eta$ (%)</th>
<th>$z_i$ ($\Omega$)</th>
<th>$\overline{V}_L$ (mS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>87.5</td>
<td>28</td>
<td>130</td>
<td>typ. 23.2</td>
<td>typ. 7.5</td>
<td>typ. 6.2</td>
<td>typ. 75</td>
<td>0.62 + j0.73</td>
<td>273 – j42</td>
</tr>
</tbody>
</table>

List of components:

- $C_1 = 4$ to 40 pF film dielectric trimmer (cat. no. 2222 809 07008)
- $C_2 = C_9 = C_{10} = 7$ to 100 pF film dielectric trimmer (cat. no. 2222 809 07015)
- $C_3 = C_8 = 22 \, \text{pF ceramic capacitor (500 V)}$
- $C_4 = 4 \times 82 \, \text{pF ceramic capacitors in parallel (500 V)}$
- $C_5 = 390 \, \text{pF polystyrene capacitor}$
- $C_6 = 220 \, \text{nF polyester capacitor}$
- $C_{7a} = 2 \times 10 \, \text{pF ceramic capacitors in parallel (500 V)}$
- $C_{7b} = 2 \times 8.2 \, \text{pF ceramic capacitors in parallel (500 V)}$
- $L_1 = 25 \, \text{nH; 2 turns Cu wire (1.6 mm); int. dia. 5.0 mm; length 4.6 mm; leads 2 \times 5 \, \text{mm}}$
- $L_2 = L_5 = 2.4 \, \text{nH; strip (12 mm x 6 mm); tap for L4 and L6 at 5 mm from transistor}$
- $L_3 = L_7 = \text{Ferroxcube wide-band h.f. choke, grade 3B (cat. no. 4312 020 36640)}$
- $L_4 = 100 \, \text{nH; 7 turns closely wound enamelled Cu wire (0.5 mm); int. dia. 3 mm; leads 2 \times 5 \, \text{mm}}$
- $L_6 = 46 \, \text{nH; 2 turns Cu wire (2.0 mm); int. dia. 9.0 mm; length 6.0 mm; leads 2 \times 5 \, \text{mm}}$
- $L_8 = 44 \, \text{nH; 2 turns Cu wire (2.0 mm); int. dia. 9.0 mm; length 6.7 mm; leads 2 \times 5 \, \text{mm}}$
- $L_2$ and $L_5$ are strips on a double Cu-clad printed-circuit board with epoxy fibre-glass dielectric.
- $R_1 = 10 \, \Omega \, (\pm 10\%)$ carbon resistor
- $R_2 = 10 \, \Omega \, (\pm 10\%)$ carbon resistor

Component layout and printed-circuit board for 87.5 MHz test circuit are shown in Fig.17.
The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallized to serve as earth. Earth connections are made by means of hollow rivets, whilst under the emitter leads Cu straps are used for a direct contact between upper and lower sheets.

Fig.17  Component layout and printed-circuit board for 87.5 MHz test circuit.
Fig. 18  $V_{CE} = 28$ V; $f = 87.5$ MHz; $T_h = 25$ °C.

Fig. 19  $V_{CE} = 28$ V; $f = 87.5$ MHz; $T_h = 25$ °C; typical values.

The graph shows the permissible output power under nominal conditions (VSWR = 1) as a function of the expected VSWR during short-time mismatch conditions with heatsink temperatures as parameter.

Fig. 20  R.F. SOAR; c.w. class-B operation; $f = 87.5$ MHz; $V_{CE} = 28$ V; $R_{th mb-h} = 0.2$ K/W.
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**Fig. 21** $V_{CE} = 28$ V; $P_L = 130$ W; $T_h = 25$ °C; typical values.

**Fig. 22** $V_{CE} = 28$ V; $P_L = 130$ W; $T_h = 25$ °C; typical values.

**Fig. 23** $V_{CE} = 28$ V; $P_L = 130$ W; $T_h = 25$ °C.
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PACKAGE OUTLINE

Flanged ceramic package; 2 mounting holes; 4 leads  SOT121B

DIMENSIONS (millimetre dimensions are derived from the original inch dimensions)

<table>
<thead>
<tr>
<th>UNIT</th>
<th>A</th>
<th>b</th>
<th>c</th>
<th>D</th>
<th>D1</th>
<th>F</th>
<th>H</th>
<th>L</th>
<th>p</th>
<th>Q</th>
<th>q</th>
<th>U1</th>
<th>U2</th>
<th>U3</th>
<th>W1</th>
<th>W2</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>7.27</td>
<td>5.82</td>
<td>0.16</td>
<td>12.68</td>
<td>12.83</td>
<td>2.67</td>
<td>28.45</td>
<td>7.93</td>
<td>3.30</td>
<td>4.45</td>
<td>18.42</td>
<td>24.90</td>
<td>24.63</td>
<td>12.32</td>
<td>0.51</td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>inches</td>
<td>0.286</td>
<td>0.229</td>
<td>0.006</td>
<td>0.506</td>
<td>0.505</td>
<td>0.105</td>
<td>1.120</td>
<td>0.312</td>
<td>0.130</td>
<td>0.175</td>
<td>0.725</td>
<td>0.98</td>
<td>0.255</td>
<td>0.485</td>
<td>0.02</td>
<td>0.04</td>
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</tr>
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OUTLINE  VERSION  REFERENCES  EUROPEAN  PROJECTION  ISSUE DATE

| SOT121B | IEC | JEDEC | EIAJ | EU | 97-06-28 |
DEFINITIONS

**Data Sheet Status**

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective specification</td>
<td>This data sheet contains target or goal specifications for product development.</td>
</tr>
<tr>
<td>Preliminary specification</td>
<td>This data sheet contains preliminary data; supplementary data may be published later.</td>
</tr>
<tr>
<td>Product specification</td>
<td>This data sheet contains final product specifications.</td>
</tr>
</tbody>
</table>

**Limiting values**

Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

**Application information**

Where application information is given, it is advisory and does not form part of the specification.

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.