U.H.F./V.H.F. POWER TRANSISTOR

N-P-N silicon transistor for use in class-B and C operated mobile, industrial and military transmitters with a supply voltage of 13.8 V.
It has a capstan envelope with a moulded cap. All leads are isolated from the stud.

QUICK REFERENCE DATA

R.F. performance up to $T_h = 25 \degree C$ in an unneutralized common-emitter class-B circuit

<table>
<thead>
<tr>
<th>mode of operation</th>
<th>$V_{CE}$ (V)</th>
<th>$f$ (MHz)</th>
<th>$P_S$ (W)</th>
<th>$P_L$ (W)</th>
<th>$I_C$ (A)</th>
<th>$G_P$ (dB)</th>
<th>$\eta$ (%)</th>
<th>$\overline{I}$ (Ω)</th>
<th>$\overline{V}$ (mS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>c.w.</td>
<td>13.8</td>
<td>470</td>
<td>typ. 0.19</td>
<td>1.5</td>
<td>typ. 0.17</td>
<td>typ. 10</td>
<td>typ. 65</td>
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<td>typ. 0.28</td>
<td>typ. 9.3</td>
<td>typ. 79</td>
<td>2.9 + j5.1</td>
<td>27 – j21</td>
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<td>c.w.</td>
<td>12.5</td>
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<td>&lt; 0.35</td>
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<td>&gt; 65</td>
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<td>typ. 0.03</td>
<td>3.0</td>
<td>typ. 0.29</td>
<td>typ. 20</td>
<td>typ. 84</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-48/3

Torque on nut: min. 0.75 Nm (7.5 kg cm) max. 0.85 Nm (8.5 kg cm)

Diameter of clearance hole in heatsink: max. 4.2 mm.
Mounting hole to have no burrs at either end.
Deburring must leave surface flat; do not chamfer or countersink either end of hole.

When locking is required an adhesive is preferred instead of a lock washer.

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.

3565 C-04 August 1986
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter) peak value
Collector-emitter voltage ($R_{BE} = 0$) peak value
Collector-emitter voltage (open base)
Emitter-base voltage (open collector)
Collector current (average)
Collector current (peak value) $f > 1$ MHz
Total power dissipation up to $T_h = 90^\circ$C
$f > 10$ MHz
Storage temperature
Junction temperature

THERMAL RESISTANCE
From junction to mounting base
From mounting base to heatsink

$V_{CBOM\ max.} = 36$ V
$V_{CESM\ max.} = 36$ V
$V_{CEO\ max.} = 18$ V
$V_{EBO\ max.} = 4$ V
$I_{C(\ AV)}\ max. = 0.7$ A
$I_{CM\ max.} = 2.0$ A
$P_{tot\ max.} = 4.5$ W
$T_{stg} = -65$ to $+150$ $^\circ$C
$T_J\ max. = 150$ $^\circ$C

$R_{th\ j-mb} = 12$ K/W
$R_{th\ mb-h} = 0.6$ K/W
**CHARACTERISTICS**

Breakdown voltages

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-base voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>open emitter, $I_C = 10$ mA</td>
<td>$V_{(BR)CBO}$</td>
<td>$&gt; 36$ V</td>
</tr>
<tr>
<td>Collector-emitter voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{BE} = 0$; $I_C = 10$ mA</td>
<td>$V_{(BR)CES}$</td>
<td>$&gt; 36$ V</td>
</tr>
<tr>
<td>Collector-emitter voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>open base, $I_C = 25$ mA</td>
<td>$V_{(BR)CBO}$</td>
<td>$&gt; 18$ V</td>
</tr>
<tr>
<td>Emitter-base voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>open collector, $I_B = 1.0$ mA</td>
<td>$V_{(BR)EBO}$</td>
<td>$&gt; 4$ V</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_C = 100$ mA; $I_B = 20$ mA</td>
<td>$V_{CEsat}$</td>
<td>typ. $0.1$ V</td>
</tr>
<tr>
<td>D.C. current gain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_C = 100$ mA; $V_{CB} = 5$ V</td>
<td>$h_{FE}$</td>
<td>typ. $10$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>typ. $40$</td>
</tr>
<tr>
<td>Transition frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_C = 0.2$ A; $V_{CB} = 5$ V; $f = 500$ MHz</td>
<td>$f_T$</td>
<td>typ. $1400$ MHz</td>
</tr>
<tr>
<td>Collector capacitance at $f = 1$ MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_B = I_C = 0$; $V_{CB} = 10$ V</td>
<td>$C_C$</td>
<td>typ. $6.5$ pF</td>
</tr>
<tr>
<td>Feedback capacitance at $f = 1$ MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_C = 20$ mA; $V_{CB} = 10$ V</td>
<td>$C_{re}$</td>
<td>typ. $4.8$ pF</td>
</tr>
<tr>
<td>Collector-stud capacitance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$C_{cs}$</td>
<td>typ. $2$ pF</td>
</tr>
</tbody>
</table>

$T_j = 25$ °C unless otherwise specified.
APPLICATION INFORMATION

$T_J = 25 \, ^\circ\text{C}$ unless otherwise specified

R.F. performance in c.w. operation (unneutralized common-emitter class B circuit)

$T_h$ up to $25 \, ^\circ\text{C}$

<table>
<thead>
<tr>
<th>$f$ (MHz)</th>
<th>$V_{CC}$ (V)</th>
<th>$P_S$ (W)</th>
<th>$P_L$ (W)</th>
<th>$I_C$ (A)</th>
<th>$C_p$ (dB)</th>
<th>$\eta$ (%)</th>
<th>$Z_L$ (Ω)</th>
<th>$V_L$ (mS)</th>
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<tr>
<td>470</td>
<td>13.8 typ. 0.15</td>
<td>1.5 typ. 0.17</td>
<td>1 typ. 10</td>
<td>typ. 65</td>
<td>-</td>
<td>-</td>
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<td>13.8 typ. 0.35</td>
<td>3.0 typ. 0.28</td>
<td>3 typ. 12</td>
<td>typ. 79</td>
<td>2.9 + j51</td>
<td>27 - j21</td>
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<td>&gt; 8.5</td>
<td>65</td>
<td>-</td>
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Test circuit 1 (470 MHz)

$C_1 = C_2 = C_6 = C_7 = 1.8$ to $18 \, \mu\text{F}$ film dielectric trimmer
$C_3 = C_4 =$ 18 $\mu\text{F}$ disc ceramic capacitor
$C_5 =$ 4 $\text{nF}$ feed-through capacitor
$C_8 =$ 0.1 $\mu\text{F}$ polyester capacitor
$L_1 =$ 1 turn Cu wire (1.2 mm); int. diam. 6 mm; max. lead length 1 mm
$L_2 =$ 1 $\mu\text{H}$ choke
$L_3 =$ 30 mm straight Cu wire (2 mm); height above print 2 mm
$L_4 =$ 2 turns closely wound Cu wire (0.5 mm); int. diam. 3 mm; max. lead length 8 mm
$R =$ 10 $\Omega$ carbon

At $P_L = 2.5$ W and $V_{CC} = 12.5$ V, the output power at heatsink temperatures between 25 $^\circ\text{C}$ and 90 $^\circ\text{C}$ relative to that at 25 $^\circ\text{C}$ is diminished by typ. 5 mW/K

The transistor is designed to withstand full load mismatch in the test circuit under the following conditions: $V_{CC} = 16.5$ V; $f = 470$ MHz; $T_h = 70$ $^\circ\text{C}$;
V.S.W.R. = 50 : 1 through all phases; $P_S = P_{Nom} + 20 \%$
where $P_{Nom} = P_S$ for 2.5 W transistor output into 50 $\Omega$ load and $V_{CC} = 13.8$ V

3570 c-09

860 May 1974
APPLICATION INFORMATION (continued)

Component lay-out and printed circuit board for 470 MHz test circuit.

Shaded area copper
Back area completely copper clad.
Material of printed circuit board: 1.5 mm epoxy fibre glass.
Conditions for R.F. SOAR

\[ f = 470 \text{ MHz} \]
\[ T_h = 70 \text{ °C} \]
\[ V_{CC\text{nom}} = 13.8 \text{ V} \]

The transistor was developed for use with unstabilized supply voltage \( V_{CC} \).
The above graph is based on its measured performance in test circuit 1.
Supply voltage was varied from \( V_{CC\text{nom}} \) to 1.2 \( V_{CC\text{nom}} \), and VSWR from 1 to 50.
It shows the max. permissible output power under nominal conditions in order not to exceed the max. permissible power dissipation under conditions of supply over-voltage
\( (V_{CC} > V_{CC\text{nom}}) \) and load mismatch (VSWR > 1).
It is assumed that the drive power increases linearly with the supply voltage; i.e.
\[ P_S/P_{SNom} = V_{CC}/V_{CC\text{nom}} \]
APPLICATION INFORMATION (continued)

Test circuit II (175 MHz)

\[ \text{C1} = \text{C3} = \text{C4} = 30 \text{ pF concentric air trimmer} \]
\[ \text{C2} = 60 \text{ pF concentric air trimmer} \]
\[ \text{C5} = 0.25 \mu\text{F ceramic capacitor} \]
\[ \text{C6} = 4 \text{ nF polyester capacitor} \]

\[ \text{L1} = 25 \text{ mm straight Cu wire (1.2 mm); height above print max. 3 mm} \]
\[ \text{L2 = 3 turns closely wound Cu wire (1.2 mm); int. diam. 10 mm; lead length 5 mm} \]
\[ \text{L3 = 2 turns closely wound Cu wire (1.7 mm); int. diam. 12 mm; lead length 5 mm} \]

\[ \text{R1} = 50 \Omega \text{ carbon} \]
\[ \text{R2} = 1.2 \text{ k}\Omega \text{ carbon} \]
\[ \text{R3} = 5 \Omega \text{ carbon} \]
APPLICATION INFORMATION (continued)

Component lay-out and printed circuit board for 175MHz test circuit.

Shaded area copper
Back area not metalized
Material of pcb : 1.5 mm epoxy fibre glass
OPERATING NOTE: Below 200 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for both d.c. and r.f.

![Graph of power gain versus frequency (class B operation)](image1)

- $V_{CC} = 13.8$ V
- $P_L = 3$ W
- $T_h = 25$ °C
- Typ. values

![Graph of input impedance (series components) versus frequency (class B operation)](image2)

- $V_{CC} = 13.8$ V
- $P_L = 3$ W
- $T_h = 25$ °C
- Typ. values

![Graph of load impedance (parallel components) versus frequency (class B operation)](image3)

- $V_{CC} = 13.8$ V
- $P_L = 3$ W
- $T_h = 25$ °C
- Typ. values